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***Patterns: the Good, the Bad and  
the Beautiful***

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# Patterns

Reusable solutions to problems in context

- Problem frame is a kind of pattern

Communicates knowledge about decisions

- Chosen solution to the problem (what)
- Decisions that led to the solution (why)
- How decisions link problem to solution (what & why)

Role in systems engineering processes

- requirements-related decision-making
  - investigate support for making decisions about trade-offs in complex systems - submarines and air traffic control

# Systems Engineering

Decisions are made by systems engineers

- human judgement and experience

Useful patterns arise

- from reflection about people's design decisions and experiences (Patterns literature)

Pilot sessions with BAE SYSTEMS

- systems engineers designing submarines
- open-ended elicitation sessions
  - what structures most natural to reuse
  - categories of decisions elicited with card sorts

# The Quiet Manoeuvre Pattern

From BAE SYSTEMS designers

“Submarines use hydroplanes to manoeuvre. The systems engineers make decisions to trade-off between the satisfaction of the accurate-manoeuve requirement and the quiet-manoeuve requirement, so as to navigate successfully and avoid detection”

The I\* representation of the pattern includes

- system, sub-system and component agents, goals and tasks of these agents, different dependencies, means-end and contribution-links, and networks associated with the alternative solutions

A pattern of forces?

# About the Pattern....

## Usefulness for the systems engineers

- supports extensive reflection about design process
- potentially reusable in engineering projects

## Characteristics of the pattern

- elements of the operational environment (scenarios), different machine agents, goals and tasks attributed to these agents
- complex relationships between the elements (dependencies, means-end links, contribution links, cause-effect links), and rationale structures
- some elements precise, some less precise

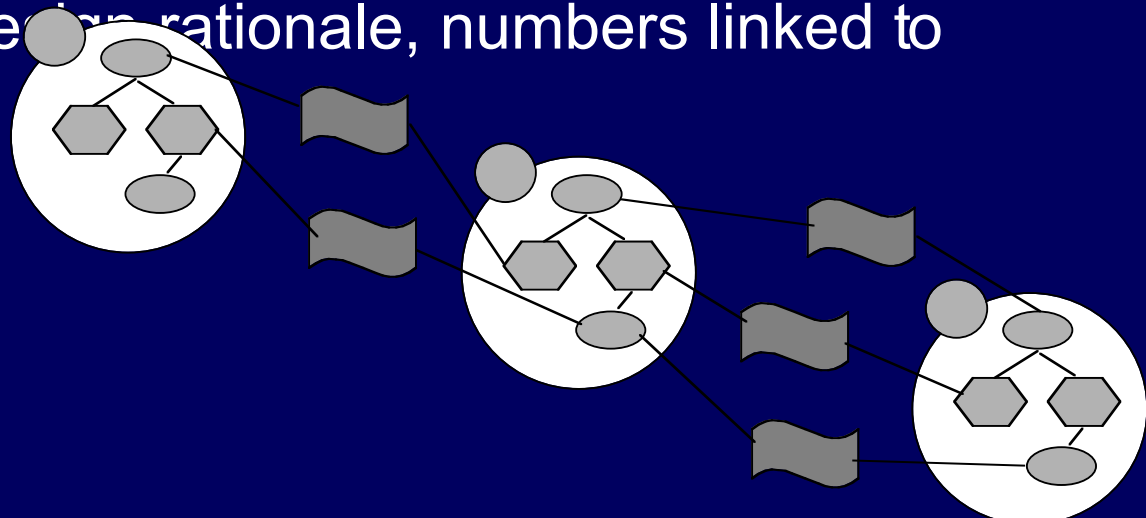
# What Characterises the Pattern

## Solution to problem

- different hydroplane designs that are compliant with goals of the submarine and manoeuvring systems

## Decisions LINKING solution to problem

- dependencies, means-end links, contribution structures, decision rationale, numbers linked to solutions



# Quality without a Name

- Alive (e.g. a well-made fire)
  - self-contained system of interacting elements
- Whole
  - system is harmonious, free from internal contradictions and inner forces acting against themselves
- Exact
  - precise model of forces acting in balance
- Egoless
  - no single masterplan, rather emergent design

## So What....

Patterns emerge bottom-up from design domains

- So can we define a priori categories?

So what can we do?

- Better understand the nature of decision-making related to system requirements
- Work from experience and patterns literature to define what patterns are, and to develop semantics and syntax for modeling, analysing and reflecting on patterns
  - what does Alexander have to say...