

An Introduction to a Top Down Design Process

Agenda

***LaBudde
Systems, Inc***

- Why You Should Be Concerned
 - » Problems With Product Development
- Introduction to a Systems Approach
 - » What Engineers Should Do
- The Three Pillars of Management
 - » Project Leadership
- The Three Levels of Abstraction
 - » Decomposing Designs
- Graphical Specifications
 - » Better Than Natural Language Documents
- The Experiment
 - » Need for Volunteers

Why You Should Be Concerned

***LaBudde
Systems, Inc***

- Customer Unhappiness Eventually Leads to Regulation
 - » Human Safety Problems Accelerate the Process
- Quality Movements Now Enforce “Design Controls”
 - » ISO-9000
 - » FDA CGMP
- Safety Critical Software Will Be Next
 - » IEEE-USA PACE Conference 1998
 - » PE for Software Engineering

Development Stress Creates Product Risks

***LaBudde
Systems, Inc***

- Development Projects Are Subject to Numerous **Constraints**
 - » Cost
 - » Schedule
 - » Time-to-Market
 - » Technology Limitations
- **Unforeseen** Problems Compromise Product Quality
 - » Surprises Create Opportunities for Confusion
- Lack of **Visibility** on Impacts of Key Decisions Promote Disaster
 - » “It sounded like a good idea at the time...”

Bad Management Causes Problems

***LaBudde
Systems, Inc***

- Many Projects Are **Behind** Schedule/Over Budget
 - » Management Dictated Cost/Schedules
 - » Lack of Planning
 - » Failing to Stay on Top of Projects
- Requirements **Creep** Is a Major Source of Project Problems
 - » Especially for Software
- Lack of Good Historical Project Cost **Metrics**

20th Century Engineering Process Problems

***LaBudde
Systems, Inc***

-
- Most Project Management And Planning Methods Are **Activity Based**
 - » Difficult to Maintain in the Presence of Dynamic Changes
 - Most Product Design Tools Are **Bottom up** or Implementation Oriented
 - » Fail to Capture All Requirements
 - Natural Language Specification Methods Are **Ambiguous**
 - » Difficult to Capture Complex Product Behavior

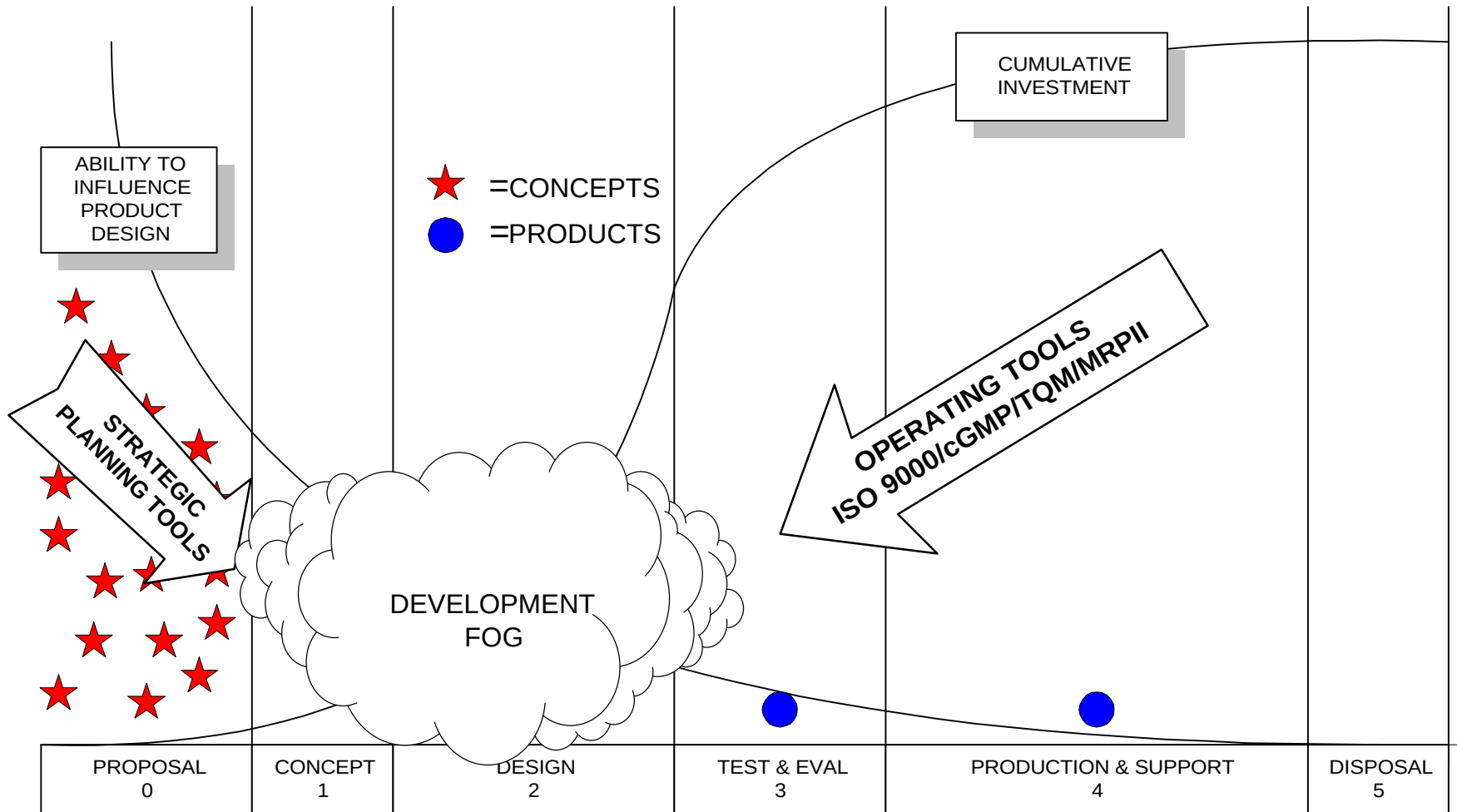
Why Development Continues to Become Harder

***LaBudde
Systems, Inc***

- Lack of a “**Systems**” Approach to Product Development
- **Complexity** of Technology
- **Interdisciplinary** Products
- More **Competition**

The Development Life Cycle

**LaBudde
Systems, Inc**



Why There is a Fog

***LaBudde
Systems, Inc***

Everything Exists Only in the Heads of the Engineers!

- Early Phases Lack **Documentation** Everyone Can Understand
- High Levels of **Abstraction** Are Difficult for Many People to Grasp
- Lack of Clear **Plans** Make Coordination Difficult

Accelerated Product Developmentsm System

INTRODUCTION
TO
A SYSTEMS APPROACH

Definitions

- Science
 - » The Ability to Create **Mathematical Models** of Natural Behavior
- Mathematics
 - » The **Language** of Science
- Engineering
 - » The Ability to **Apply** Science and Mathematics to Solve Problems
 - » Ability to **Model** Designs
 - » Prove It Will Work **Before** It Is Made
- Design
 - » The **Creative** Process Which Defines a Man Made Device
 - » Does Not Necessarily Require **Engineering** Skills

Engineering Definitions

***LaBudde
Systems, Inc***

- Product Architecture
 - » The Process That Leads to the Creation of Documentation Necessary to Define the Product Function, Behavior and Performance **Requirements**

- Design Engineering
 - » The Process That Leads to the Creation of Documentation Necessary to Define How the Product Is **Made**

What Do Engineers Do?

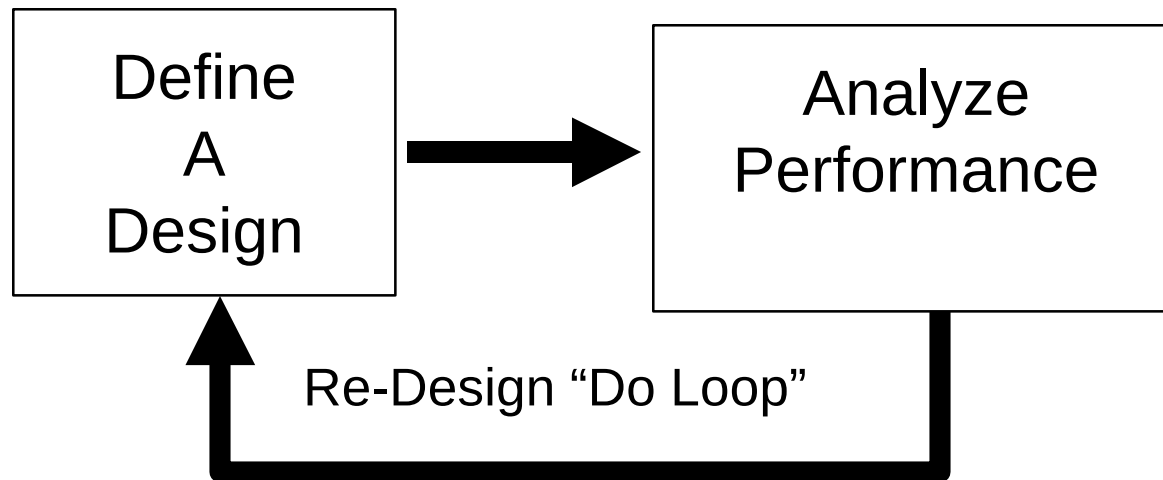
***LaBudde
Systems, Inc***

- **Use** Science and Mathematics to Solve Problems
- Make **Paper** for Someone **Else** to Use

The Way Engineers Are Taught to Think

***LaBudde
Systems, Inc***

Bottom Up Approach



This Approach Is Also Used
by Many Inventors

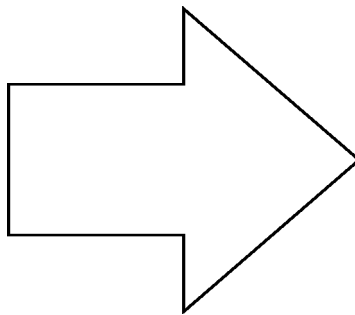
***LaBudde
Systems, Inc***

Inventors Syndrome

Define a Solution



Look for a Problem



The Top Down Approach

***LaBudde
Systems, Inc***

- Necessity Is the Mother of Invention
- Find a Need and Fill It
- “Never Invent Something Unless You Have a Customer Ready to Buy It”
 - » T.A. Edison
- The Architect Model

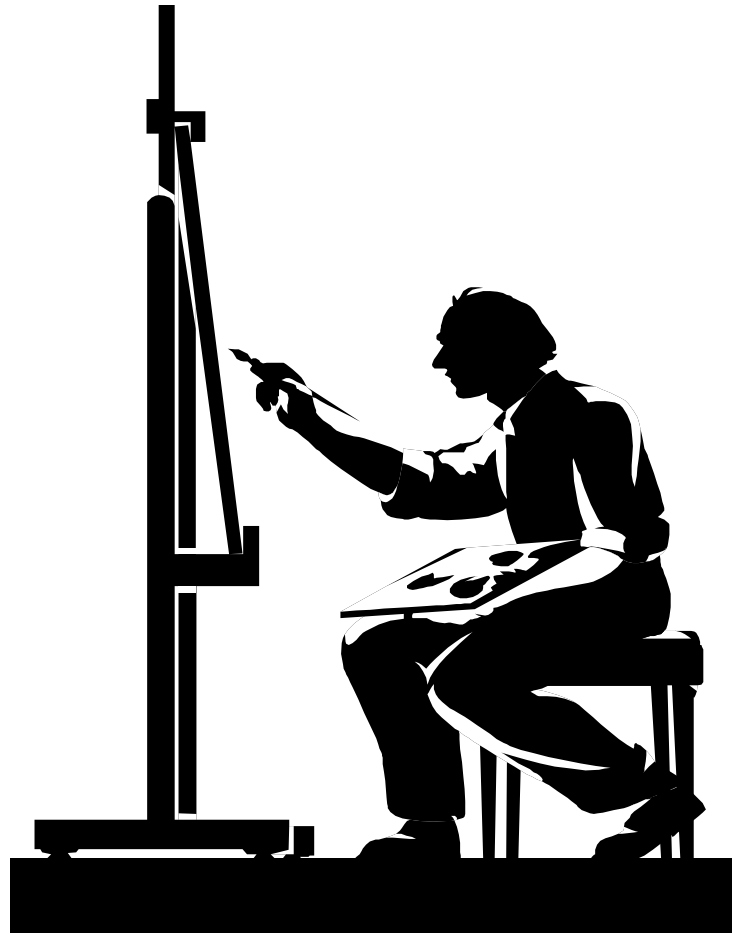
Architects See The Big Picture at the User Level

**LaBudde
Systems, Inc**



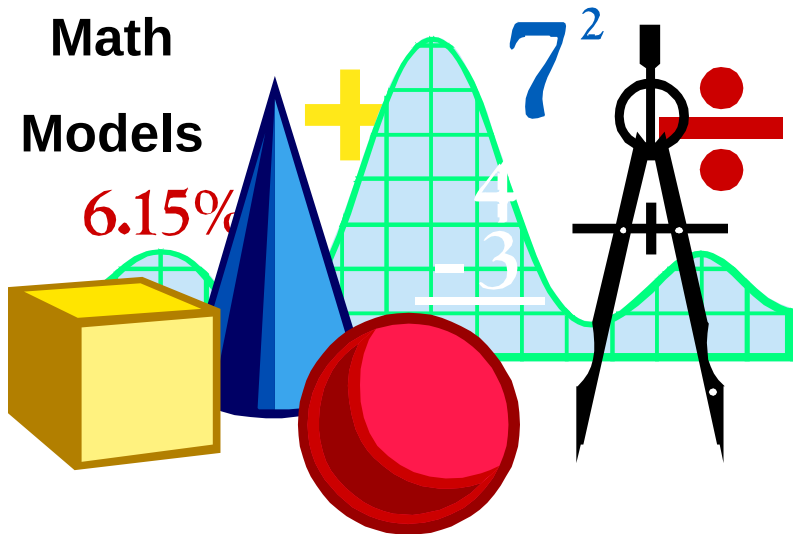
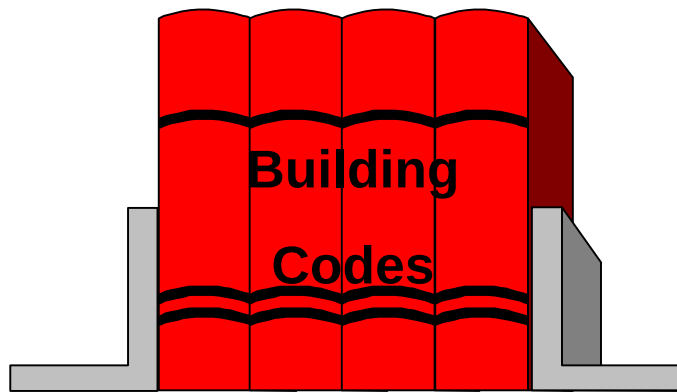
Architect Creates Overall Design Concepts

***LaBudde
Systems, Inc***



Engineers Make It Work

**LaBudde
Systems, Inc**



**Engineering
Calculations**

Architect Shares Plans With Everyone

***LaBudde
Systems, Inc***



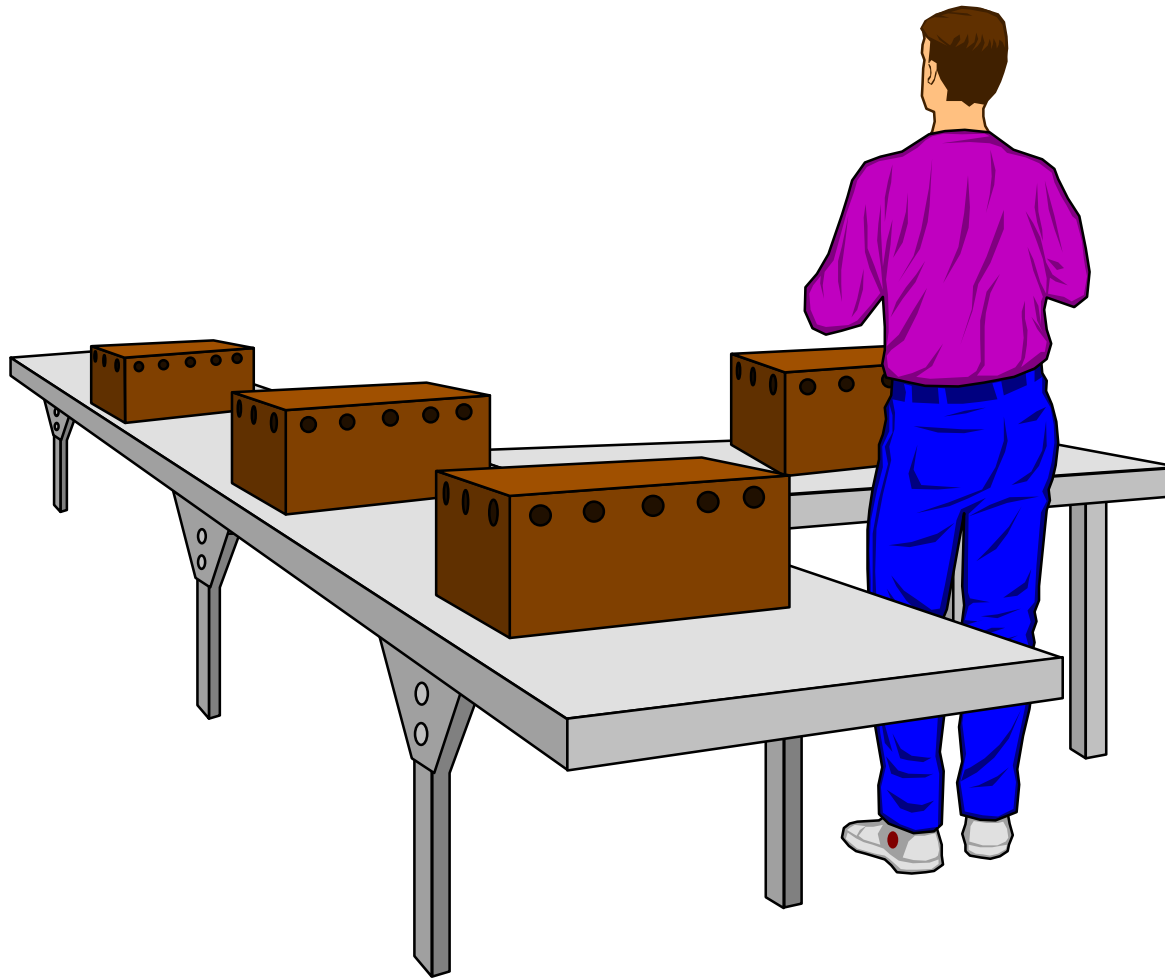
General Contractor Plans And Directs The Job

***LaBudde
Systems, Inc***



Specialists Implement The Design

***LaBudde
Systems, Inc***



Inspectors Check Everything Against The Codes

***LaBudde
Systems, Inc***



The
Result

*LaBudde
Systems, Inc*



A Model for a Solution

***LaBudde
Systems, Inc***

- Architect (Product Architect)
 - » Integrates Function, Esthetics, Performance
- Engineers (Product Analyst)
 - » Designs Structures to Meet Codes
- **A Single Set of Plans Can Be Read by Everyone**
- General Contractor (Project Manager)
 - » Plans and Executes Job
- Specialists (Design Engineers) Build/Install Components
- Inspectors (Test Engineers) Check Each Step Against Codes

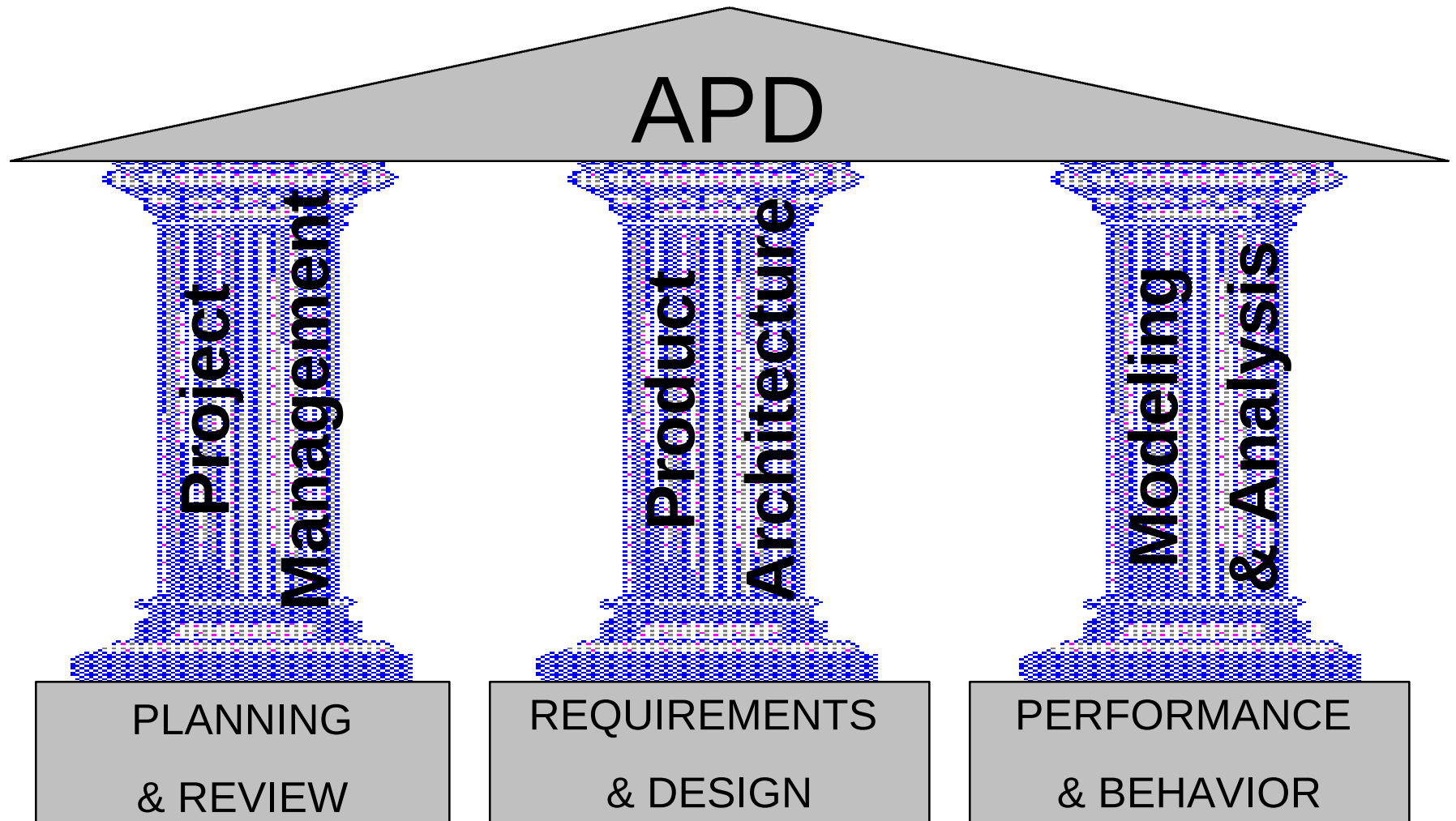
Marketing Interface

***LaBudde
Systems, Inc***

- The Architect Model Works Well If There Is a **Customer** to Talk to
 - » Contract Development Work
- Private Venture Development Work Requires a **Surrogate Customer**
 - » Provided by a Joint Effort With Marketing
- Must Define Customer **Characteristics**
 - » Demographics
 - » User Requirements
 - » Customer ROI

APDsm System is Founded on 3 Pillars

**LaBudde
Systems, Inc**



Introduction to the Systems Approach

**LaBudde
Systems, Inc**

PRODUCT DEVELOPMENT MANAGEMENT

PROJECT MANAGEMENT

- COST
- SCHEDULE
- PERFORMANCE



LIFE CYCLE MODELS
PHASE REVIEWS
PRO-FORMA'S
CHECK LISTS
DELIVERABLE ITEMS
RISK ANALYSIS

PRODUCT ARCHITECT

- FLOW DOWN
- PARTITION
- INTEGRATION
- VERIFICATION



REQUIREMENTS ANALYSIS
REQUIREMENTS MANAGEMENT
TRADE OFF STUDIES
DESIGN RULES
DESIGN AUTHORITY
RISK ANALYSIS

PRODUCT ANALYSIS

- MODELING
- ANALYSIS
- SIMULATION



MODEL DESCRIPTIONS
MODEL VALIDATION
PERFORMANCE ANALYSIS
TOLERANCE STUDIES
CONFIDENCE LEVELS
BEHAVIOR SIMULATION

Management Visibility and Control

***LaBudde
Systems, Inc***

- Provides Management with Better **Visibility and Control**
- Life Cycle Planning Templates for **Rapid** Planning and Estimating
- Integrates All **Organizations** Into the Development Process
- **Reduces** Items That “Fall Through The Cracks”
- Measures Percentage **Completion** Not Just Costs
- Early Visibility on **Risks and Tradeoff's**
- Promotes **Faster** Decision Making
- Simple but **Effective** Documentation and Review Methods
- Facilitates Development Team **Communications**
- **Improves** the Managerial Process

Product Architecture

***LaBudde
Systems, Inc***

- Requires a **Life Cycle View** of the Product
- Makes **Visible** Product Function, Behavior and Performance
- Promotes **Alternatives** and Enhances Creativity
- Gets the Design **Right** the First Time
- Reduces Design **Iterations**
- **Shortens** Design and Testing Time
- Allows **Parallel** Development Processes
- **Reduces** Quantity and Skill Levels During Implementation Phases
- Forces **Integration** of Marketing and Engineering Functions

Modeling and Analysis

***LaBudde
Systems, Inc***

- **Validates** Requirements
- Proves Product Will **Work** Before It Is Made
- **Reduces** Test and Evaluation Time and Cost
- Verifies Production Design **Margins**
- Verifies and Validates Designs Outside the **Testable Envelope**
- Reduces Time to **Solve** Production and Quality Problems

How Products Requirements Can Be Modeled

***LaBudde
Systems, Inc***

- Function
 - » What It **Does**
- Behavior
 - » **How** It Does It
- Performance
 - » How **Well** It Achieves Function and Behavior

How Products Can Be Decomposed

***LaBudde
Systems, Inc***

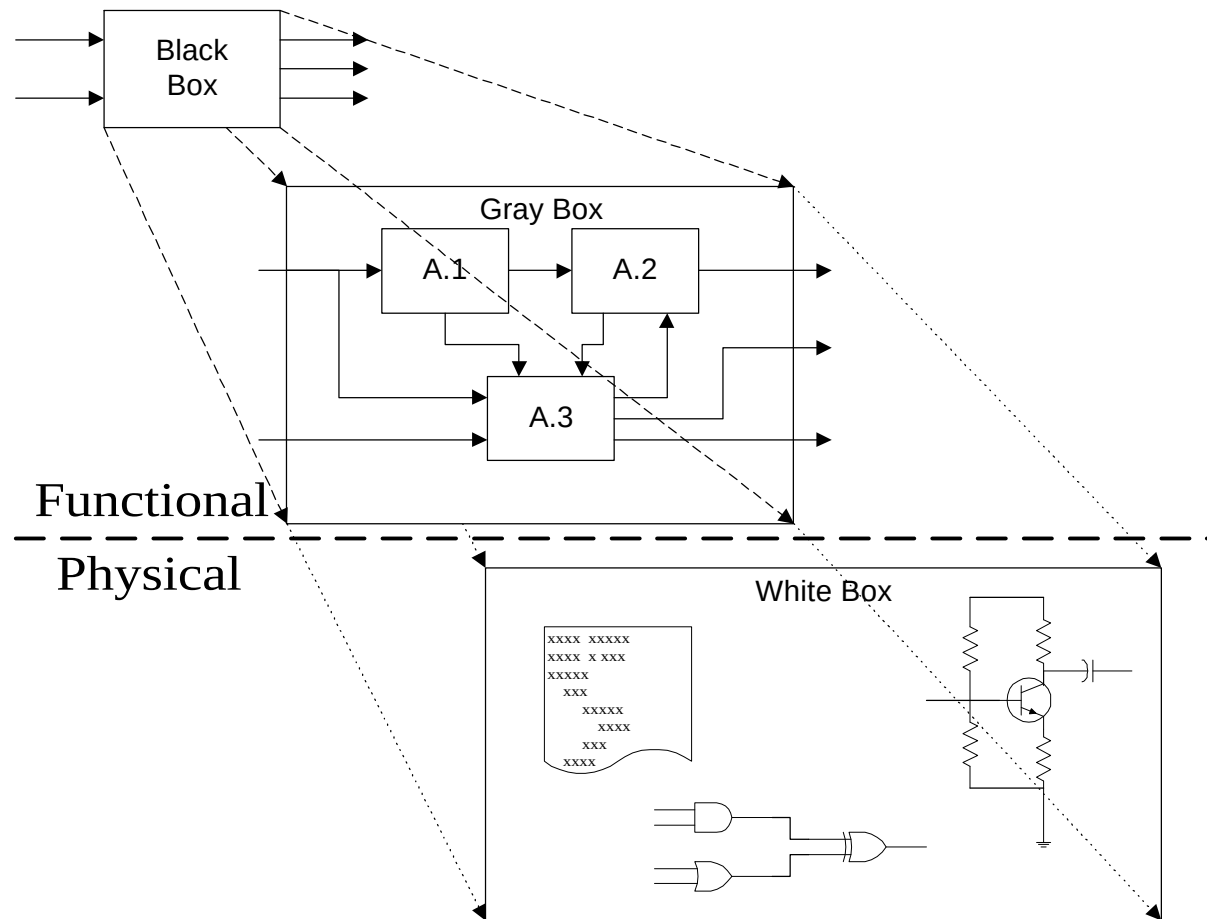
- Black Box
 - » Internal Workings Are **Unknown**
 - » Must Be **Modeled** by External Properties

- Gray Box
 - » Function, Behavior and Performance Can Be **Specified**
 - » **Physical** Implementation May Be Unknown

- White Box
 - » Physical Design Is **Known**
 - » Multiple Functions May Be Implemented by **Same** Physical Objects

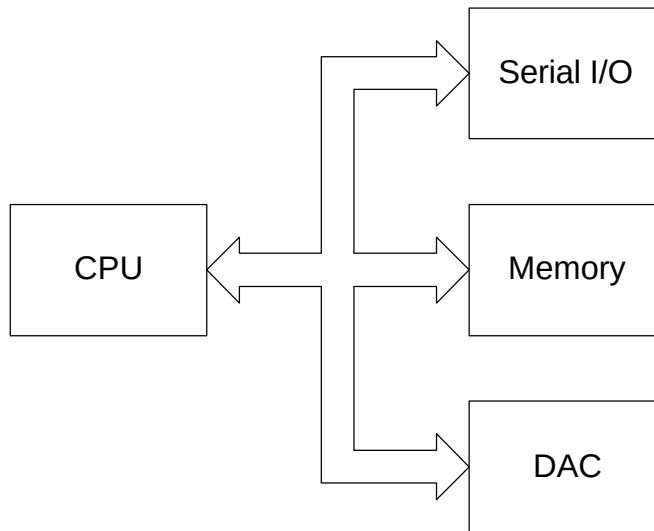
Levels of Abstraction

**LaBudde
Systems, Inc**



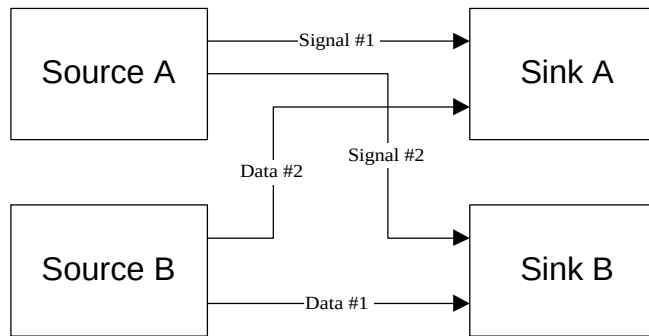
Functional Vs. Physical

**LaBudde
Systems, Inc**



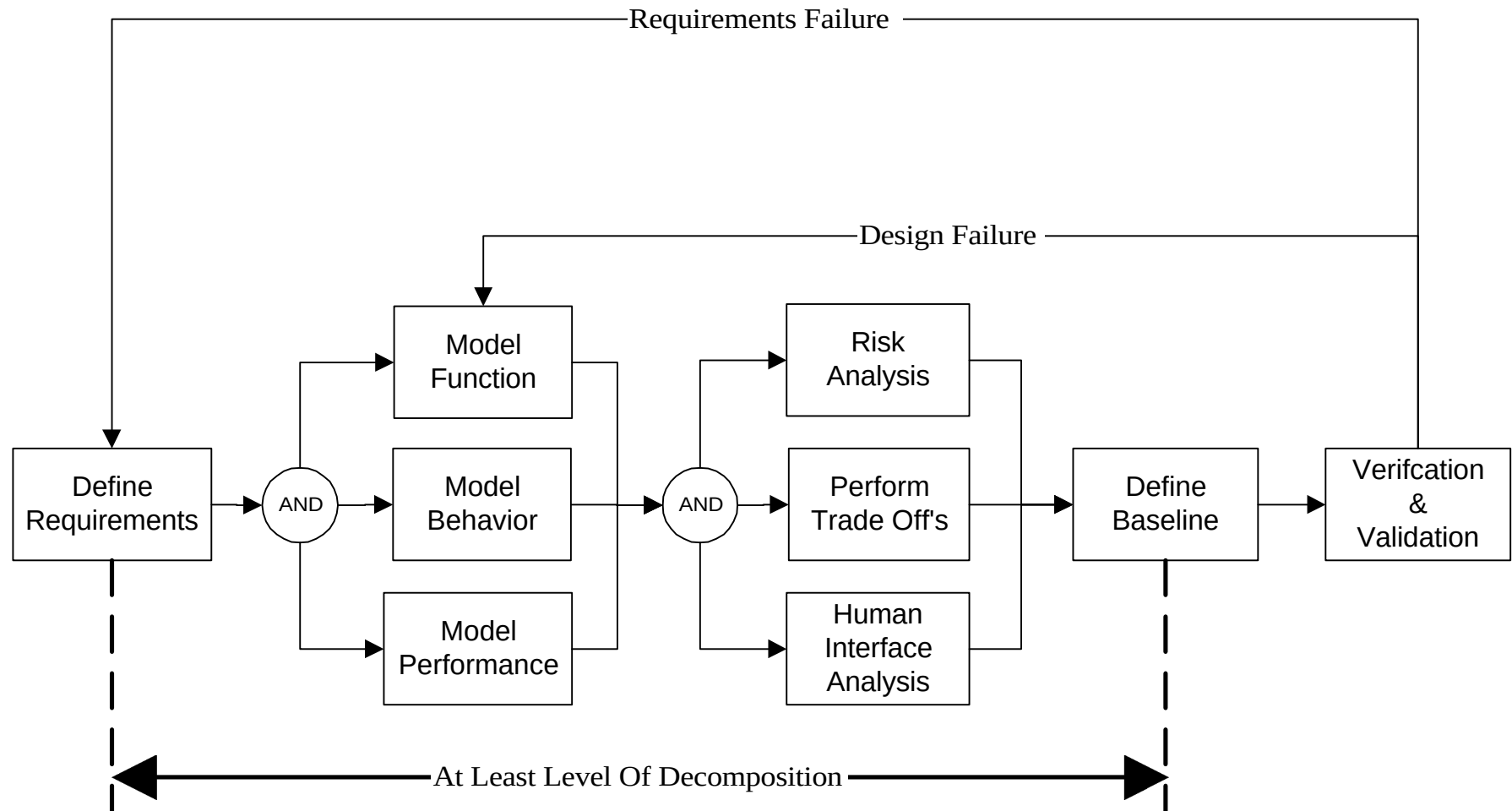
Physical

Functional



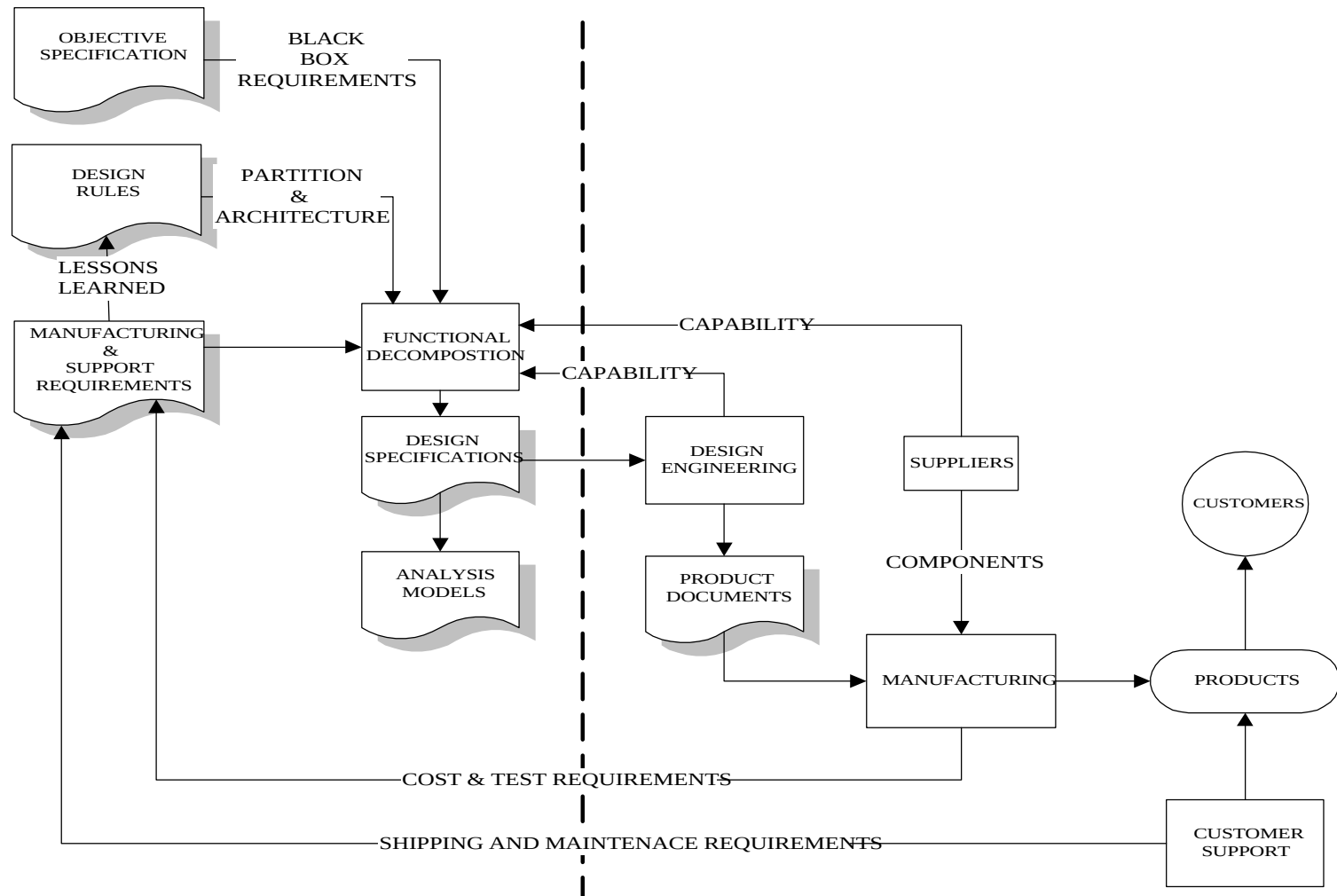
Core Engineering Process

**LaBudde
Systems, Inc**



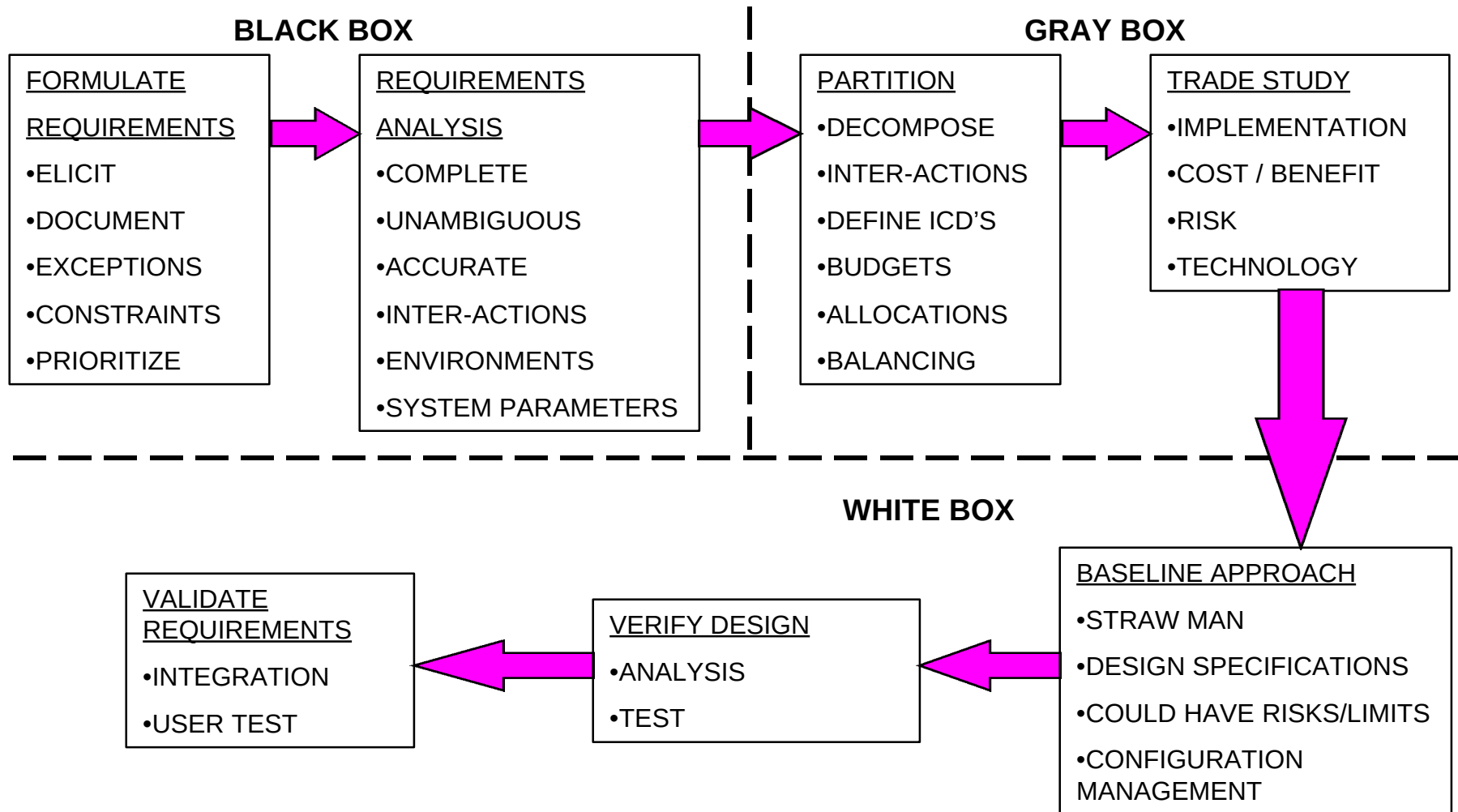
Role of the Product Architect

**LaBudde
Systems, Inc**



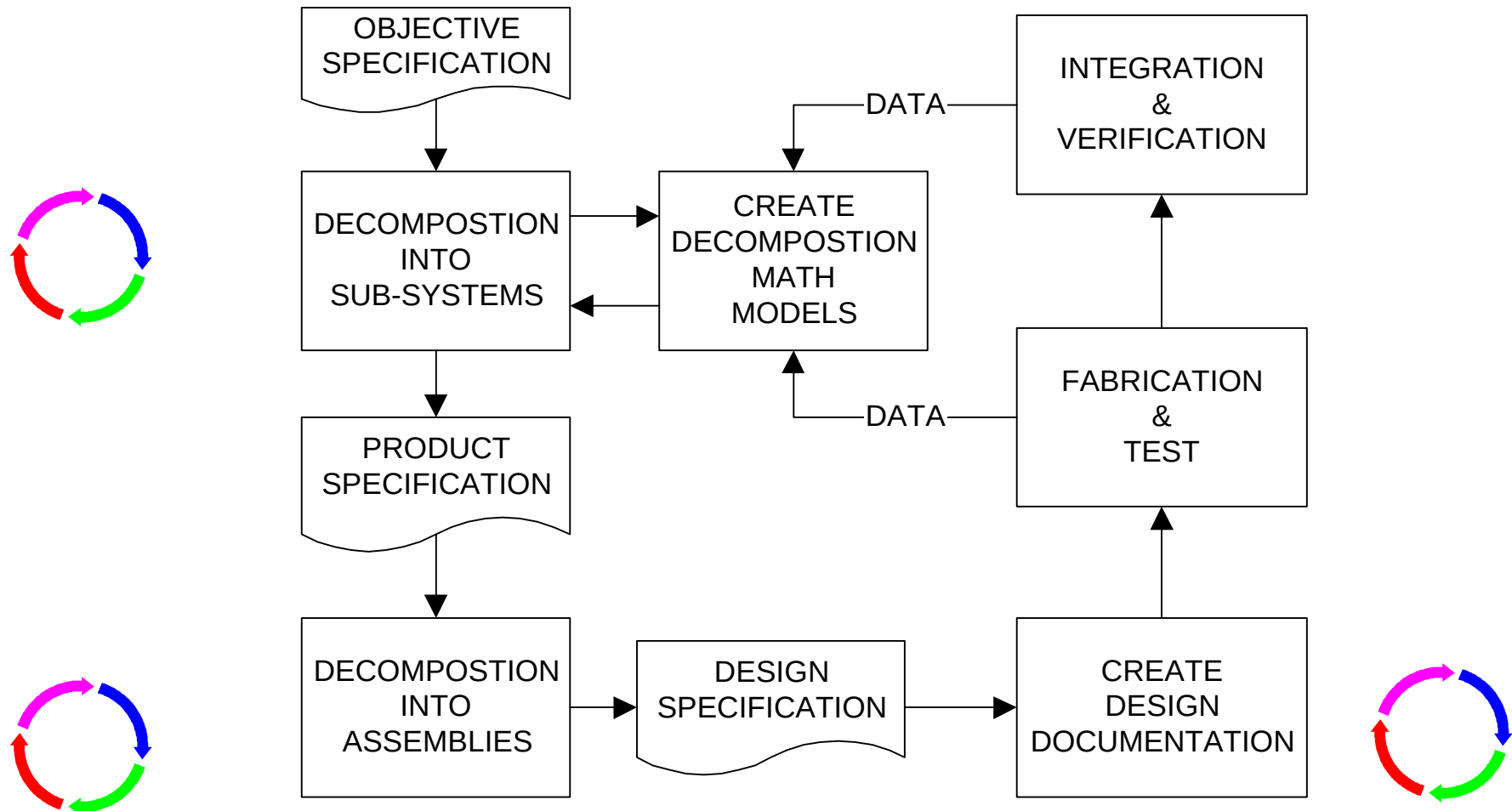
21st Century Product Design Process

**LaBudde
Systems, Inc**



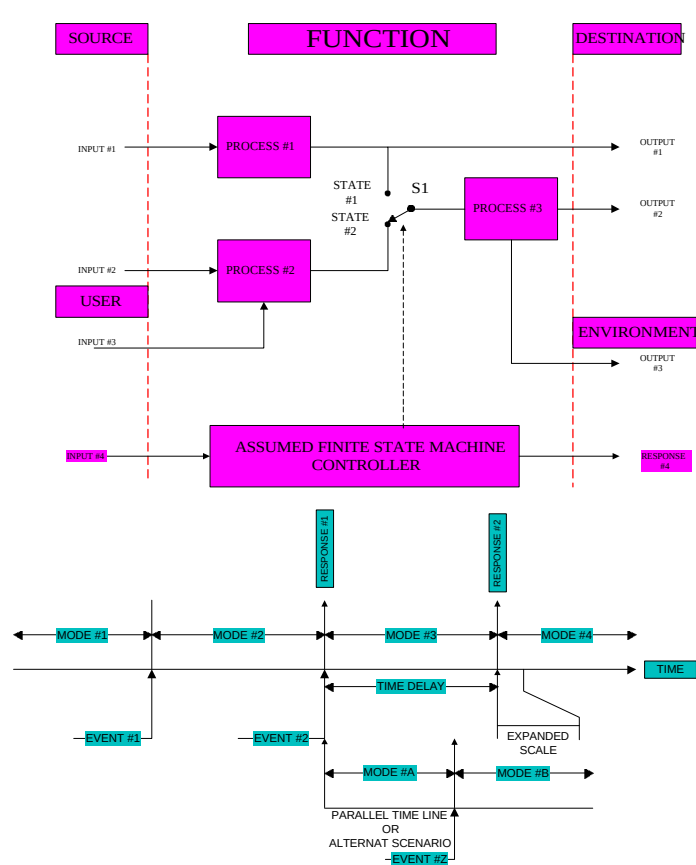
Decomposition Process

**LaBudde
Systems, Inc**

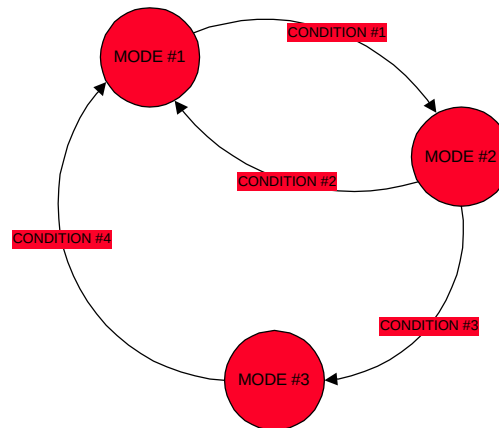


Graphical Description Language*

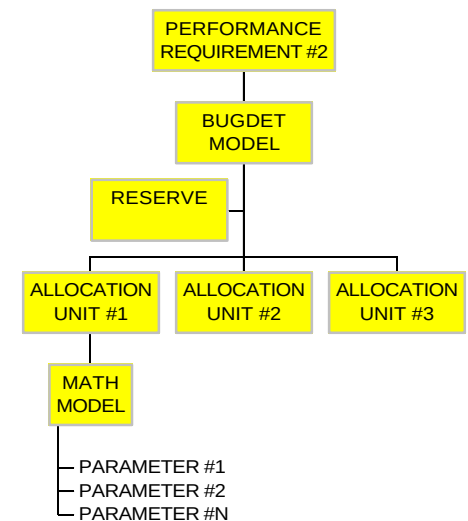
**LaBudde
Systems, Inc**



MODE	OUTPUTS		
	OUTPUT #1	OUTPUT #2	OUTPUT #3
MODE #1	OFF	OPERATE	FAIL
MODE #2	TEST	OFF	OPEN
MODE #3	NORMAL	OPERATE	CLOSE
MODE #4	BYPASS	LATCHED	OPEN



PERFORMANCE TREES



* TM LaBudde Systems, Inc. *Graphical Description Language: A Solution to the System-Software Interface Problem.* INCOSE 1996

The Benefits

***LaBudde
Systems, Inc***

- **Reduced Risk**
 - » Know It Will Work Before It's Built
 - » Find and Solve Problems on Paper
 - Not in the Lab, Factory Floor, or the Field
- **High Quality** Products
 - » Meets All the Requirements
 - » Fewer Design Flaws
 - » Easier to Produce
 - » Easier to Maintain
- **Better Competitive** Position
 - » Time-to-Market
 - » Product Cost
 - » Product Performance

Qualities of a Good Project Manager

***LaBudde
Systems, Inc***

- Highly **Goal** Oriented
 - » A Finisher
 - » Expediter
 - » Follow Up
- Good **People** Skills
 - » Negotiator
 - » Empathy
 - » Motivates
 - » Good Communicator
- Well **Organized**
 - » Attention to Details
 - » Foresight

Qualities of a Good Product Architect

***LaBudde
Systems, Inc***

- Broad and **Deep** at the Same Time
 - » Sees the Big Picture
 - » Likes the Details Too
- Good **Technical** Skills
 - » Has Excellent Creative Skills
 - » Mastered at Least Two Disciplines
 - » Understands High Levels of Abstractions
 - » A Good Communicator
- **User** Oriented
 - » Life cycle Oriented
 - » Understands the Application
 - » Focus on the Right Product
 - » Can Take Objective Feedback

Qualities of a Good Product Analyst

***LaBudde
Systems, Inc***

- Strong **Analytical** Orientation
 - » Need for Quantitative Understanding
 - » Uses Analysis to Find and Solve Problems
- Good **Mathematical** Skills
 - » Has Excellent Analytical Skills
 - » Mastered All Engineering Analysis Methods
 - » Uses Automation Tools
- Focused on Getting **Results**
 - » When Good Enough Is Good Enough
 - » A Good Communicator

Best Practices Proposal

***LaBudde
Systems, Inc***

- Embedded Into EE482 Capstone Course
- Essential Elements of the APD™ System
 - » Project Management Life Cycle Model
 - » Risk Management
 - » Trade Off Studies
 - » Performance Analysis and Modeling
 - » Functional Decomposition
 - Graphical Description Language
 - » Memo System
 - » Compliance Matrix

Project Management

***LaBudde
Systems, Inc***

- Product Development Life Cycle Model
 - » Phases, Reviews, Deliverable Items
- Use for Planning the Capstone Project
 - » Status Reporting
- See PHASCNTL.PDF
- Use PROFORMA.XLS

Risk Management

***LaBudde
Systems, Inc***

- Formal Risk Management System
- Requires
 - » Identification of program and technical risks
 - » estimates probability of occurrence and impact
 - » establishes risk mitigation plans
- See RISK.PDF
- Use RISK.XLS

Trade Studies

***LaBudde
Systems, Inc***

- Formal approach to evaluating alternatives
- Requires
 - » Identification of the need for a study
 - » Identifies trade-off criteria
 - » evaluates candidates using quantitative scores
- See TRADE.PDF

Performance Analysis and Modeling

***LaBudde
Systems, Inc***

- Establishing Requirements Using Math Models
- Requires
 - » Flow Down Model of Key System Requirements
 - » Use of Tolerance Bands for Environment and Life
 - » Estimates of Probability of Success
- Math Models and Simulations of Design
- See PERFORM, PARAMETR, ANALYSIS, RODESIGN.PDF
- Use TEMPLAT3.XLS

Functional Decomposition

***LaBudde
Systems, Inc***

- Used for Requirements and Designs
- Requires
 - » Mission Requirements (Black Box)
 - » Functional Design (Gray Box)
 - » Physical Design (White Box)
- Graphical Description Language
 - » Used for Functional Decomposition
 - » Implemented in VISIO
- See FUNCTION, DECOMP, MISSION.PDF
- Use GDL.VST

Memo System

***LaBudde
Systems, Inc***

- Formal Documentation System
- Requires
 - » Use of a Memo Template
 - » Computer Database for Searching Key Words and Abstract
 - » Self Serve Logging of Memo's Into Database
- See MEMO.PDF
- Use MEMOTEMPLATE.DOC, MEMOLOG.XLS

Compliance Matrix

***LaBudde
Systems, Inc***

- Used to Status Requirements
- Requires
 - » Database of All System Requirements
 - » For All Levels of Specifications
 - » Compares Actual to Requirements
 - » Determines Pass/fail of Each Specification
- See COMPLY.PDF
- Use COMPLY.XLS