

Managing Systems Engineering of Complex Systems

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Abstract

Procurement of complex systems is one phase of a system's total lifecycle and as such benefits from the application of Systems Engineering. Of special interest is the management of requirements as the basis for the validation activities during acquisition and verification activities at subsequent delivery of the system. The acquisition and engineering of complex systems require a tight co-ordination in four dimensions -- roles, responsibilities, artefacts and competence – visualised in the Project Product Model Pyramid. The pyramid illustrates the evolution of information from project related to product related uses over the system lifecycle. The value of using ERP technology to manage this evolution is also addressed.

Systems Engineering

- Two of many definitions of Systems Engineering

- Systems Engineering is a robust approach to the design, creation, and operation of systems. (NASA SE Handbook)
- An interdisciplinary approach and means to enable the realization of successful systems. (INCOSE)

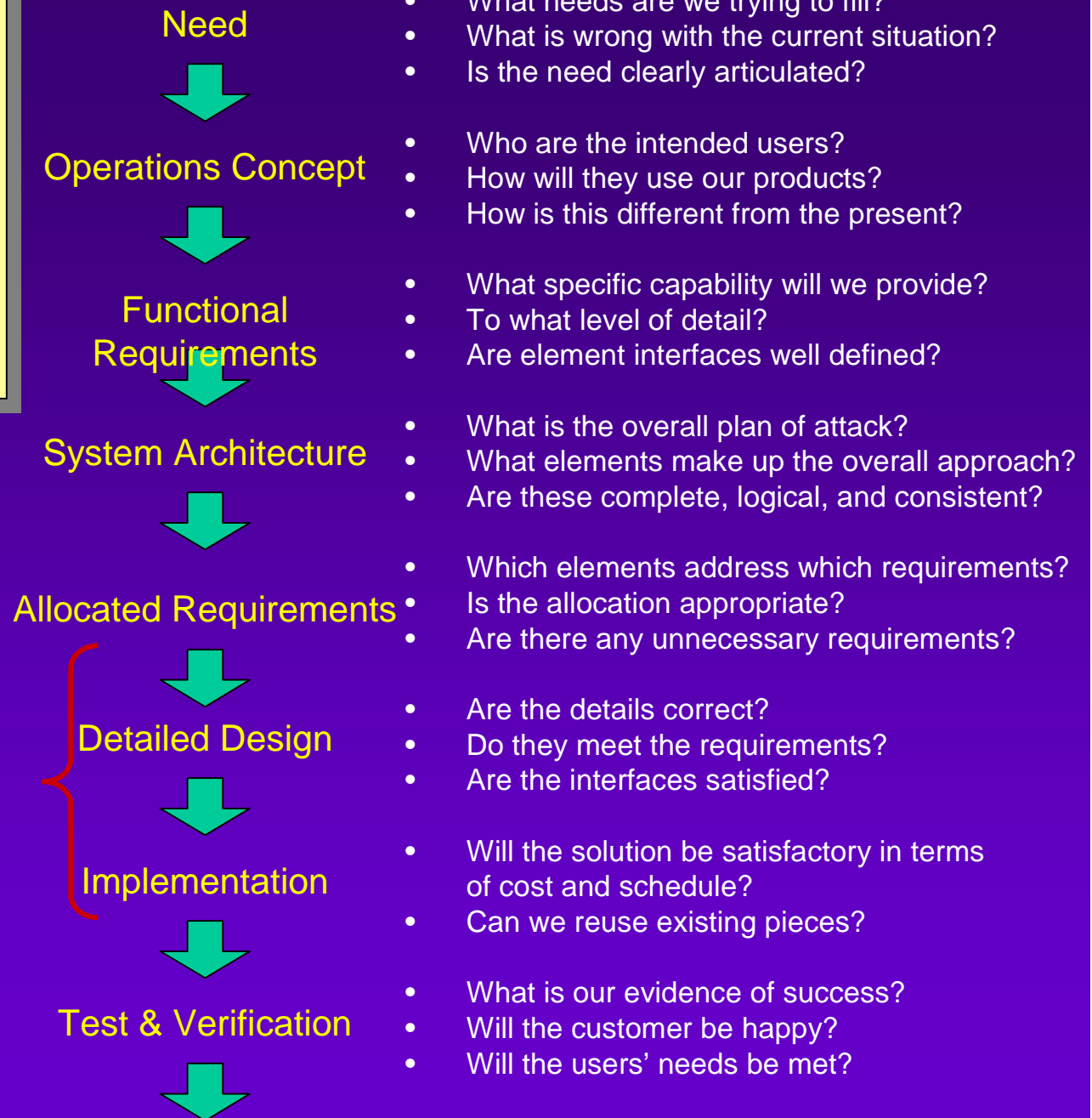
- Systems Engineering consists of:

- Identification and quantification of system goals and requirements
- Creation of alternative system design concepts (functional and physical)
- Performance of design trades
- Selection and implementation of the correct design (balanced and robust as related to the requirements)
- Verification that the design is actually built and properly integrated in accordance with specifications
- Assessment of how well the system meets the goals

• Focus of Systems Engineering

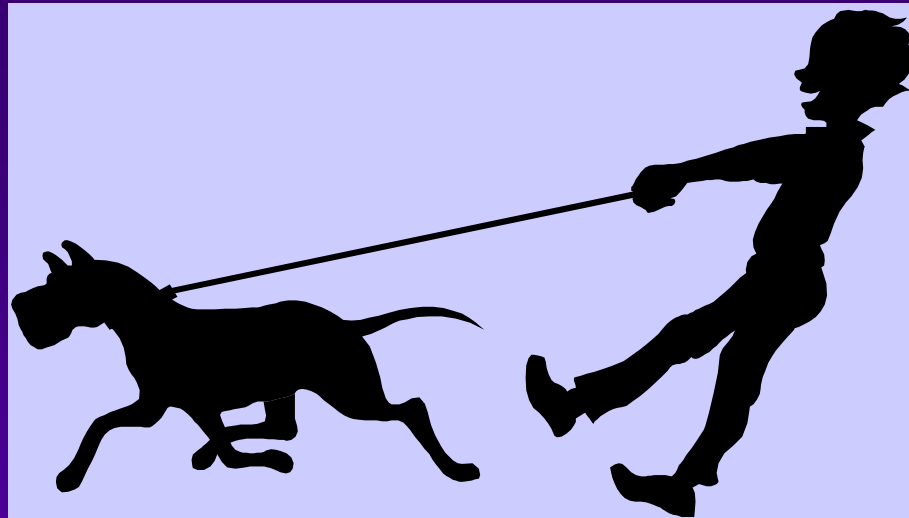
- From Original Need
- To Final Product
 - The Whole System
 - The Full System Life Cycle

Focus of Component Engineering
On Detailed Design
And Implementation



Complexity

- What do we mean when we say that something is complex?
 - That it has many sides or aspects to it,
 - needs many variables or parameters to describe it,
 - or consists of many parts?
 - Or that it is hard to understand,
 - needs many words to explain,
 - or is difficult to predict?
- Usually we mean an unspecified combination of some or all of these and similar definitions, with the emphasis depending on the particular case.
- In one way or the other, complexity is related to the number of parameters required to describe behaviour.
- Complexity increases enormously as soon as humans are involved. Or any living organism, for that matter.



The latter can be exemplified by the fact that we can predict the position of the planets five years from now, but not the position of a dog five minutes from now.

The generic Project phases

PRR Process Review

PDR Preliminary Design Review

CDR Critical Design review

FCA Functional Configuration Audit

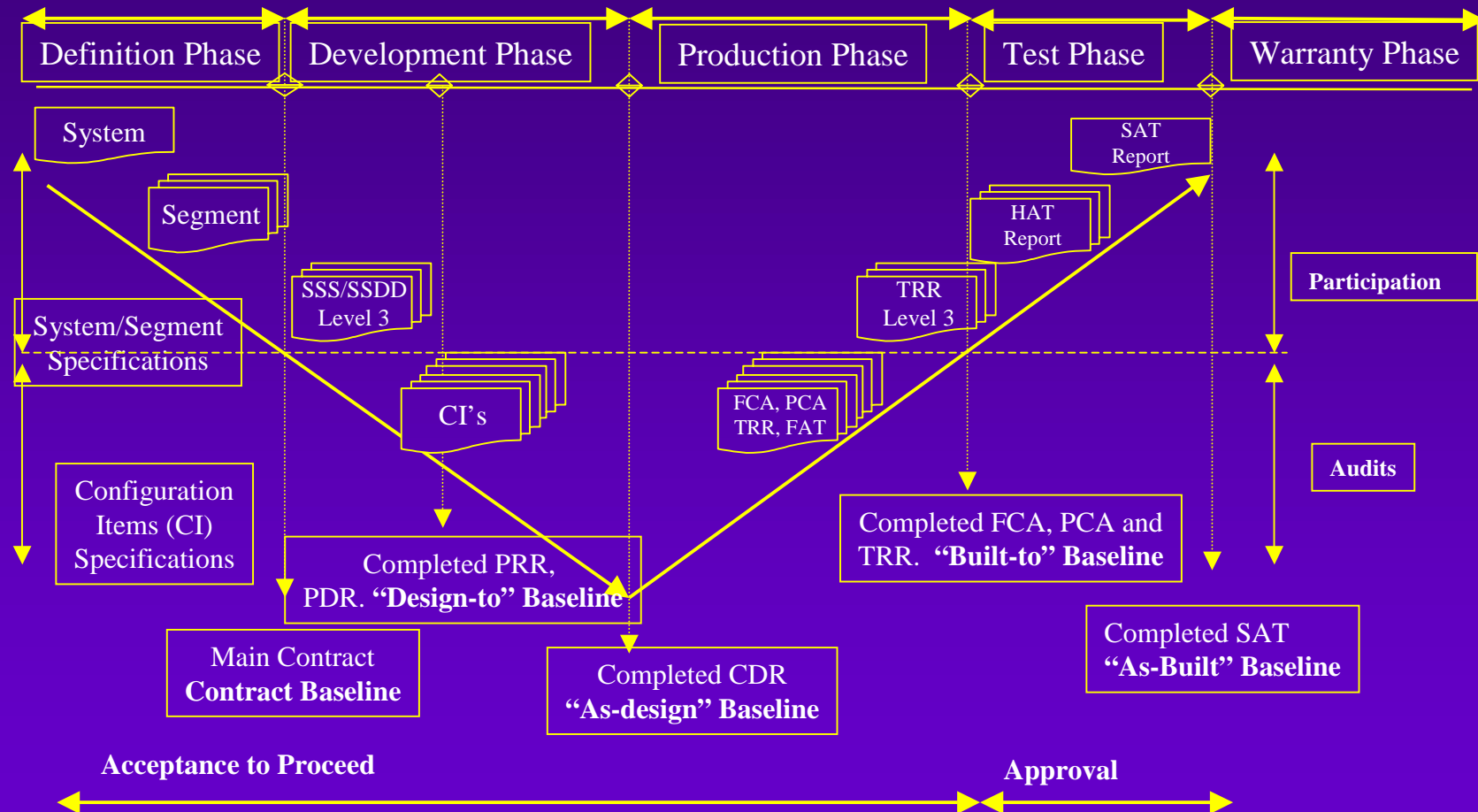
PCA Physical Configuration Audit

TRR Test Readiness Review

FAT Factory Acceptance Test

HAT Harbour Acceptance Test

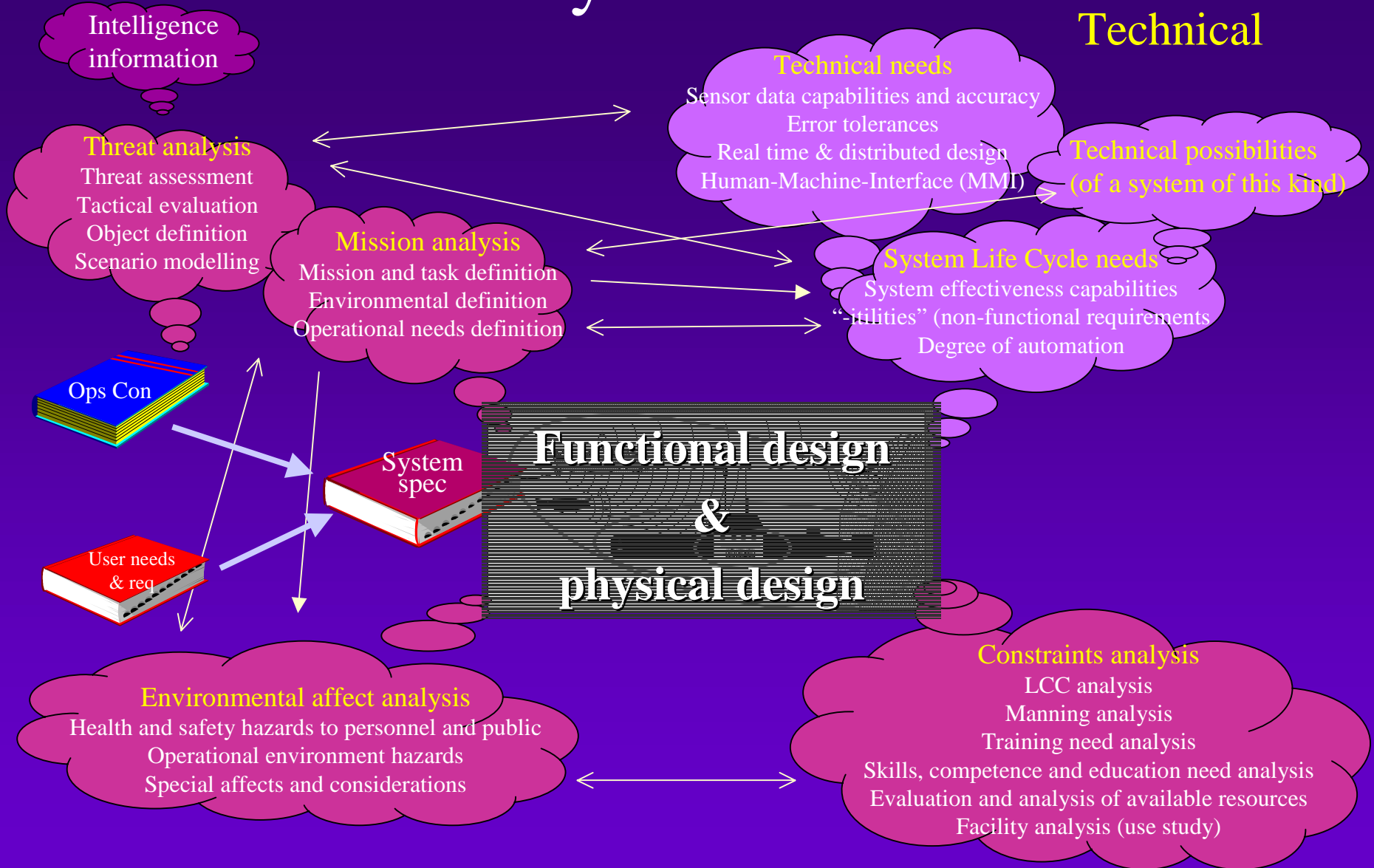
SAT Sea Acceptance Test



Operational

The System definition

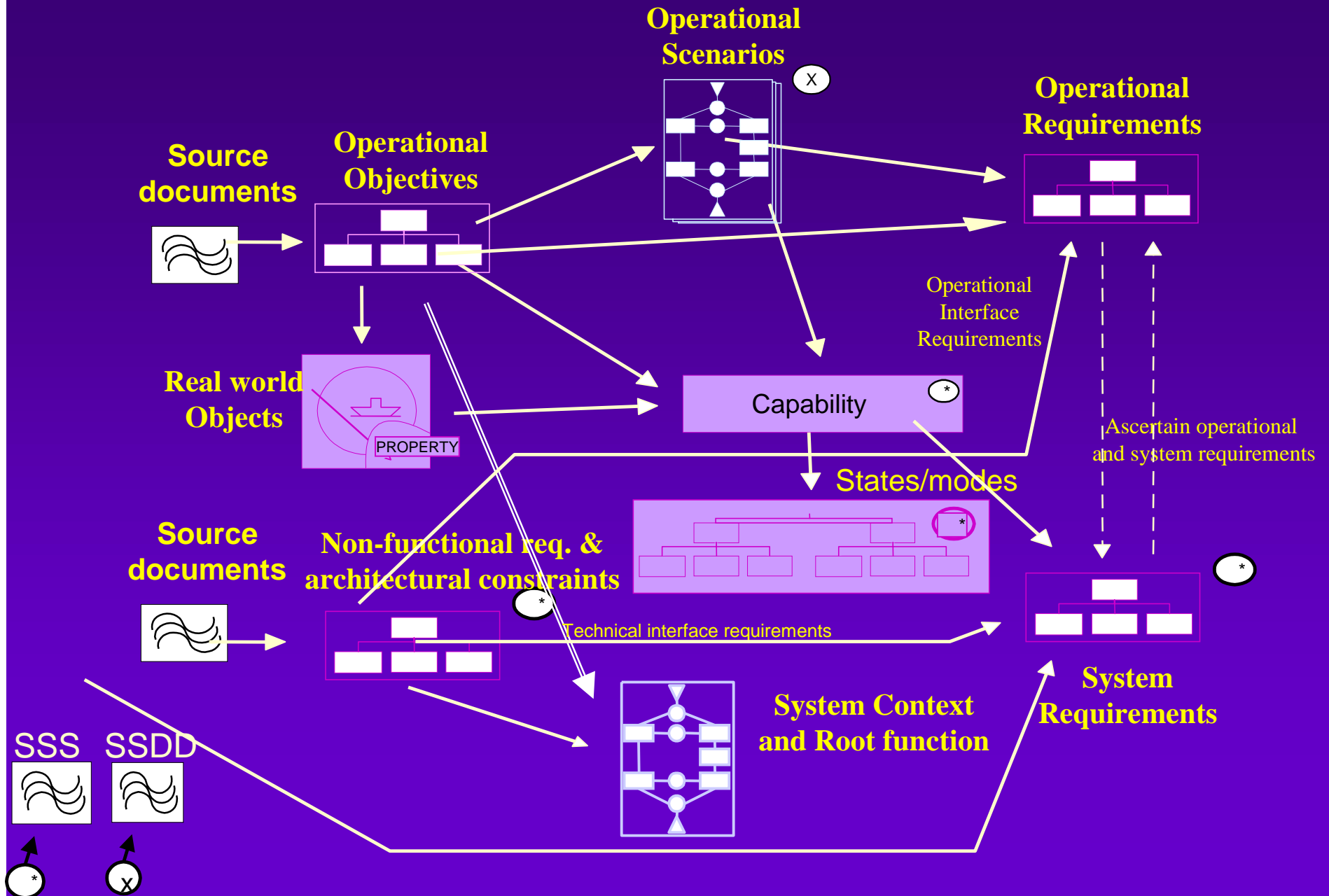
Technical



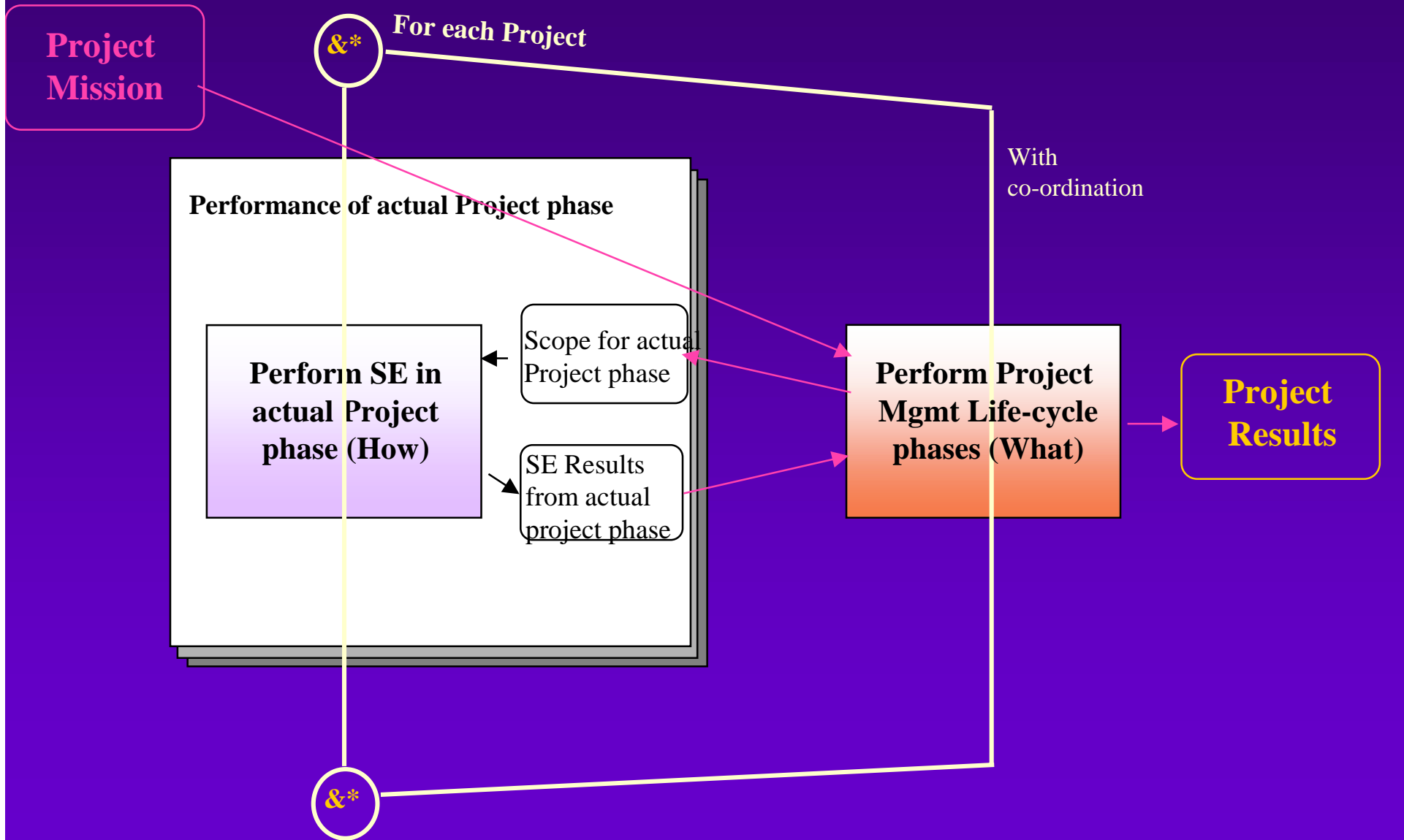
Environmental

Resources and organisational

A SE process for SE of complex systems



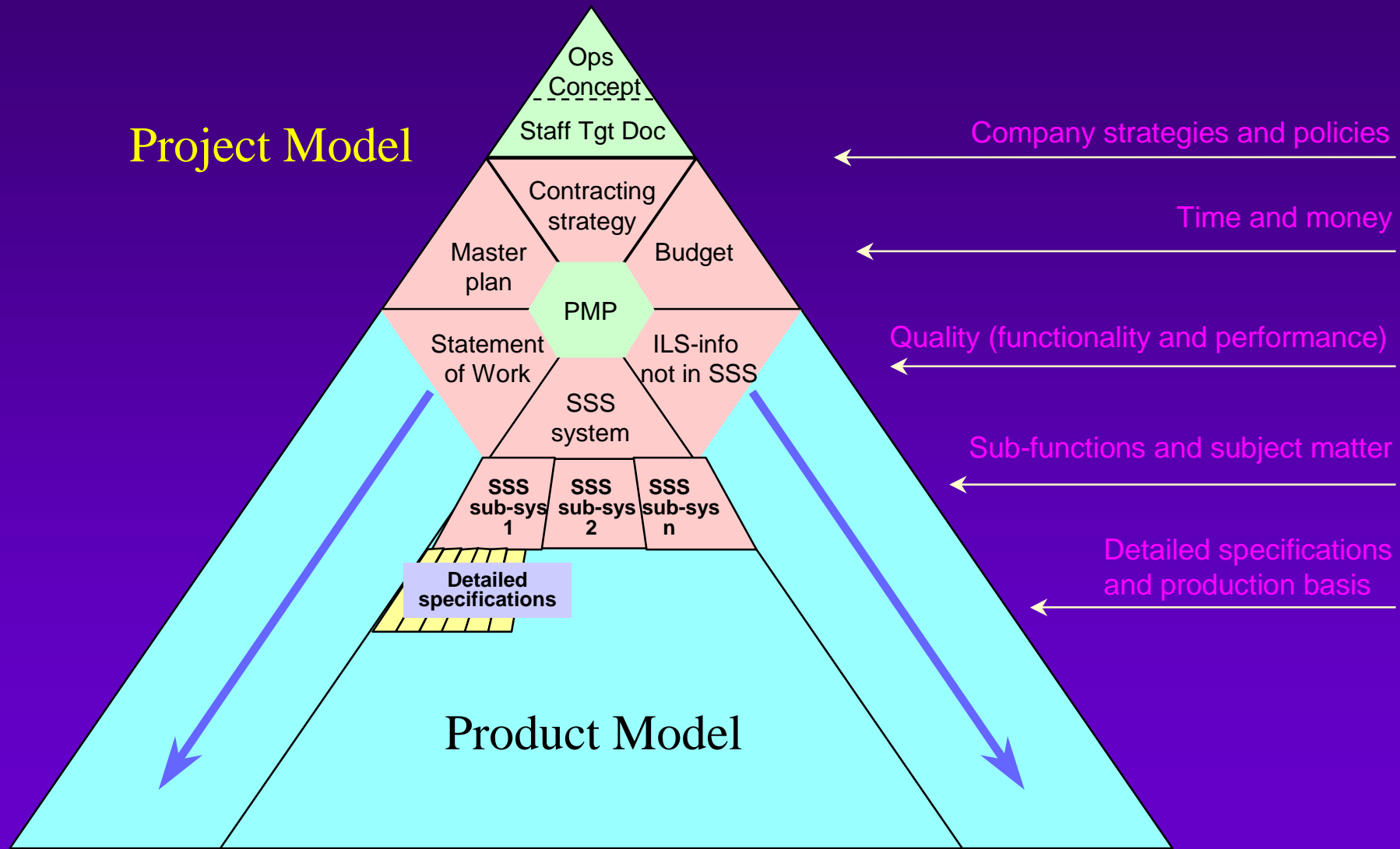
Top level Systems Engineering Process Model



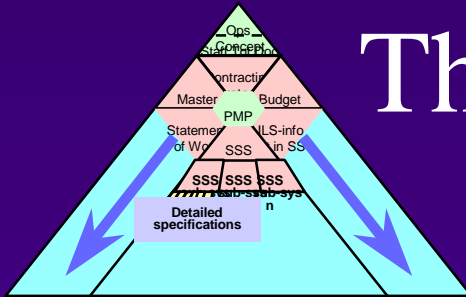
SE-CMM key process areas assigned to process categories

Engineering Process Areas	Project Process Areas	Organisational Process Areas
1. Analyse Candidate Solutions	8. Ensure Quality	13. Define Organisation's SE Process
2. Derive and Allocate Requirements	9. Manage Configurations	14. Improve Organisation's Systems Engineering Processes
3. Evolve System Architecture	10. Manage Risk	15. Manage Product Line Evolution
4. Integrate Disciplines	11. Monitor and Control Technical Effort	16. Manage Systems Engineering Support Environment
5. Integrate System	12. Plan Technical Effort	17. Provide Ongoing Knowledge and Skills
6. Understand Customer Needs and Expectations		18. Co-ordinate with Suppliers
7. Verify and Validate System		

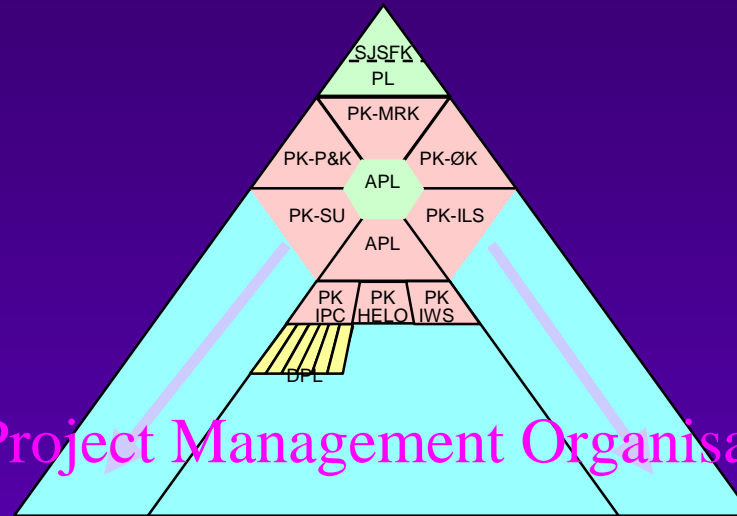
The Specifications / Configuration Items as part of the Project/Product Model



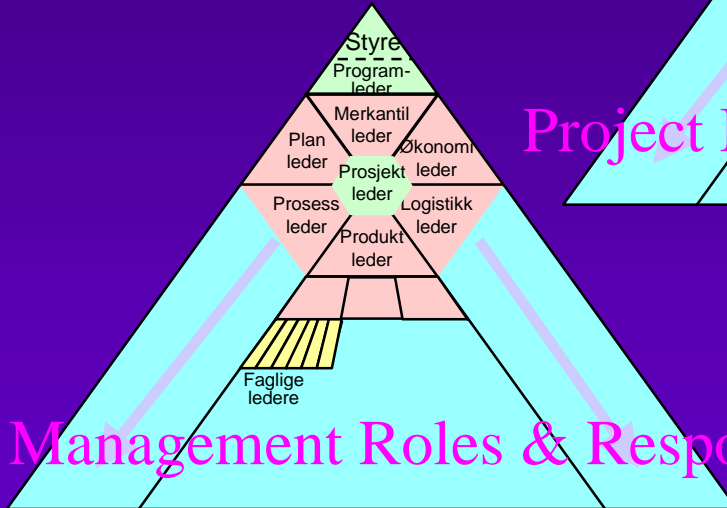
The Project / Product Model



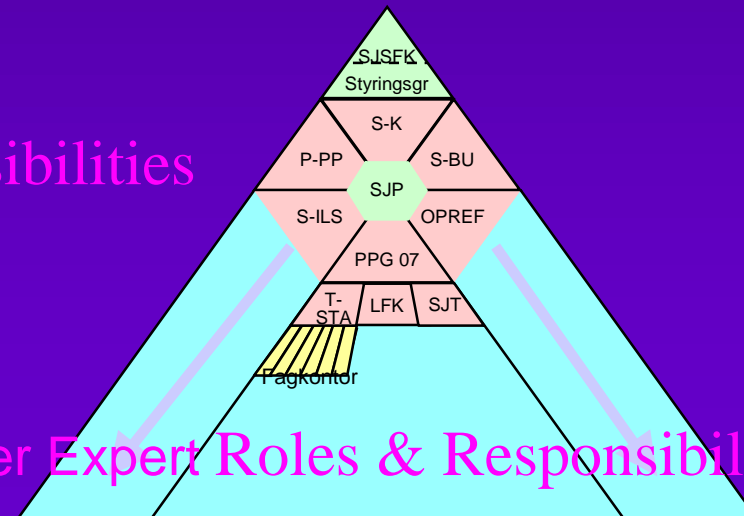
Configuration Items
(including specifications)



Project Management Organisation

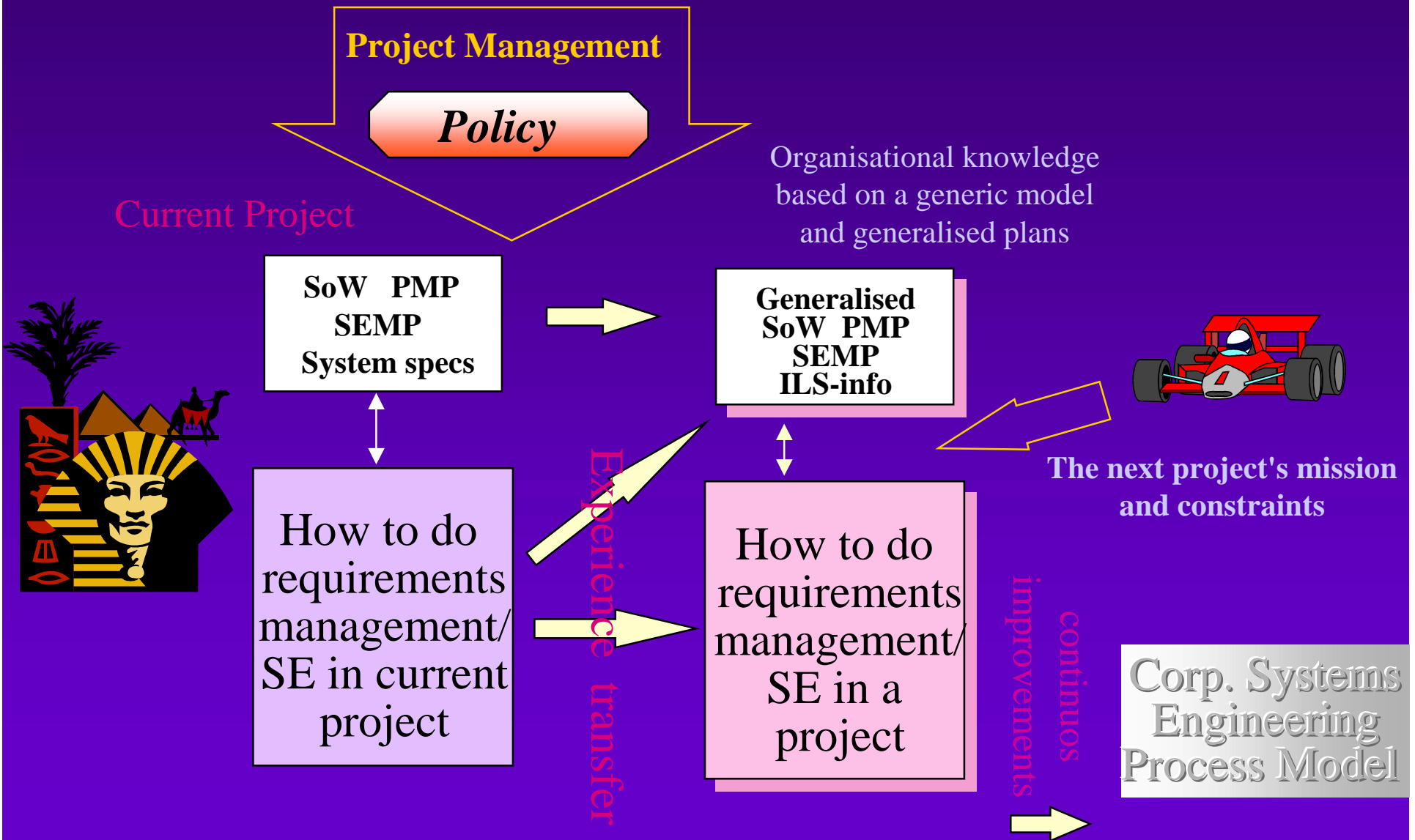


Project Management Roles & Responsibilities



Subject Matter Expert Roles & Responsibilities

Implementing improvements



Methodology Improvement Cycle



