The Many Faces of Systems Engineering

Or, why it is so exciting to be a Systems Engineer?

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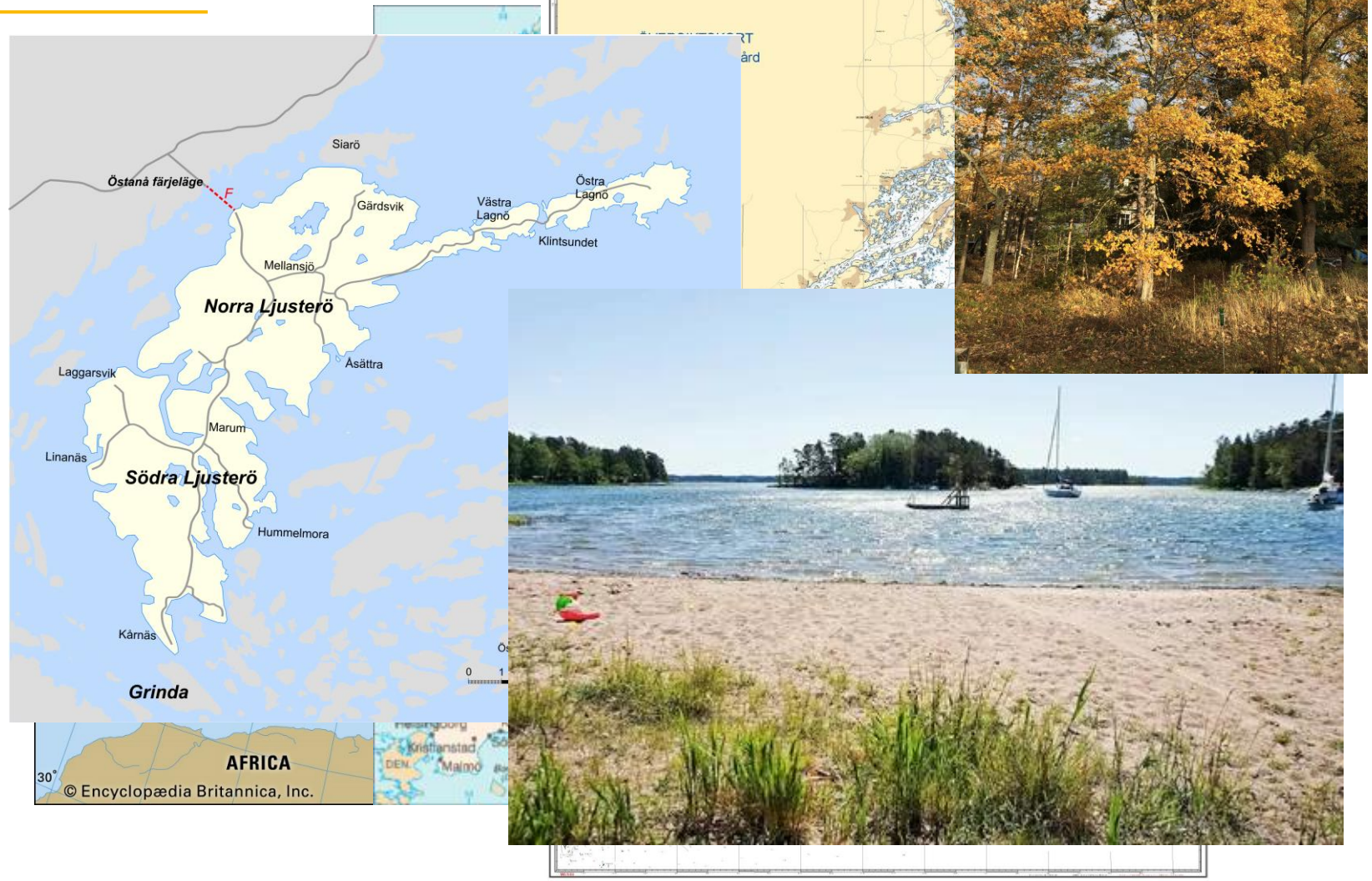
SAAB Technical Fellow - Systems Engineering

SAAB - The domain

Saab Aeronautics

Erik Herzog @ Saab Aeronautics



Development and coaching in
- Systems Engineering
- Change leadership

President INCOSE Sweden chapter

Systems Engineering

Really necessary?

Challenge: Managing the system properties

RCS

Payload

Fuel capacity

Fuel consumption

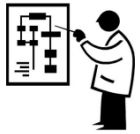
Service life

Weight

Center of Gravity

Environmental impact

Safety



Range

Supportability

Availability

Development Cost

Maintenance interval

Flight envelope

Operational cost

Survivability

Challenge: Developing the same system

Systems Engineering from a roles perspective


Requirements owner


System designer


System analyst

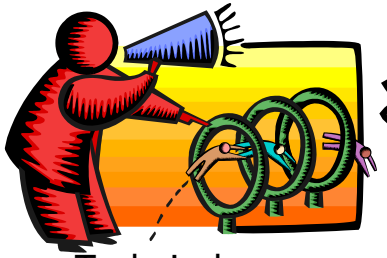

Verification & Validation

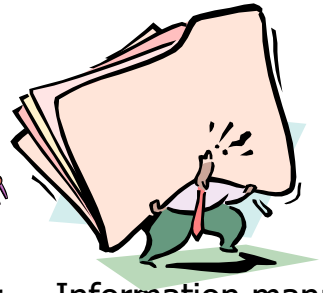

Logistics & Operation


Glue engineer


Customer interface


Co-ordinator


Technical manager


Information manager


Process engineer


Classified ads engineer

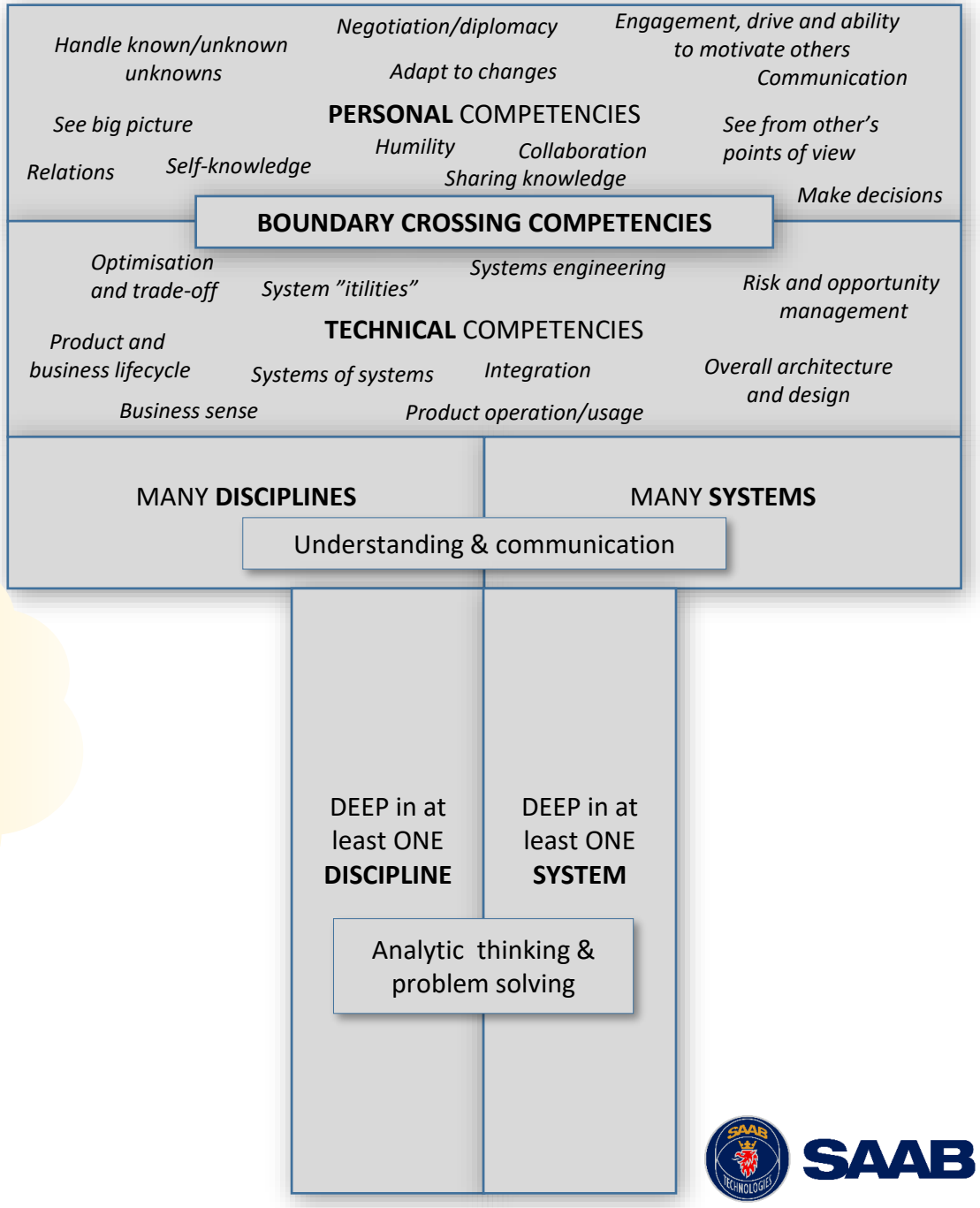
S. Sheard,"12 Systems Engineering roles", Proc of INCOSE 1996

The Competence view

Systems Engineering competences

- **Technical** competences
- **Personal** comptences

But this is clearly impossible for a single person to master!



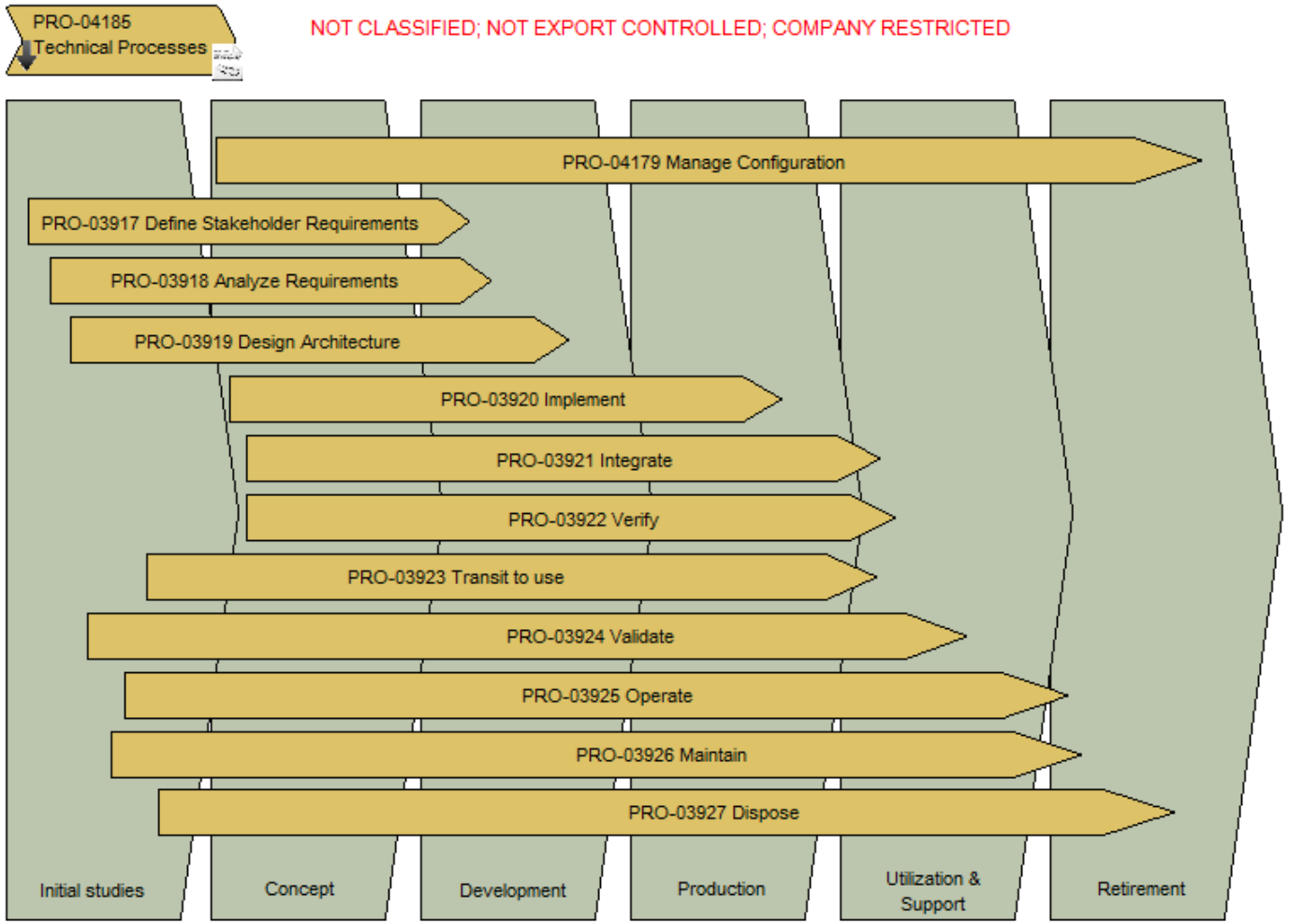
Complexity – the nature of the challenge

(Snowden 1999)

- **Obvious** – known knowns
  - Linear work, progress one thing at a time
- **Complicated** – known unknowns
  - Linear work – with feedback
- **Complex** – unknown unknowns
  - Parallel work
- **Chaos** – cause and effect - unclear
  - Parallel work

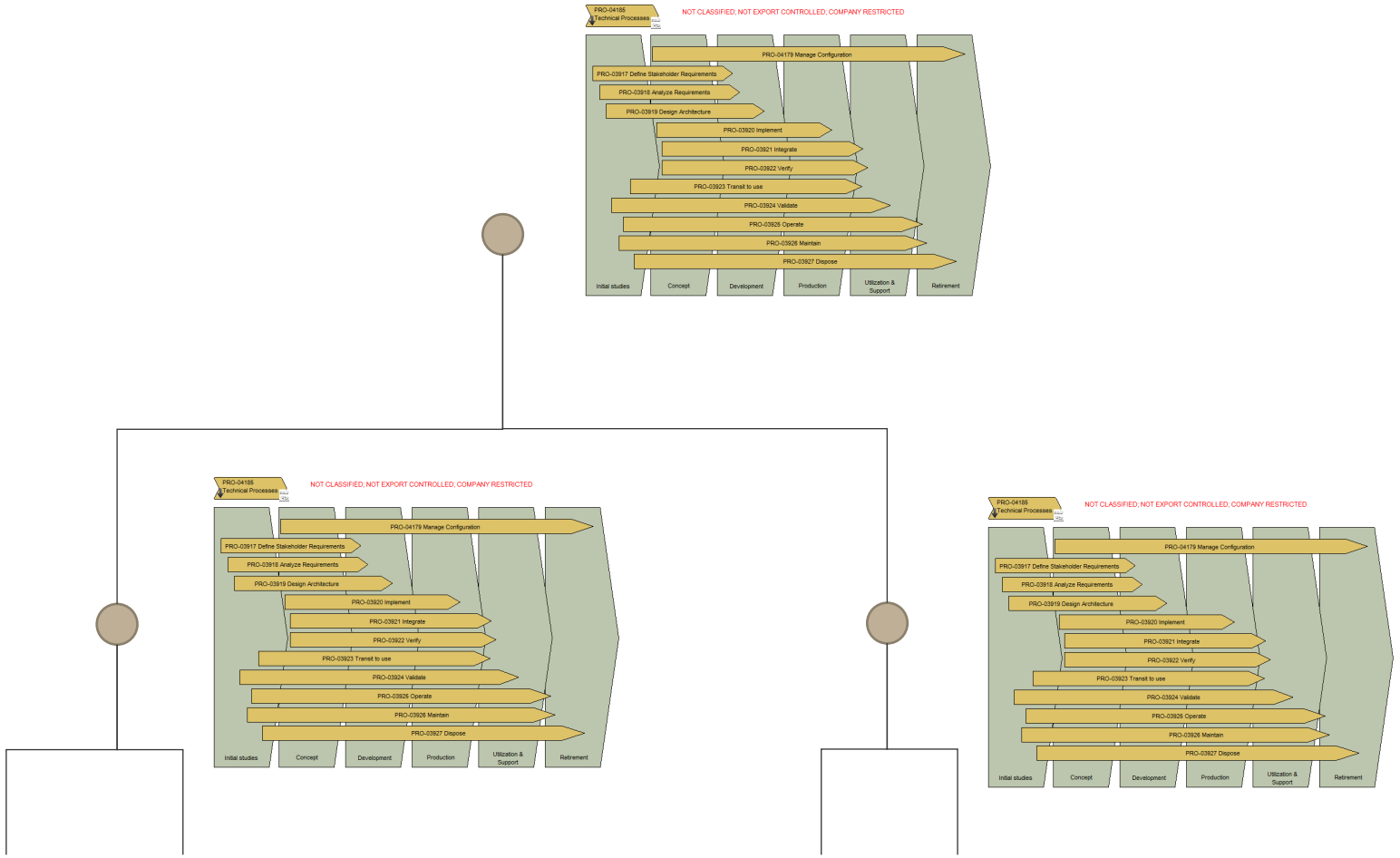
Process

Lifecycle and Processes view



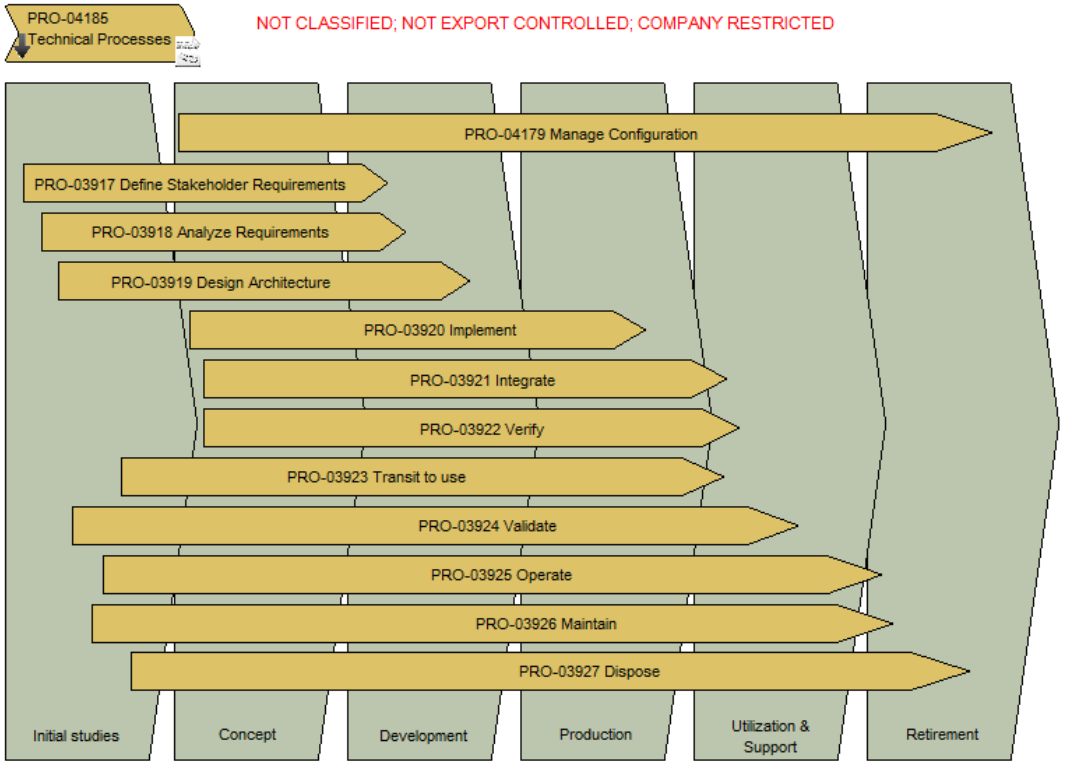
Saab process framework – based on ISO 15288:2008

Process, Lifecycle and System Structure



Why processes?

- Process as a mean for communication
  - Setting the organisation vocabulary – for the complete development scope
  - Defines the basis – but must be tailored for each application
- The baseline for building Systems Engineering competency
  - Ensure that the same vocabulary and principles are shared by all in the organisation
- The baseline for continuous improvement



So lets start development!

Development: a down to earth view

- At least 4 planning views looking into the future
- **Requirements**
  - The desired properties of the realised system
- **Architecture**
  - The desired structure, behaviour, interfaces of the realised system
- **Resources**
  - Who shall perform the work, and when
  - Priorities between contesting tasks
- **Time**
  - The desired point in time when a particular realisation should be ready

There is a lot of uncertainty embedded in these views

Proper application of modelling and simulation may decrease, but not remove the uncertainty

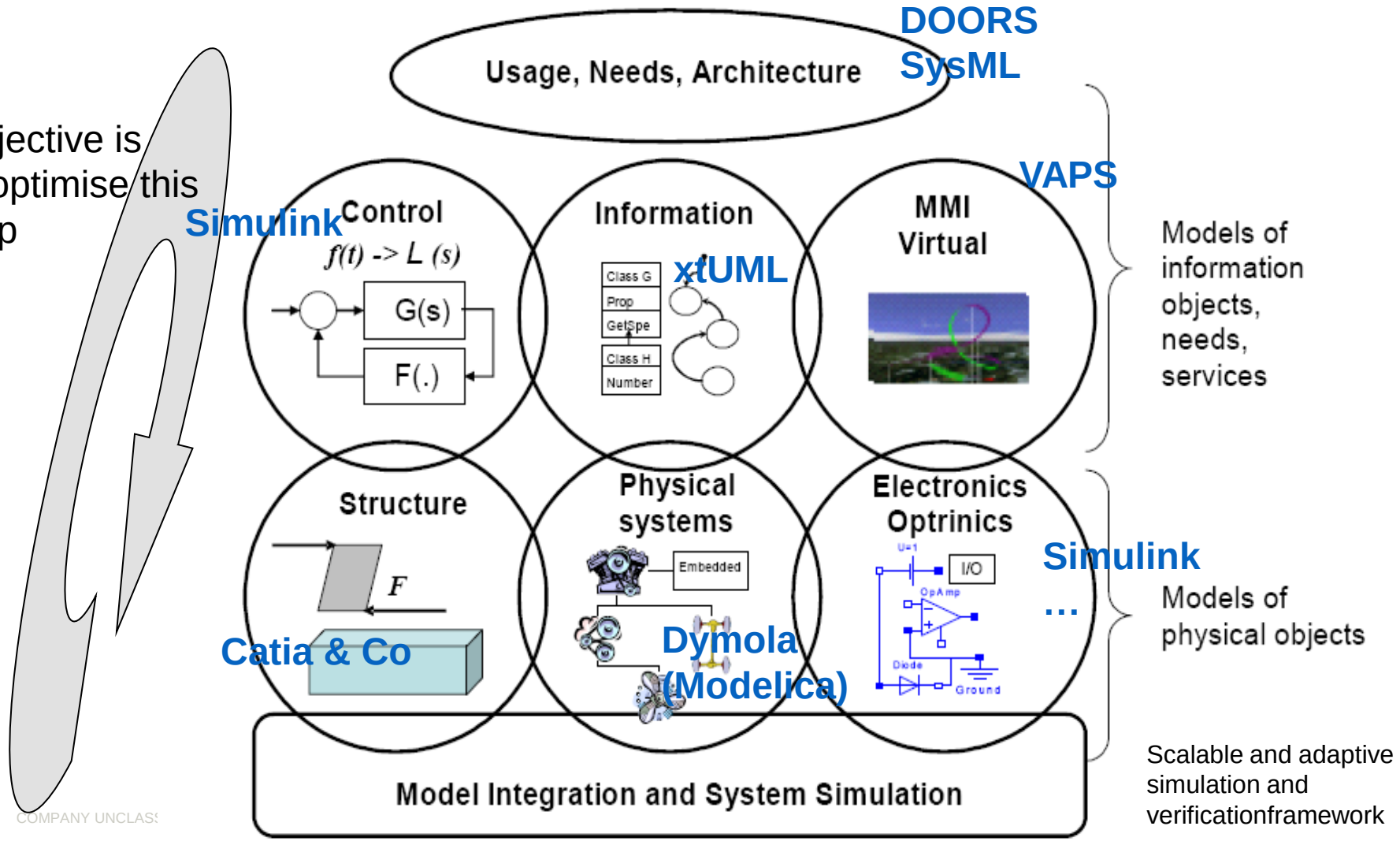
We are not clairvoyant enough to identify what we will integrate a long time in advance!

There is also the constant change in the opportunities of when to integrate

Designing with model-based support

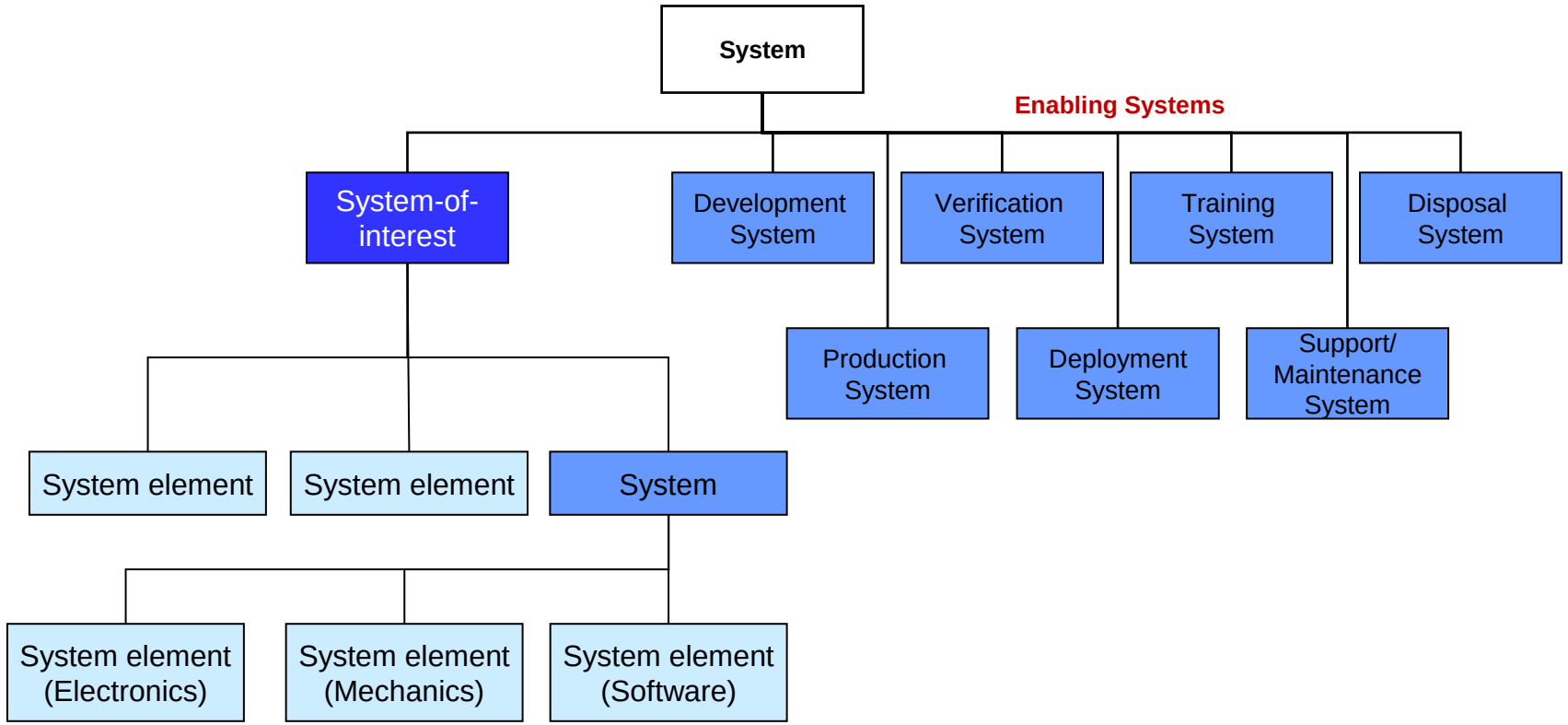
Working with models

Objective is to optimise this loop



Building the enabling systems

Enabling systems model



Enabling systems example

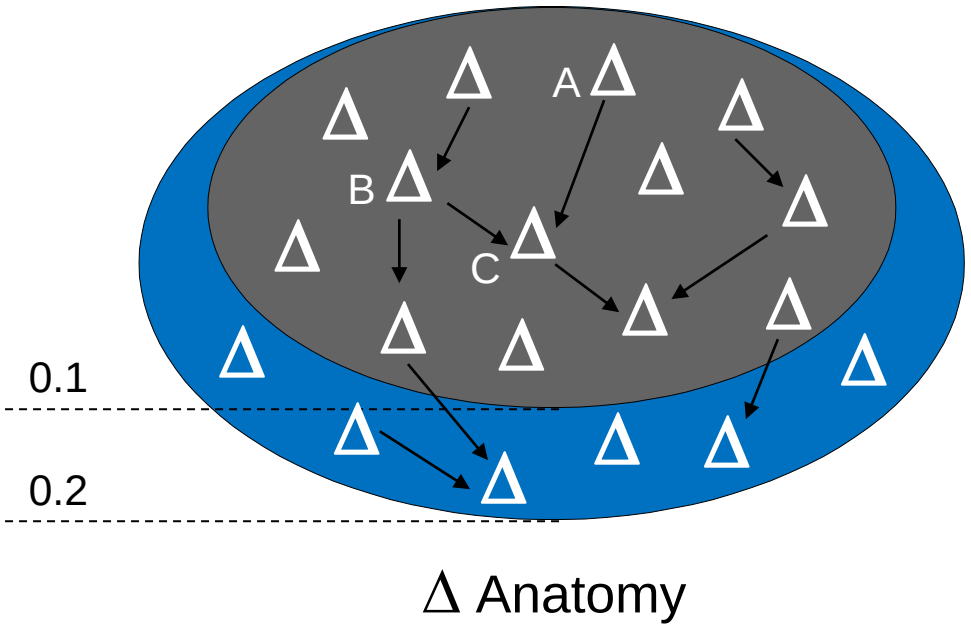
How well does the models in a test rig represent the real aircraft?

A note on integration

Integration: It can be hard…

Integration

Parallel incremental development is mastered using delta anatomies



Δ Anatomy

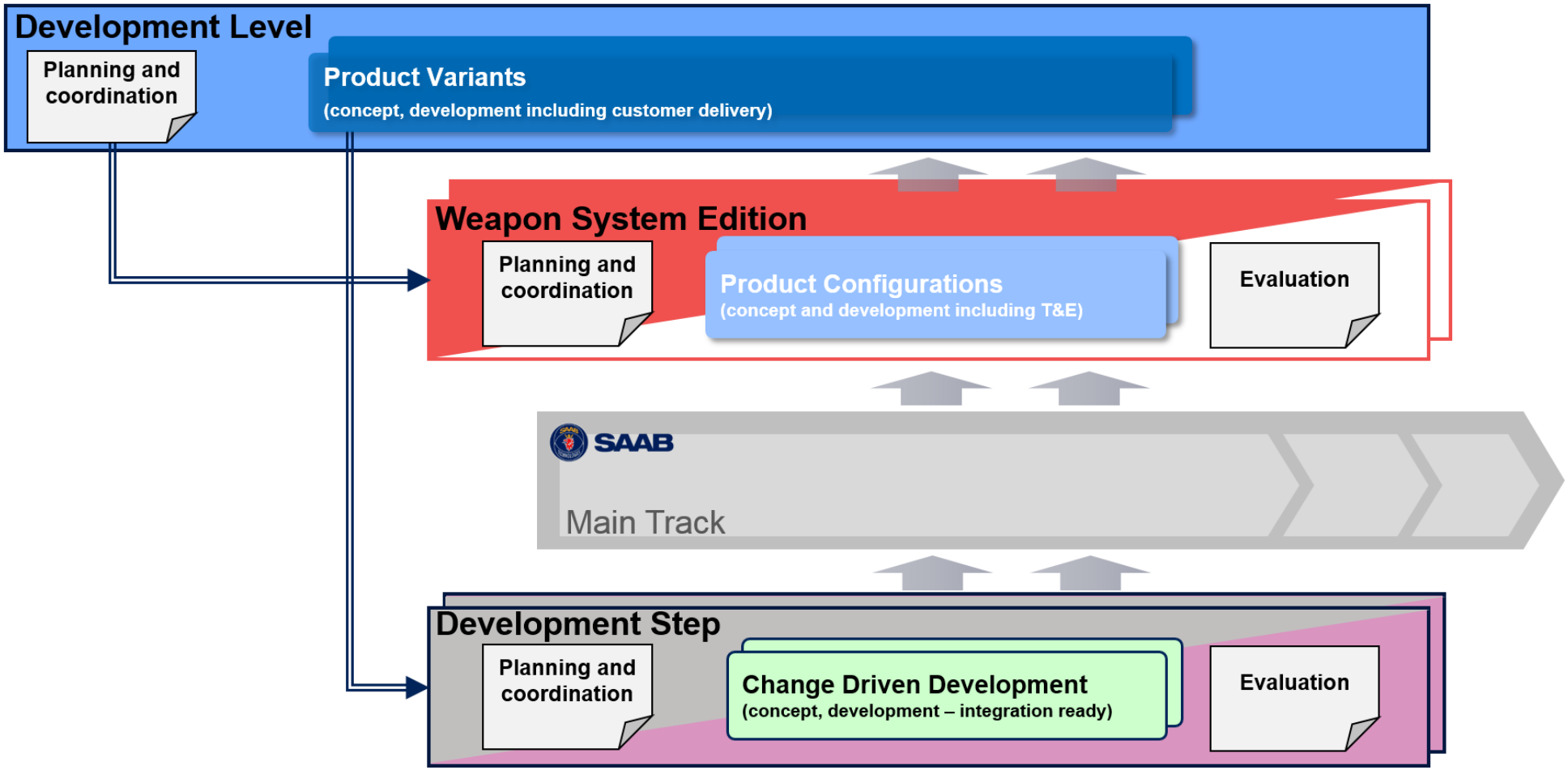
The anatomy shows all currently planned system changes (Δ) and their dependencies.

The dependencies constrain the order in which changes can be done, and determine the possible level of parallelism.

→ Integration Dependency: Both A and B must be integrated before C can be integrated and tested.

The development framework

Saab Aeronautics development model



Transit to use

Delivery of the first Gripen E to Brazil

Operations and Maintenance

Operations and maintenance

Summary

Summary

- Systems Engineering is the enabler for development, operations and retirement of complex systems!

How are Saab using INCOSE?

INCOSE benefits for Saab

- The authority
  - Internal methodology harmonisation
  - Yardstick for state-of-the-art
- Communication with industry colleagues
  - Nationally within the chapter
  - Working groups
  - International events
  - Corporate Advisory Board
- Certification of engineers
- Competence development
- Publication of papers for demonstrating our achievements