

PROJECT DEVELOPMENT AND MANAGEMENT: The Challenge of Uncertainties

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ICDRiA

CONTENTS

1. New risks facing a business
2. Goals of Risk Management
3. The role of simulation
4. Project Management and Product Development Processes
5. The Need of Flexibility
6. Real Options
7. Organizational Aspects

New Risks facing a Business

- **Globalization and Societal Changes modify the Economic Activity (Delocalization; New Markets; Services and Systems; New Competitors, ...)**
- **Technical Changes and Complexity are significant sources of uncertainty: Skyrocketing cost of R&D, Finding Competencies,...**
- **External Risks affect the Environment : Energy prices, Natural Hazards, Climate Change**
- **Security is a major concern: Terrorism, Cybersecurity.**

THE UPSIDE OF RISKS

- **Globalization and Technical Progress are sources of opportunities**
- **Companies must take risks to avoid regression**
- **How to limit the downside of risk and improve the odds of success? How to identify opportunities of growth?**
- **Management is shifting from resource allocation, efficiency in production and market performance to assessment and mitigation of risks**

GOALS OF RISK MANAGEMENT

- The process of analyzing exposure to risk, measuring or assessing risk and then developing strategies to adapt to risk exposures
- Includes transferring the risk to another party, avoiding the risk, reducing the negative effects of the risk, and accepting some or all of the consequences of a particular risk
- Minimizes both risk and costs

LIMITS OF RISK MANAGEMENT

- Risk management is a scientific approach that anticipate bad things before they actually happen and reduce the negative effects when they occur
- It is a process of analyzing exposure to risk and then developing strategies to best handle such exposure
- The objective of risk management is first to decide the amount of effort which is worthwhile to reduce uncertainly, by a cost benefit analysis, and then to model the randomness which is structural and the uncertainty which remains after reduction
- Risk management does not actually remove the risk. It just reduces the negative effects when bad things happen

DIFFICULTIES TO DEVELOP RISK MANAGEMENT

- **Obtaining Data**
- **Building an accurate view of risks across the business**
- **Measuring risks**
- **Integrating risks**
- **From Assessment to better decision making.**

THE ROLE OF SIMULATION

- **Most Decisions are based on best expected values of variables: DCF, NPV, Business plans,..**
- **Example of a new product: variables**
 - ✓ **Total market, share of market, promotion expense**
 - ✓ **Selling price, operating cost, investment cost**

THE ROLE OF SIMULATION

- ✓ Based on best estimates, return= 30%
- ✓ If each guess is correct with probability 60%, the estimated return has a probability of less than 5% to be true.
- **Simulation manipulates random variables or probabilities instead of numbers.**

Problems With Project Estimation

- The initial “Best Guess” becomes the official project timescale
- Estimates are ignored or cut in half
- “It can’t be quantified.”
- “How long is a piece of string?”
- “It will take as long as it takes!”

Formal Analytical Methods Used to Quantify Cost Risk

Leads to Problems with Policy Makers and Public

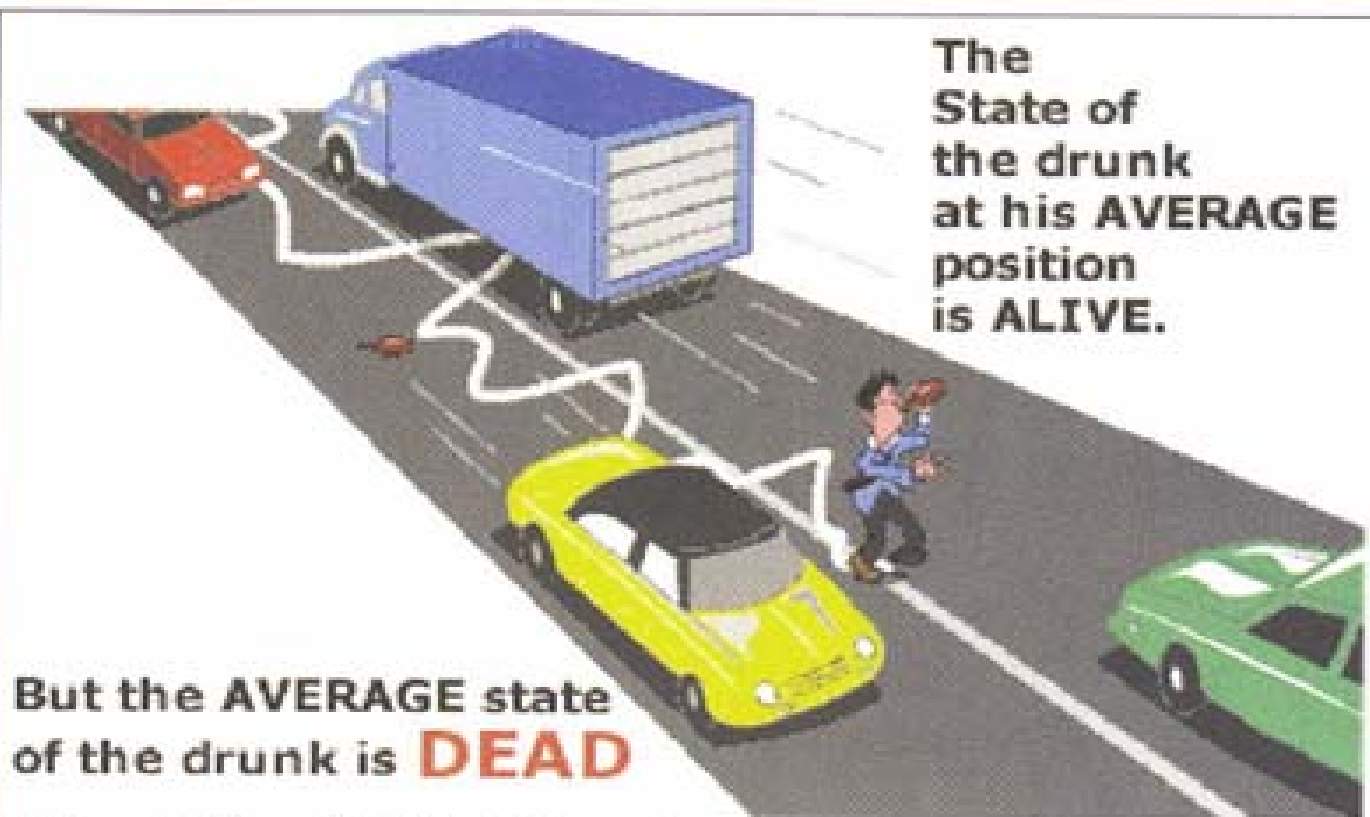
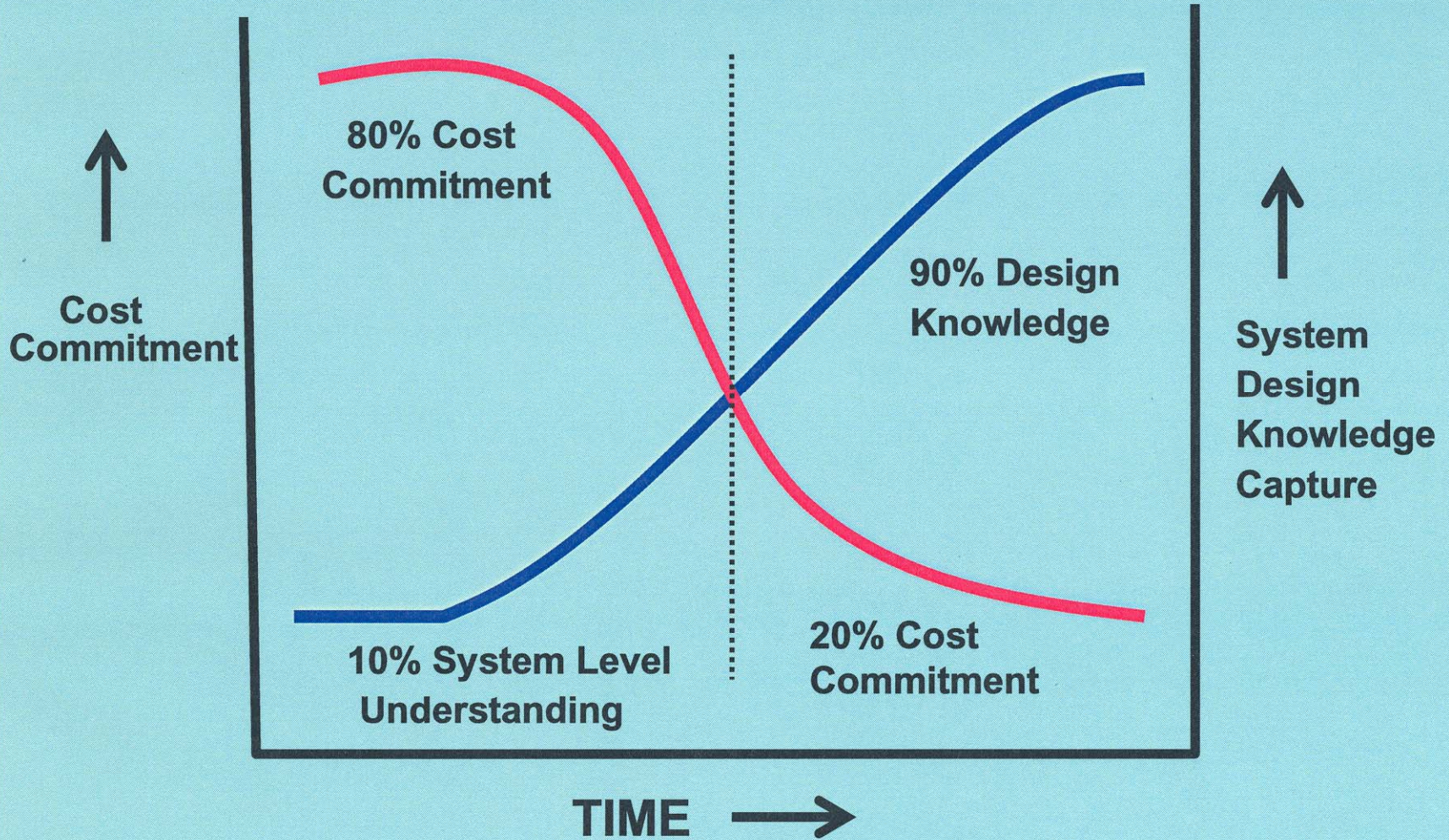


Figure 1: A drunk staggering down the middle of a busy highway illustrates a sobering example of the flaw of averages [9].

PROJECT MANAGEMENT AND PRODUCT DEVELOPMENT PROCESSES

- The challenges are more and more at the design and development phases.
- Risks are technical and managerial (not meeting schedules and costs).
- The issue is to allocate in the best way the resources to projects in order to minimize failures of projects during product development. Tight budgets are a source of risk.
- Decisions trees and optimization techniques are used.

“Design Paradox”



Management Influence on Projects

- 31% of projects will get cancelled before they ever get completed.
- 88% of all projects are over schedule, over budget or both
- For every 100 projects started, there are 94 restarts
- Average cost overrun is 189% of original estimate
- Average time overrun is 222% of original estimate

Why Projects Fail

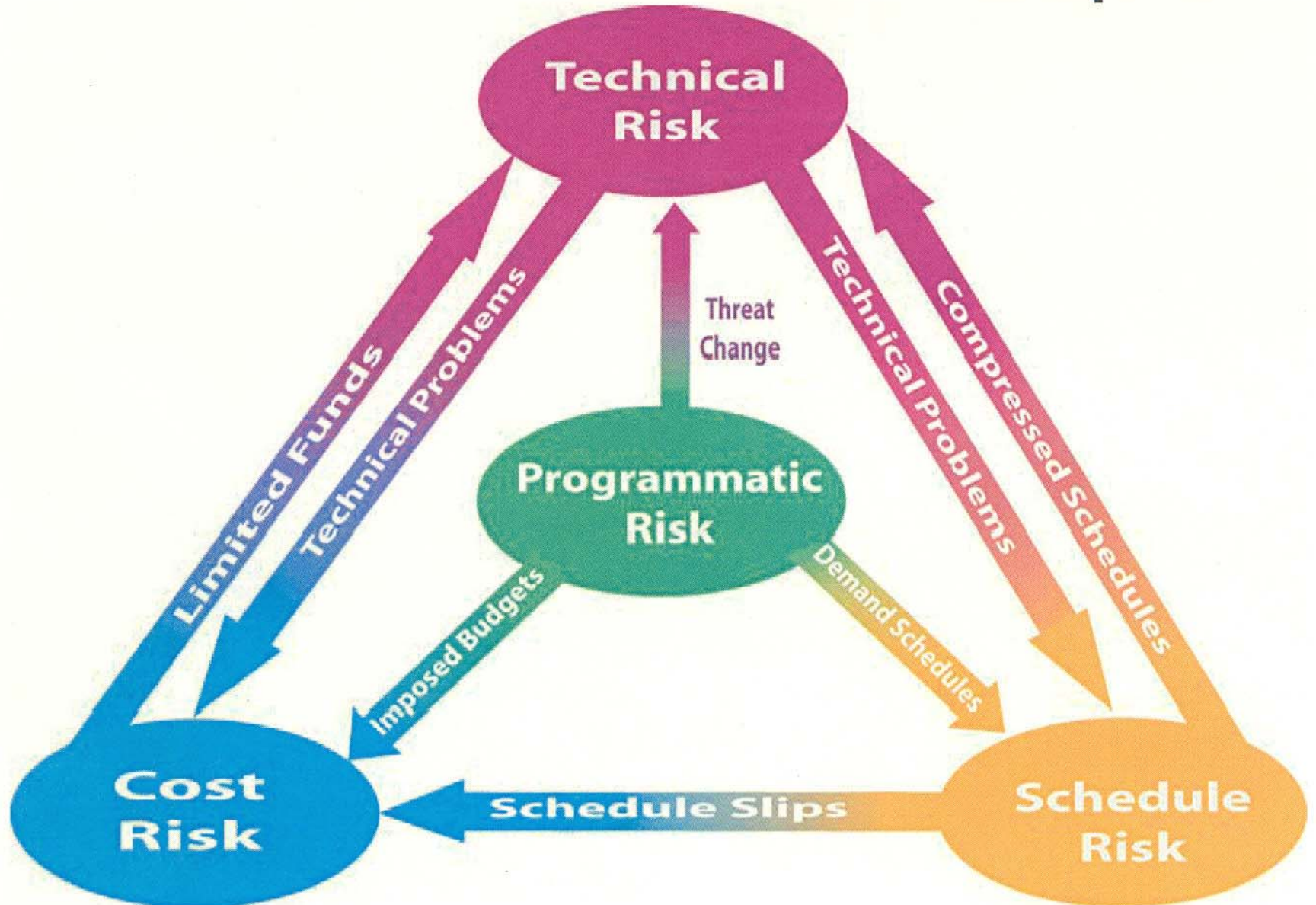
- Incomplete requirements - 13.1%
- Lack of user Involvement - 12.4%
- Lack of resources - 10.6%
- Unreasonable expectations - 9.9%
- No Management support - 9.3%
- Spec changes - 8.7%
- Lack of planning - 8.1%
- No longer needed - 7.5%

Why projects succeed

- User Involvement - 15.9%
- Management support - 13.9%
- Clear requirements - 13%
- Proper planning - 9.6%
- Realistic expectations - 8.2%
- Smaller milestones - 7.7%
- Competent staff - 7.2%
- Ownership - 5.3%

Source: Standish Group

Risk factors are often coupled



TRADITIONAL DEVELOPMENT METHODOLOGY

- **Point-based or “Design-Freeze” approach:**
- Need fast development + Concurrency costs
 - ✓ *Converge early*
- ***Traditional Wisdom:*** Freeze design early to improve the chosen design more & limit costs

TRADITIONAL DEVELOPMENT METHODOLOGY

- **Development Strategy:**
- 1) Lock-in on one alternative as quickly as possible.
- 2) Iterate to improve that alternative.-
 - ✓ Clear focus of design team efforts
 - ✓ Less internal competition, friction, etc
 - ✓ Efficient use of limited resources

THE NEED OF FLEXIBILITY

- To adapt better to uncertainties
 - ✓ More information on economic and technical matters
 - ✓ Benefit from Opportunities.
- NPV (even with simulation) has no flexibility.
- NPV underestimates the value of a project.

TOYOTA DEVELOPMENT METHODOLOGY

Set-based approach:

Uncertain best alternative + High value of quality \rightarrow Converge later

Toyota Wisdom: Delay decisions to improve alternative selection

Development Strategy:

- 1) Develop multiple alternatives (sets) in parallel
- 2) Continuously gather information on alternative attractiveness
- 3) Frequently compare alternatives
- 4) Delay decisions to choose or abandon until relative attractiveness is clearer (as clear as possible)

REAL OPTIONS

- Real options bring to “real” projects and assets what financial options bring to “financial” securities and assets.
- They allow the re-design of investment strategies along two key dimensions, time and scope.
- Postponing costly investments permits one to acquire more information and thus to mitigate “downside” risk in the process.
- Possibility of Abandonment
- The scope dimension introduces a wider array of choices for future decisions.

REAL OPTIONS IN SUPPLY CHAINS

➤ Sales Options

- ✓ Offer a set of product choices to consumers
- ✓ Create consumer value
- ✓ Give information on the demand, reducing risks
- ✓ Postpone procurements
- ✓ Match supply and maximize profit

REAL OPTIONS IN SUPPLY CHAINS

➤ Manufacturing Options

- ✓ **Introduce modularity**
- ✓ **Delay final customization**
- ✓ **Adapt to better demand forecasts**
- ✓ **Replace inventory by careful staging of the manufacturing process**
- ✓ **Use alternative types of capacity or processes adapted to demand**

PROCUREMENT OPTIONS

- Long term contracts and short term flexible contracts
- Use of spot markets; e.g., electronic components, commodities, etc.
- How to build portfolios: Like portfolios of financial investments, the issue is to trade off increase of value (or reductions in cost) with decrease of risk exposure. One can define procurement portfolios, as well as product and services portfolios.
- Contract engineering is needed in the spirit of financial engineering.
- Difficulty: Analysis of costs and risks is much more complex, since the analog of financial markets does not exist or is limited.

ORGANIZATIONAL ASPECTS

➤ CREATIVE RISK MANAGEMENT

- ✓ Lower risks with higher financial returns

➤ New View on Projects:

- ✓ Exceeding targets instead of meeting targets
- ✓ Abandonment and Improvement Options
- ✓ Chasing Opportunities for improvements and growth.

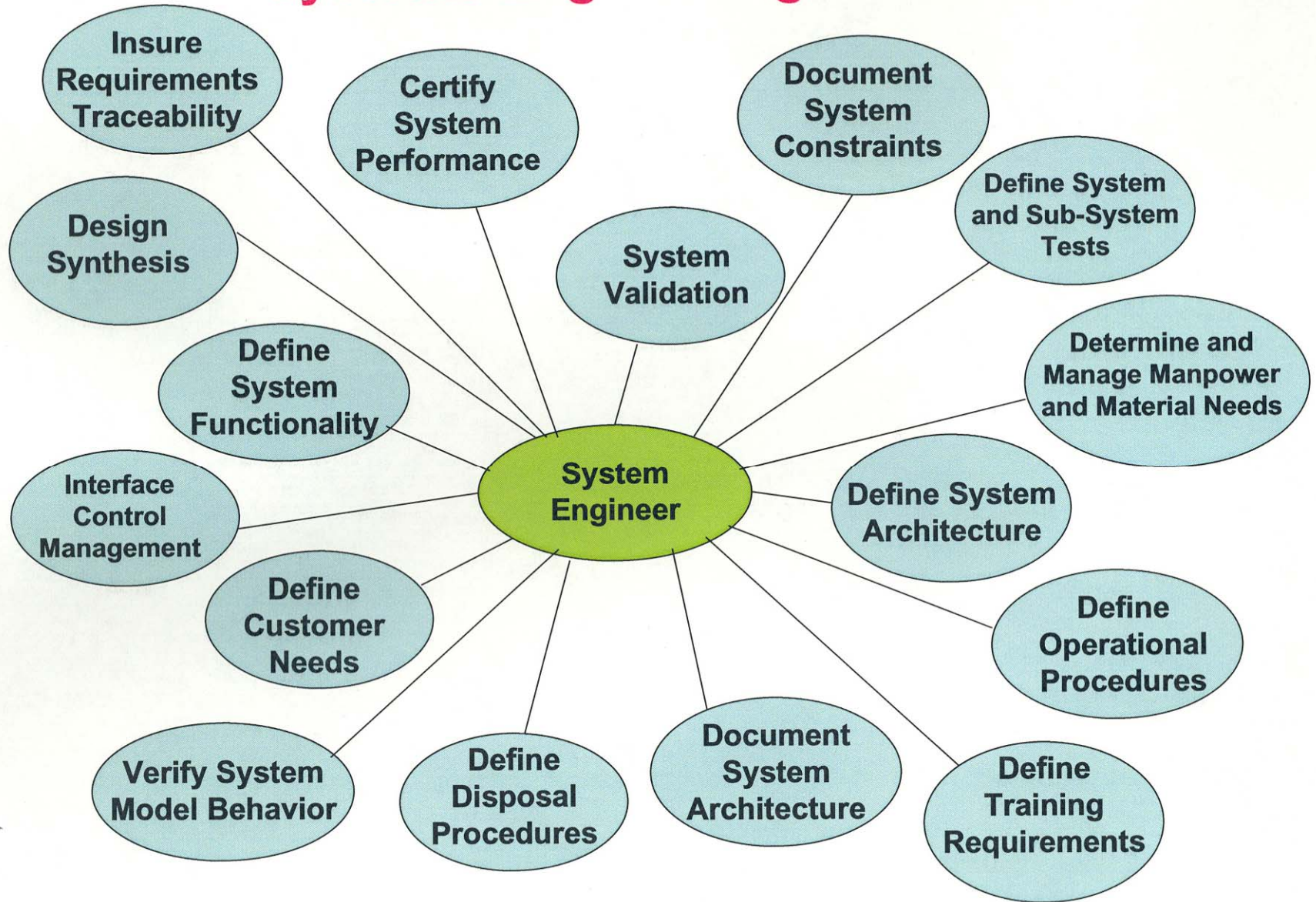
ORGANIZATIONAL ASPECTS

- **Flexibility, like democracy, is good if it does not lead to tensions.**
 - ✓ **Is abandonment possible? Lobbies!**
- **Comprehensive risk management** →
System approach: system engineering
- **Phase Development: spiral development**

What is Systems Engineering ?

Systems Engineering is defined as an ***“interdisciplinary approach and means to enable the realisation of successful systems. It focuses on defining customer needs and required functionality early in the development cycle, documenting requirements, then proceeding with design synthesis and system validation while considering the complete problem: Operations, Performance, Test, Manufacturing, Cost and Schedule, Training and Support, Disposal.”***

Systems Engineering Functions



The Systems Engineering Process

State the problem

Investigate alternatives

Model the system

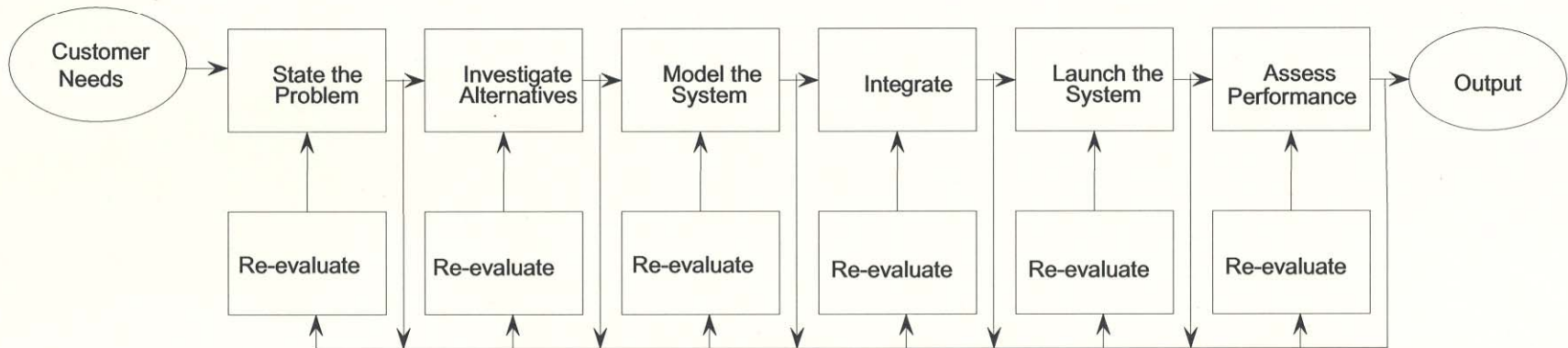
Integrate

Launch the system

Assess performance

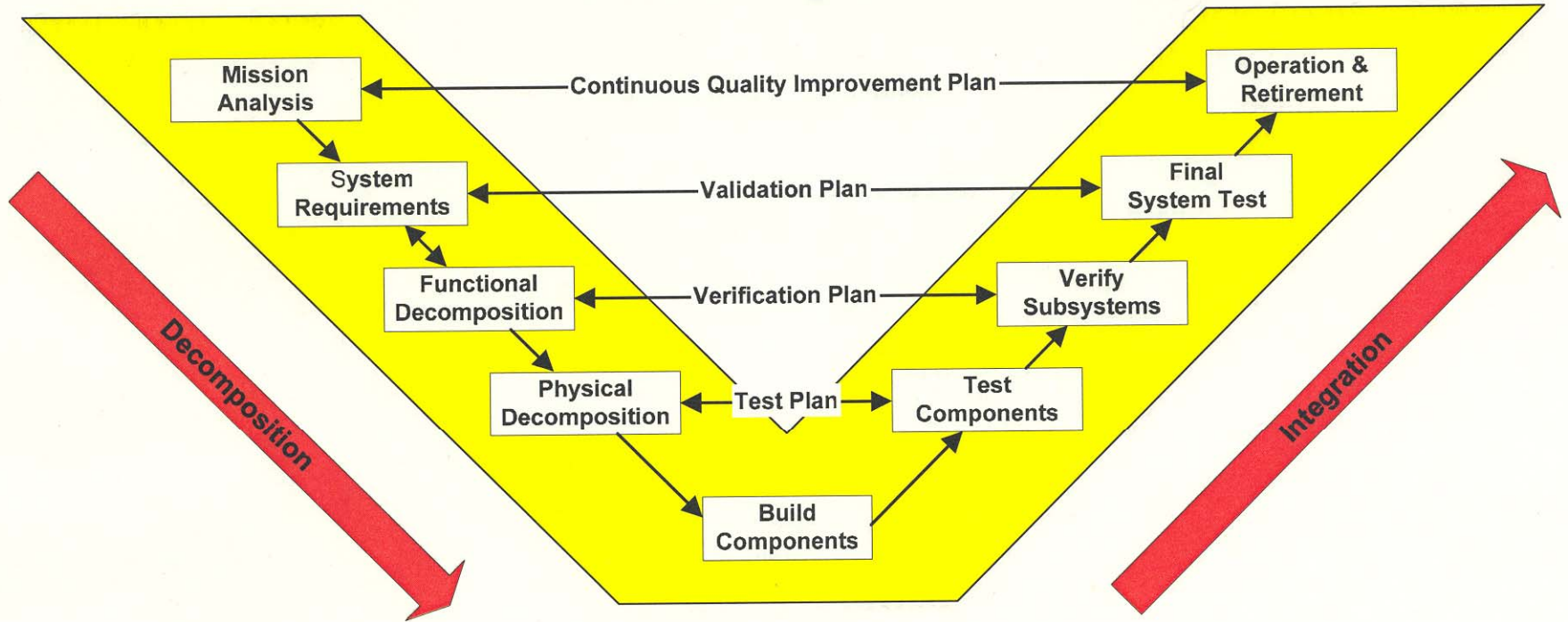
Re-evaluate

These functions are captured in the acronym **SIMILAR**.



Systems Engineering Process
Iterative not Sequential Steps

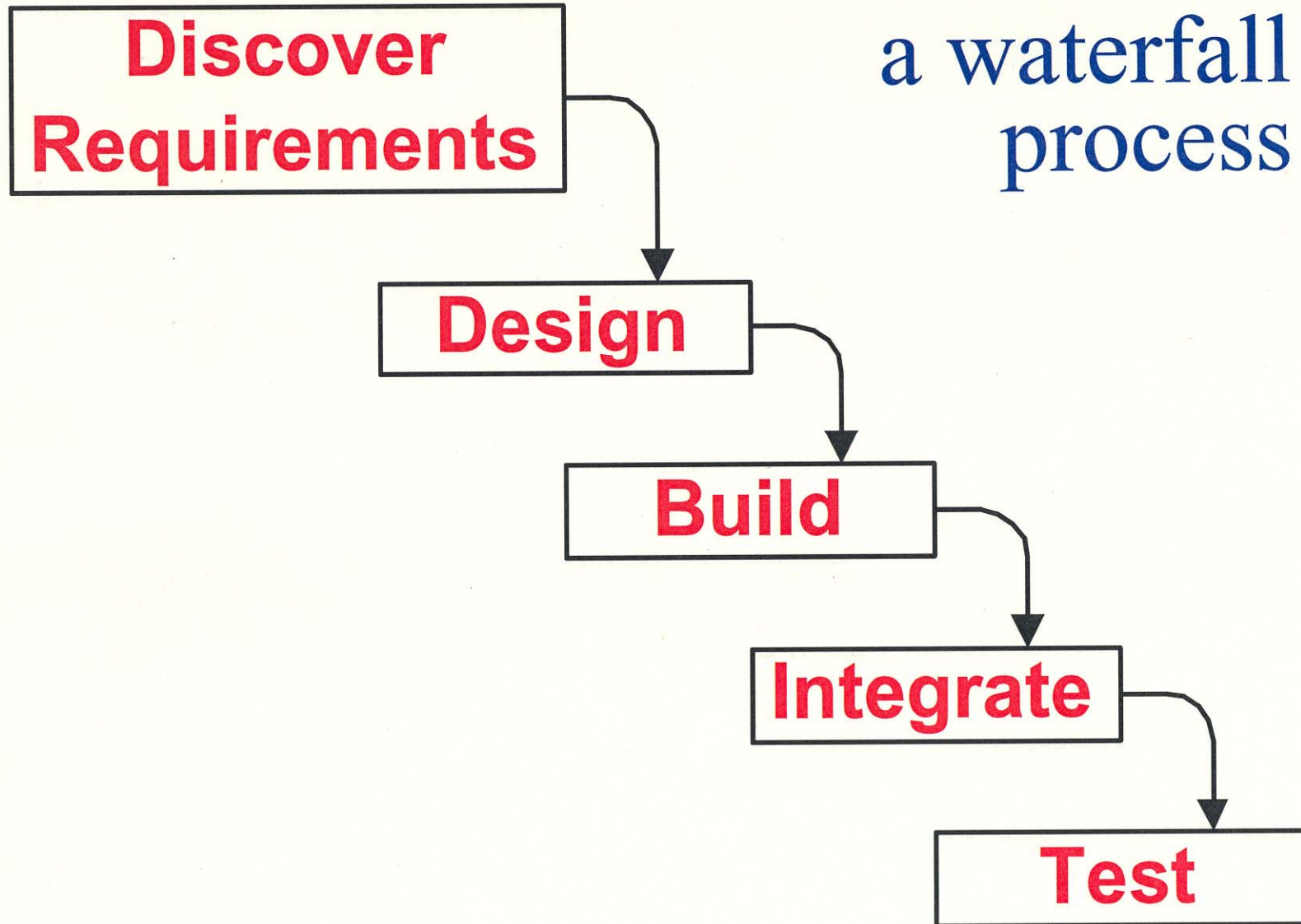
The vee life-cycle model



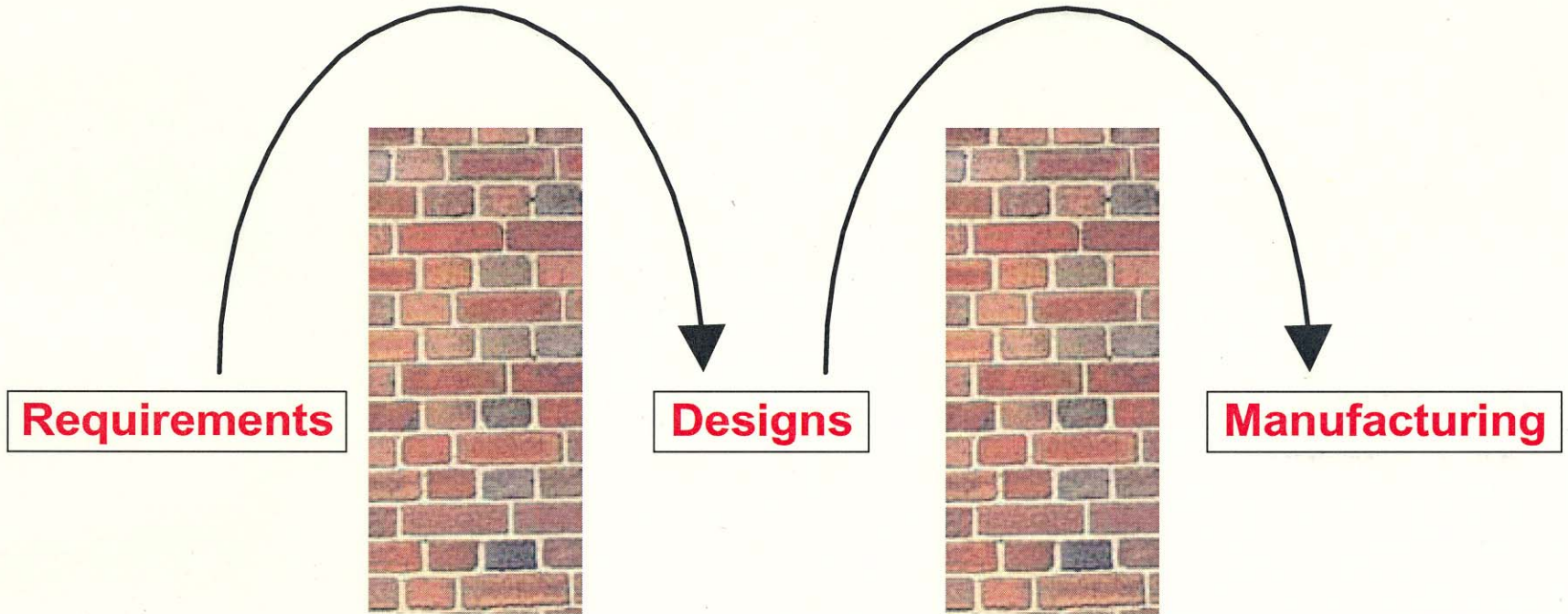
The design downstroke and the manufacturing upstroke

Systems engineering is not

a waterfall
process

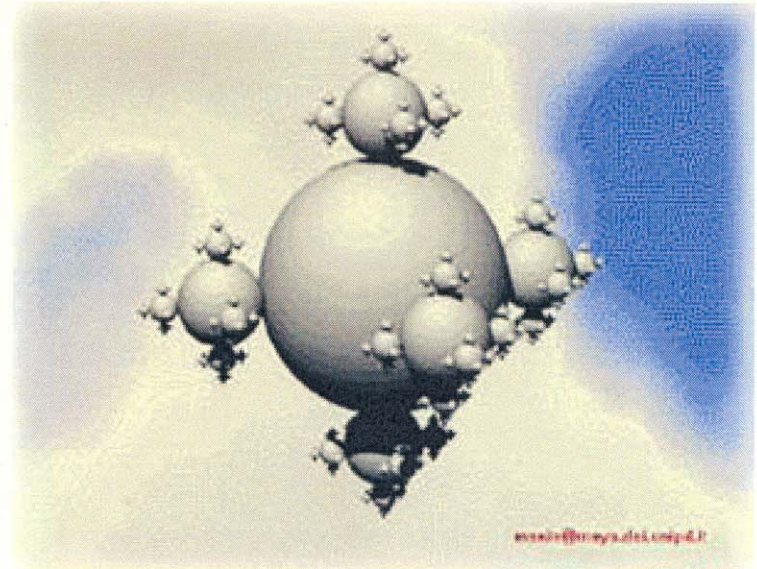
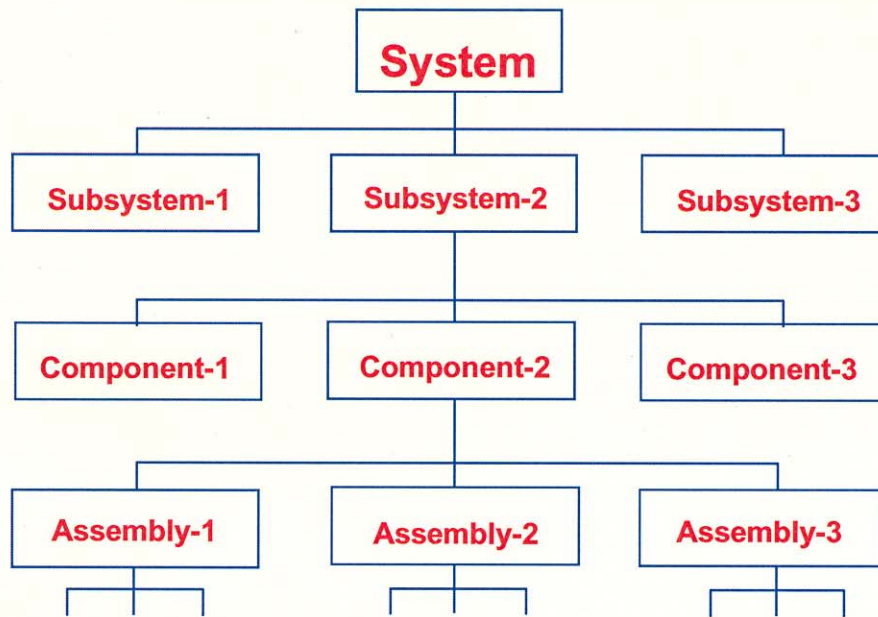


Systems engineering is not



a throw it over the wall process

Systems engineering is a fractal process



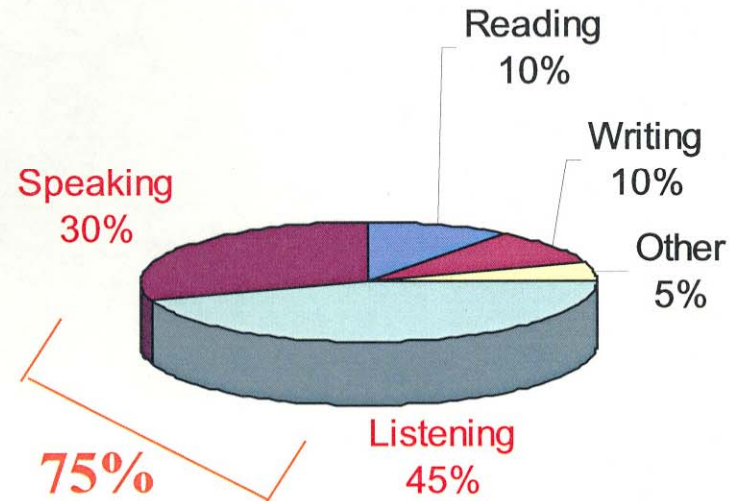
The systems engineering process is applied at levels of greater and greater detail. It is applied to the system, then to the subsystems, then to the components, etc. Similarly for the fractal pattern above, the same algorithm was applied at the large structural level, then at the medium-scale level, then at the fine-detail level, etc.

Project Communications

Project Managers spend roughly 75-90% of their work time communicating

“One’s effectiveness is determined by one’s ability to reach others through the spoken or written word... perhaps the most important of skills.”

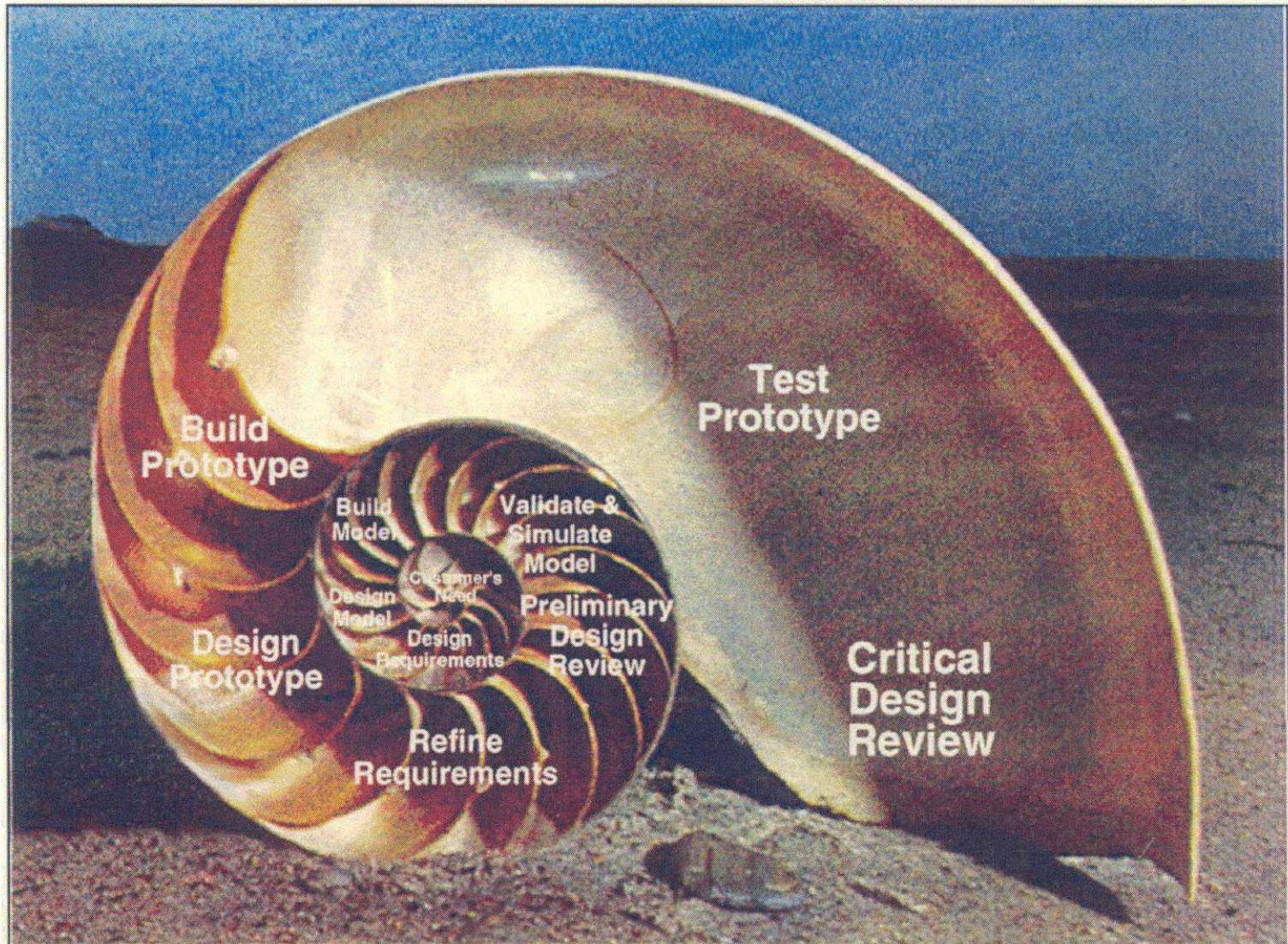
- Peter Drucker



Required Skills For Systems Engineers

- **Broad View and Perspective on Systems and New Concepts**
- **Capacity to Synthesize Not Just Analyze**
- **Broad Range of Technical Understanding and a Very High Degree of Intellectual Curiosity**
- **Strong Ability to Effectively Communicate with Customers, Disciplinary Technical Experts and Senior Management**
- **Ability to View and Understand a Problem or System from Top Down Perspective: Identify and Focus on Critical Issues**
- **Broad Range of Work Experience**
- **Ability to Provide Team Leadership**
- **Ability to Structure and Conduct Reviews as Required to Meet System Requirements and Operational Performance**
- **Good Understanding and Use of Systems Engineering Tools**
- **Understanding of Past Failures and Lessons Learned and Applying to Current and Future Programs**

First Steps of the System Design Process



SPIRAL DEVELOPMENT

- Large innovative development programs in aerospace and defense are procured following spiral development principles. This concept started in software development.
- The terminology comes from a graphic representation of all development and implementation phases of a system.
- The successive phases expand like a spiral, not a purely sequential process. At each phase an analysis is conducted.
- Flexibility of choices is allowed at early stages.
- In the spirit of real options → delay decision and utilize maximum flexibility.

WINWIN SPIRAL MODEL

A REFINED SPIRAL MODEL

- **The original spiral model has difficulty determining the roots of elaborated objectives, constraints, and alternatives.**
- **The WinWin spiral model resolves this by adding three activities to the front of each spiral cycle:**
 - ✓ **Identify the system or subsystem's key stakeholders**
 - ✓ **Identify the stakeholders' win conditions for the system or subsystem**
 - ✓ **Negotiate win-win reconciliations of the stakeholders' win conditions**

WINWIN SPIRAL MODEL

KEY CONCEPTS

- **Win Condition:** an objective that makes a stakeholder a winner
- **Issue:** Conflict or constraint on a win condition
- **Option:** A way of overcoming an issue
- **Agreement:** Mutual commitment to an option or win condition
- **WinWin Equilibrium State**
 - ✓ All Win Conditions covered by Agreements
 - ✓ There are no outstanding Issues

From the lecture notes of Prof. Larry Bernstein at Stevens Institute of Technology

WINWIN SPIRAL MODEL

RATIONALE

- **Avoids costly rework**
- **Builds trust**
- **Manages expectations**
- **Makes teamwork a realistic proposition**
- **Helps stakeholders adapt to change**

From the lecture notes of Prof. Larry Bernstein at Stevens Institute of Technology

BEYOND REAL OPTIONS ANALYSIS

- **When target markets and technical agendas are flexible, that is,**
 - ✓ demarcation between investment stages is blurry,
 - ✓ the scope for possible modifications in the initial stages is vast,
 - ✓ opportunities are linked to the actions of the corporation; i.e., endogenous,

and actors at different levels of the corporation have different perspectives on the attractiveness of a given opportunity due to psychological biases, cognitive issues, and different incentive structures, the discrete logical framework of real options breaks down.
- **There is a need for more generic path-dependent processes, such as:**
 - ✓ Probe and learn (Lynn et al., 1996)
 - ✓ Incremental search (March & Simon, 1958)
 - ✓ Innovation journeys (Van de Ven et al., 1999)