AARHUS
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TISYE1 – Lecture 3

Projects, Decision Analysis and Agreements

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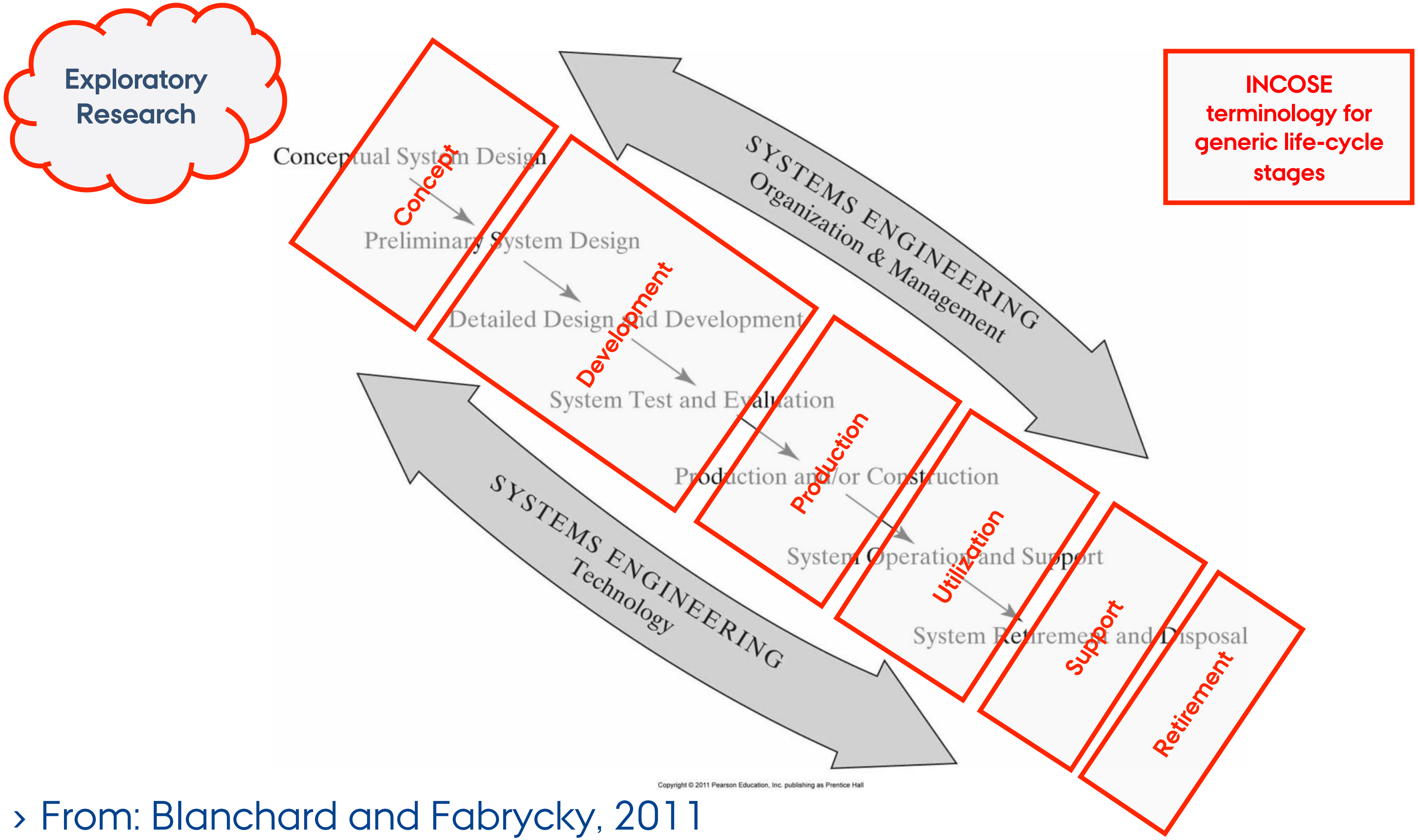
Management and the SE Process



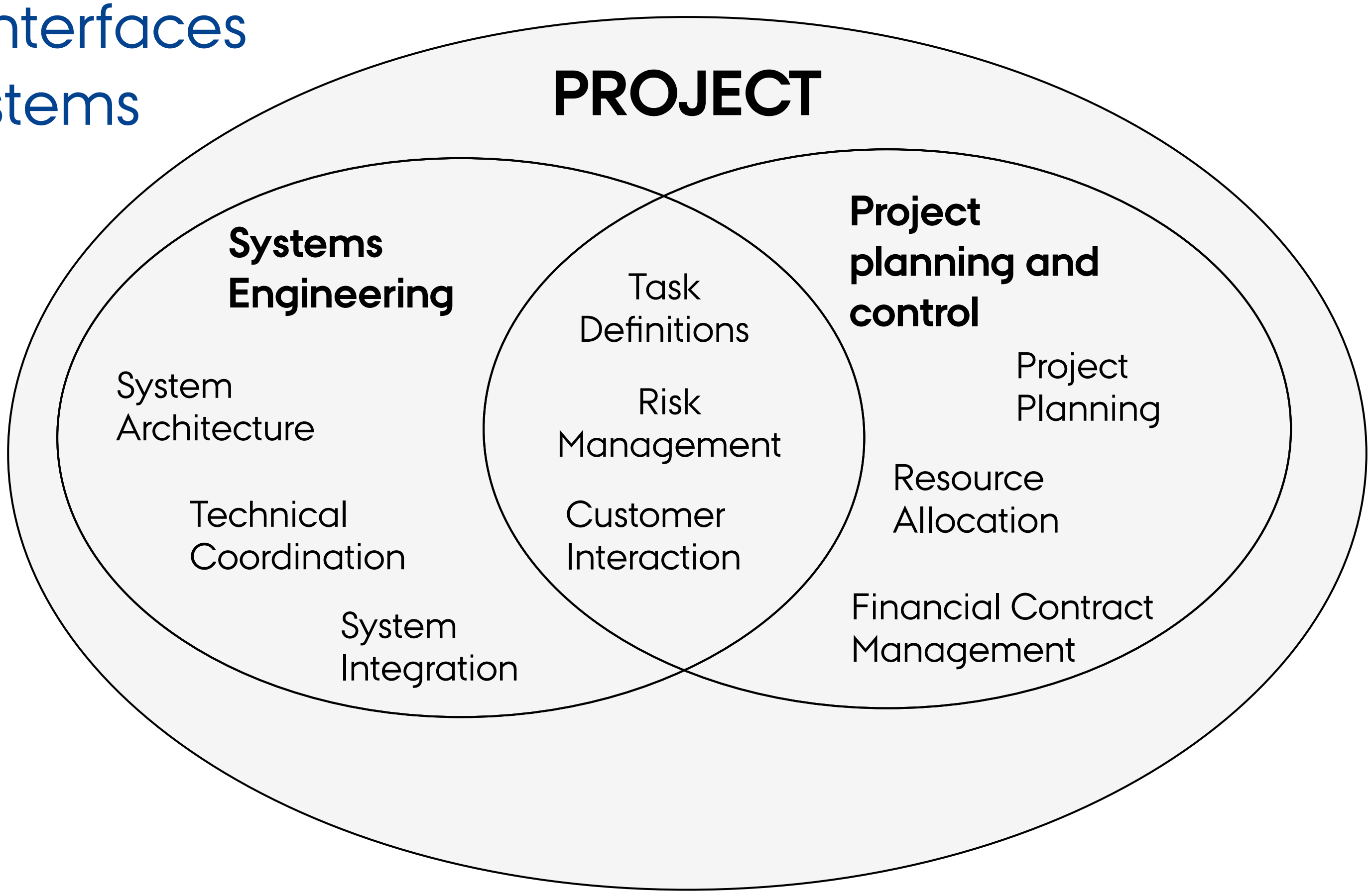
› From: Blanchard and Fabrycky, 2011

Plan for the Lecture

- Project planning, assessment and control
- Configuration management
- Issue handling (risk, mitigation, root cause)
- Decisions analysis and trade studies
- Agreement processes

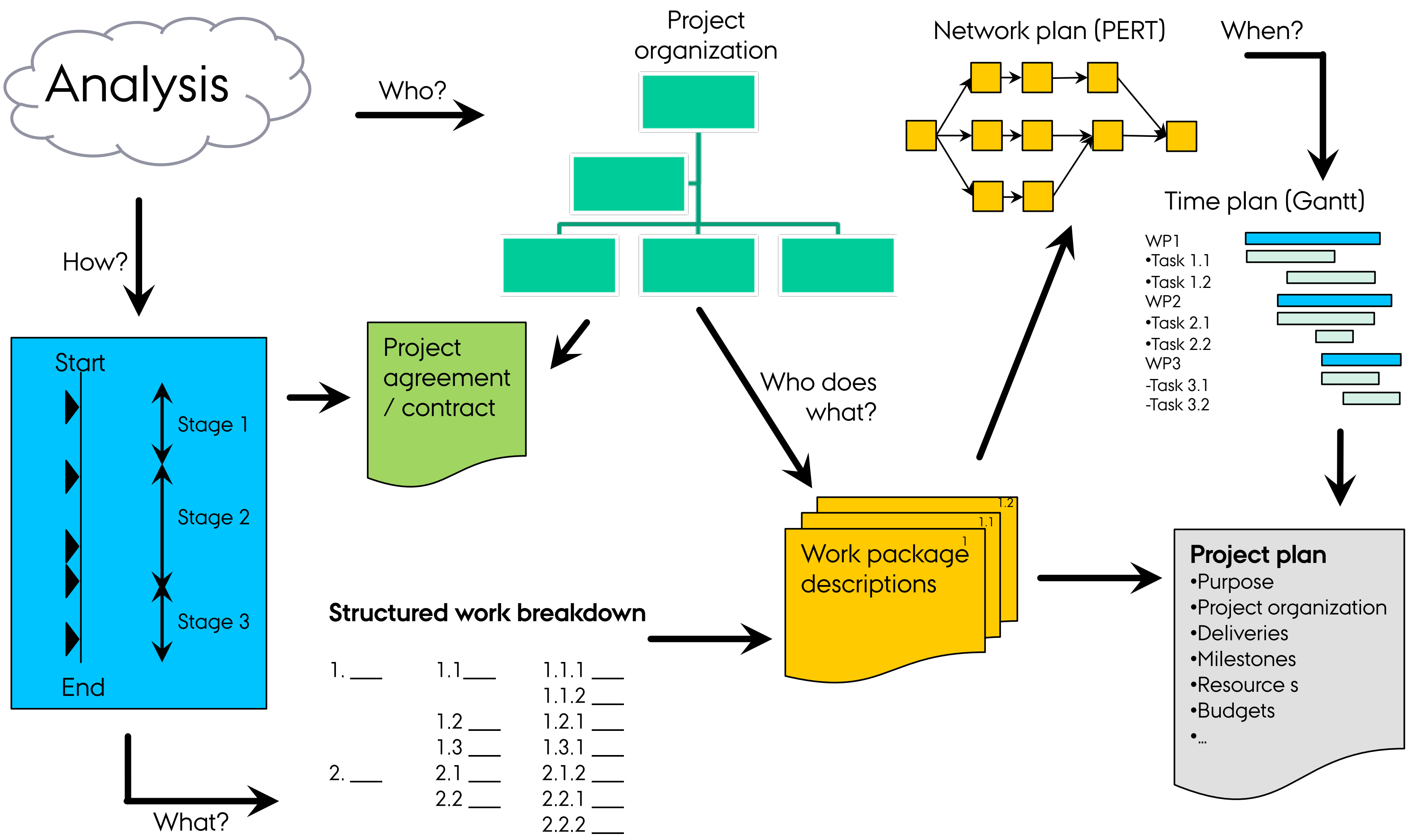
Project Management versus SE

- The Venn Diagram depicts the interfaces between Systems Engineering and project planning and control

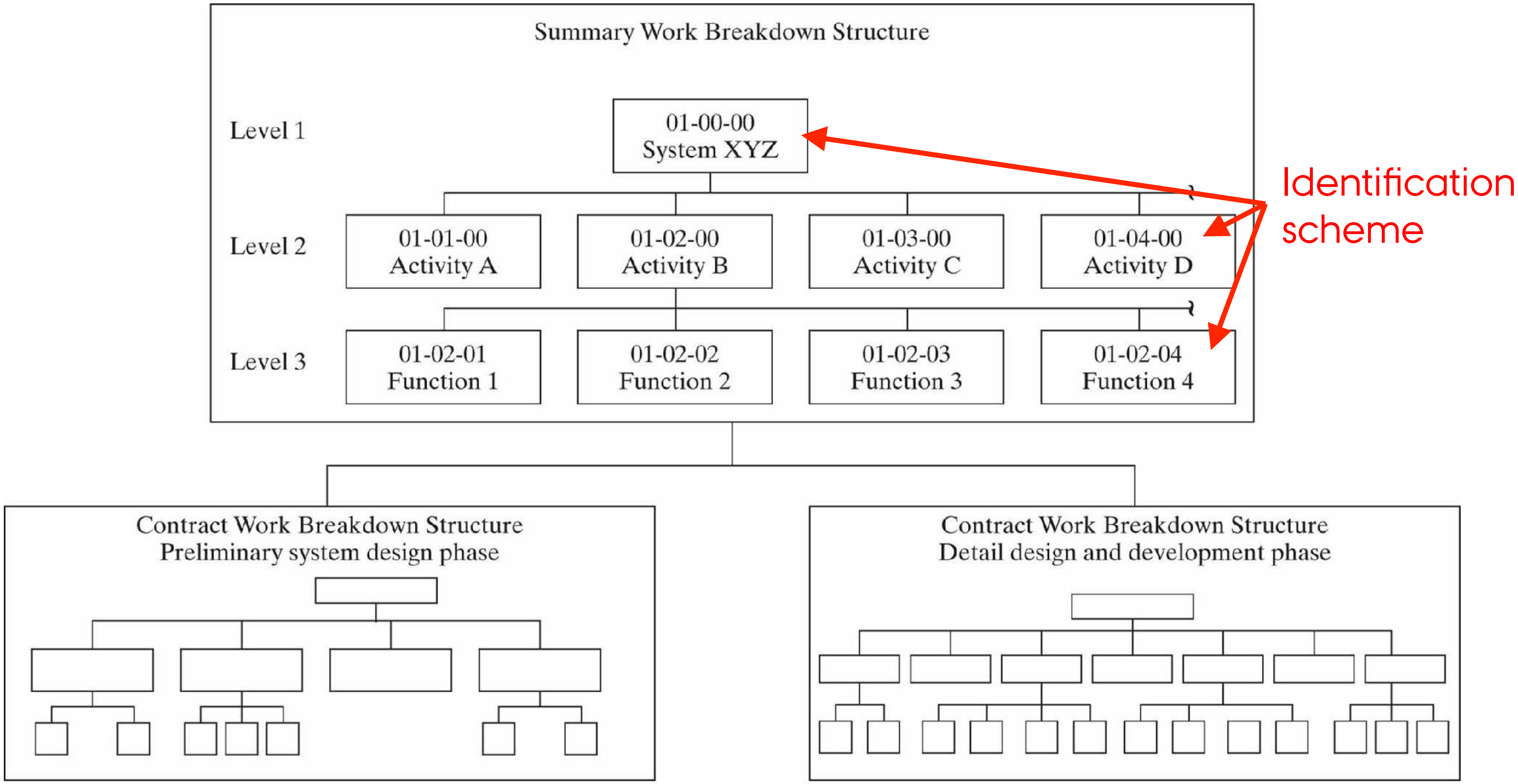


- Systems engineers continuously interact with project management

Elements of Project Planning



Work Breakdown Structure



› From: Blanchard and Fabrycky, 2011

SEMP

Systems engineering management plan

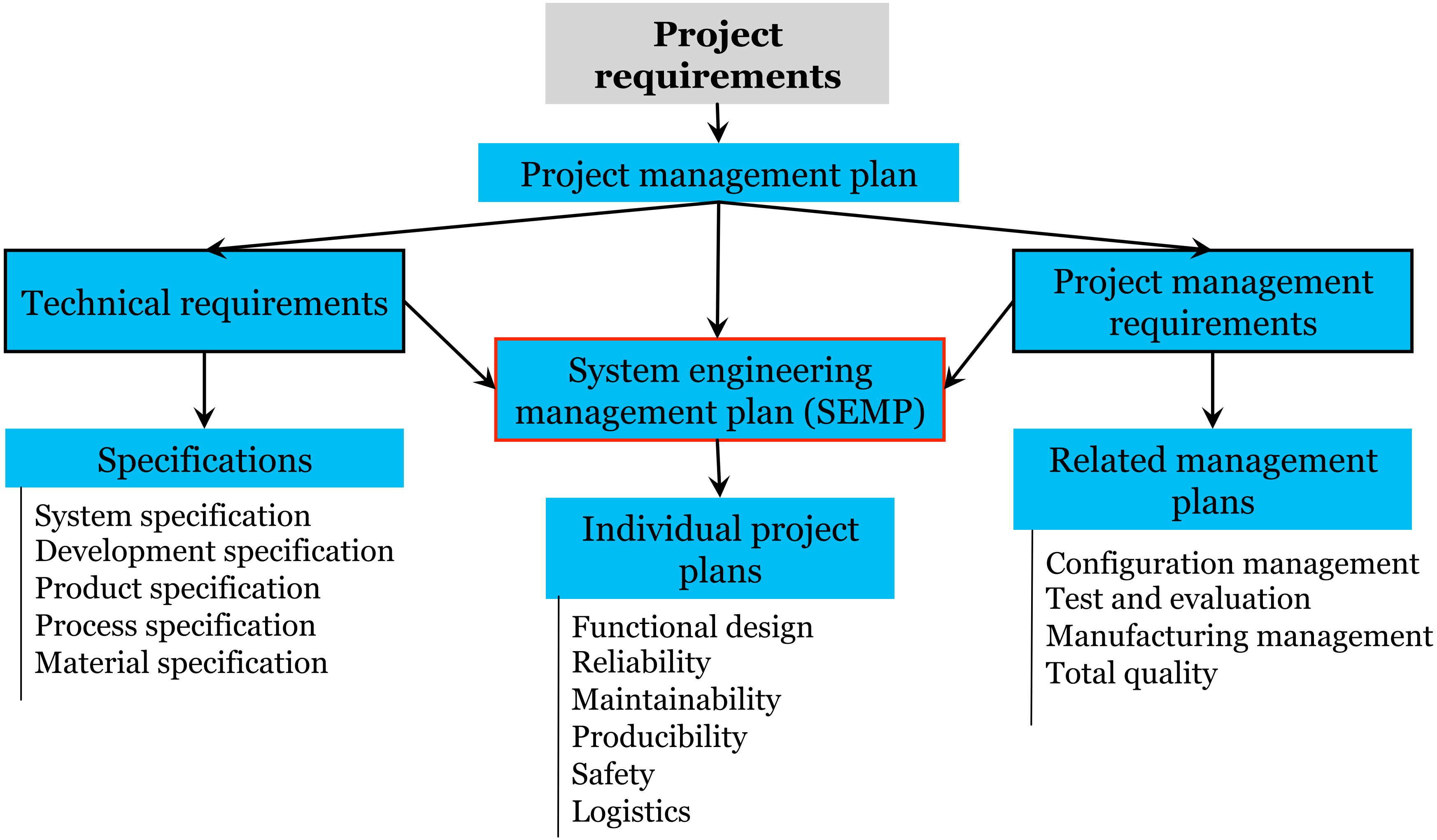
› The top-level plan for managing the SE effort in a project/ program.

› It defines technical management activities including planning, scheduling, reviewing and auditing the SE process.

› It facilitates integration of all design-oriented plans and provides link to other key planning activities, e.g., CM strategy, QMP, maintenance strategy etc.

A well-written SEMP provides guidance to a project/program management and helps the organization avoid unnecessary discussions

Plans and Specifications



SEMP: A Generic Approach

Systems engineering management plan

Technical project planning, implementation and control

Describes the technical program tasks that must be planned and implemented in the fulfillment of the SE management objectives.

<u>Includes:</u>
Project requirements (SoW)
Project planning (Spec. WBS, schedule, cost, reporting…)
Supplier requirements
Organization (consumer, producer , supplier relationships)
Technical interface management
Project management
Risk management

System engineering process

Describes the SE process as it applies to the definition of system requirements and the development of those requirements into a final product configuration.

<u>Includes:</u>
Needs analysis
Feasibility analysis
Operational requirements
Maintenance concepts
Technical performance measures
Functional analysis
…

Engineering specialty integration

Describes the system requirements in the various engineering specialty areas and the integration of these specialty areas into the overall "mainstream" engineering design and development effort.

<u>Includes:</u>
Functional engineering
Reliability engineering
Maintainability engineering
Human factors, and security safety engineering
Software engineering
…

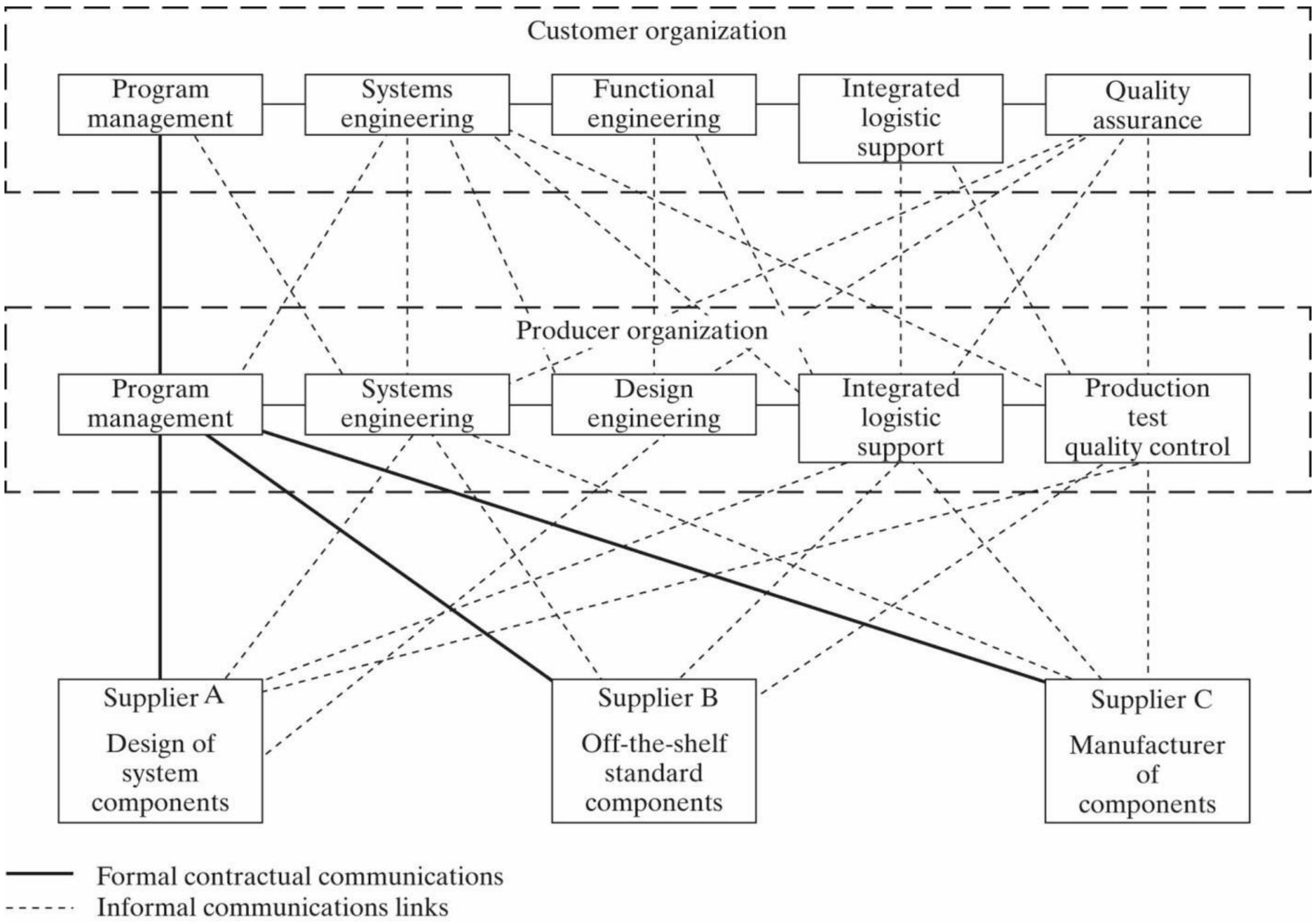
Integrated Product Development

- Recognize the need to consider all elements of the product life-cycle, i.e., from “cradle to grave”.

- Integrated Product Teams (IPT) are a process-oriented, integrated set of cross-functional teams responsible for defining, developing, produce and support a product/service.
  - Used in complex development programs/projects for review and decision making.

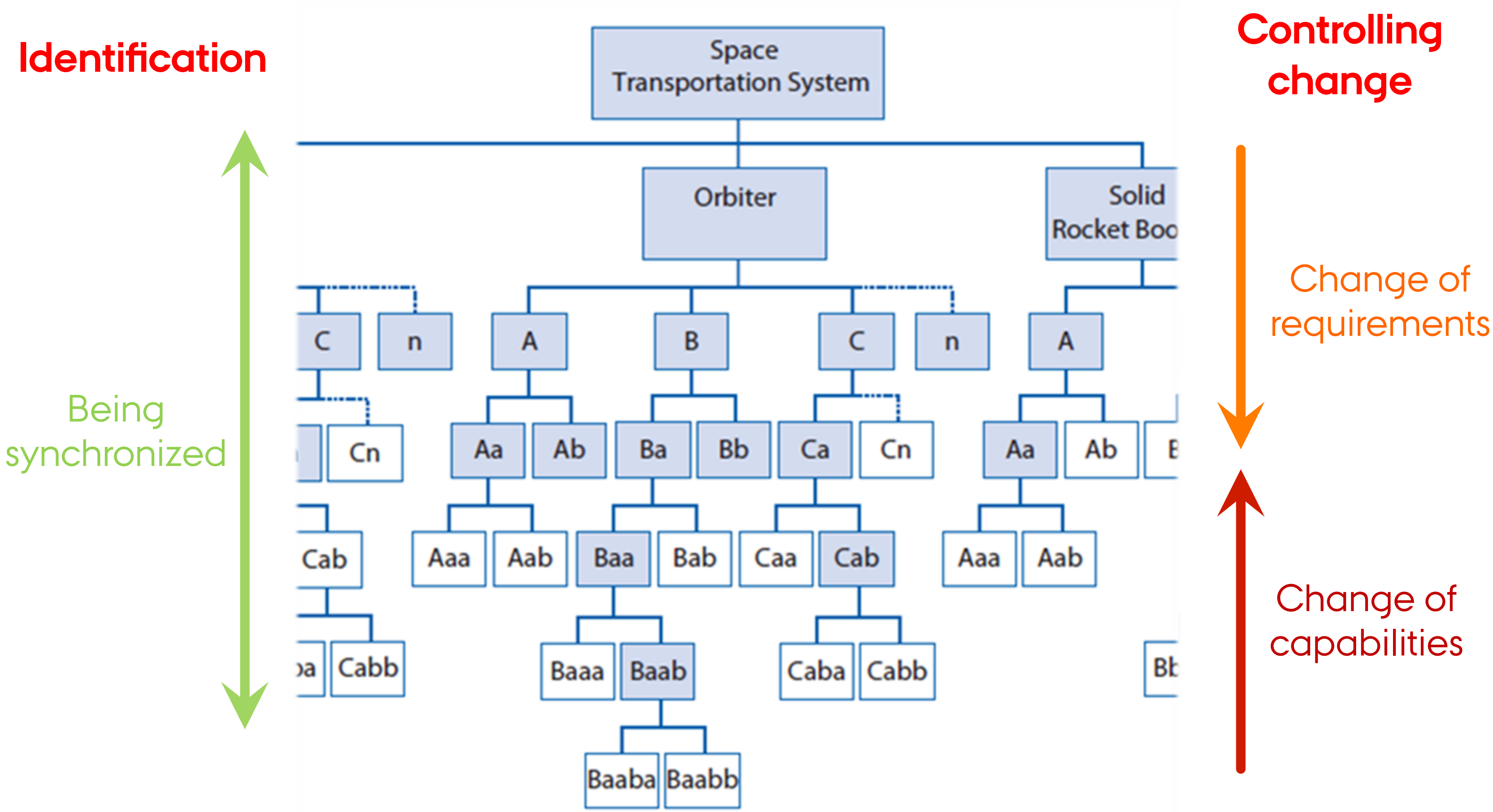
- Benefits of using IPD are
  - reduced time to market,
  - improved product quality,
  - reduced waste, and
  - saved cost through integration.

Organizational Relationships



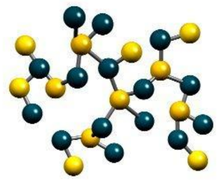
› From "Systems Engineering and Analysis" by Blanchard & Fabrycky, 2011

Purpose of CM



Configuration Items (CIs)

› A configuration Item (CI) is the ”atom” of configuration management (CM)



› **MIL-HDBK-61A**:

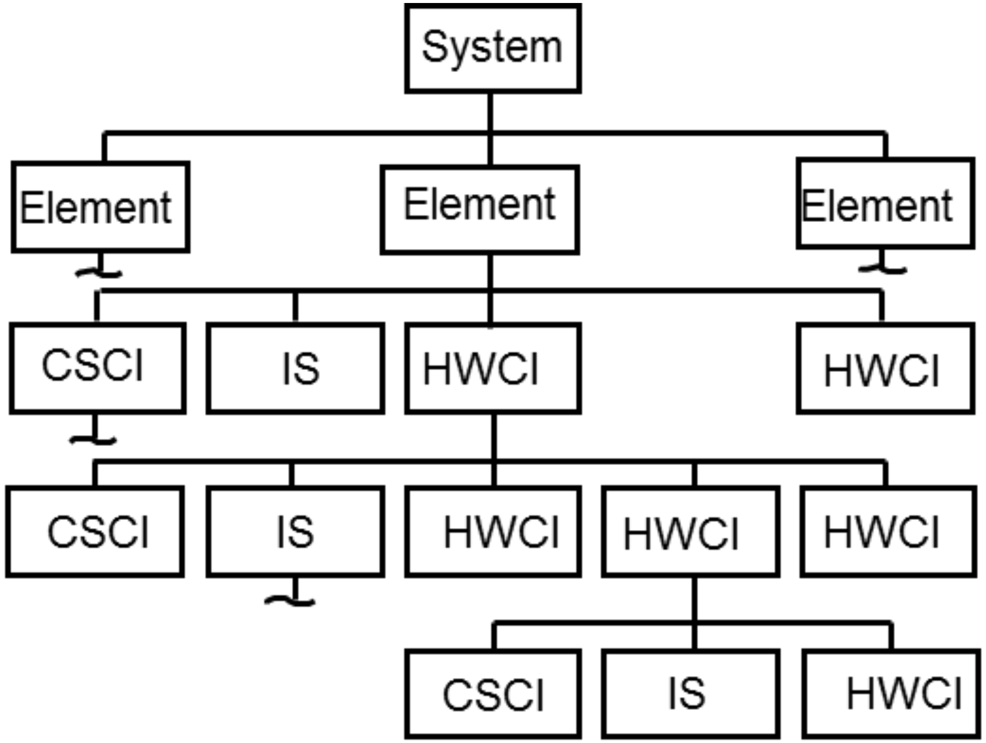
› “Configuration Item: A CI is any hardware, software or combination of both that satisfies an end use function and is designated for configuration management …”

› **EIA-649-A**: (‘Product’ is alias for ‘Configuration Item’)

› “Product: Something that is used or produced to satisfy a need or is the result of a process; e.g., documents, facilities, firmware, hardware, materials, processes, services, software, systems.”

Product Structure

› Configuration items may be organized into a product structure



› Source: INCOSE Systems Engineering Handbook

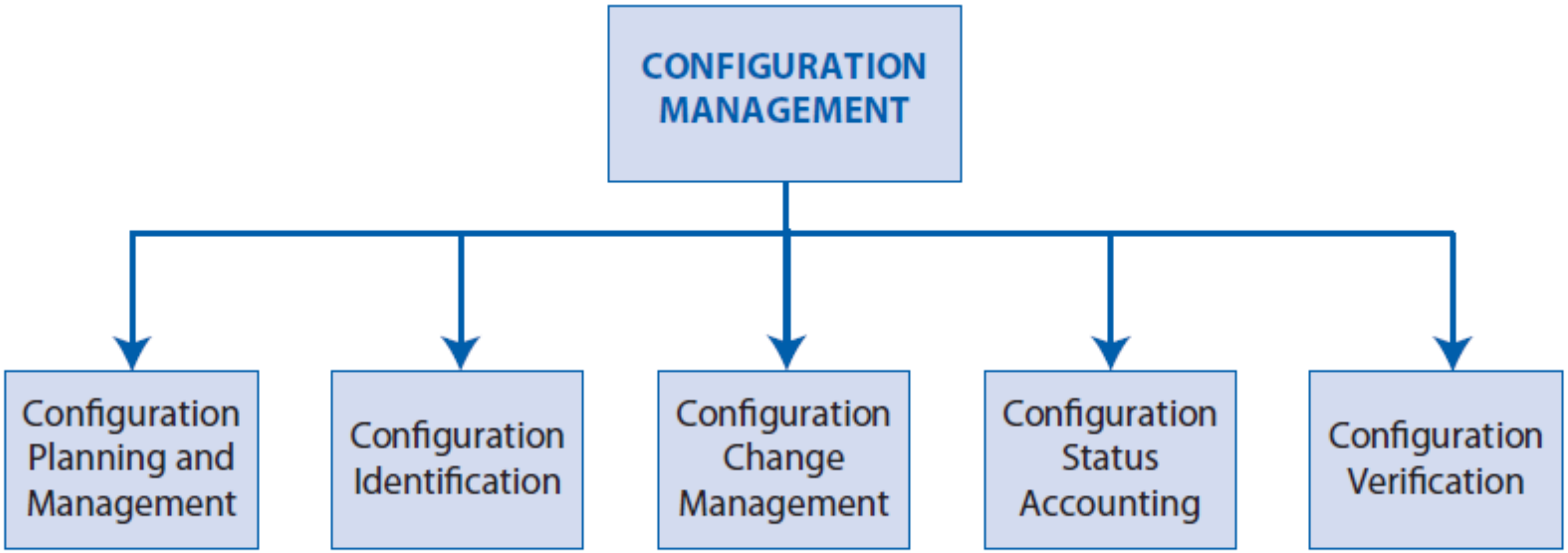
Interchangeability

The Principle of Interchangeability:

- Instances of same configuration identity must be interchangeable with respect to all specified parameters.

- Also referred to as “Form Fit and Function” compatibility.
- Nothing is identical! **Similarity is a matter of definition**.
- Standard part must be back- and forward compatible.
- Software and Documents are almost never interchangeable (may be subset/superset compatible)”.

Elements of CM



Identification

Effective identification is a prerequisite for any CM.

- Unique identification
  - Per Product (part number, document number)
  - Per Instance (serial number)
  - Namespace (CAGE, Enterprise identifier)
  - ‘Globally’ Unique Identifiers (GS1 system, ISO/IEC 15459)
- Revision (Remember interchangeability)
- Barcodes vs. human readable

Identification plane →

Revisioning

Life-cycle of configuration item:

1. Draft/Preliminary/Under construction (Versioning)
2. Release for Use (frozen configuration)
3. Approved change
4. Revised Release
5. Obsoleted (Not for sale/production/use)

› **EIA-649-A**:

› “Release: Authorization for dissemination of approved information and/or product subject to configuration change management”

1 → 2 → 1A → 2A → **A** → **A1** → 1B → **B** → 1C → **C**

Configuration Baselines

- INCOSE:
- "Fundamental to [CM] is the establishment, control and maintenance of software and hardware baselines"

- EIA-649-A:
- "Configuration Baseline: Agreed to information that defines and establishes the attributes of a product at a point in time and serves as the basis for defining change."

- Practical Definition:
- "A released set of interdependent documentation satisfying a defined purpose"

Types of Baselines

	Examples
Contractual baseline	• Contract, Statement of Work, Terms and Conditions • Customer requirements
Requirement baseline	• Requirement specifications • Interface specifications • Installation/Envelope drawings • Operation Manual /User Interaction specification
Product baseline	• Parts List, Part Drawings • Digital Data Master Files • Production Test Specifications
Design baseline	• Design data (Schematics, source code, mechanical model) • Design Documentation • Simulation/Analysis Reports

Types of Baselines

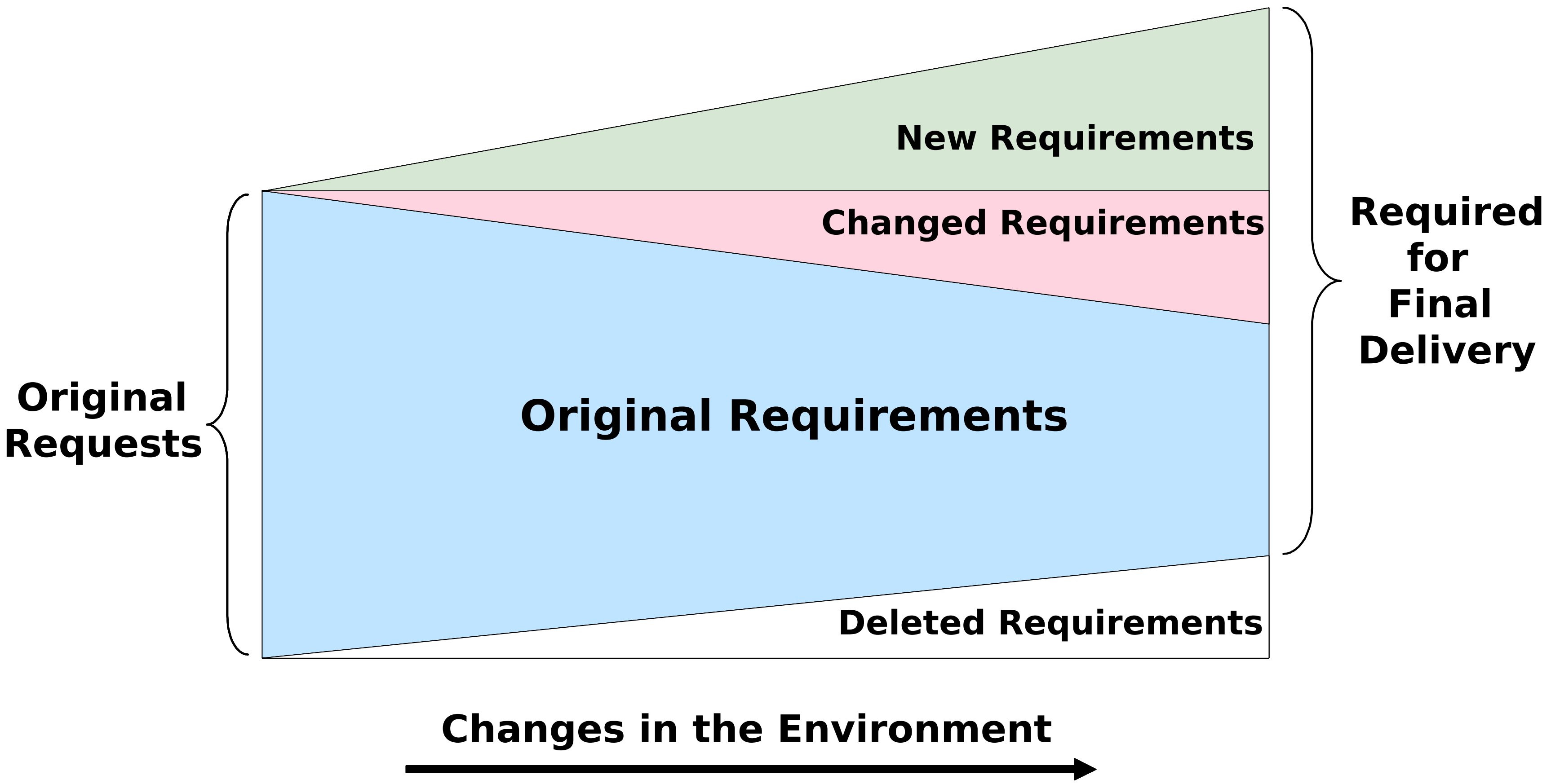
	Examples
As-built baseline	• Configuration Item Record (Serial no. tracking) • Operation Sheet, Deviations, Non-conformance, Repairs • Production Test Data
Product verification baseline	• Verification test procedure • Verification test and analysis report
Product planning baseline	• Project Management Plan • Schedule • Misc. plans (risk, configuration management, safety, verification, …)
Company organization baseline	• Organization structure • Definition of positions and responsibilities (Organizational description)
…	

Archival

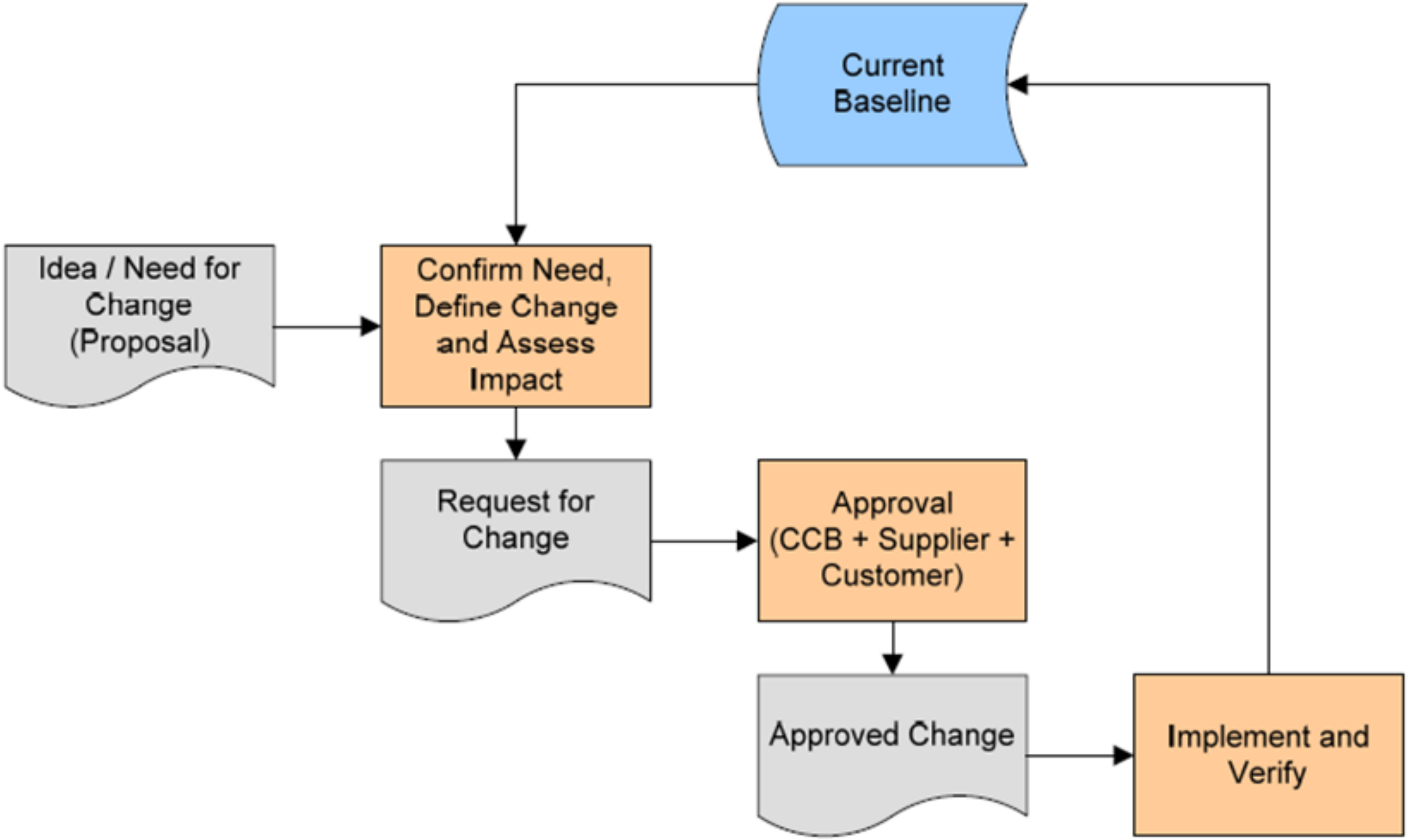
- Ensuring the ability to retrieve and use data (Media, data formats, applications…)
- Ensure high data quality (consistency)
- Ensuring atomic and visible release (keep everyone in sync)
- Managing access rights (or share your value)
- Configuration Manager /Data Manager (ensure responsibility)

- Remember: The life-time of the system may be higher than expected.

Requirement changes …



Change Management



› Current configuration = Current baseline + approved changes

Change Proposals (ECP)

- A request to change the current configuration of a system is typically made using an Engineering Change Proposal (ECP)

- Possible origins
  - Customer
  - Supplier
  - Breakthrough in technology

- Typically, it results in the conduct of an analysis to understand the effect of the change.

Change Management

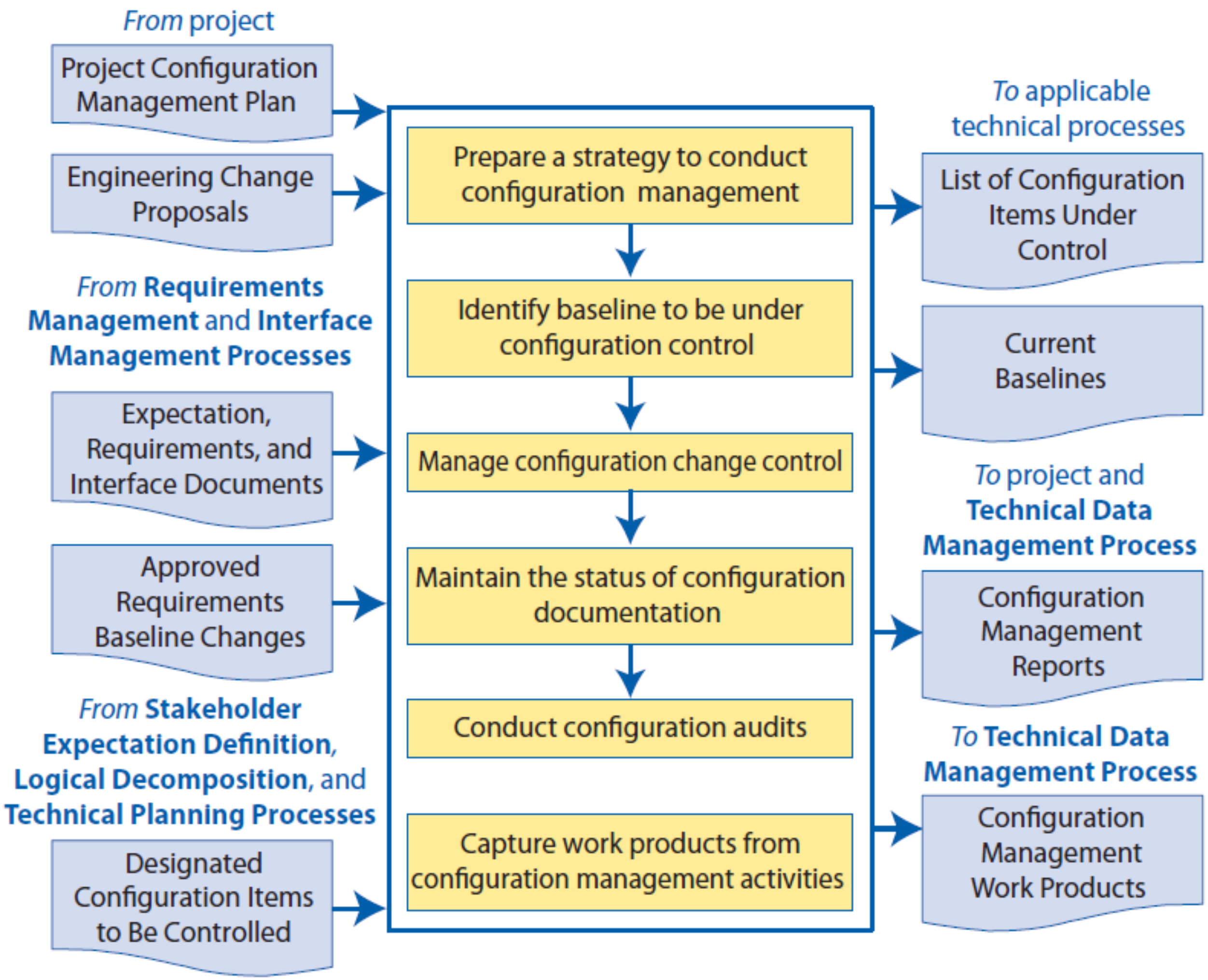
- Change classification
  - Major (change of Form, Fit and Function)
  - Minor
  - Economic consequences
- Change Control Board: Entity for approval
  - Identify decision makers (follow the money)
  - Customer may need to approve change
- Change management is costly
  - Use where needed (Versioning vs. Change control)

Change Control Board (CCB)

- Central point/body to
  - coordinate,
  - review,
  - evaluate, and
  - approve

- Scope: All proposed changes to baseline documentation and proposed change to baseline configurations (hardware, software and firmware)

Configuration Management Process



› Source: NASA Systems Engineering Handbook

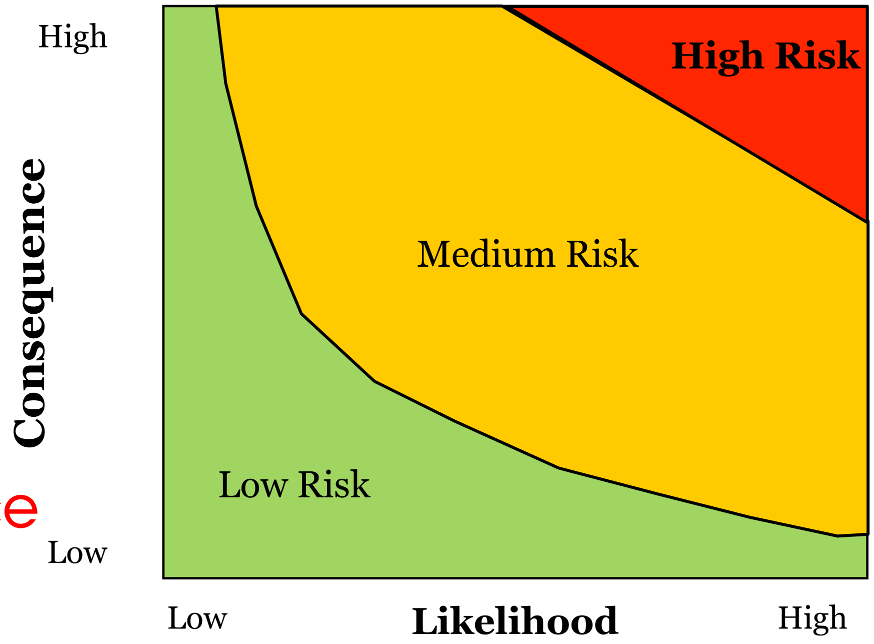
“Issue” handling

- Risk Management
- Step issue mitigation
- Root cause analysis

- To Err is Human,
  To Correct is Divine

Risk management

Proactive issue handling

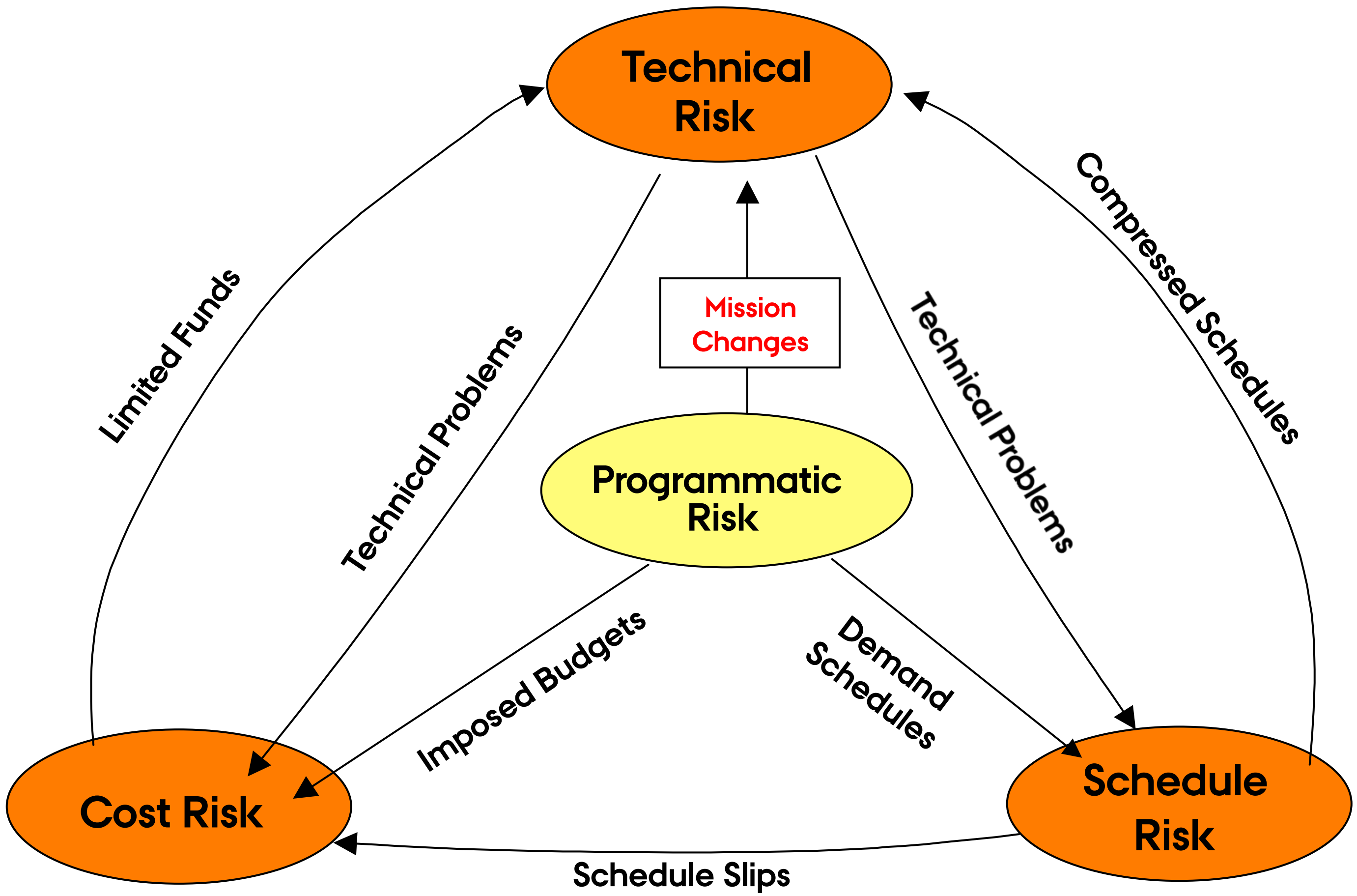


› Risk = Likelihood * Consequence

› Risk Management

1. Identify risks
2. Assess risk (Categorize and prioritize)
3. Mitigation
4. Plan consequence handling
5. Track and control

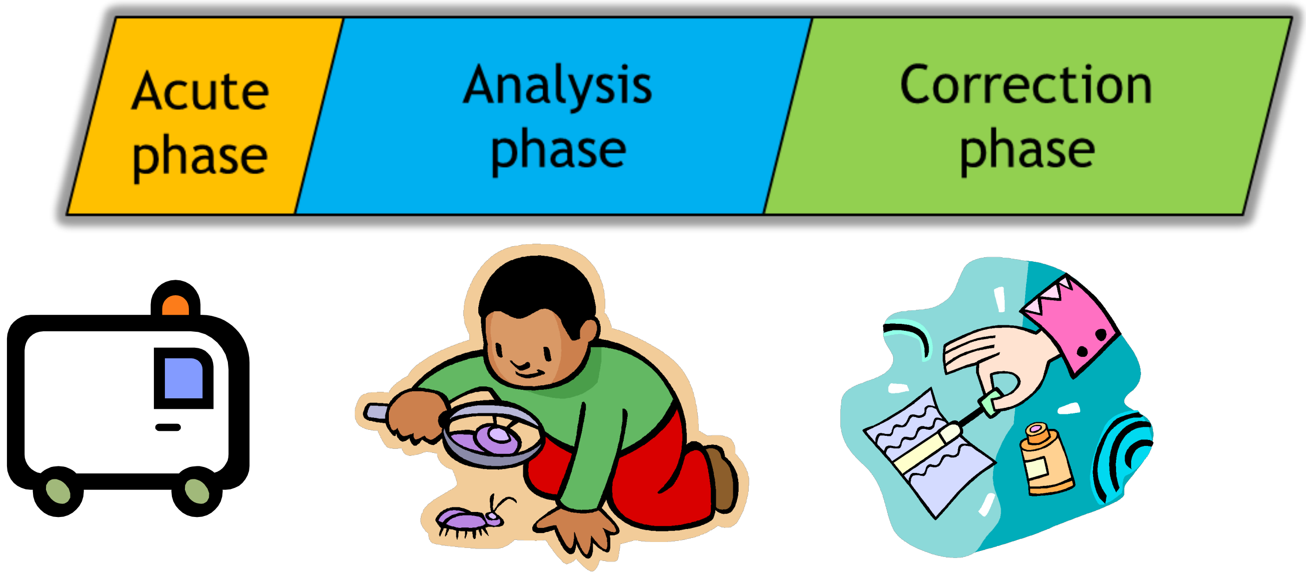
Relationships: Risk Categories



› Source: INCOSE Systems Engineering Handbook

Three Phases of Issue Handling

Be prepared …



The Acute Phase

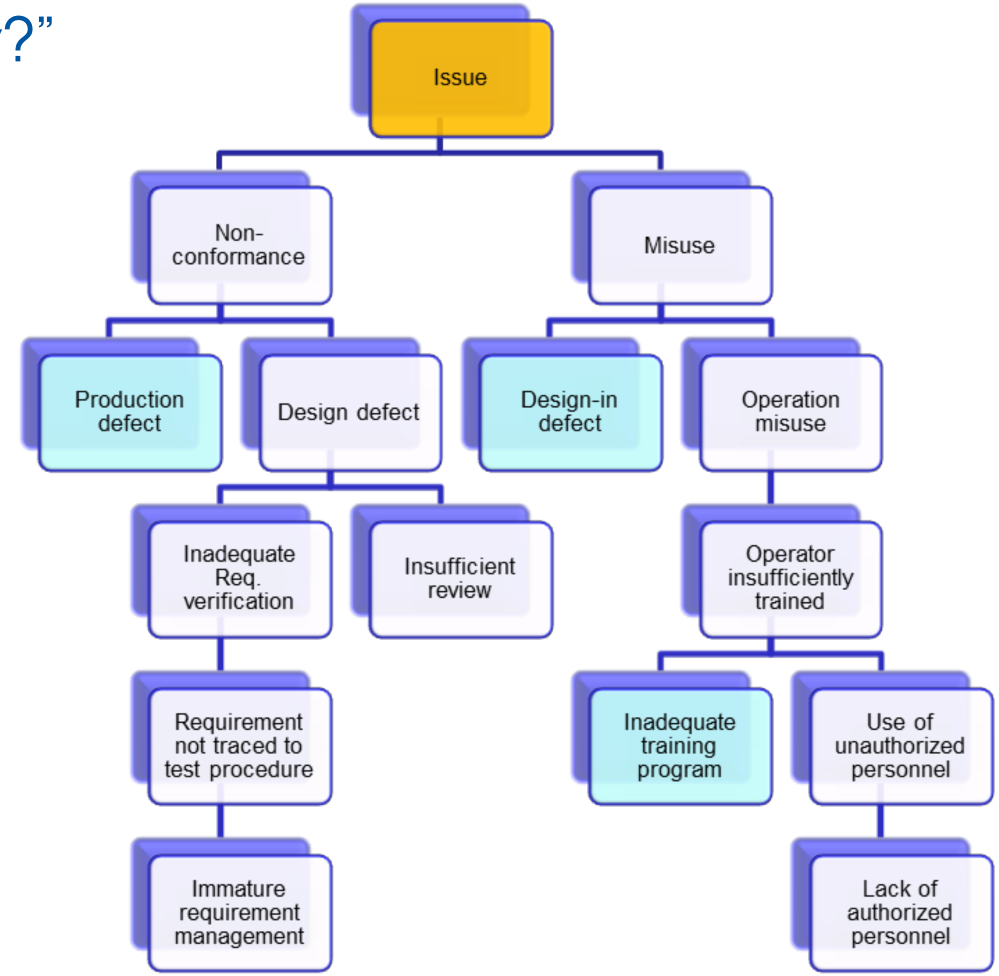
1. **Perceive the incident**
2. **Stop the issue from escalating**
   - Do not “just try again”
3. **Seek assistance**
   - Inform relevant responsible
4. **Initiate necessary workarounds**
   - Mission criticality? Safety?
5. **Secure the evidence**
   - Circumstances (system configuration)
   - Physical evidence
   - Pictures, log- files, screen dumps etc.
   - Implicated persons, witnesses
   - Avoid modifying the system, if possible
6. **Initiate structured issue handling**
   - Track and control
   - Assess cost
   - Manage communication!

The Analysis Phase

1. **Identify and describe the issue**
   - Failure mode, effect and criticality?
   - Circumstances?
   - Activities leading up to the incident?
   - How to replicate up to the incident?
   - How to replicate the incident?
   - Probable cause and extent; Probable extend?
   - Relation to other known issues?
2. **Identify Root Cause**
   - Non-compliance or misuse?
   - Replicate incident if feasible
   - Eliminate insignificant factors.
   - Discern between cause and effect (disease and symptoms)
   - Avoid ”trial and error”

Root Cause Analysis Tree

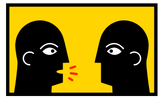
› Asking: "Why?"



The Analysis Phase

3. **Identify extent**
   - Re-evaluate failure mode, effect, criticality
   - Affected configurations items
   - Affected customers / End-systems
4. **Identify possible corrections**
   - Solutions vs. trade-offs
5. **Assess consequences**
   - Decide and Approve corrections

The Correction Phase



- Communication is important!
- Employ change management
- Correction may need to involve change of processes and training of people
- Customer may have different needs/requirements/opinions

- Can you think of an example?

Decision Management

- **Purpose**:
  - To select the most beneficial course of project actions where alternatives exists

- **Decision gates**
  - Approval event - included in the schedule.
  - Entry and exit criteria are established for each gate at the time they are included into the project management baseline.

Making Difficult Decisions

› **Decision analysis** is a method of identifying the best option from a set of alternatives, under uncertainty, using the possible outcomes of each alternative and their probabilities of occurrence to calculate the expected value of the outcome.

› **Trade studies** are objective foundation for the selection of one of the alternative approaches to the solution of an engineering problem.

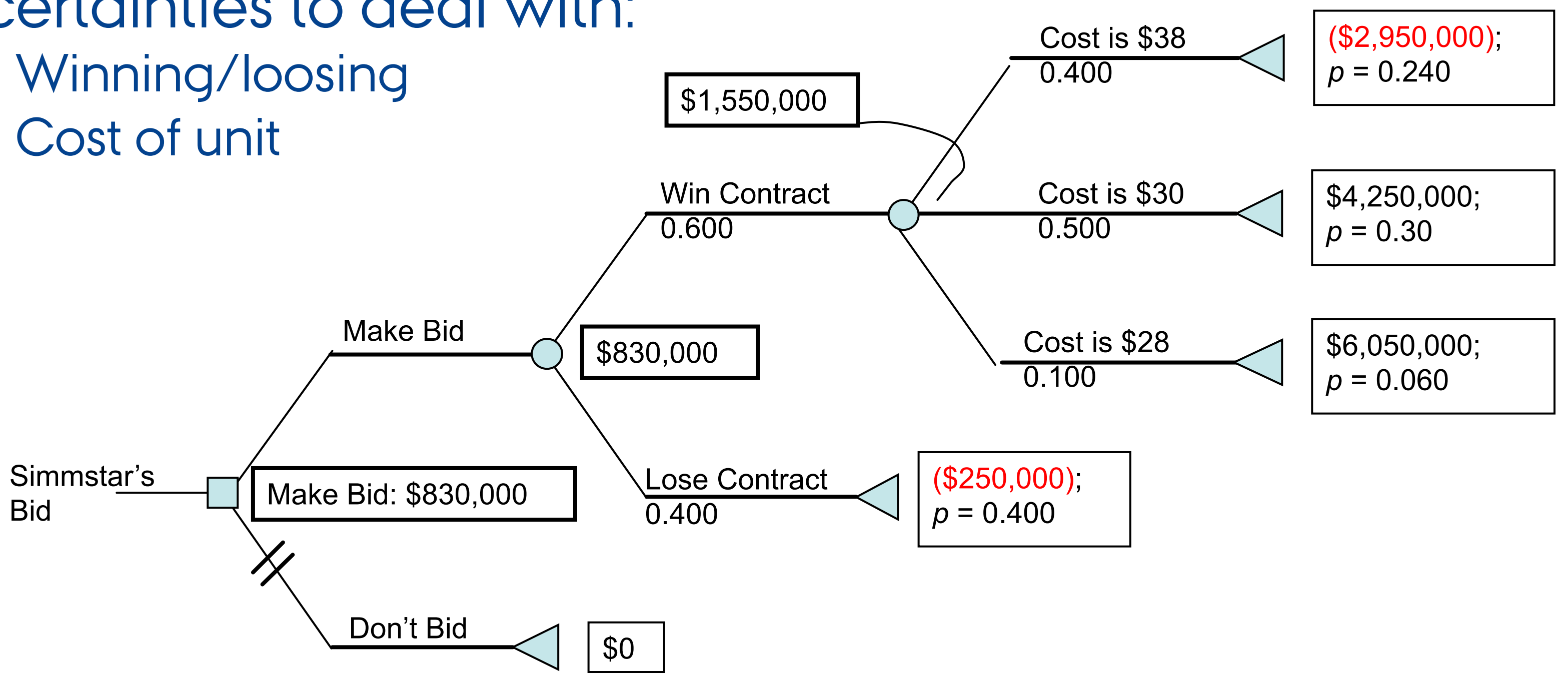
› **Sensitivity studies** look at the relationship between the outcomes and their probabilities to find how "sensitive" a decision point is to the relative numerical values.

Good Decision Making

1. Understand the business situation.
2. Use a value creation "lens" for developing and evaluating opportunities.
3. Clearly establish objectives and trade-offs.
4. Discover and frame the real problem.
5. Develop creative and unique alternatives.
6. Identify experts and gather meaningful and reliable information.
7. Embrace uncertainty as the catalyst of future performance.
8. Avoid "analysis paralysis" situations.
9. Use systemic thinking to connect current to future situations.
10. Use dialog to foster learning and clarity of action.

Decision Analysis Tree

- Uncertainties to deal with:
  - Winning/loosing
  - Cost of unit



- Starting on the left with the initial decision point and proceeding to the right, the decision diagram must accurately represent each point where a decision is to be made and all the possible consequences of that decision.

Trade Studies

- Purpose: To provide an objective foundation for the selection of one of alternative approaches to the solution of an engineering problem
- Trade studies may address any of a range of problems
  - from the selection of high-level system architecture to the selection of a specific COTS parts
- It is tempting to select a solution without performing a formal trade study
  - the selected solution may seem obvious to the developer
  - it will be far easier to justify the selected solution in a proposal or at a formal design review if certain procedures are followed
- Use of a formal trade study procedure
  - will provide discipline in the decision process and may prevent some ill-advised decisions.

Trade Studies: On Formality

- Whenever a decision is made, a trade-off process is carried out, implicitly, if not explicitly.
- Different levels of formality:
  - **Formal**. Use a standardized methodology, formally documented, and reviewed with the customer or internally at a design review
  - **Informal**. Follow the same kind of methodology, but are only recorded in the engineer's notebook and are not formally reviewed
  - **Mental**. Implicitly performed: With less rigor and formality than documented trades. Continuously in our everyday lives.
- Trade studies may not be appropriate when:
  1. the consequences of the selection are not too important
  2. one alternative clearly outweighs all others
  3. time does not permit a more extensive trade

Trade Study Process

1. Frame the problem context, scope, constraints.
2. Establish communications with stakeholders.
3. Define evaluation criteria and weights where appropriate.
4. Define alternatives and select candidates for study.
5. Define measures of merit and evaluate selected candidates.
6. Analyze the results and select best alternative.
7. Review results with stakeholders and re-evaluate.
8. Investigate the consequences of implementation.
9. Use scenario planning to test assumptions about the future.

Trade Study Report Format

1. Scope
2. Tradeoff Study Team Members
   A.
   B. (List Names and Specialties Represented)
   C.
3. Functional and Performance Design Requirements
   A.
   B.
   C.
4. Design Approaches Considered and Significant Characteristics
   A.
   B.
5. Comparison Matrix of the Design Approaches

Feature or Design Requirement	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Requirements 1 (Weight)				
Requirements 2 (Weight)				
Requirements n (Weight)				

6. Design Approach Recommended
   A.
   B.
   C.

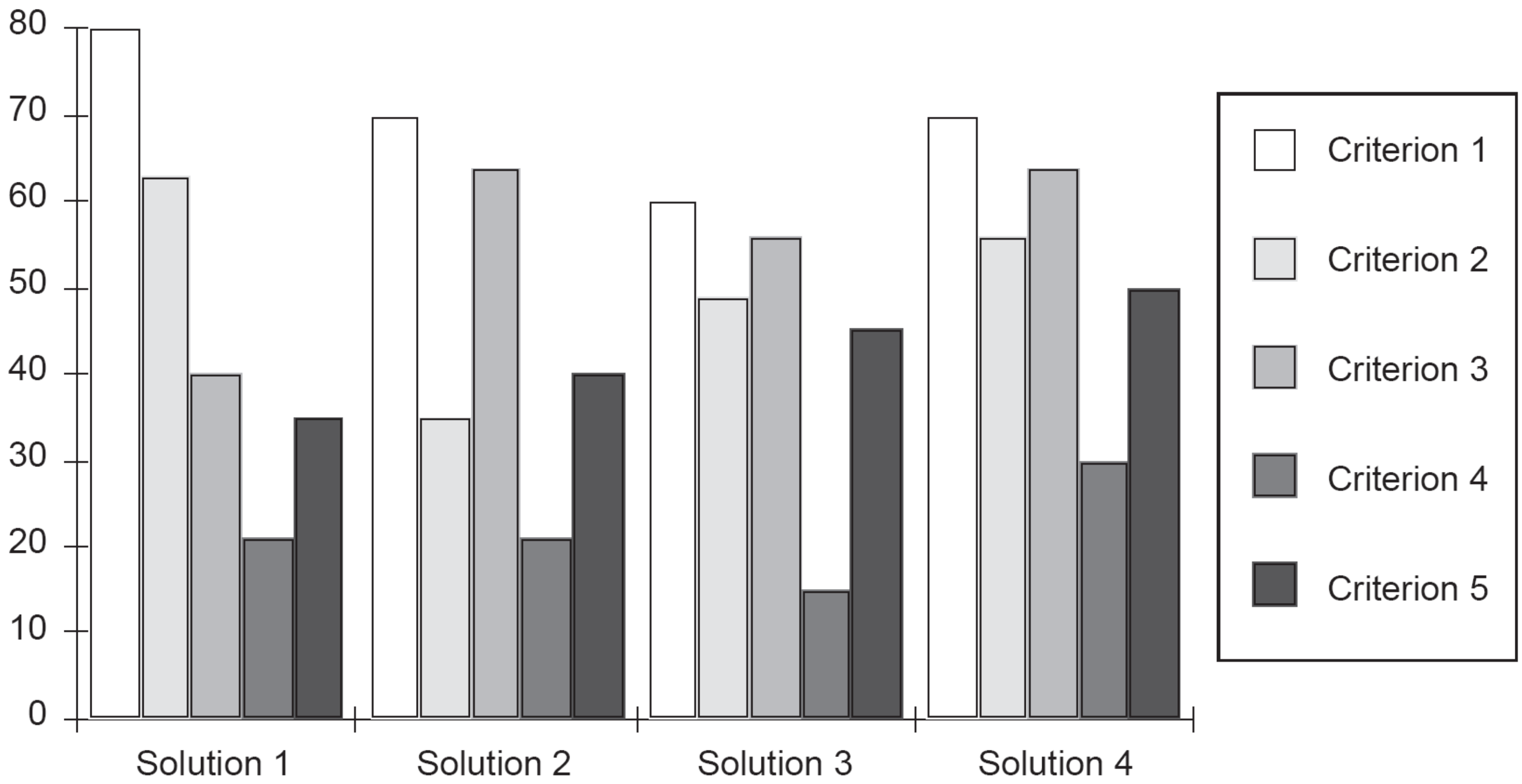
Sensitivity Analysis

- The utility or value of each feature of an alternative is determined or estimated, and often a weight is defined that assigns a relative importance of each feature across all alternatives.

- A sensitivity analysis involves varying each utility and each weight and re-computing the weighted total for each alternative to ascertain what would change if the values of the utilities or weights were different.

- For the final evaluation and selection, a sensitivity analysis should be performed to determine if a relative small variation in scoring is affecting the outcome.

Presenting the Results



› Weighted scores for each criterion for each alternative. Weights are based on utilities of each feature.

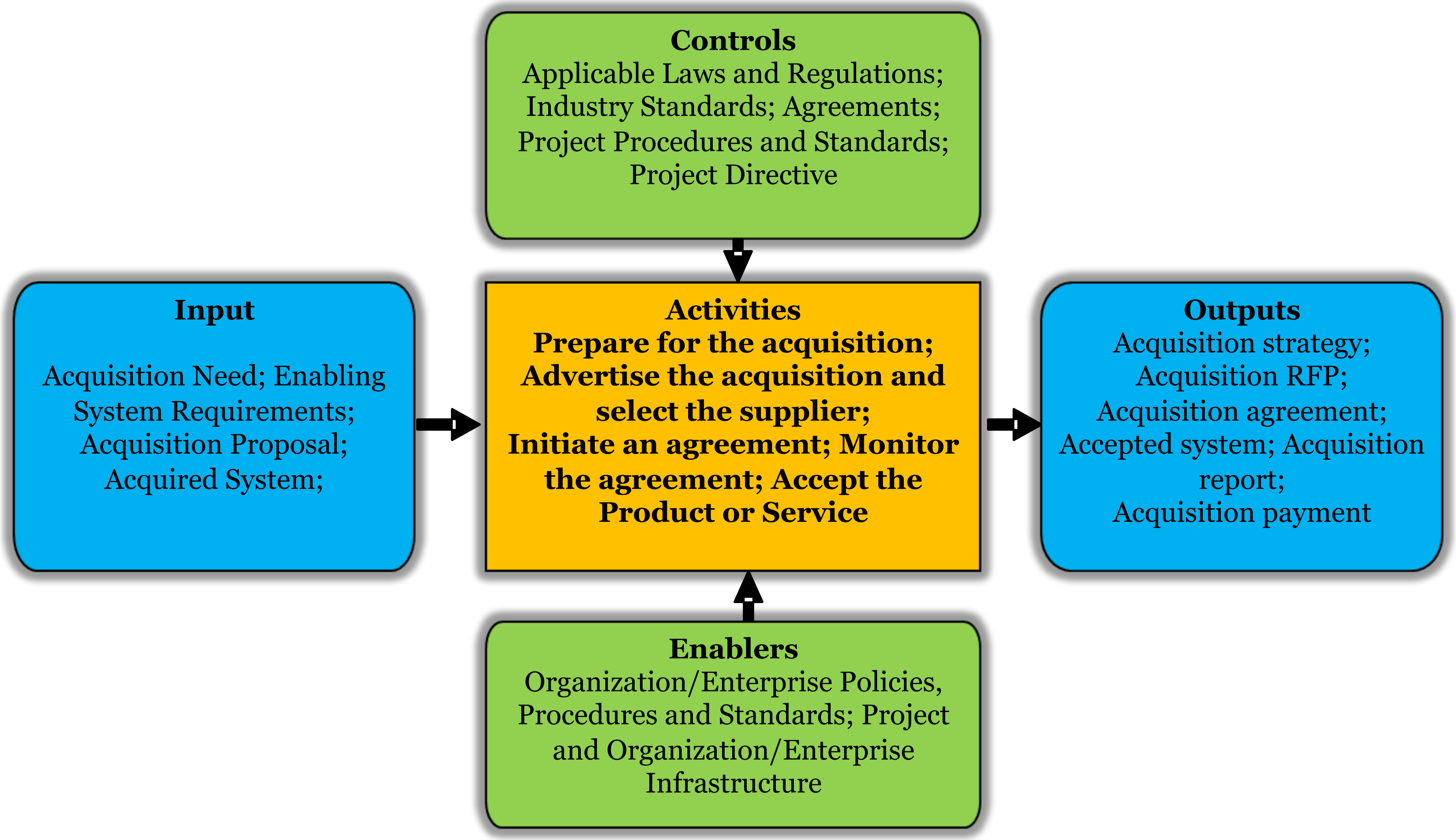
Agreement Processes

Agreement processes define the activities necessary to establish an agreement between two organizations.

- **Acquisition Process** is invoked, it provides the means for conducting business with a supplier: of products that are supplied for use, of services in support of operational activities, or of elements of a system being developed by a project.

- **Supply Process** is invoked, it provides the means for conducting a project in which the result is a product or service that is delivered to the acquirer.

Acquisition Process



› Source: INCOSE Systems Engineering Handbook

Acquisition and Supply Needs

- The start of the Acquisition and Supply process begins with determination of and agreement on user need.

- Once need is perceived and resources are committed to establish a project it is possible to establish parameters of an acquisition and supply relationship.

- Systems engineering responsibility is to facilitate the purchase of more complex services and products.

Acquisition Program Completion

› Systems Engineering supports acquisition program management in defining what must be done and gathering information, personnel, and analysis tools to define program objectives.

› Completion Criteria:

› User organizations have gained authorization for new system acquisition.

› Program development prepares: SOW, SRS, RFP.

› Potential contractors have been selected and have provided input to acquisition.

Request for proposal (RFP)

- Give background
- Document acquisition process
- Document requirements
- Establish evaluation criteria
- Specify terms and conditions
- Give contact information

Evaluation Criteria

- The criteria can be elaborated here based on the parameters that you have decided such as price, duration, quality, flexibility, reliability, innovation etc.
- Accepting a response for a RFP does not mean you have to award the project to the bidder.
- Educating bidders on this clause is equally important as the selection criteria. Following the selection, a contract should be made for the actual project.

Dependency and Outsourcing

	Dependent for knowledge	Dependent for capacity
Outsourcing items decomposable	**A potential outsourcing trap** Your partners could supplant you, They have as much or more knowledge and can obtain the same elements as you can	**Best outsourcing opportunity** You understand it, you can plug it into your process or product, and it can be obtained from several sources. It does not represent competitive advantage in itself. Buying it means you save attention to put into areas where you have competitive advantage such as integrating other things
Outsourced item is integral	**Worst outsourcing situation** You don't understand what you are buying or how to integrate it. The result could be failure since you will spend so much time on rework or	**Can live with outsourcing** You know how to integrated the item so you may retain competitive advantage even if others have access to the same item.

Outsourcing Pros and Cons

Pros

- Provide competitive alternatives.
- Allows contact with different sources and kinds of knowledge.
- Augments in-house capabilities.
- Augments in-house capacity.
- Reminds everyone that there is no monopoly on skill or knowledge.

Cons

- Decentralizes things that need central oversight.
- Breaks chains of delivery of quality.
- Disperses responsibility and accountability.
- Opens the door to conflicts of interest.
- Devolves power (performance processes, or knowledge).
- Fosters the illusion that everything is plug and play and that cost is the only differentiator.
- Foster the illusion that risk can be eliminated while reward can be retained.

Supply Process