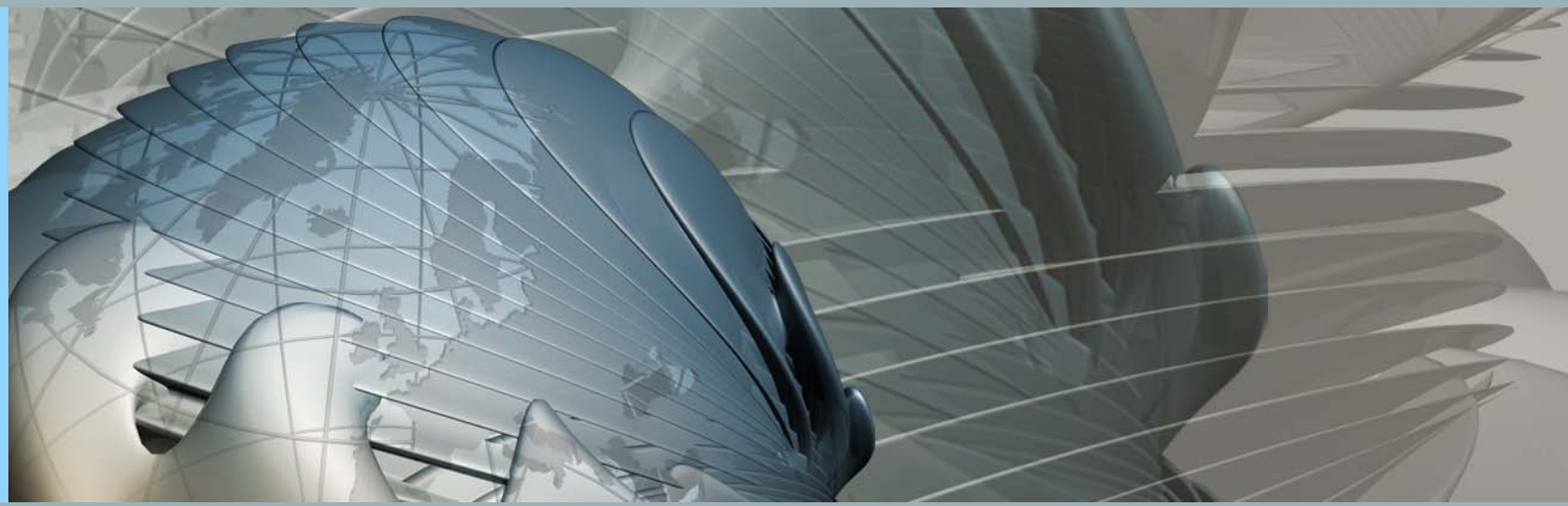
Innovation Works



Providing Innovation in Engineering for the benefit of EADS

EADS Innovation Works

IW Staff in France and Germany
Headcount : 600+
+
PhD/Thesis : 75+

IW Spain :
75 Planned

SRTC (Singapore)
25 Planned

IW UK
200 Planned

Core Competencies

Materials & processes and advanced manufacturing

Structures engineering and acoustics

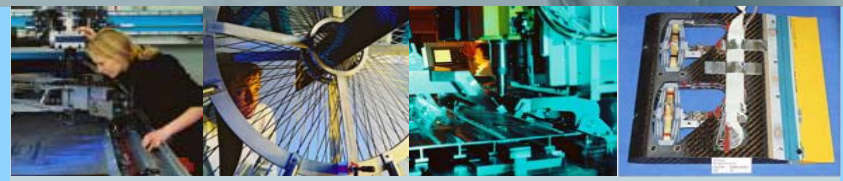
Microsystems, electronics and image processing

Systems engineering and systems environment sciences

Information systems security

Processes for engineering and information management techniques

Standardization, patents, intellectual property strategy and knowledge management



Composites technologies | Friction stir welding | Smart structures

Adv. structural modeling | Advanced concepts | EMC simulation

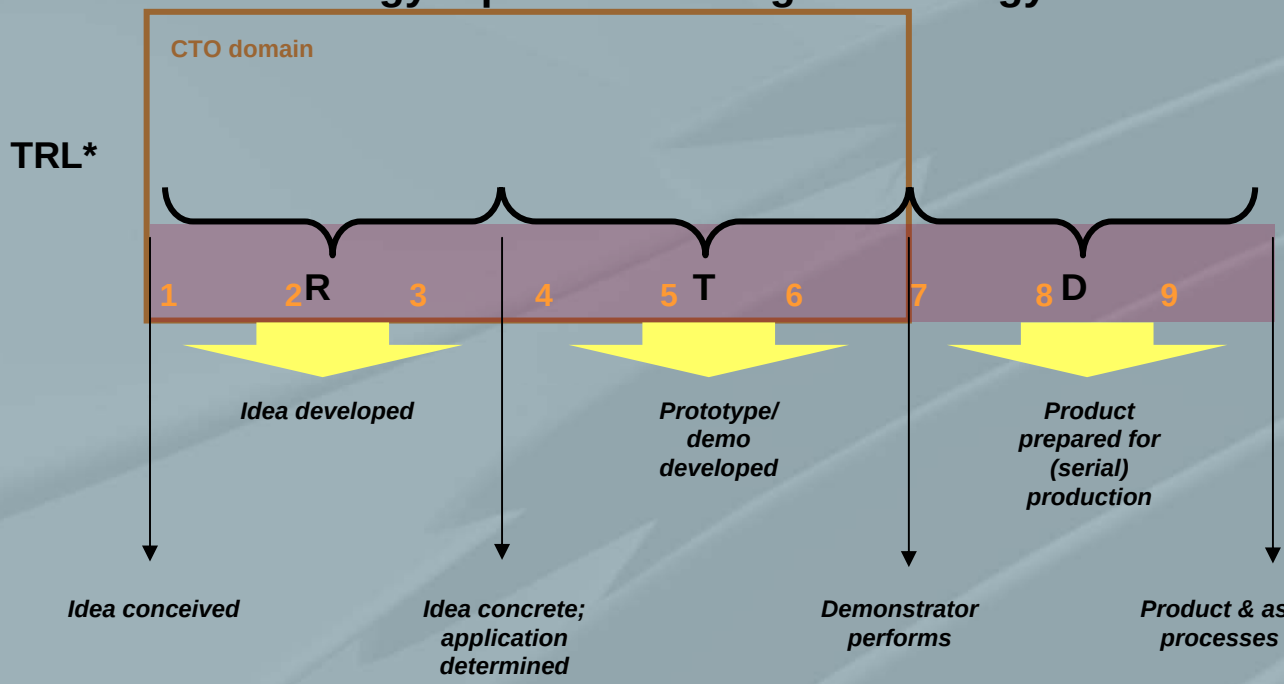
Cabin-air test rig | Virtual product engineering

Microsystems

The R & D Process

Research, Technology, and Development are related but distinct

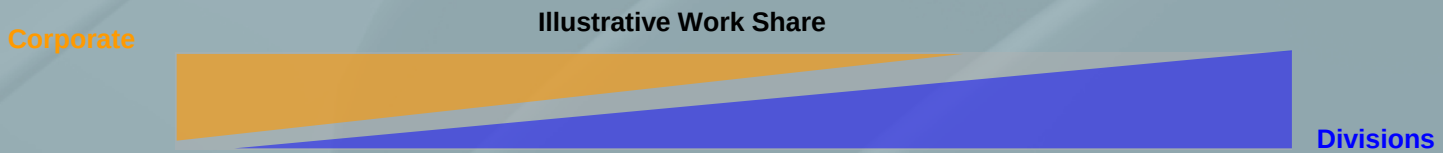
The Technology Pipeline ensuring Technology Readiness



Worldwide R & D spend was circa €3.4Bn

-Ranked 34th world best*

* UK Government figures



* Technology Readiness Level

Innovation Works structure

EADS Innovation Works Structure

Head of EADS Innovation Works
Yann Barbaux

Human Resources Coordination
Guenther Launspach

Finance
Stefan Lindemann

Programme Management
Dr. Felix Nitschké

General Secretary
Arnaud Marfurt

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Composites Technologies

Luis Maria Fernandez-Alonso

Metallic Technologies & Surface Engineering

Dr. Claudio Dalle Donne

Structures Engineering, Production & Mechatronics

Pr. Didier Guedra-Degeorges

Sensors, Electronics & Systems Integration

Dr. Richard Arning

Simulation, IT & Systems Engineering

Simon Bradley

Advanced Concepts

Guy Gallic

National site Manager France

National site Manager Germany

National site Manager Spain

National site Manager UK

RTO
(Russian Technology Office)

SRTC
(Singapore Research & Technology Centre)

Foundations, Bauhaus Luftfahrt, etc.

EADS INNOVATION WORKS

SIMULATION, ENVIRONMENT OF SYSTEMS, INFORMATION TECHNOLOGIES & SYSTEMS ENGINEERING

EADS

IW Changes compared to the January, 1st 2007 version are indentified in RED; Questions in ORANGE

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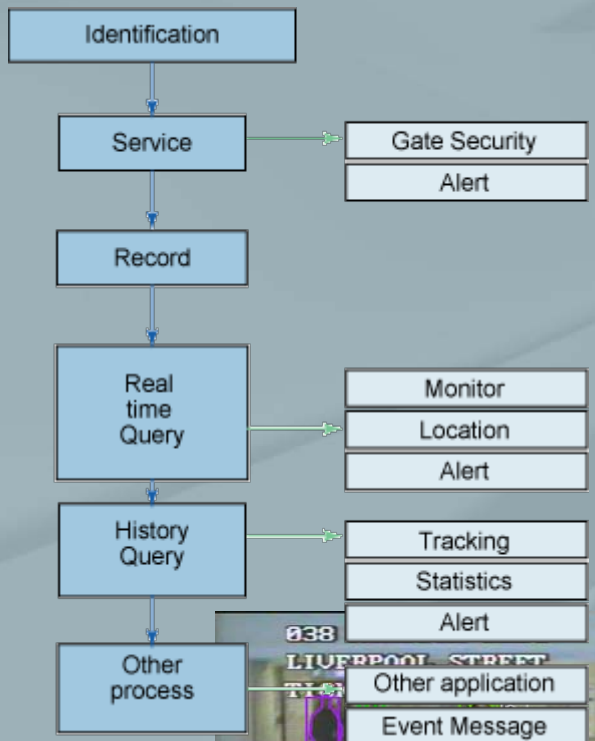
2008/9 Programme

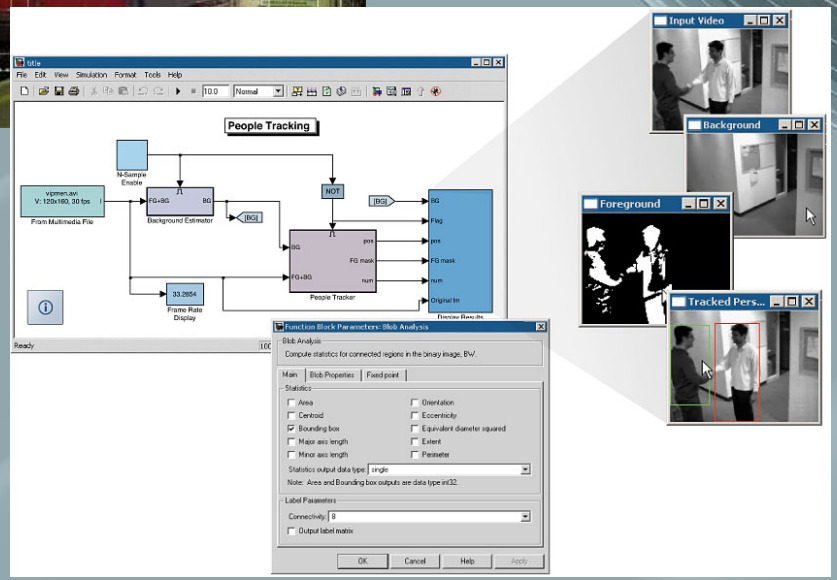
Engineering & Security

Large scale event demonstrator

We intend to create a walk-through scenario for demonstration of key EADS Innovation Works and Business Unit capabilities in upstream research, to showcase our potential new products and solutions. A key driver for this is to create a permanent area where customers, key contacts within our sectors and EADS executives can see how we can bring areas of research together to produce innovative solutions to meet customer needs. The initial demonstration will be established on the Innovation Works floor – 2nd floor of Building C, at the Newport Quadrant site.

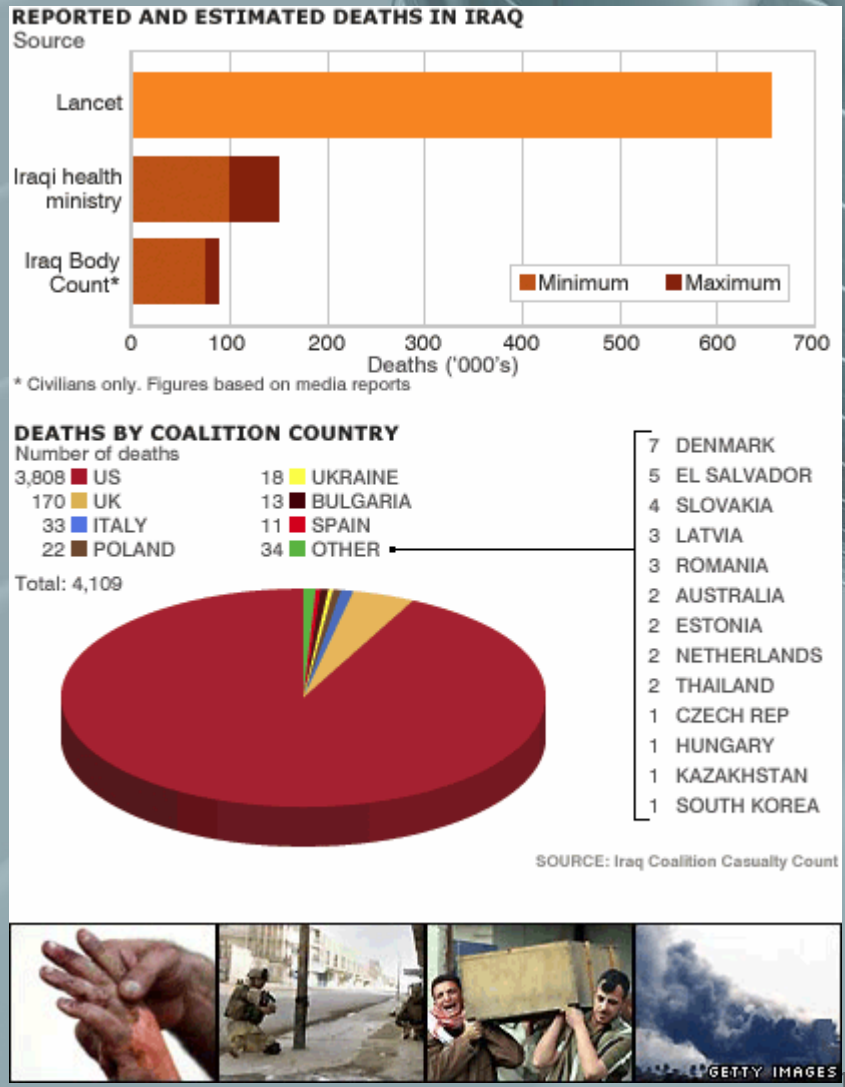
Intent Detection





Improvised Explosive Devices

- Working with JIEDDO – detection & Render Safe Procedure (RSP) measures
  - EM simulation
  - Explosive detection
  - Acoustic/Vibration simulation/propagation waves
  - Lasers
- Human behaviours
  - Cognitive behaviour modelling
  - Intent detection
- Training
  - Capturing tacit knowledge
  - Dissemination of tacit knowledge to troops
- Upstream Academic contacts
  - Swansea University



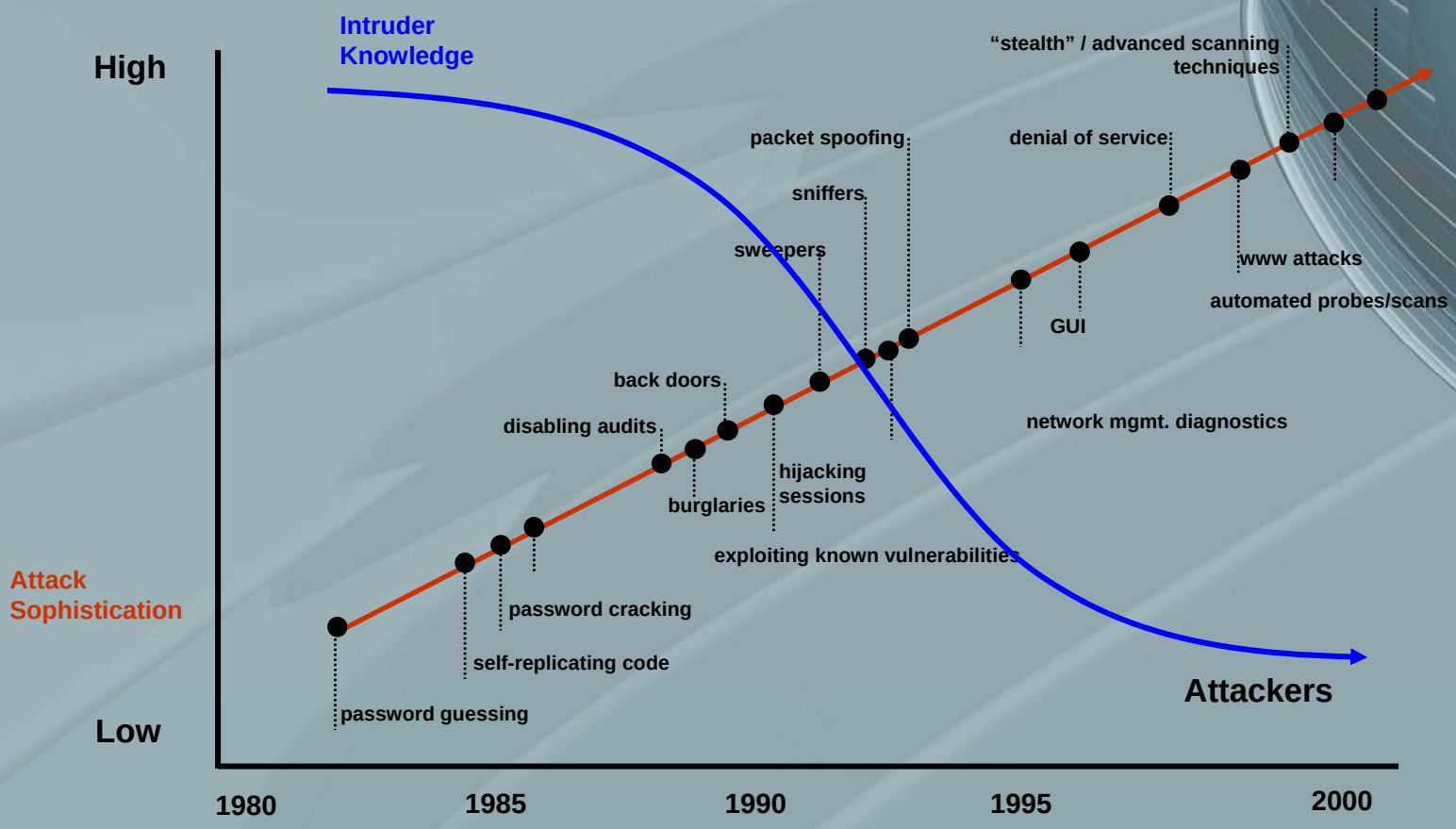
Information Systems Security: The need is recent

- The move to Open Systems and Systems of Systems Solutions
- Information systems become ubiquitous in our products
  - Massive use of civilian technologies (COTS, standard protocols e.g. IP, standard architectures e.g. Windows) where dedicated technologies were the rule (defence, aeronautic, space...)

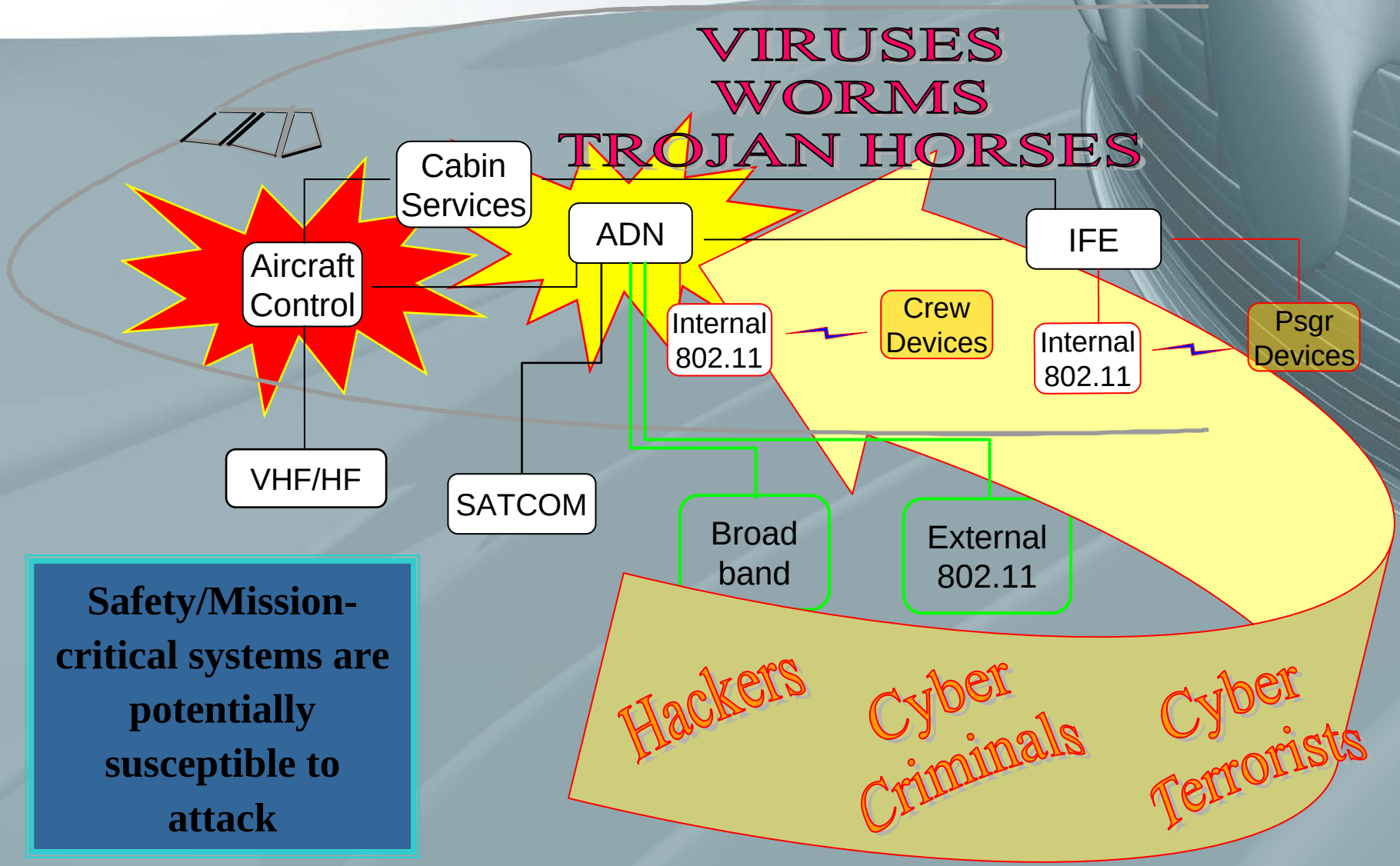
- Connectivity and opening of Information Systems enhances our business
  - ⇒ New services to IS users (IFE, Maintenance,…)
  - ⇒ Ease of use & interconnection
  - ⇒ Cost reduction

- This has a price: a higher risk exposure (Safety & Assets)
  - No implementation has formal guarantee
  - Multitude of ways to penetrate IS (various connections and software…)
  - Description of attacks is widespread (tools on the web, large community, …)
    - 🗝 Terrorism action is simplified!
    - 🗝 Spying!

IS threats evolution



Our needs: airplane example



Safety/Mission-critical systems are potentially susceptible to attack

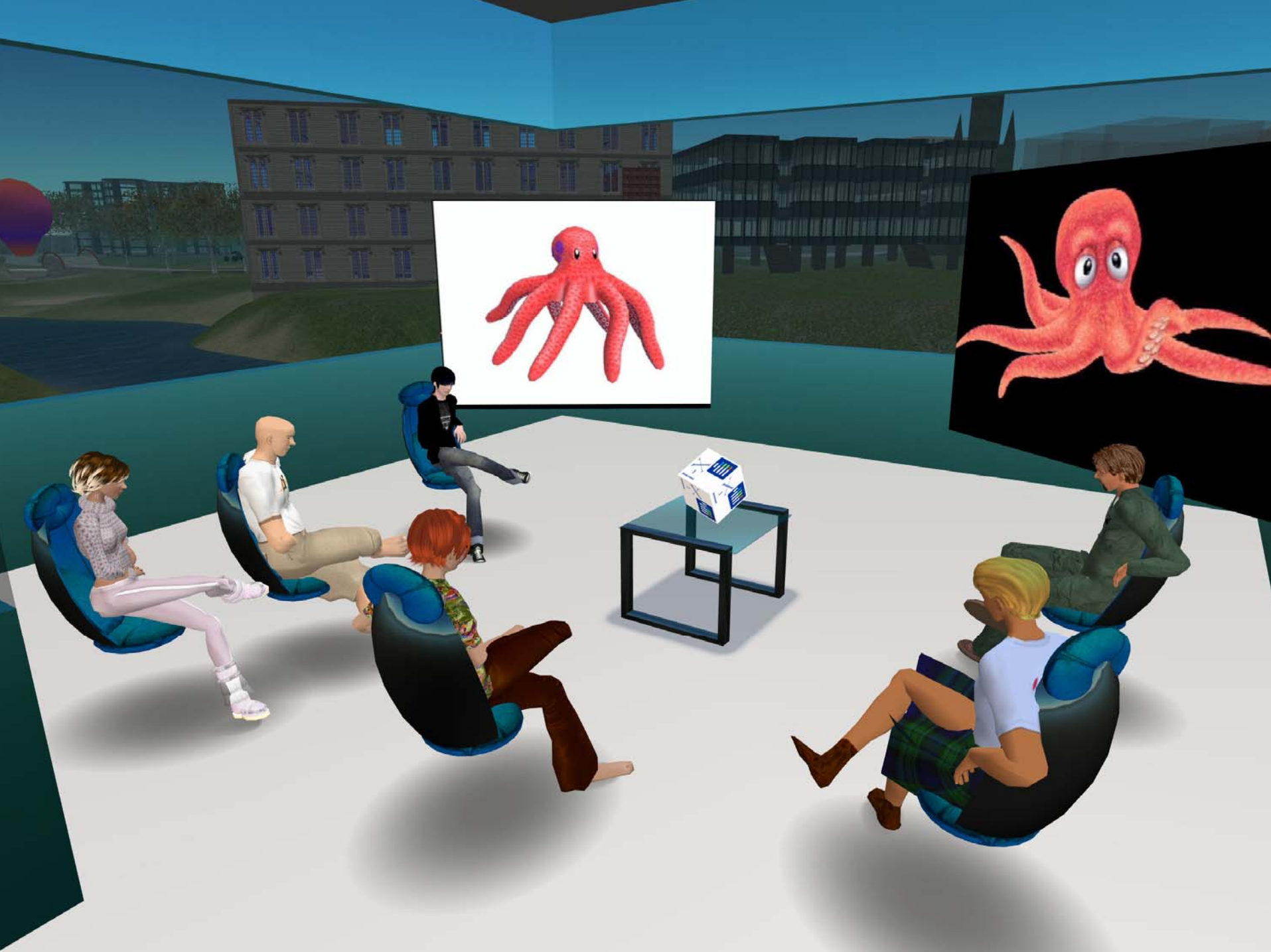
Communication & Interaction online

How graphics have evolved


Ai Austin


Second Life
SECOND LIFE
GRID STATUS: ONLINE
Second Life Time: 8:35 am PDT
Total Residents: 6,667,444
Logged In Last 60 Days: 1,737,273
Online Now: 31,501
Want to Learn More About Second Life?
1. Tech Support at Your Fingertips
2. Secrets of Scripting
3. Tools, Tutorials and Templates
4. Organize Your Out-of-control Inventory
5. Attend a Class going on now!
News & announcements from blog.secondlife.com:
The Plan for Voice Thu 24 May 19:06 PM PDT
Grid Slowdown Experienced Thu 24 May 17:31 PM PDT
Second Life Sculpted Prim Contest: Show Us Your Sculpties! Thu 24 May 09:10 AM PDT
Update aftermath... Wed 23 May 13:11 PM PDT
First Name:
Last Name:
Password:
Austin
Start Location:
My Last Location
Remember password
New Account...
Preferences...
Connect
Quit
1.16.0 (5)

To what end?



Office of the future

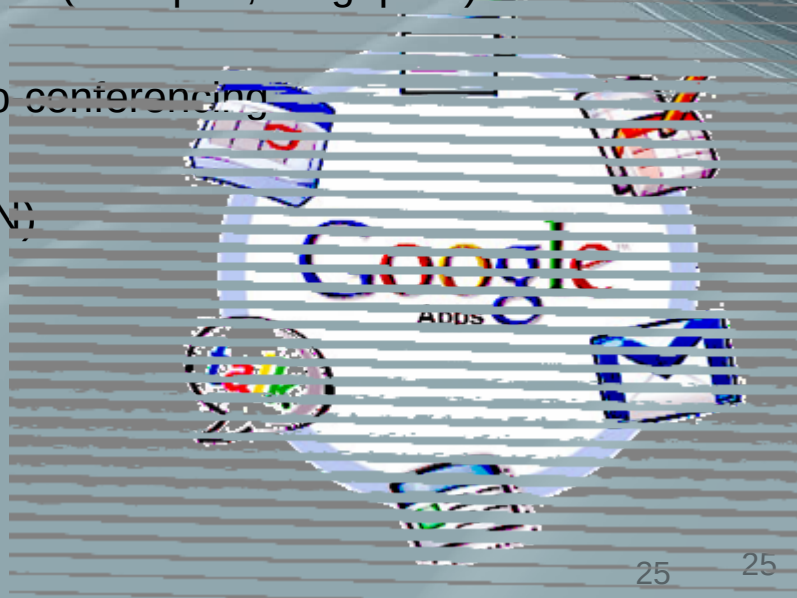
- **Objective**: Study the technical feasibility of using alternative products for business applications (email, office apps, internet, instant messaging, …)

- **Approach:**
  - Technical feasibility (security)
  - Ease of use (gap analysis with current applications)
  - Interoperability with current applications

  - Apply these new technologies to new centers (Newport, Singapore)

  - SRTC will focus on Google Apps and video conferencing

- **Collaborators:** Google (US), Nothacker (SIN)



Engineering Design

Cabin Design

Customization

A380 FC/BC Lavatories for Singapore Airlines

Cabin Innovations

Flexible wellness Device

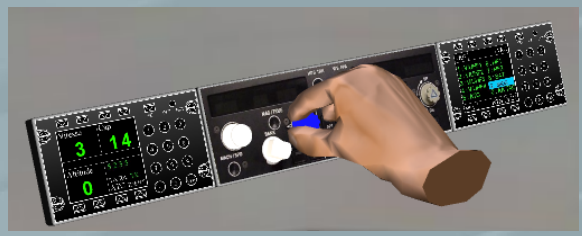
Walking

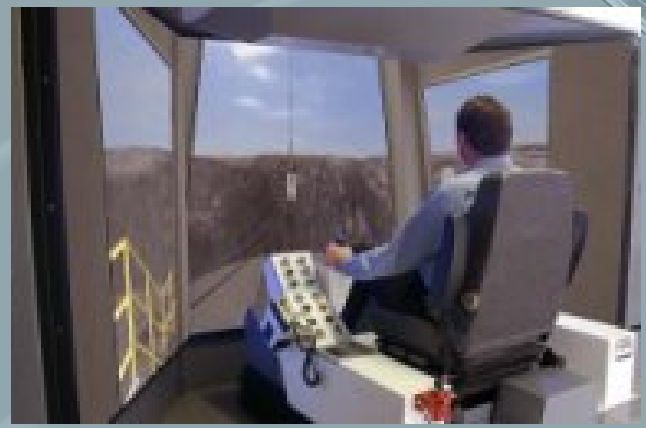
Stretching

Massage

Gym

Immersive Technologies





Mixed Reality

Reality
real world

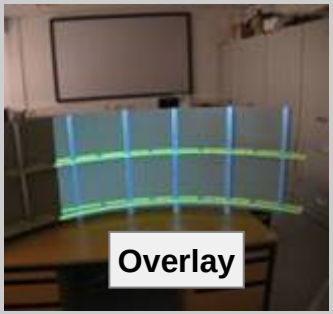
Virtuality
computergenerated world

Mixed Reality (MR)

Augmented Virtuality (AV)

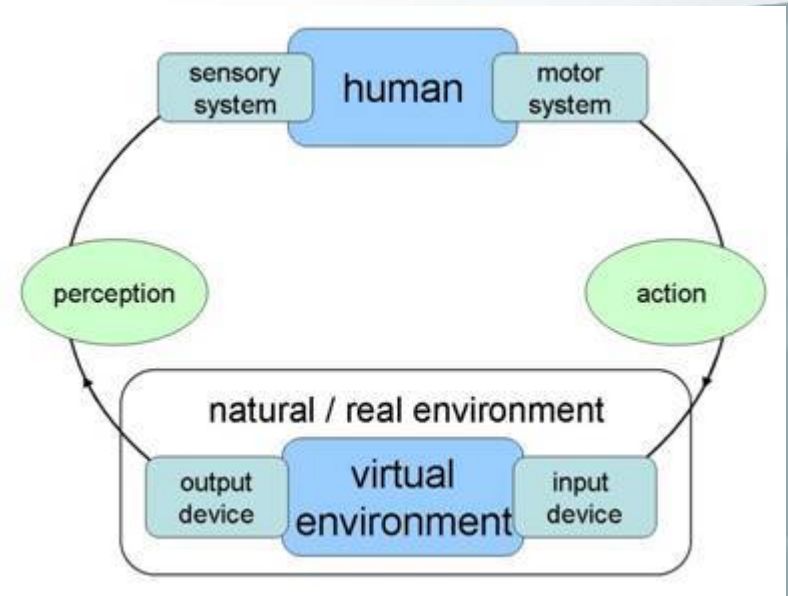
Augmented Reality (AR)

Concepts

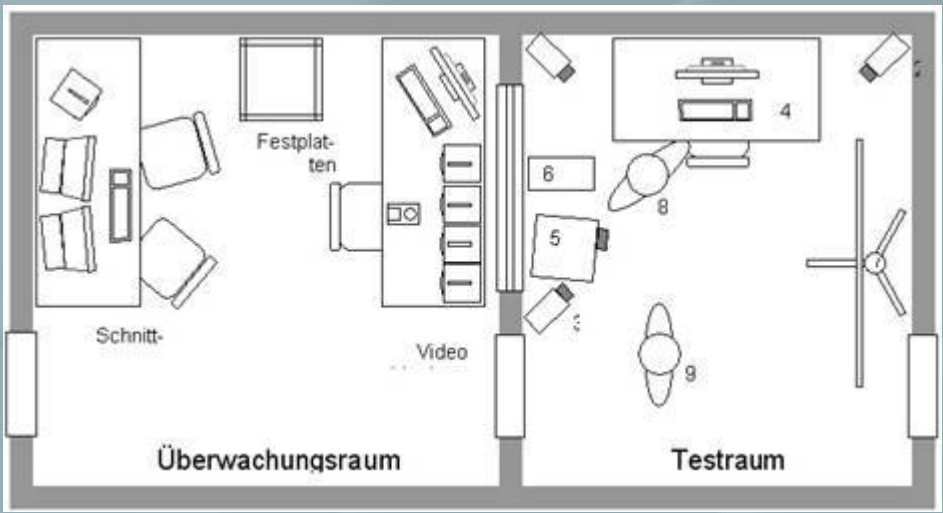


Tools

Usability of virtual environments



- Humans in the virtual environment (behaviour, perception, interaction)



- Usability studies of input devices:
- To use the development tools comfortably
- To make the development process faster

EADS

Systems/Software Engineering

What is Systems Engineering?

SYSTEMS ENGINEERING is an interdisciplinary, collaborative approach to the engineering of systems (of any type) which aims to capture stakeholder needs and objectives and to transform these into to a description of a holistic, life-cycle balanced system solution which both satisfies the minimum requirements, and optimises overall project and system effectiveness according to the values of the stakeholders.

Stakeholder measures of effectiveness could include, as applicable, time to market, cost of goods sold, increase in business net present value, measures of user benefit (e.g., product quality, military capability, political benefits, ...)

Systems engineering is NOT a rulebook. It IS a set of principles, supported by methods, to deliver maximum benefits to stakeholders by effectively applying knowledge of technology, including human factors.

Source: Robert Halligan, FIE Australia

Engineering the **„ what“** is job of EADS Business Units.

We support them in the **„how“**

EADS

Challenges

- Bonded by the multiple boundary conditions-information overflow
- Overboarding complexity blocks innovation and maturity
- Working in distributed consortiums
- Efficiency and lead time
- Tracking the heterogeneous customer needs
- Identifying all stakeholders
- Avoid local optimisation

Our SE vision

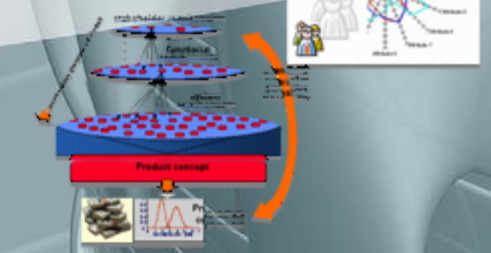
Seamless process from customer need to superior product

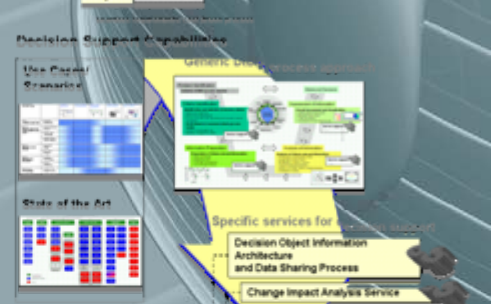
- Holistic global approach – design to X, Y and Z
- Orientation and awareness of project, process and product status
- Right first time – dealing with uncertainty in early phases
- Cost is a design variable

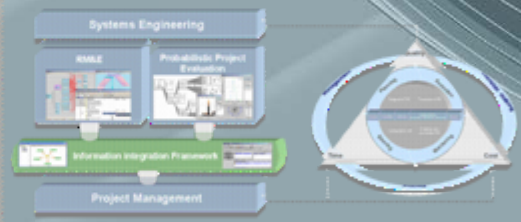
Benefits

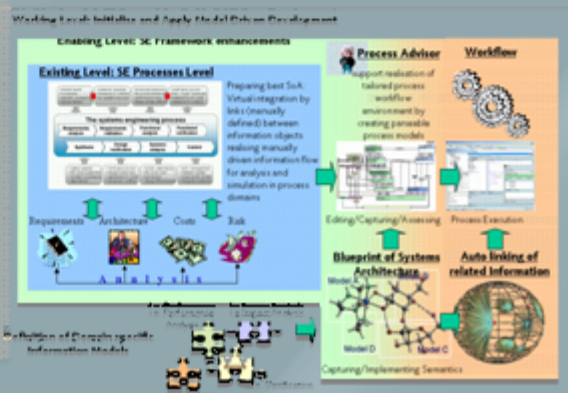
What is behind the buzzwords of time, cost and quality?

- **Keep the design process complexity handleable**
- Awareness of stakeholder demands
- Awareness of process workflow
- Traceabiliy of impacts enables more innovative concepts
- Monitoring and assessment of project/product status
- Increased efficiency by right first time
- Increased maturity by seamless processes incl. V&V
- Higher degree of freedom for engineers





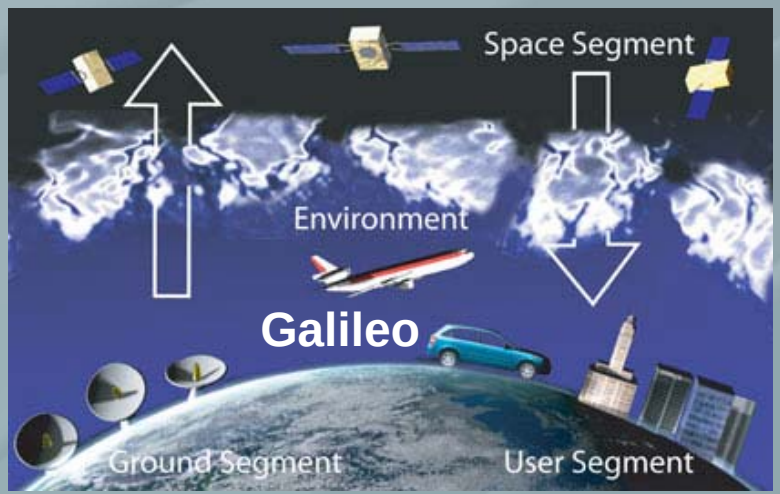


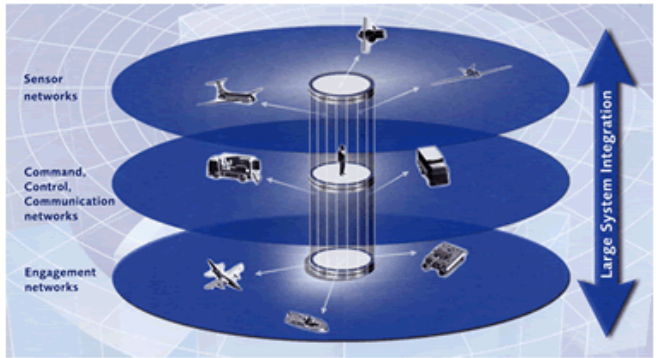


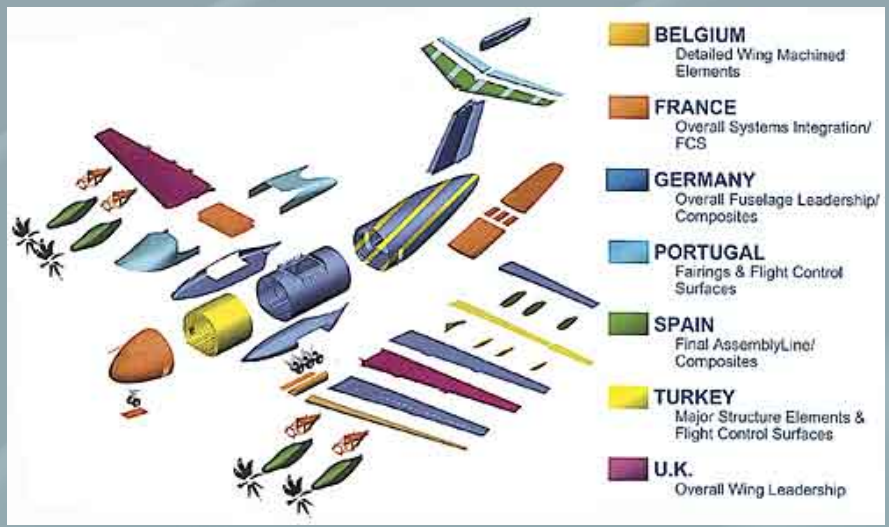
Why SE is essential to Airbus?

The key value creation process of all EADS business units is SYSTEM INTEGRATION

System Integration happens in many facets…







Challenges to be addressed

…and on all stages of product development

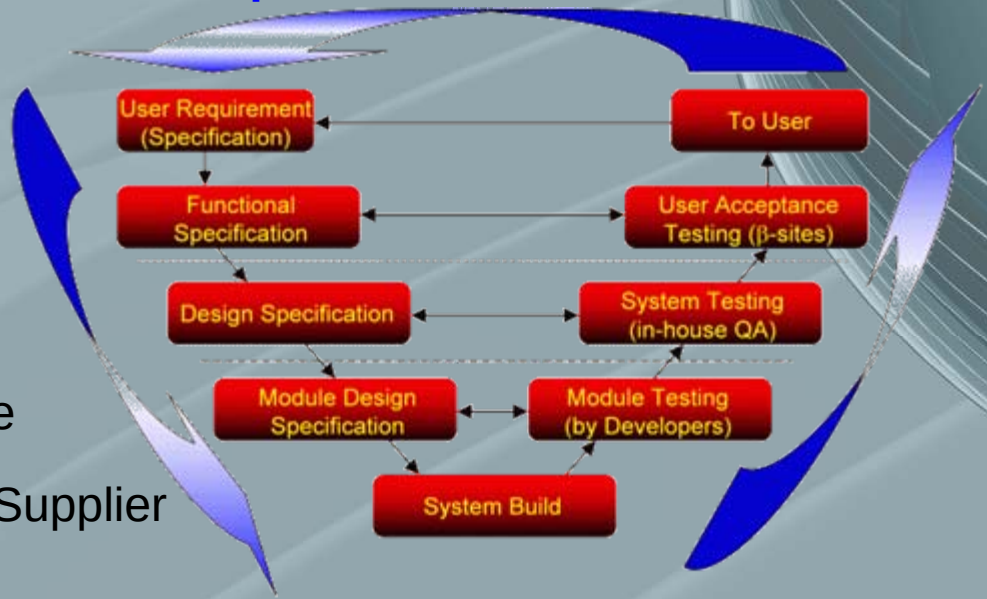
Stakeholders

Functions

Models &Simulations

Systems &Software

Extended Enterprise; Supplier



Challenges

- Bonded by the multiple boundary conditions (information overflow)
- Overboarding complexity (blocks innovation and maturity)
- Working in distributed consortiums
- Efficiency and lead time, avoid re-architecting and re-engineering
- Tracking the heterogeneous customer needs
- Identifying all stakeholders
- Avoid local optimisation

Our SE Vision

Seamless process from customer need to superior product

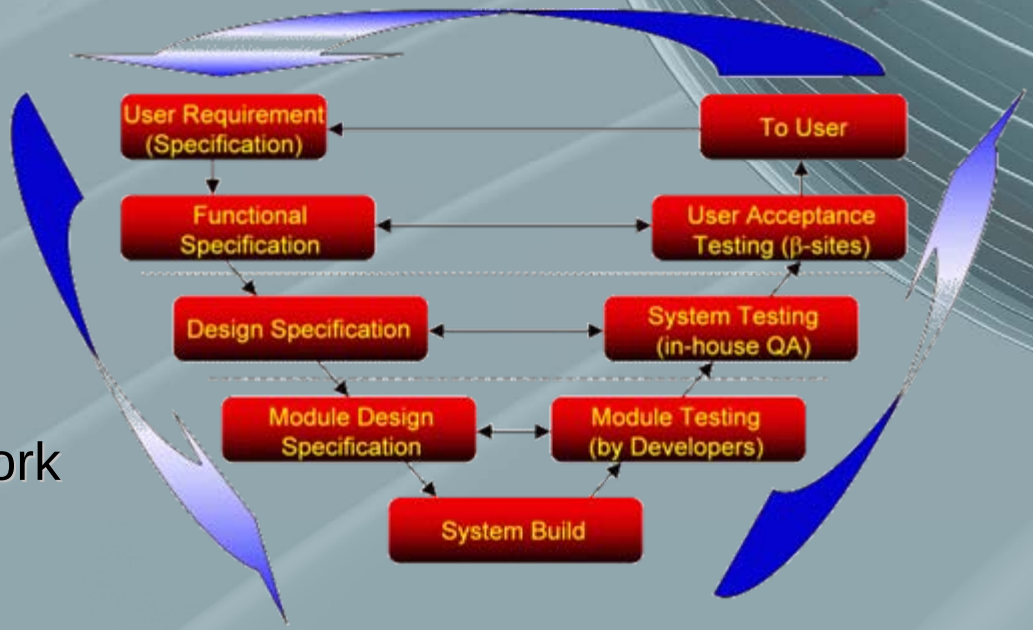
- Holistic global approach – design to X, Y and Z
- Orientation and awareness of project, process and product status
- Right first time – dealing with uncertainty in early phases (robustness)
- Cost is a design variable

Benefits - What is behind the buzzwords of time, cost and quality?

- **Keep the design process complexity handleable**
- Awareness of stakeholder demands
- Awareness of process workflow
- Traceabiliy of impacts enables more innovative concepts
- Monitoring and assessment of project/product status
- Increased efficiency by right first time
- Increased maturity by seamless processes incl. V&V
- Higher degree of freedom for engineers

The SE Innovation Perspective

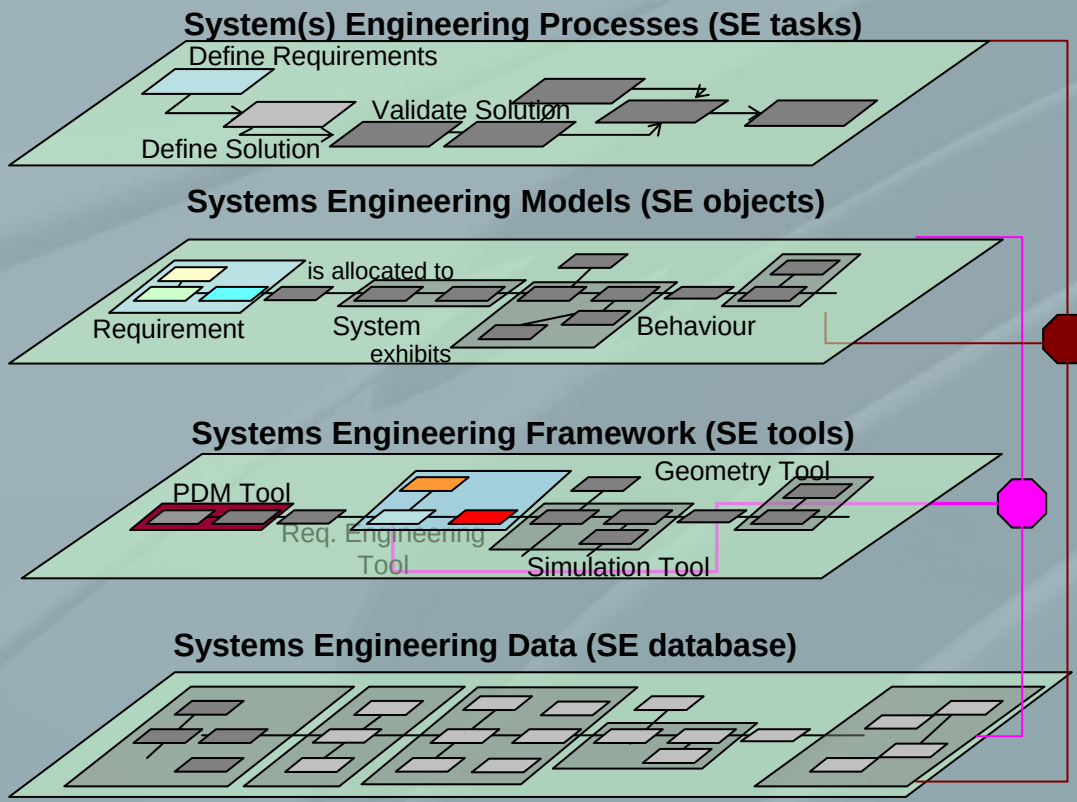
- Marketing Research
- Requirements Management & Engineering
- Decision Support System
- Probabilistic Design and Cost evaluation
- Systems Engineering Framework
- Systems Architecture
- Model Driven Engineering



SE Capability Structure

Domain-oriented Applications

- Cabin RE process
- Systems simulation needs specification
- Functional testing factory – V&V
- Integrated modular avionics costs
- Semi-formal specification concept of FMS
- Uncertainty management for architects
- Identification of passenger cabin comfort perceptions



Integrated System Awareness

- Decision Support Capabilities
- Requirements Engineering
- Market research
- Probabilistic Cost/ Design analysis
- Simulation setup process
- ROBOCOP

Model Driven Engineering

- Formal specification architecture
- Seamless engineering processes

Architecture (Model Driven)

- Architecture representation models and semantics
- Architecture Frameworks

Systems Engineering Framework

- Systems engineering framework prototype
- Framework of frameworks <>SoS related

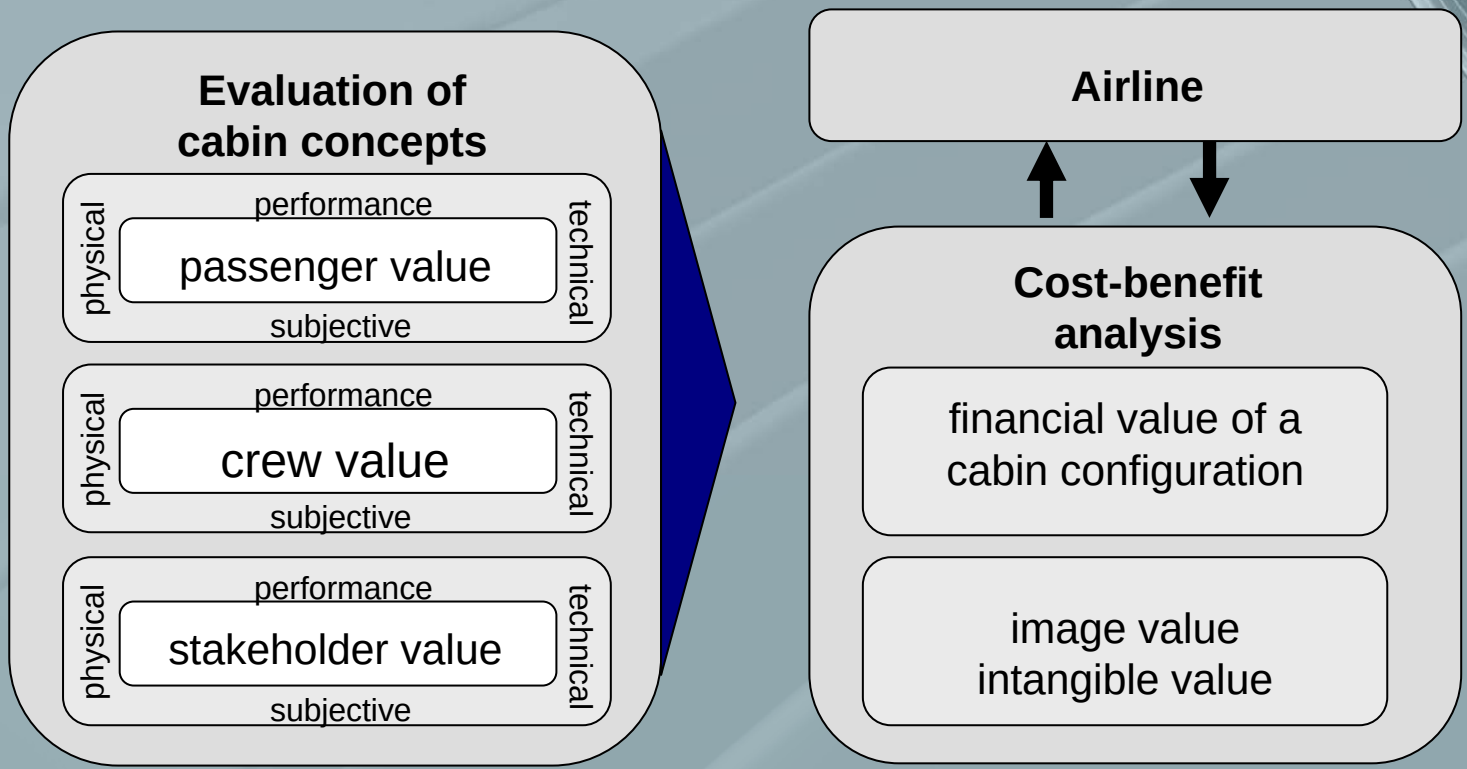
Actual topics

Marketing Research

The Overall benefit of a cabin concept from Pax perspective will be a result of both directly perceived benefits (e.g. new features) and perceived benefits from improved services (e.g. crew performance)

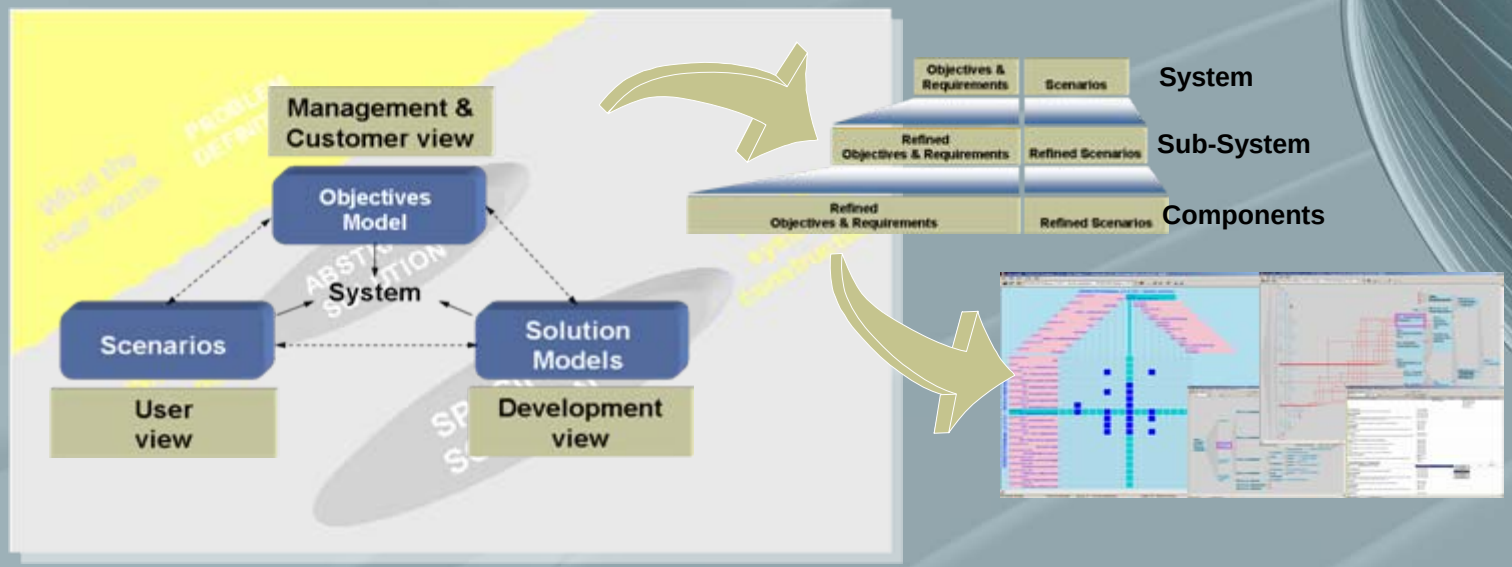
- Perceptions and expectations have to be captured, understood and converted into product objectives and requirements

MR means and skills are built up to model the environment of the customer



Requirements Management & Engineering

Objectives & scenario driven RE process

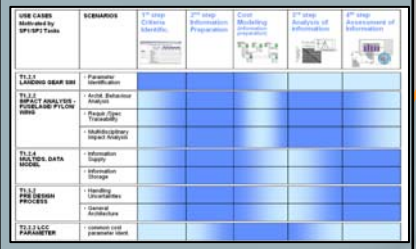


- ➔ Common elicitation & breakdown schema for objectives & requirements which creates a better common understanding and insight on and in the system to be developed
- ➔ Objectives as a structuring mean
- ➔ Objectives as starting point
- ➔ Scenarios as concrete illustrative motivations for improvement
- ➔ Stepwise detailing & structuring
- ➔ Recursive refinements of requirements and solutions
- ➔ Ease to monitor & assess and trace technical risks & addressed to objectives
- ➔ Pluggable to other supporting methods and tools used by the views expressed

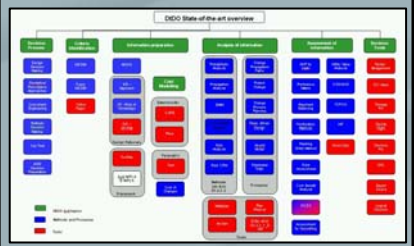
Decision Support System

EU IP VIVACE – WP Design to Decision Objectives (Leader)

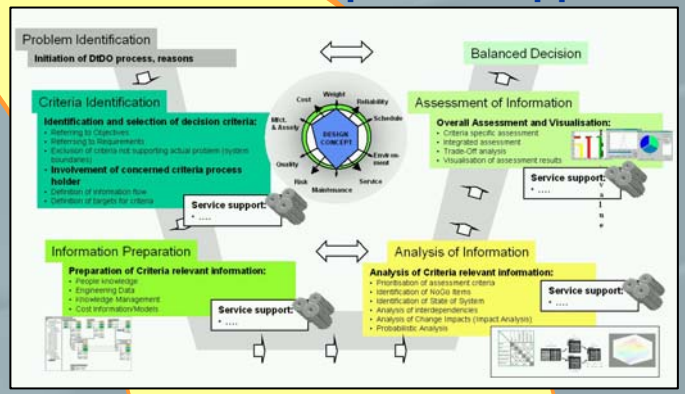
Use Cases/ Scenarios

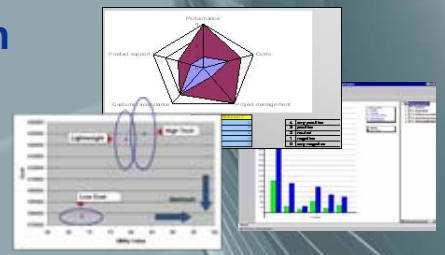


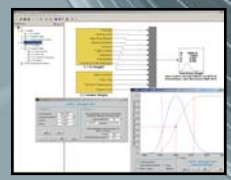
State of the Art



Generic DtDO process approach

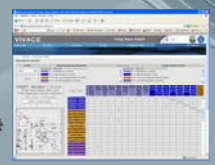


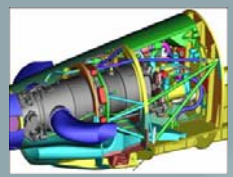




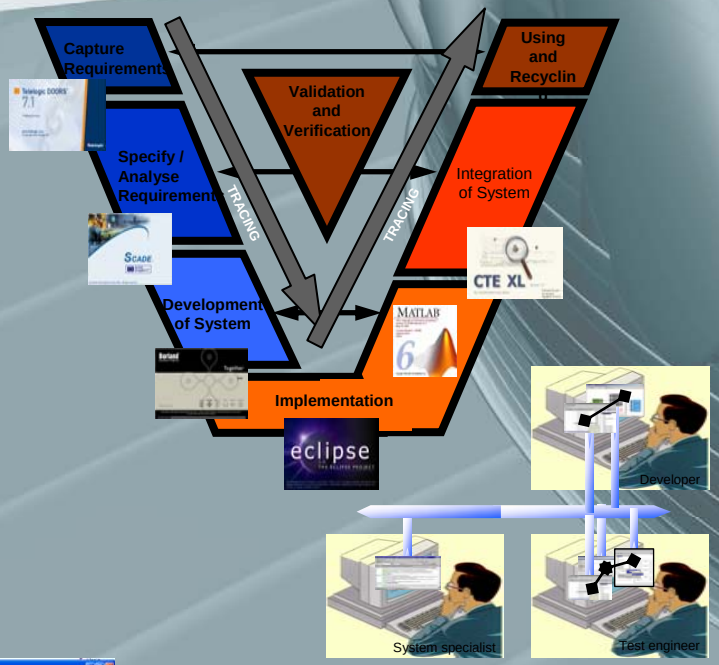
Specific services for decision support

- Decision Object Information Architecture and Data Sharing Process
- Change Impact Analysis Service
- Handling Uncertainties and heterogeneous design objectives
- Life Cycle Cost Modeling
- Assessment Service





Systems Engineering Framework



Objective

Creating flexible tool chains of commercial best-in-class tools and legacy tools

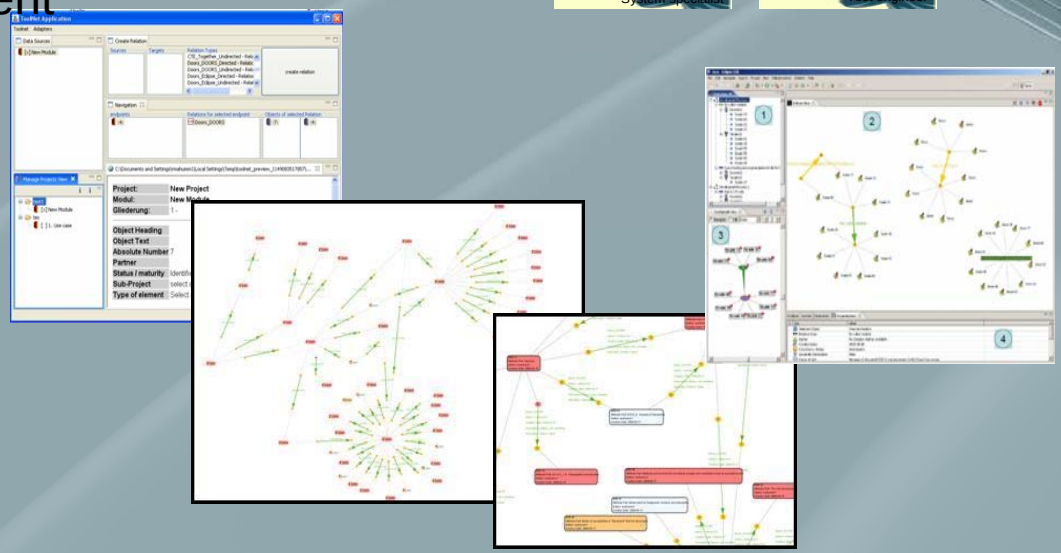
Vision

- Global Support of Systems Engineering Processes, here represented by the V-Model
- Traceability of complex and distributed Information
- Enabling distributed Development

Research Prototype ToolNet

Features:

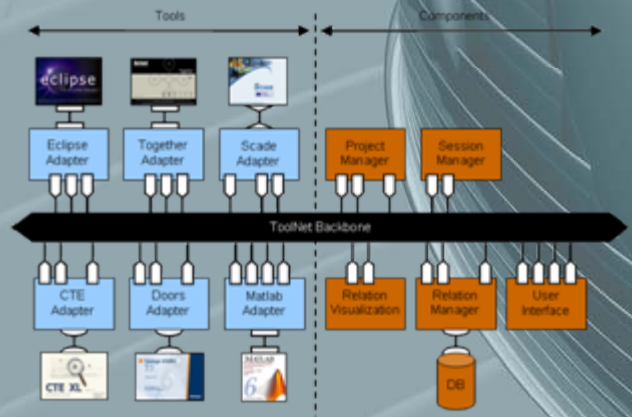
- Traceability
- Relation Viewer
- Metadata for Relations
- Tool-Independent Preview of Information Objects
- Query Engine for Relations



Systems Engineering Framework – Background

ToolNet Technology

- Only usage of royalty-free Technology
- ToolNet is based on Eclipse as Platform
- Usage of Web Services, SOAP, XML, JAVA,
  Eclipse as open and extendable Standards

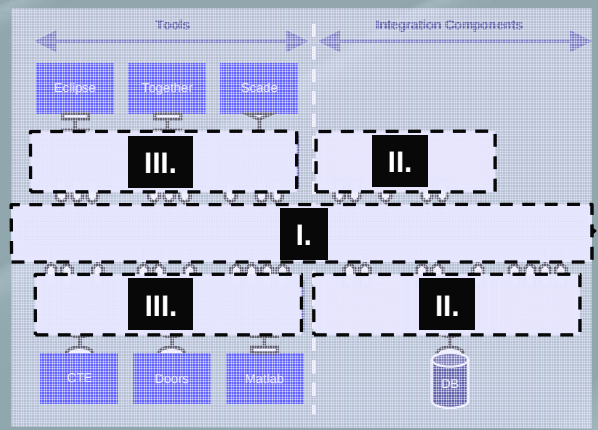


Systems Engineering Framework - Strategy

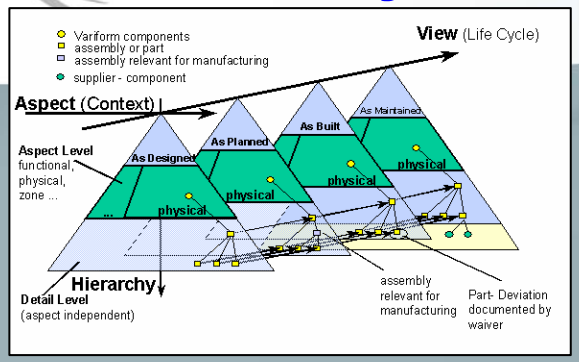
- Layered Integration Architecture
  - Modular, Scalable, Extensible, Open

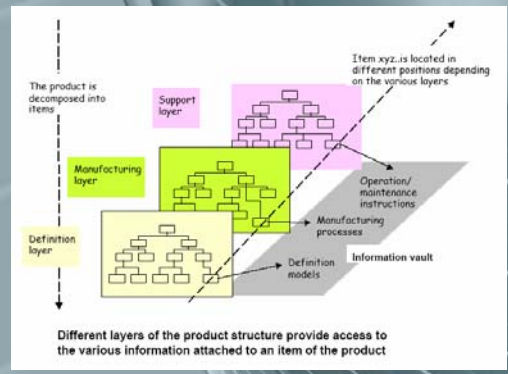
- Industrialization Concept

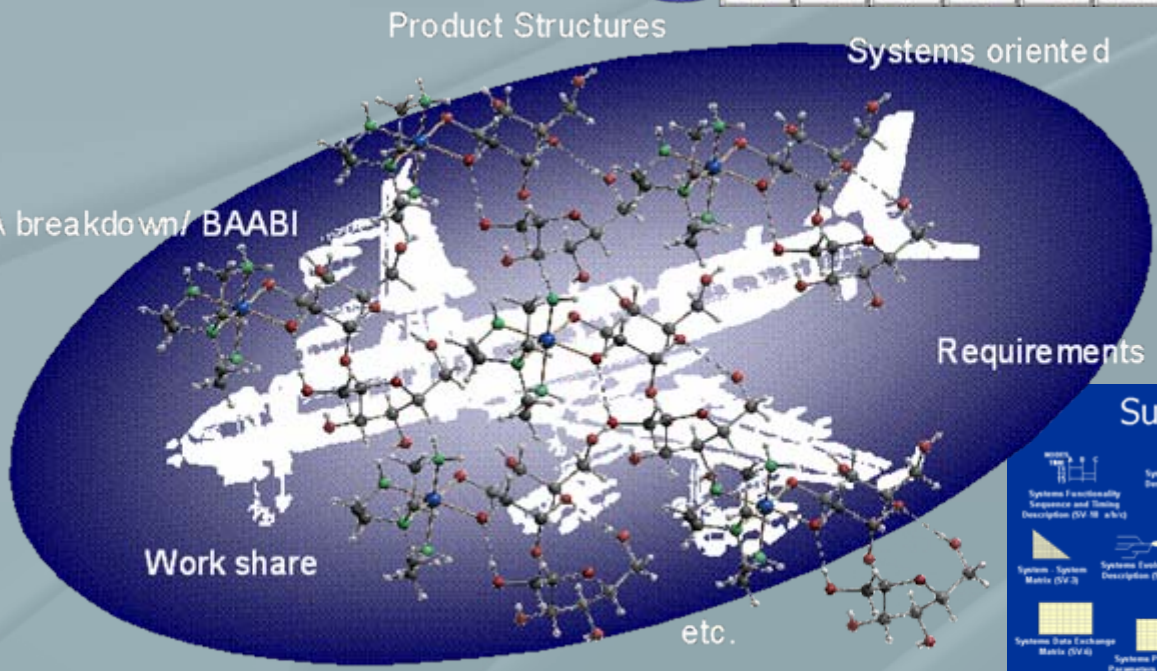
1. ToolNet Backbone: Open Source Project
2. Integration Components: CRC-Knowledge
3. Tool Adapter: Industrial Partners / CRC

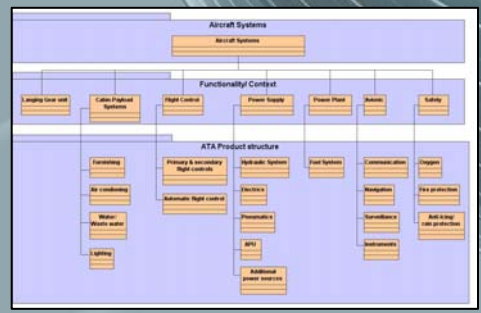


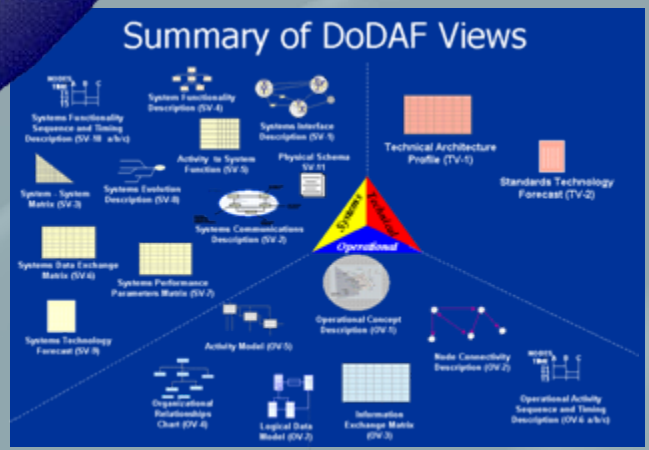
Systems Architecture









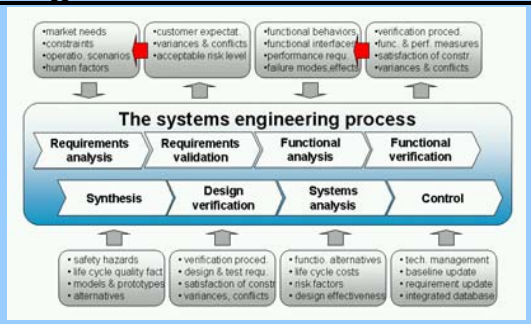


Model Driven Engineering

Working Level: Initialise and Apply Model Driven Engineering

Enabling Level: SE Framework enhancements

Existing Level: SE Processes Level



Preparing best SoA:
Virtual integration by links (manually defined) between information objects realising manually driven information flow for analysis and simulation in process domains

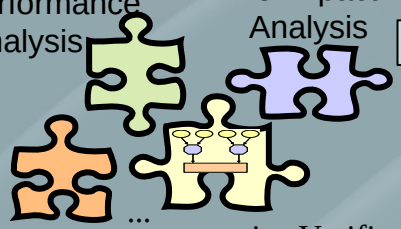
Requirements Architecture Costs Risk

A n a l y s i s

Definition of Domain specific Information Models

i.e. Performance Analysis

i.e.Impact Analysis



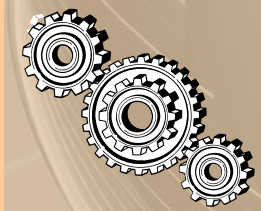
...

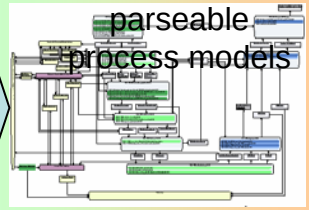
i.e. Verification

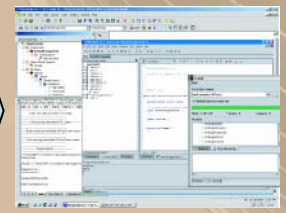
Process Advisor

support realisation of tailored process workflow environment by creating parseable process models

Workflow





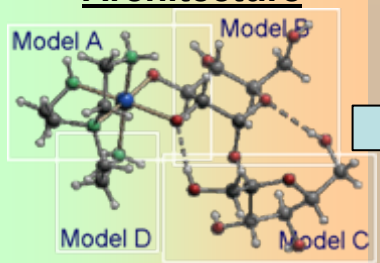


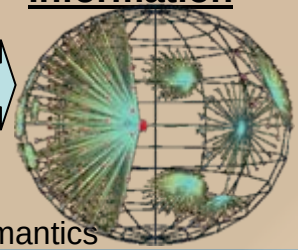
Editing/Capturing/Assessing

Process Execution

Blueprint of Systems Architecture

Auto linking of related Information

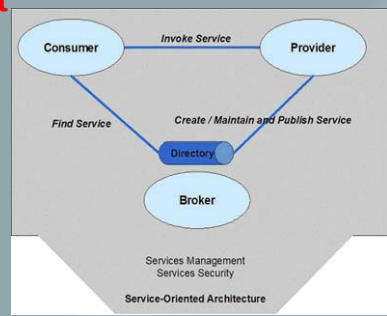




Capturing/Implementing Semantics

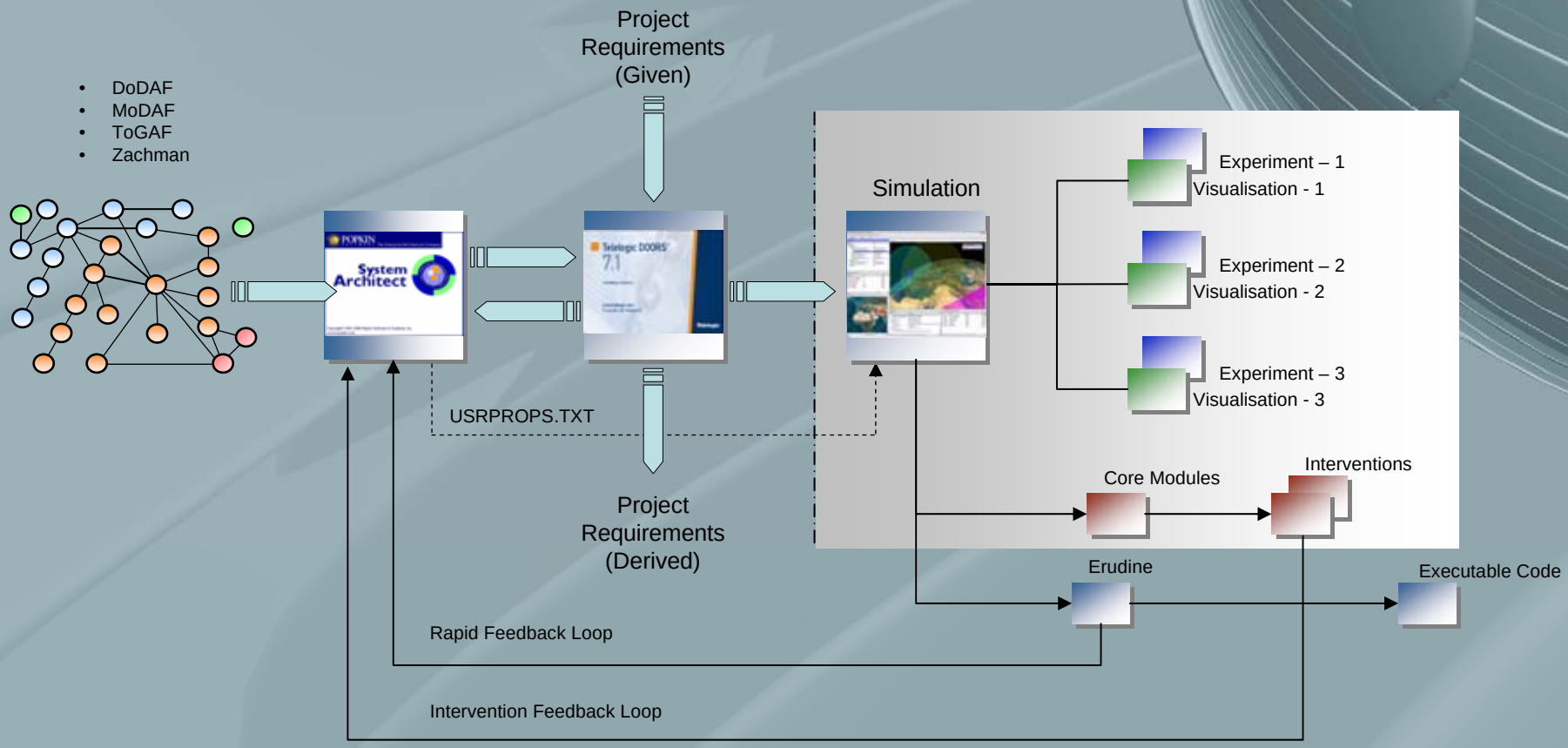
SOA is the current stage in the evolution of network-centric distributed architectures

Pre-1980	1980s to Mid-1990s	Mid-1990s to Early 2000s	Today	Next 3-5 years
Monolithic Architecture	**Client-Server Architecture**	**Network Centric Architecture**	**Service Oriented Architecture/ Web Services**	**Dynamically Re-configurable Architecture**
• Mainframe	• Visual Basic (VB) and PowerBuilder • Multiple applications • Fat clients inside enterprises • Point-to-point integration, some Broker integration • No standards	• eBusiness and eCommerce • Self-service • Thin clients over the Internet • EAI – ERP application server integration	• **Business process modeling** • **Integration using a service bus (SOI)** • **Industry wide standards** • **ERPcomponents, not applications**	• Virtual resources and operating system • Grid computing • Semantic web services

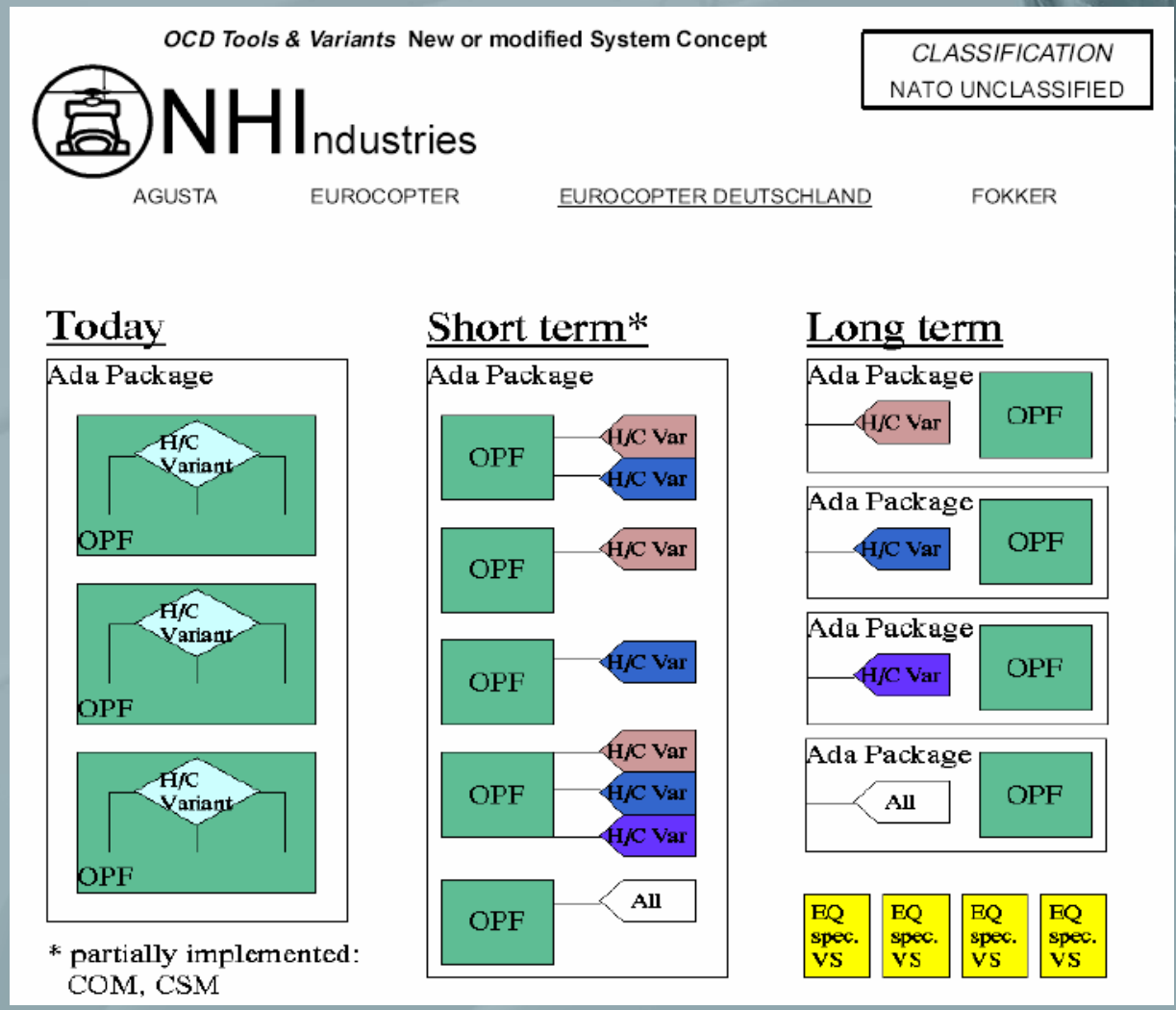


Source: SOA Concepts and Definition, Guru Vasudeva , IBM, 2004

Full executable architecture – 1 tool only - simulation without programmers



Operational Concept Document: NH90 Software Tool Enhancements to support Helicopter Variants:



Software Product Lines (SPL)

- A Product Line Systems (PLS) Program works in the 3 areas of
  1. software product lines ⇒ assessments, frameworks
  2. software architecture ⇒ achievable by system construction from components
  3. component technology ⇒ the method to construct
- Its goal is to enable widespread product line practice through architecture-based development.
- Architecture is blueprint for both the system and the project developing it:
  - Architecture can be used early in projects to determine whether a design approach will yield an acceptable system
  - It can be used after a system is deployed to understand, maintain, and reuse parts of the system
  - System qualities such as performance, modifiability, and security depend on a unified architectural vision.
- multi platform patterns ⇒ as the experience repository and pre-requisite for CMMI

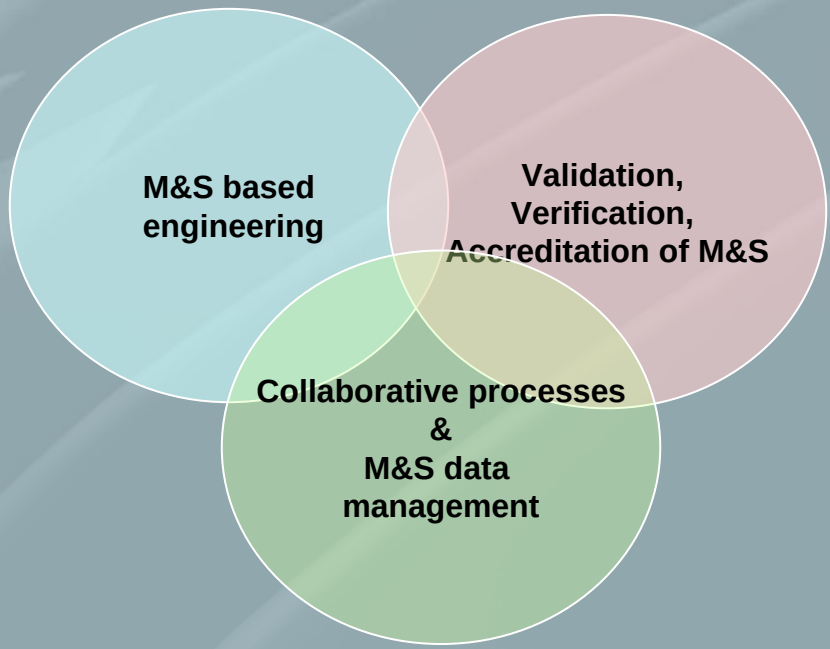
Summary of Engineering Requirements

Develop Models based on innovative methods and languages for supporting complex Functions/Systems design and optimising multidisciplinary Processes

To improve Function/System design optimization through M&S and collaborative processes

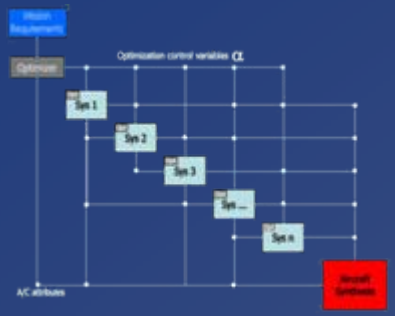
To develop Simulation based engineering for certification and full maturity at EIS

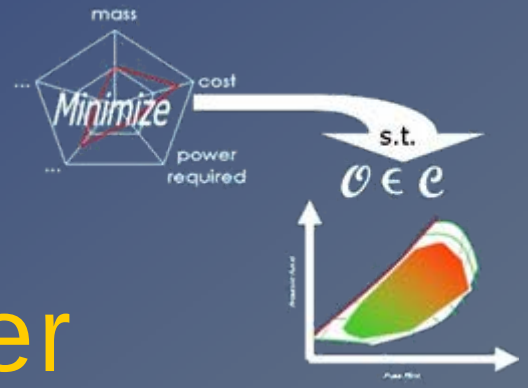
Feasibility → **Concept** → **Definition** → **Development** → **In-service**



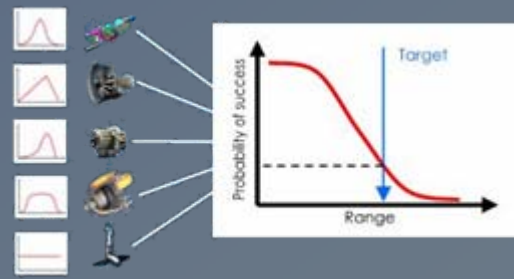
An example of student work

January 2008





Methods for Power Architecture Analysis and Optimization



PhD Thesis Overview

Cyril de Tenorio
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EADS Fellow – **Georgia** Institute of **Tech**nology
Guggenheim School of Aerospace Engineering
Toulouse, France
Atlanta, USA

Motivation

An architect designs the architecture but does not necessarily conduct R&D on technologies to be integrated

- A successful architect must be able to:
  - Adapt his/her architecture to available technologies: ability to integrate technologies while limiting integration penalties
  - Guide the development of technologies to optimize his/her product: evaluate performance gap and influence technology partners
- To do so the architect must:
  - Perform trades in early design phases: provide sufficient timeframe for partners to adjust while preparing integration phases
  - Base guidance on rigorous architectural analysis: focus on most promising technologies and provide arguments supporting technological recommendations
- Difficulty associated with actions above:
  - Aircraft system architectures are highly complex: The analysis is time consuming and computationally expensive
  - In early phases of design technologies are uncertain: lack of maturity, lack of certainty on performance and physical attributes

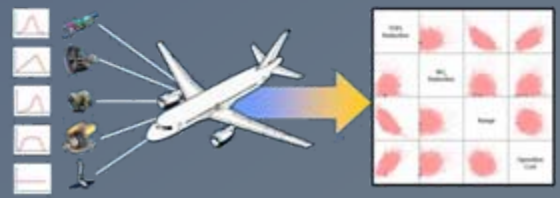
New methods are required to support the analysis and decision making process in conceptual design of architectures

Objectives

- Define **numerical analysis tools** for architecture conceptual design
  - Modular: collaborative definition process and contribution to the analysis (facilitated access to participating system specialists)
  - Flexible: model structure should adapt to the relationship of systems composing the architecture concept of interest

- Propose methods to automatically **size systems** composing the architecture
  - Definition of systems level attributes => Definition of aircraft attributes
  - Identify optimization schemes for key systems => Optimization targets for technologies

- Apply methods supporting the **analysis of the architecture** and **strategic decision making**
  - Uncertainty and risk
  - Visualization of trades and results
  - Definition of feasible goals
  - Strategic selection of technologies



- Thesis Scope:
  - Application: Aircraft power system architectures
  - Context: Pre-conceptual /conceptual design phase

EADS fellowship

- The fellowship is the concretization of a strategic partnership between Georgia Tech and EADS.
- My role as a EADS fellow at Georgia Tech:
  - Improved understanding of European industrial challenges within Georgia Tech.
  - Apply academic techniques to EADS practices.
- The research performed under the fellowship fulfills:
  - Dissertation requirements from Georgia Tech
  - EADS industrial needs

Thesis Advisors:

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