Flygteknik under 30 år på Saab

Från räknesticka till superdator

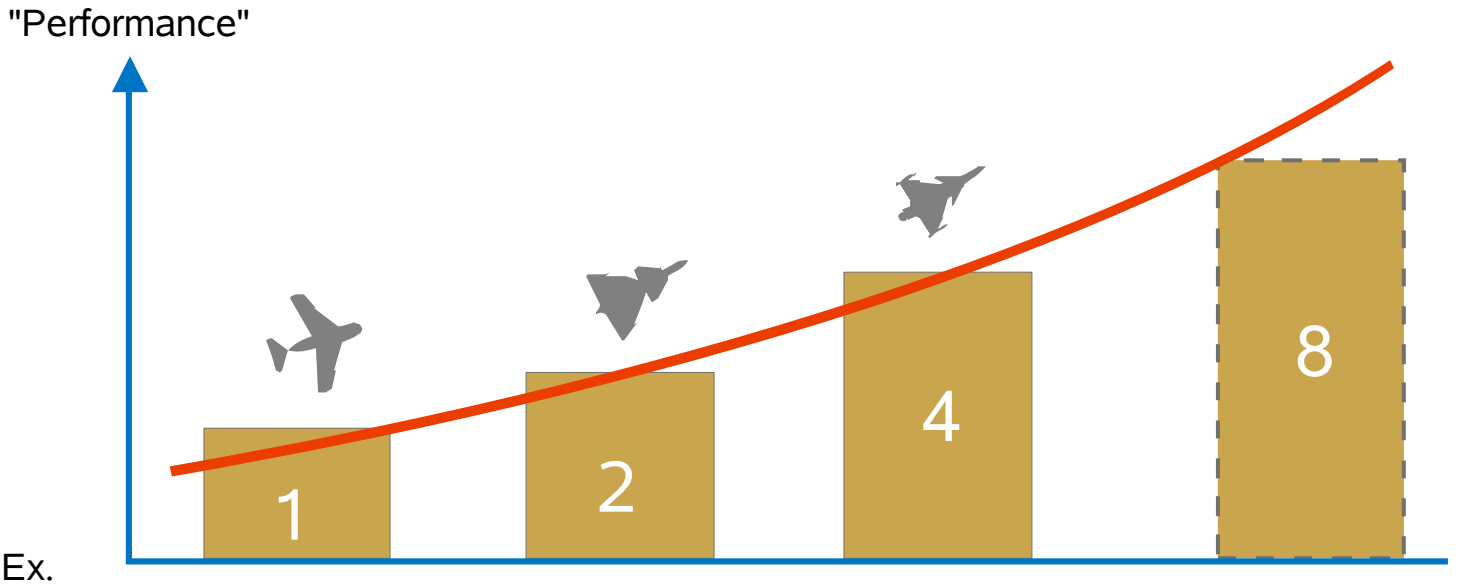
Billy Fredriksson

Flygtekniska Föreningen

Göteborg

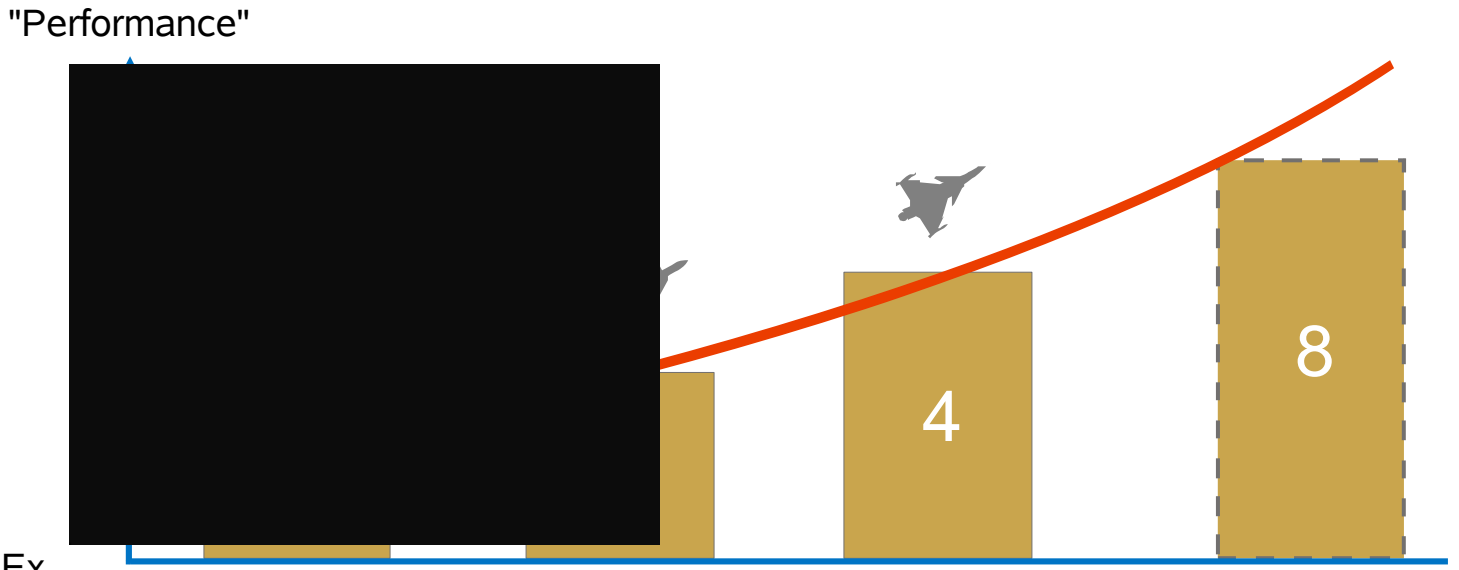
2006-11-28

Technologies - Performance and growth Mechanics and Material



Ex. Technologies	1950	1970	1990	21st century
	Swept wing	• Canard • Deltawing	• Movable canard • Reduced stability • Composite mtrl	• Vectored thrust • Electric Power generation • New materials • etc.

Technologies - Performance and growth Mechanics and Material



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G. S. SCHARER

Volkenrode
Germany
5 May 45

Col. [illegible]
[illegible]
[illegible] USA

Dear Ron,

It is hard to believe that I am in Germany within a few miles of the front lines. Everything is very quiet and I am living [illegible] in the middle of a forest. We have excellent quarters including lights, hot water, electricity, etc.

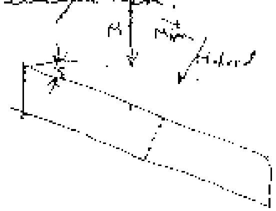
We are seeing much of German aerodynamics. They are ahead of us in a few items which I will mention.

(2) G. S. SCHARER

The Germans have been doing systematic work on high speed aerodynamics. This has led to one very important discovery. Sweepback or sweepforward has a very large effect on critical Mach No. This is quite reasonable on second thought. The flow parallel to the wing does not affect the critical Mach No and the component normal to the airfoil is the one of importance. Thus the critical M is determined by the

(3) G. S. SCHARER

airfoil section normal to the wing and by the sweepback.



Method: Munk

For instance a 12% wing might have a critical M = .8 and an 18% wing M = .7. Then in a section of .875 (cos 29° = .875) of the same [illegible] [illegible] parallel to the wind [illegible] [illegible] [illegible] thickness will [illegible] [illegible]

(4) G. S. SCHARER

2 x .875 [illegible] or 1.75 [illegible]. The length of the wing will be increased to 1/.875 = 1.14. The critical M required at the root will then decrease to 1.14/1.75 = .65. The wing bending [illegible] will decrease to .65 x 1.14 = .74. This is the large constant [illegible] [illegible] changing from a chord [illegible] 18% to one of .875 x 18 = 15.8% with the addition of 29° sweepback. All the wing weight [illegible] [illegible] [illegible] [illegible] [illegible] Mach will [illegible]

(The below letter by George Schairer was mailed to Mr. Benedict Cohn, 1509 29th Ave, Seattle, Wash., USA. The U.S. Army Postal Service postmark bears the date May 29 1945. In order to avoid possible delays, Schairer himself wrote "Censored" on the lower left corner of the envelope and signed that statement with his own name.)

" Volkmarode
Germany
5/10/45

B. Cohn
Boeing Aircraft Co.
Seattle Wash USA

Dear Ben,

It is hard to believe that I am in Germany within a few miles of the front line. Everything is very quiet and I am living very normally in the middle of a forrest. We have excellent quarters including lights, hot water, heat, electric razors, etc

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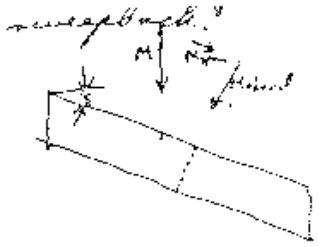
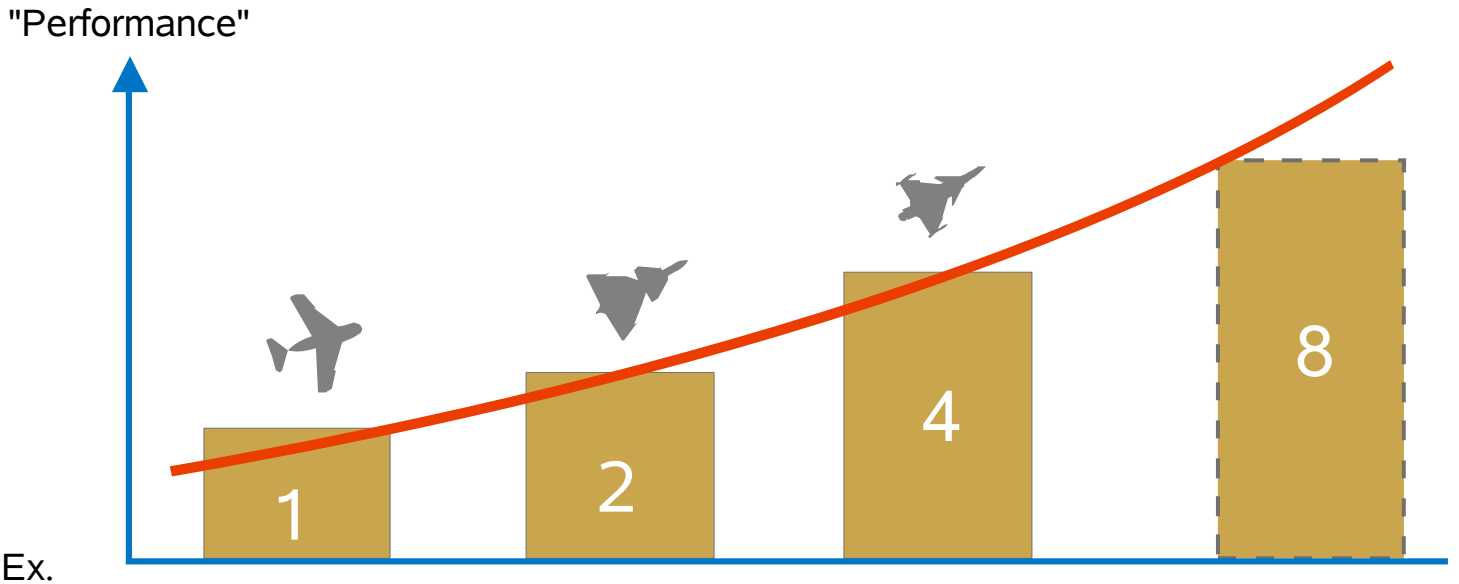


For instance a 0% wing might have a critical M = .8 and an 30% wing M = .7. This is a ratio of .8/.7 cos 30% = 30° If the same span is retained the chord parallel to the wind will be constant and the thickness will increase not by 2% but by 2 x .875% or

Technologies - Performance and growth Mechanics and Material



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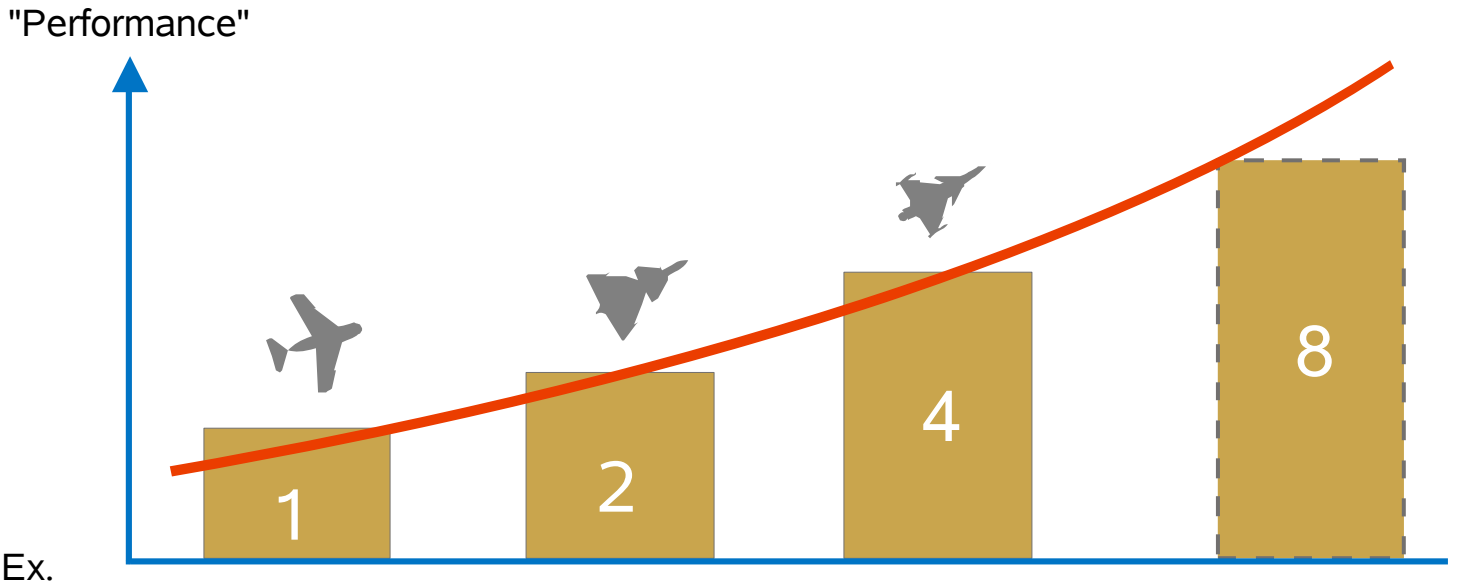
Technologies - Performance and growth Mechanics and Material



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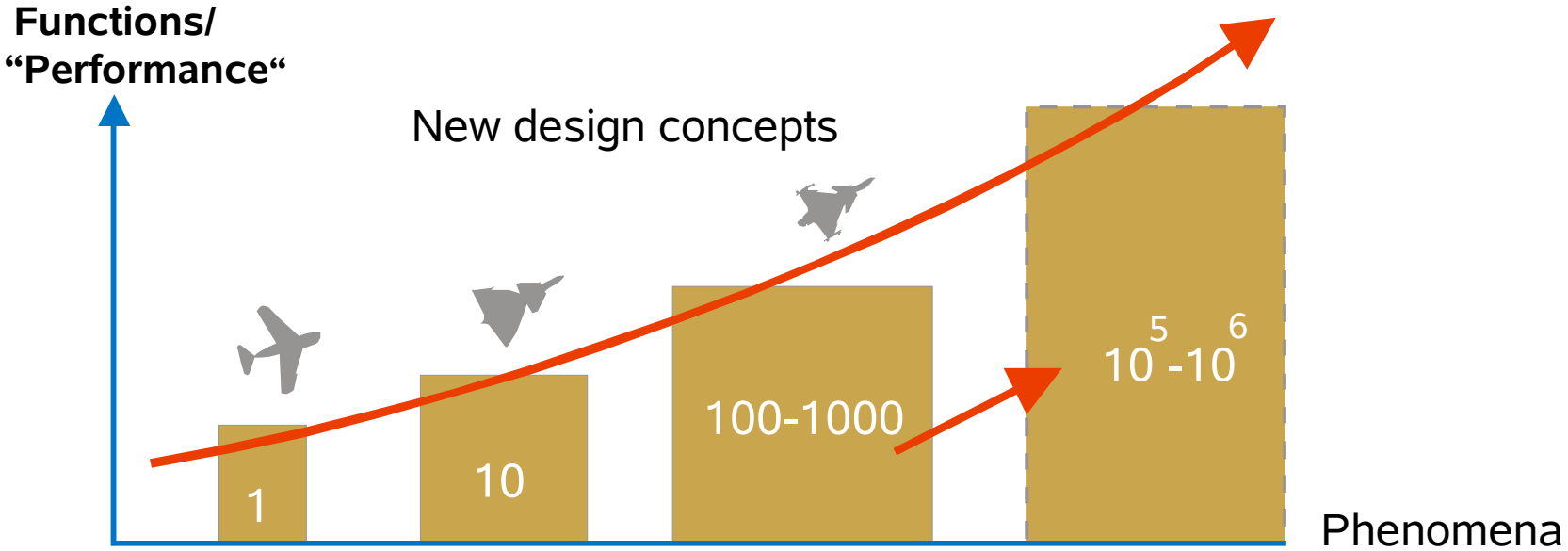
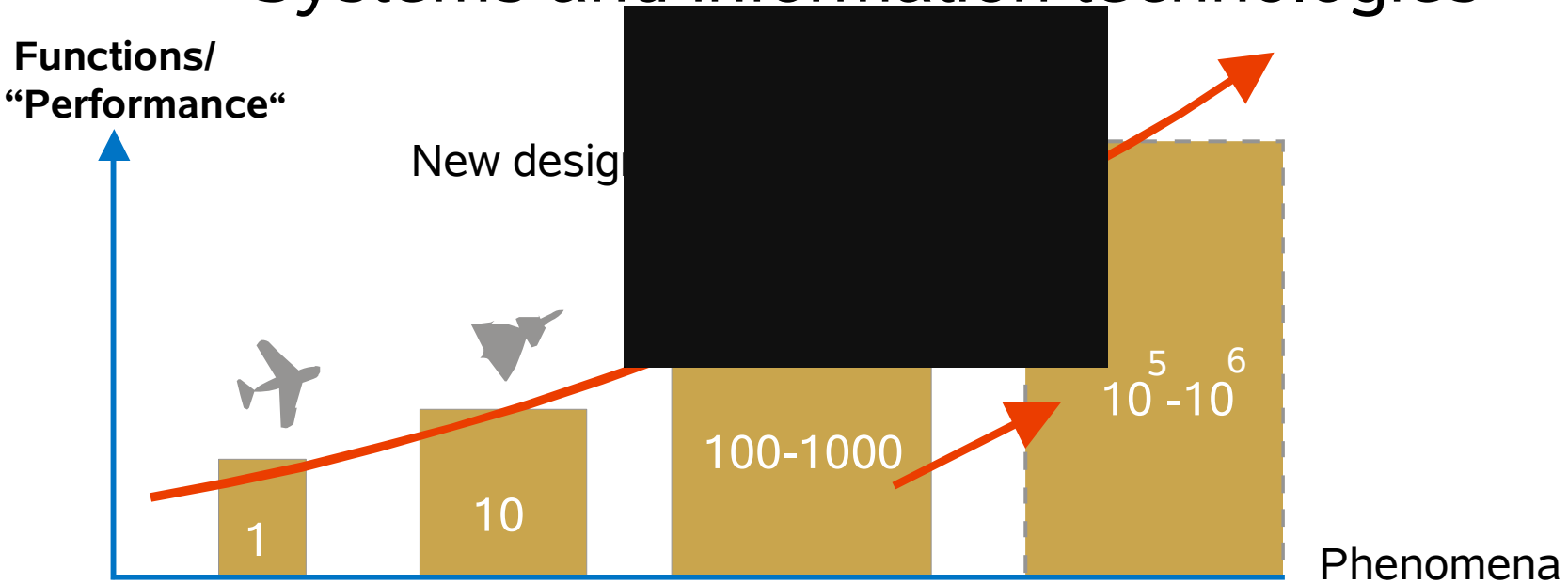
Technologies - Performance and growth
Systems and information technologies



Ex. Technologies	1950	1970	1990	21st century
		- 1 CPU - Radar	- 40 CPU - Computer memory and speed - Fully integr. digital - MMI, display etc. - Communication	- Computers and electronics - Sensor technology - Integration level - Information and data fusion - Communication - Command & Control - Autonomy - Micro electromechanics - etc.

Technologies - Performance and growth
Systems and information technologies



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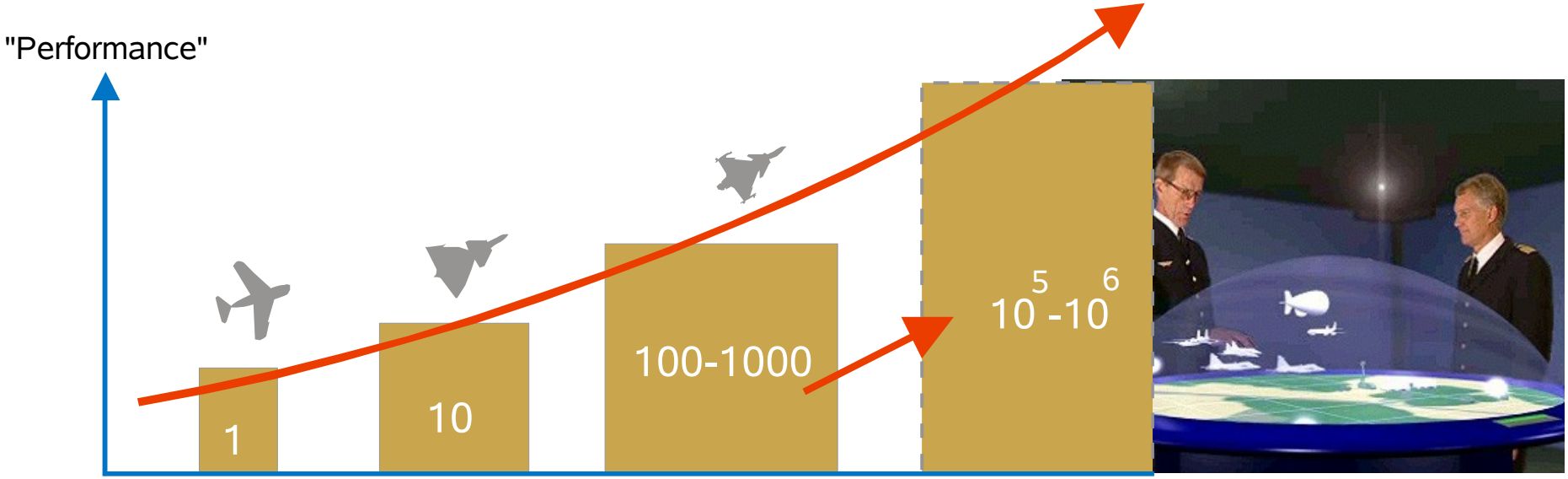
Technologies - Performance and growth
Systems and information technologies



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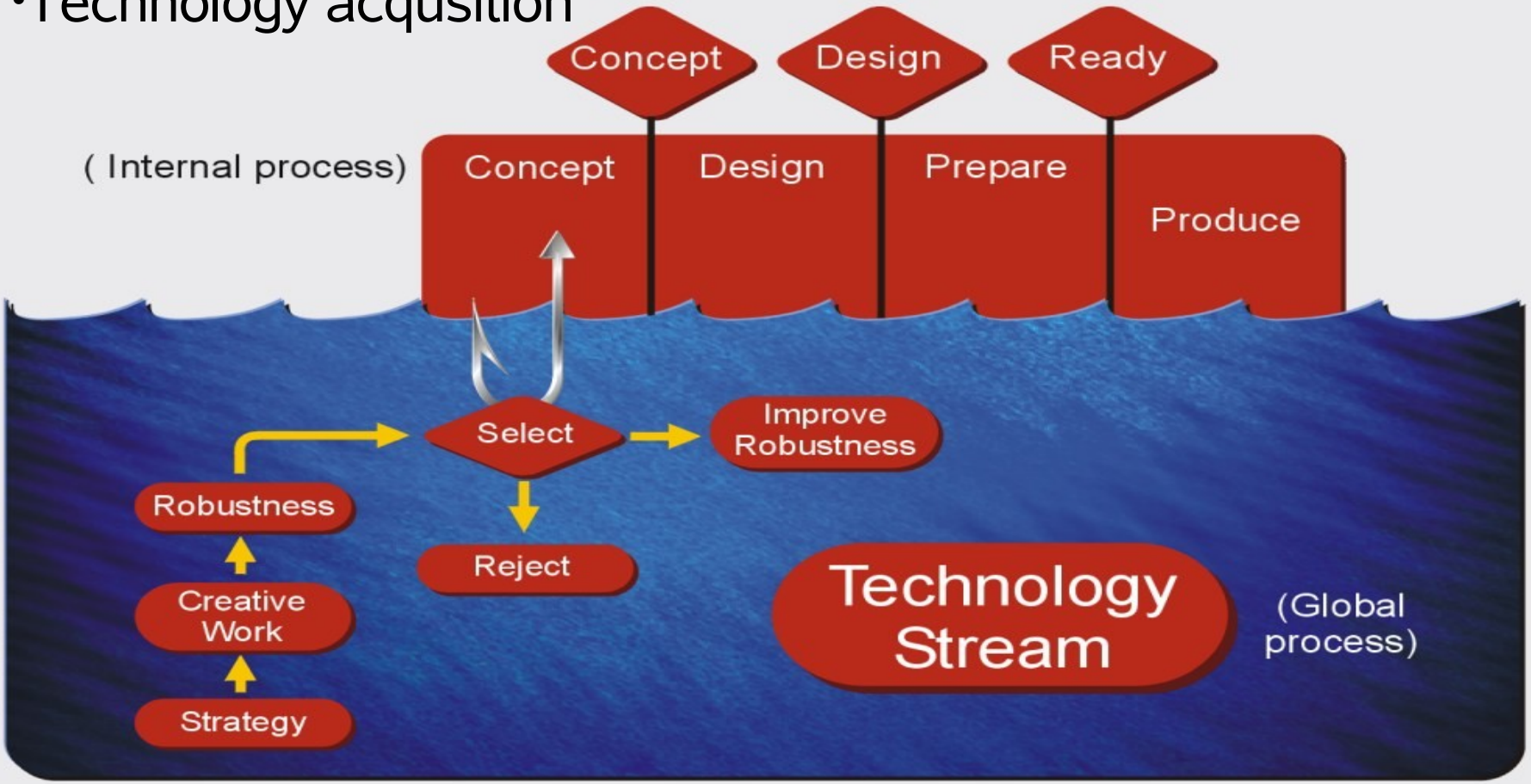
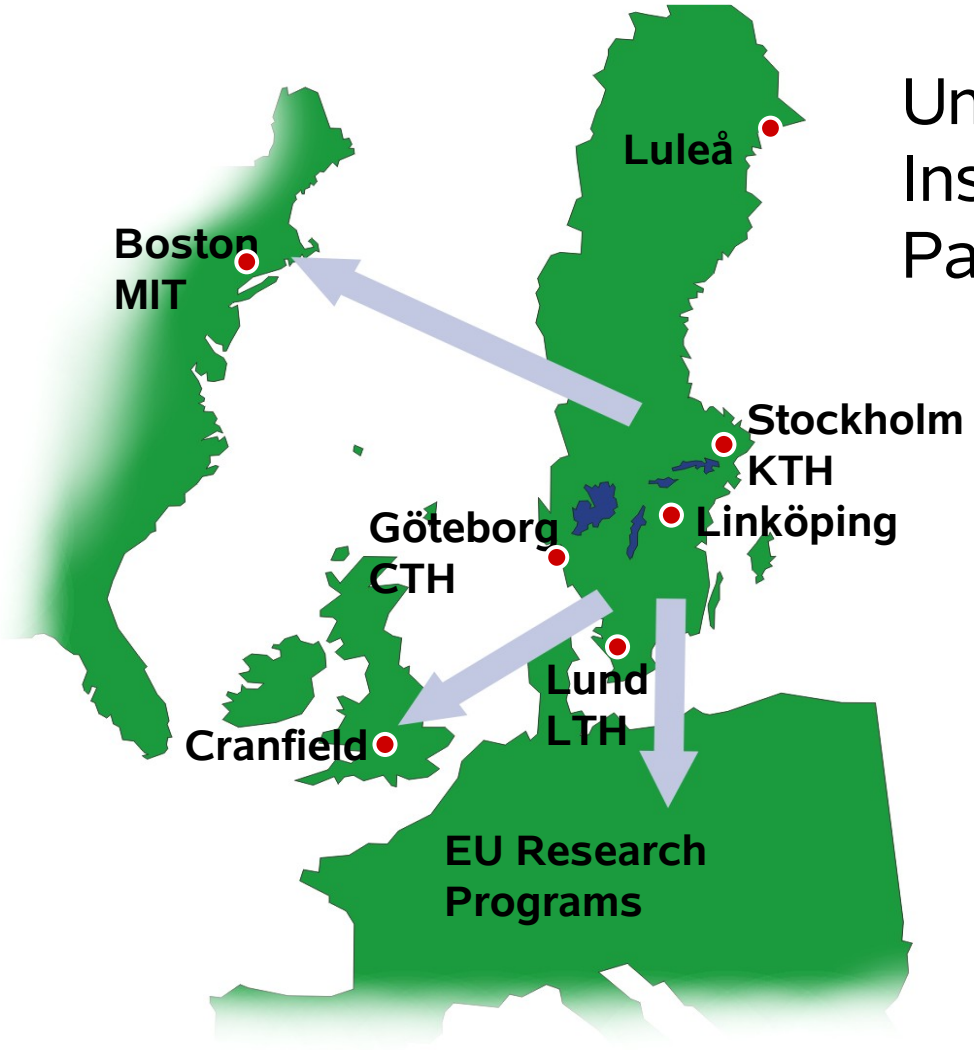
Saab är ett litet företag

Product Realization Process

- Technology acqusition



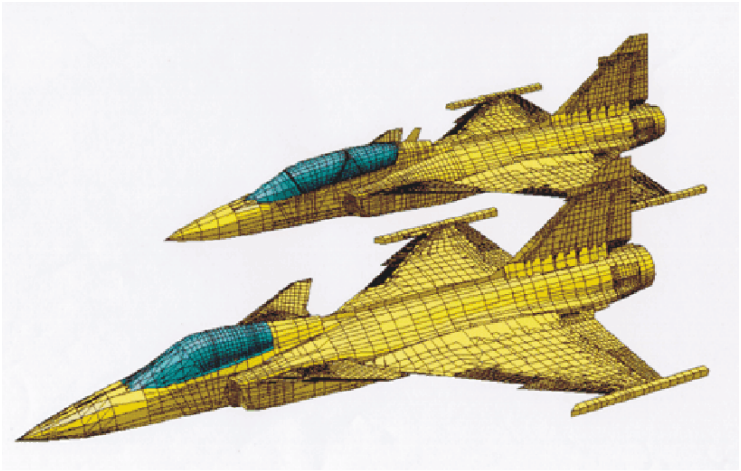
The Saab R & T Networks



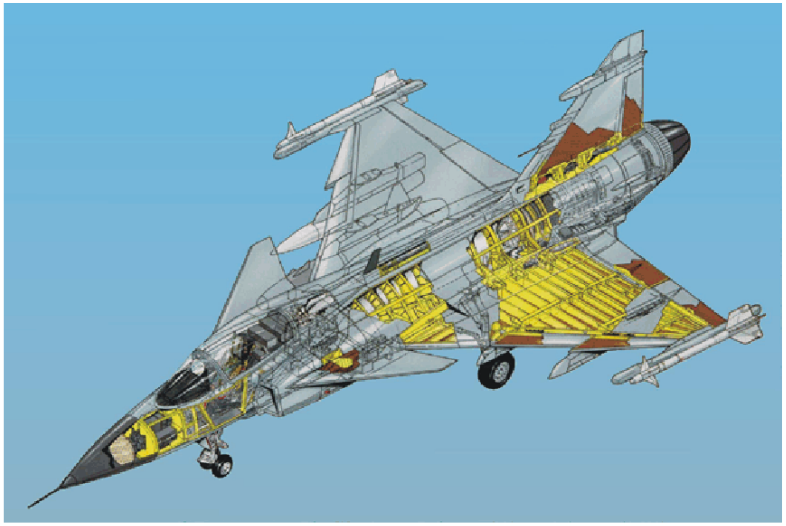
Universities, Research Institutes and Science Parks

- Examples:
- Technology Office Boston/MIT
- LINKLAB
- National Aeronautics Research Program
- ECSEL, ENDREA, HMI, WITAS
- Professors, adj. prof.
- Ph. D. students
- Defense Res. Institute-FOI,…
- EU research,….
- Etc.

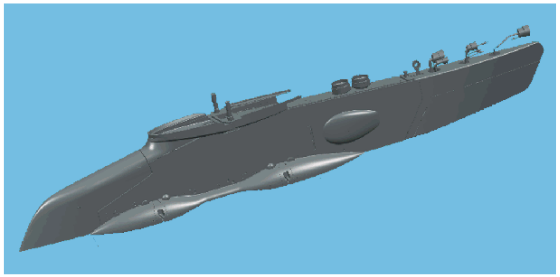
Airframe Engineering



Structural analysis



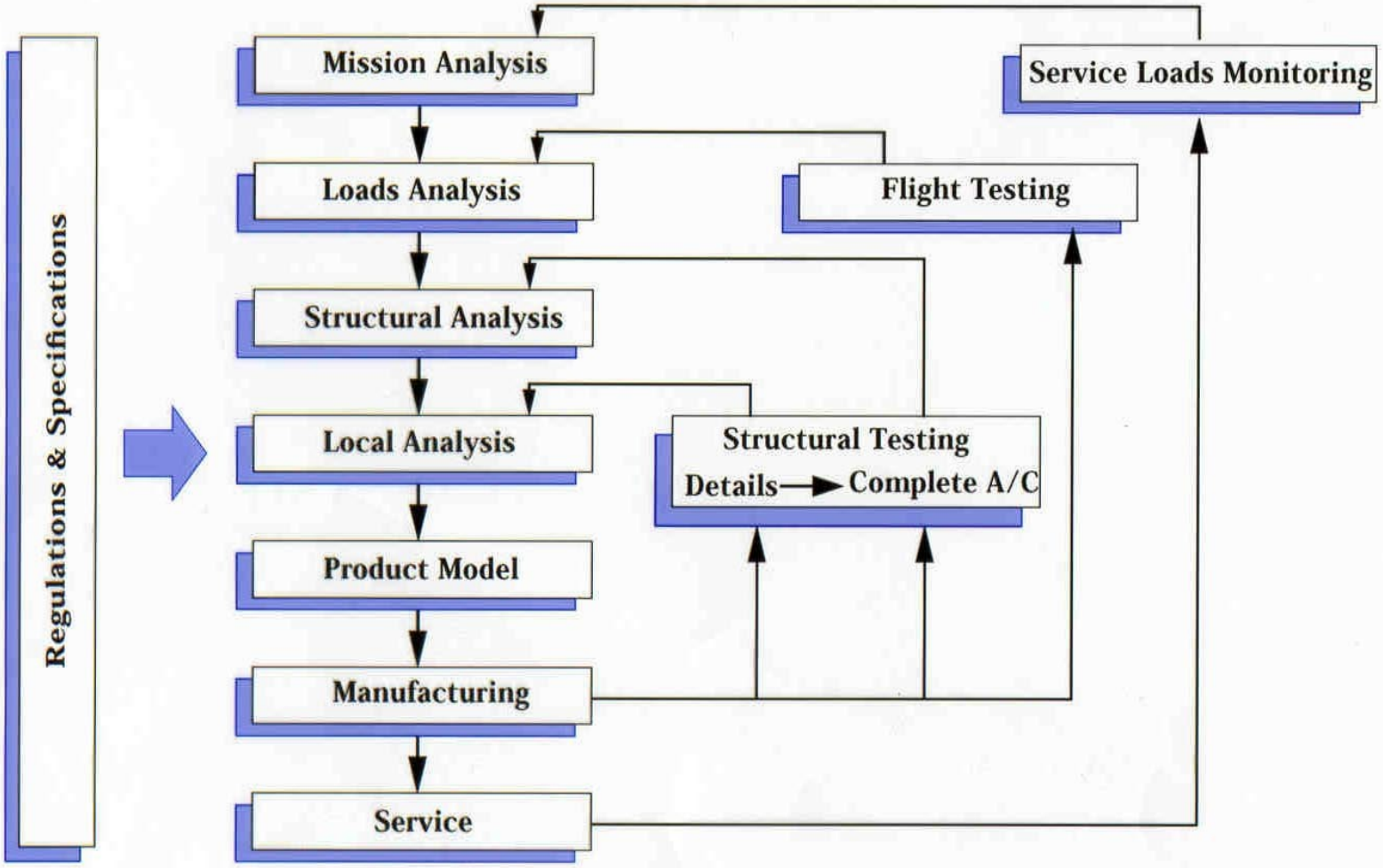
Structural testing



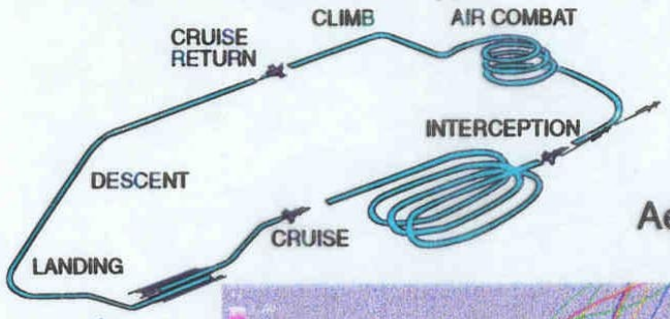
Structural design
Systems installation

- Structural design
- Systems installation
- Structural analysis
- Material and process technology
- Structural testing
- Flutter and load analysis
- Components and standards

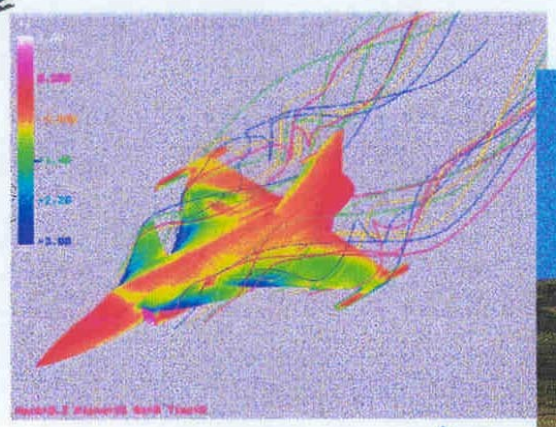
DURABILITY AND DAMAGE TOLERANCE MANAGEMENT PLAN



32 Different Mission Types

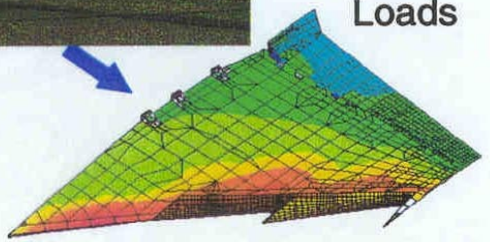


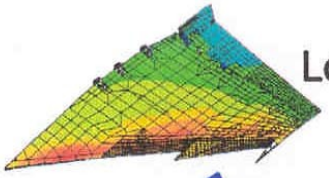
Aerodynamics



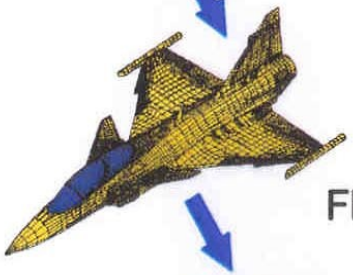
Flight Dynamics

Loads

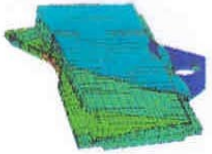




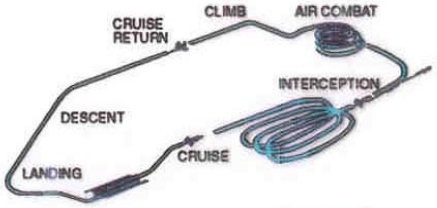
Load cases



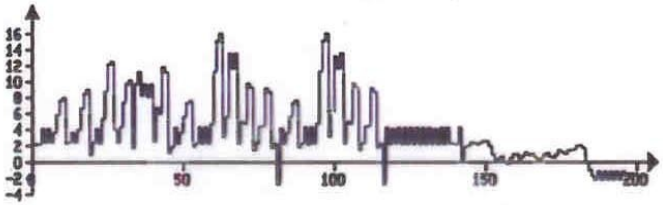
FE model



Local stress results per loadcase



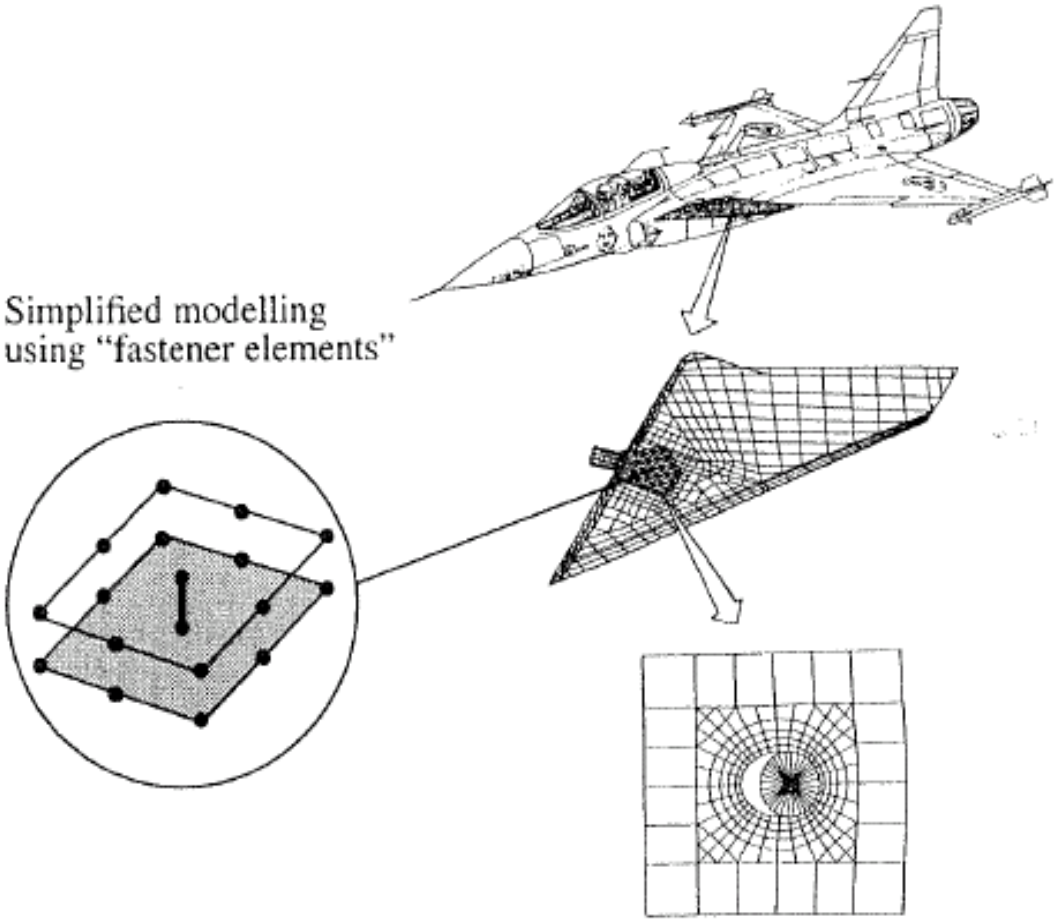
Missions



Sequence of load cases

Prediction of fatigue and damage tolerance properties

Sizing of a bolted joint



Analysis Chain

FE-ANALYSIS

PRESIZ

COBOJ

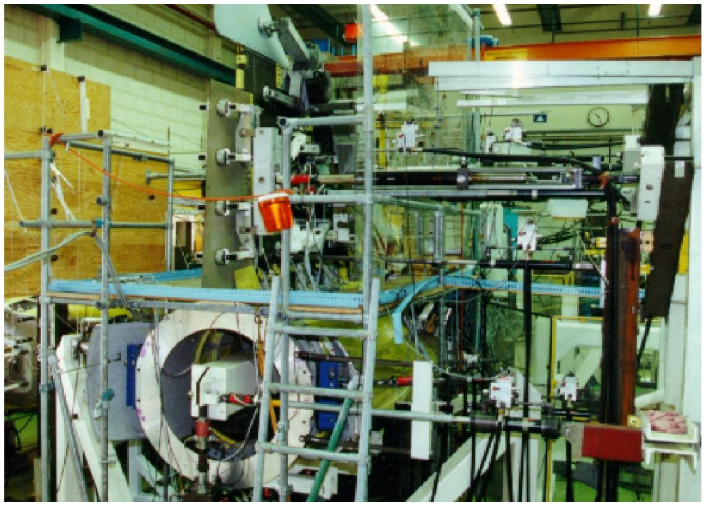
FE-analysis

Failure prediction

Report

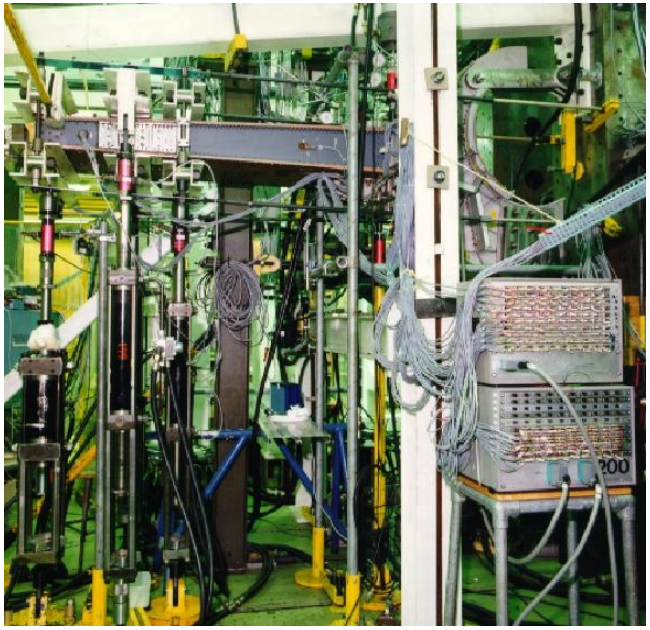
Structural Testing

Rear fuselage with fin and rudder

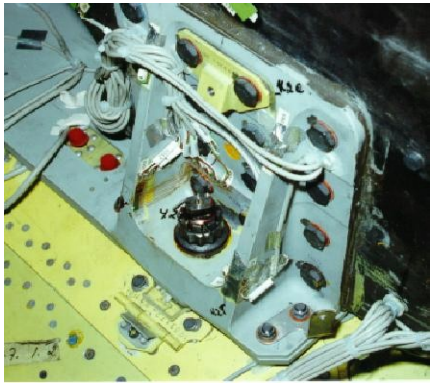


Canard wing and pivot

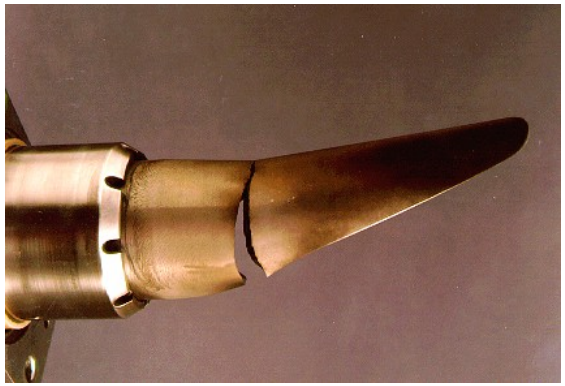
Wing to fuselage joint



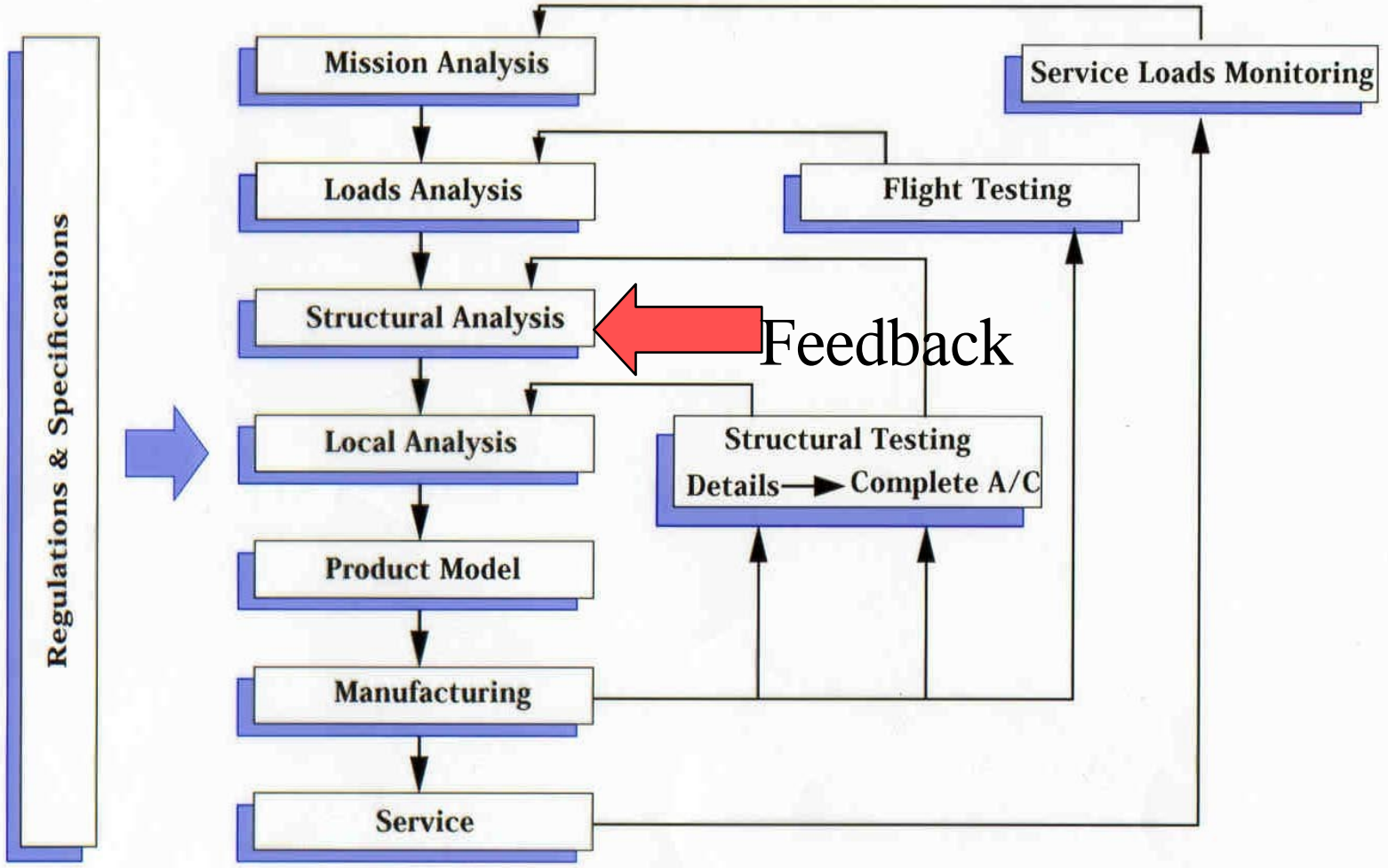
Fin attachment



Gun gas deflector nuzzle

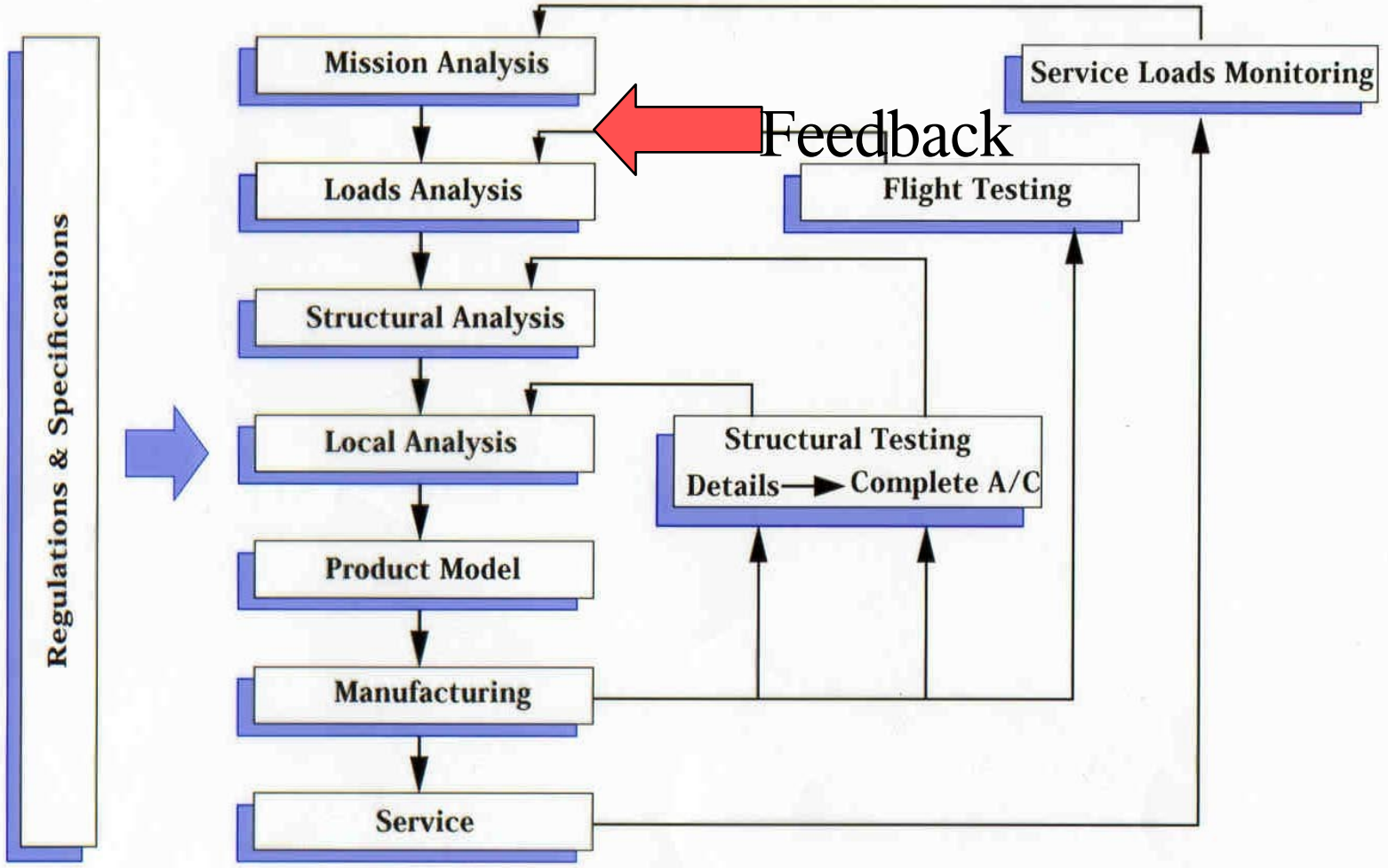


DURABILITY AND DAMAGE TOLERANCE MANAGEMENT PLAN



Flight Test

DURABILITY AND DAMAGE TOLERANCE MANAGEMENT PLAN



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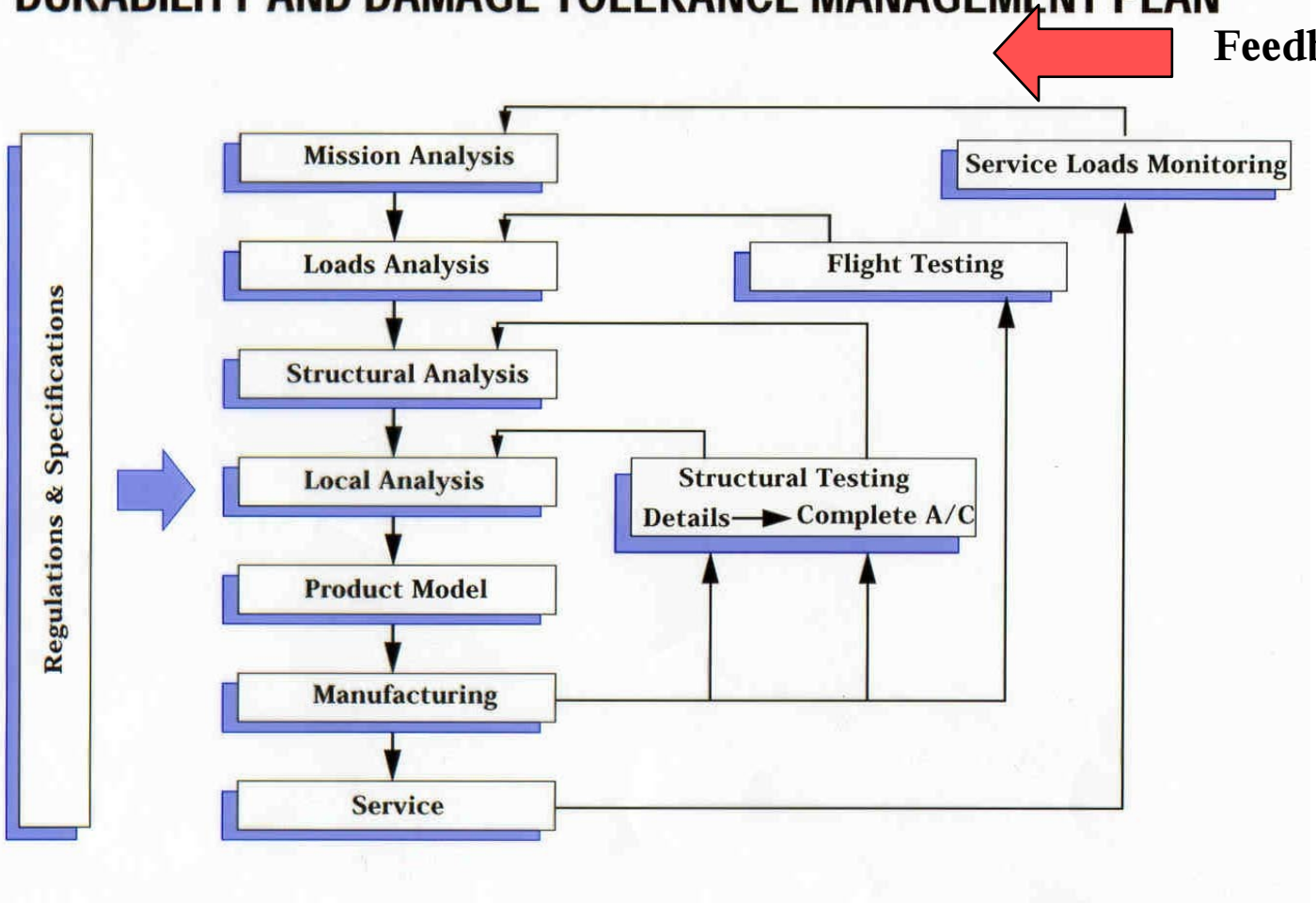
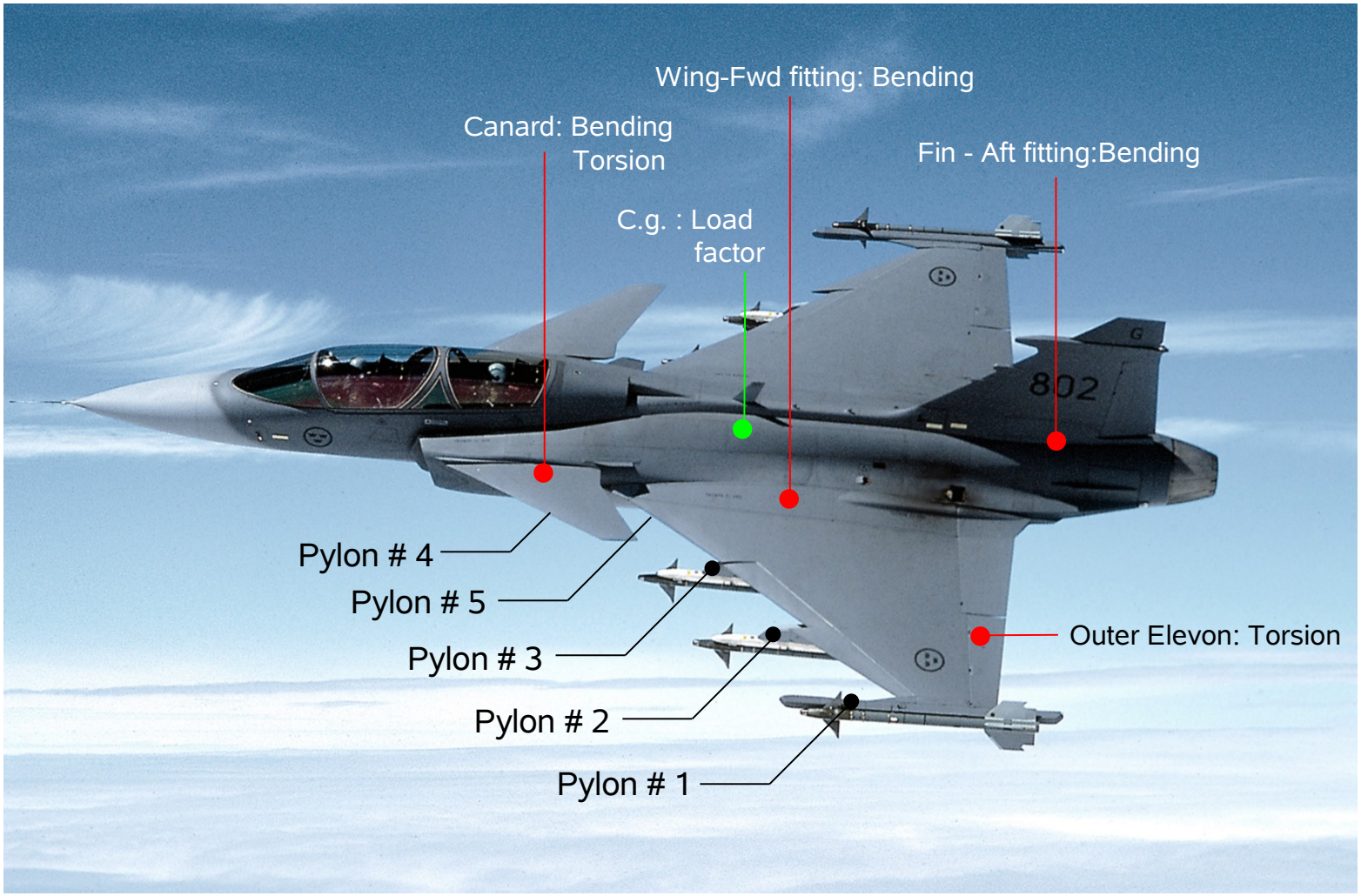
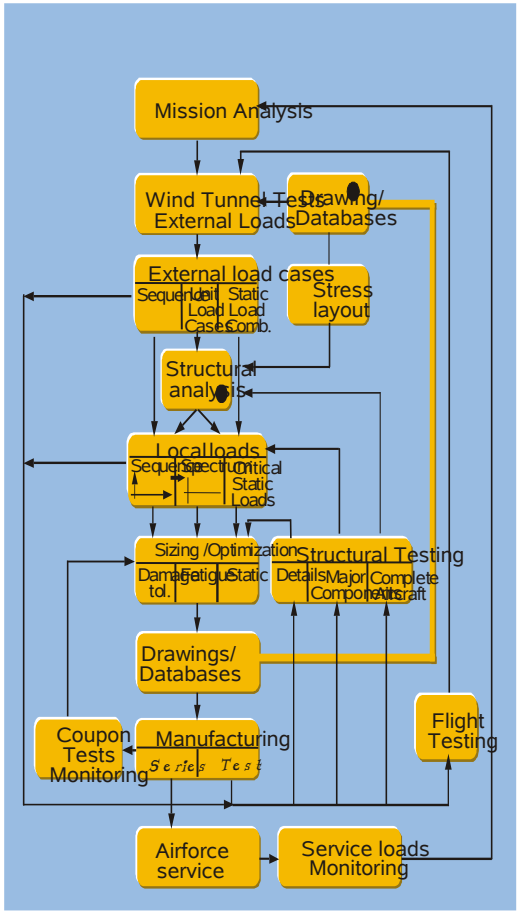
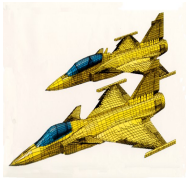


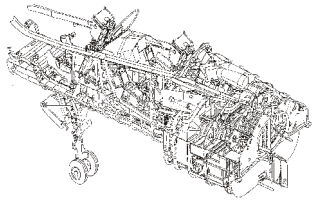
Service Life Monitoring



Modellkonceptet







- Effektivitet
- Kvalitet
- Flexibilitet i livscykeln
- Lagring av kunskap
- Etc etc

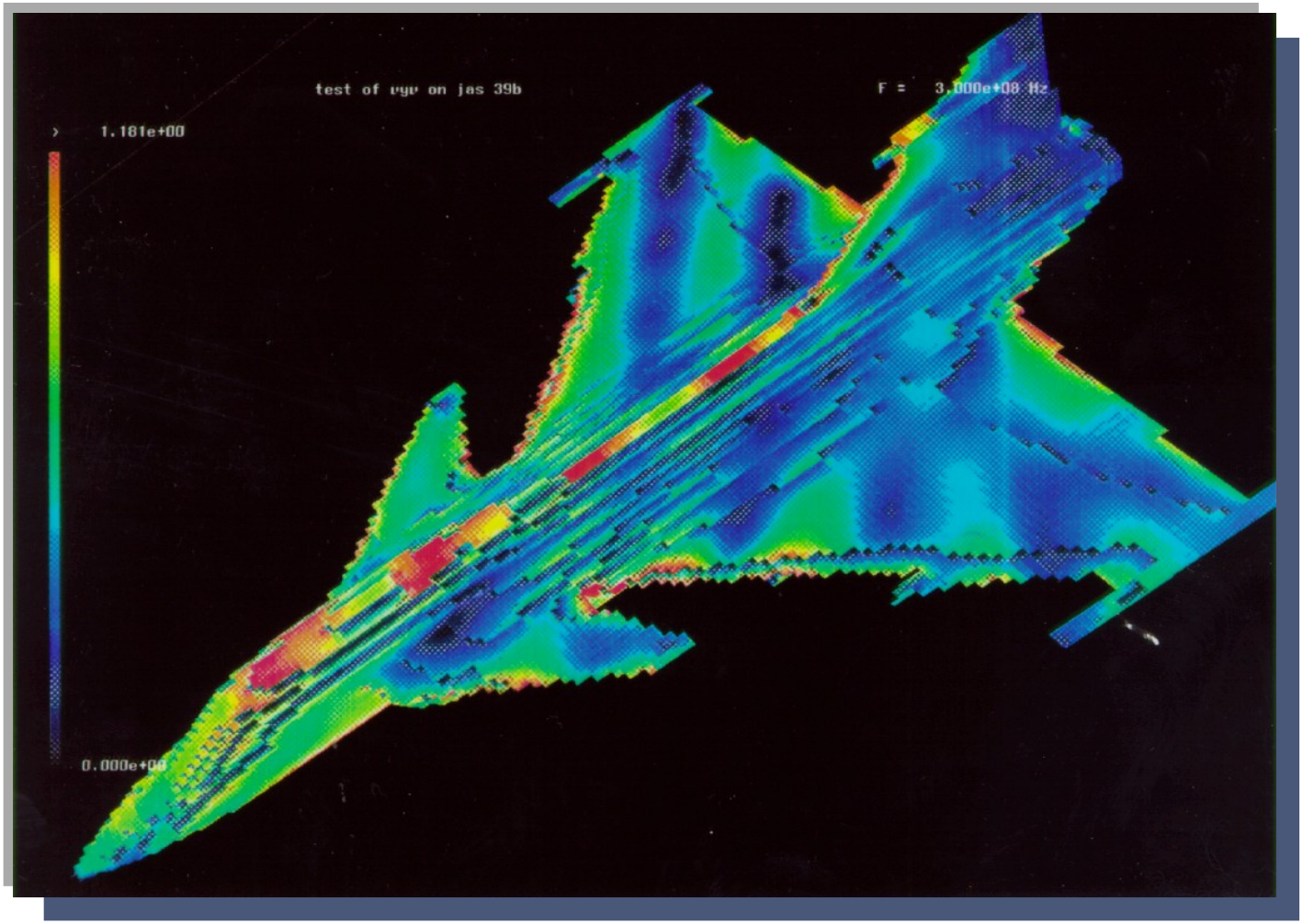
Analogier med andra områden

- Elektromagnetisk teknologi
- Aerodynamik, flygmekanik och styrning
- Systemutveckling
  -Avionik
  -Styrsystem

Elektromagnetisk teknologi
(Maxwells ekvationer)

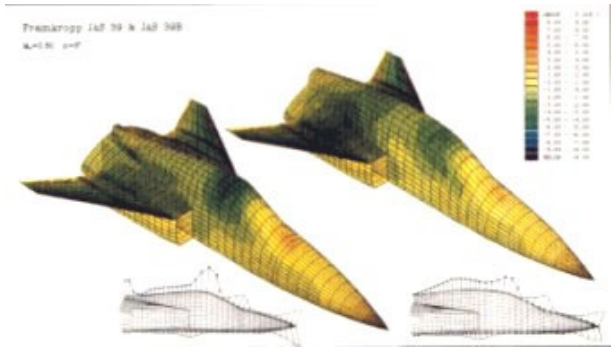
- Elektromagnetisk kompatibilitet
- Antennprestanda
- Smygegenskaper- ex Radarmålarea

JAS 39B Ytströmmar
FDM, 300 MHz



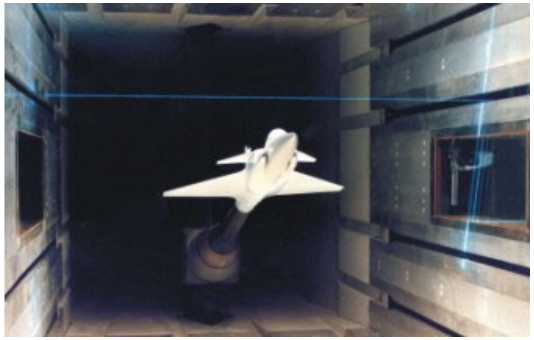
Aerodynamics, Flight Mechanics and Control

Aerodynamics
the essence of flight
...

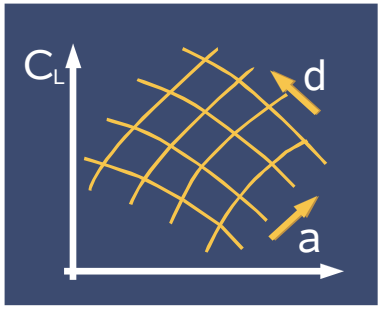


Computational fluid dynamics

Verification



Wind-tunnel testing

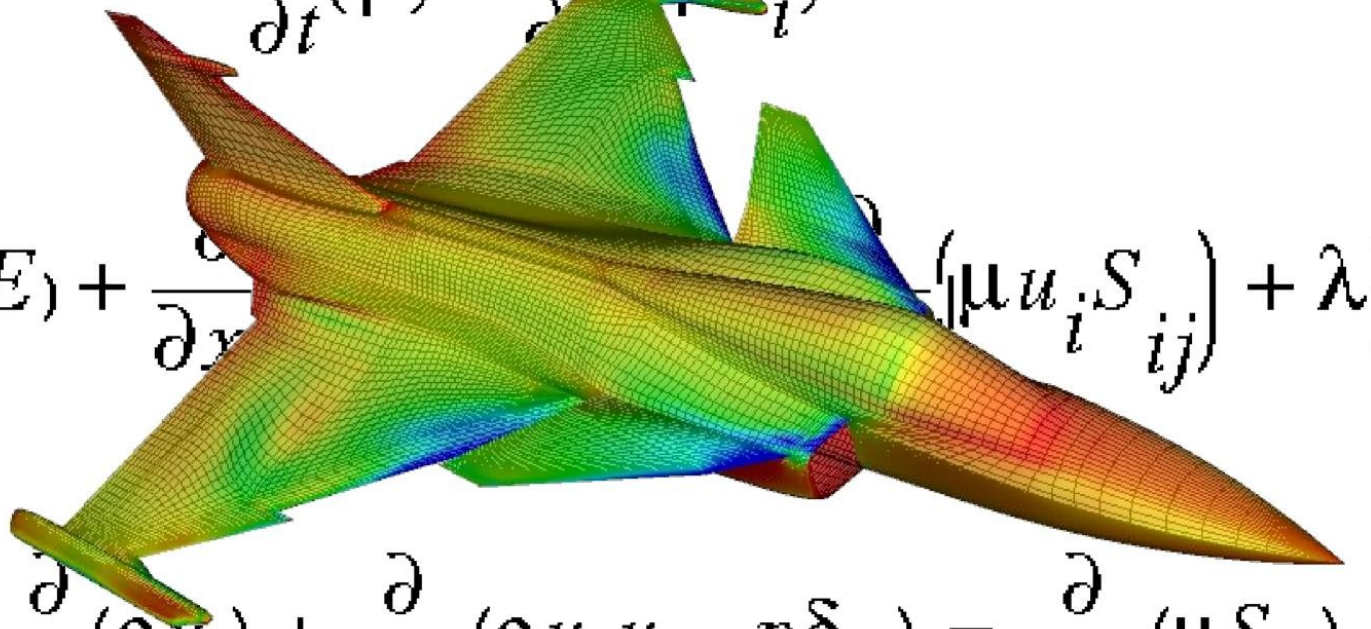


Aerodynamic data

- Flight mechanics
- **Control law development**
- Simulation
- Performance calculations

Flight Display 6.3.1.1 Flight Simulation 6.3.1.2

CFD Model to Simulate Aerodynamics

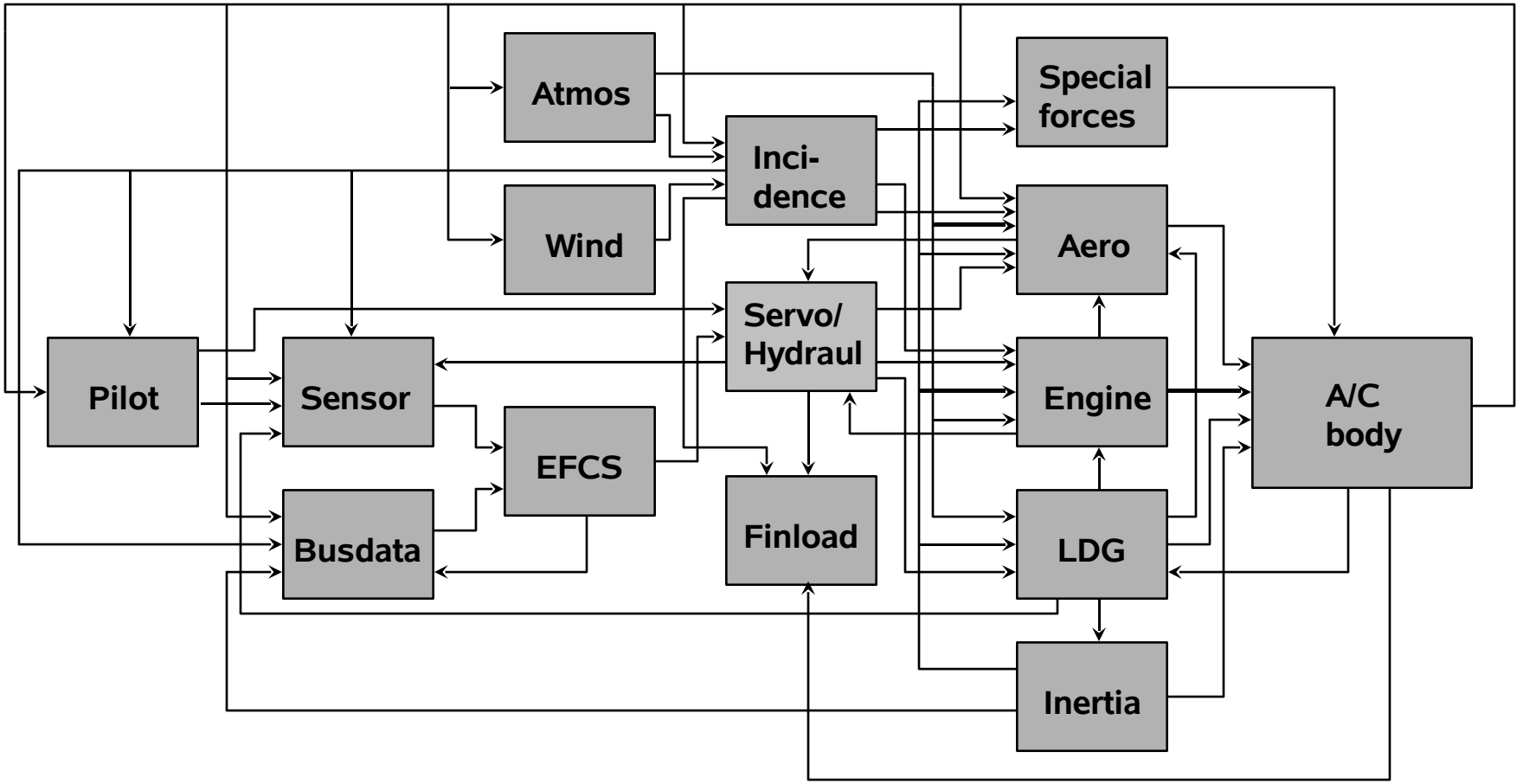


$$\frac{\partial}{\partial t}(\rho) + \frac{\partial}{\partial}(\rho u_i) = 0$$

$$\frac{\partial}{\partial t}(\rho E) + \frac{\partial}{\partial x} \left(\mu u_i S_{ij}\right) + \lambda \frac{\partial T}{\partial x_j}$$

$$\frac{\partial}{\partial t}(\rho u_i) + \frac{\partial}{\partial x_j}(\rho u_i u_j + p\delta_{ij}) = \frac{\partial}{\partial x_j}(\mu S_{ij})$$

The Flight System ARES39 Flowchart



Flight Simulation

Aerodynamics, Flight Mechanics and Control

Aerodynamics
the essence of flight
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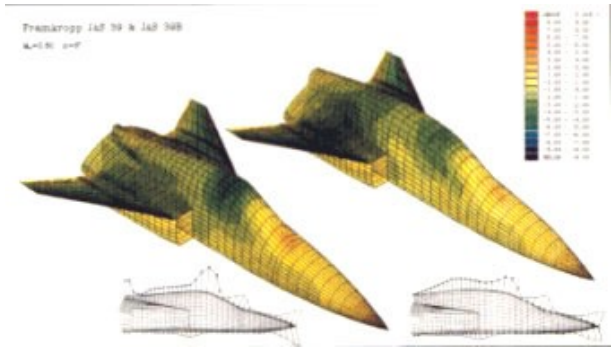
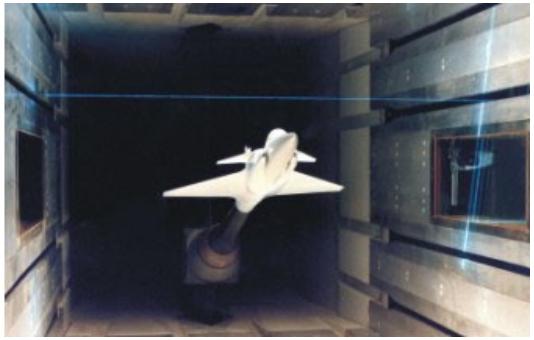
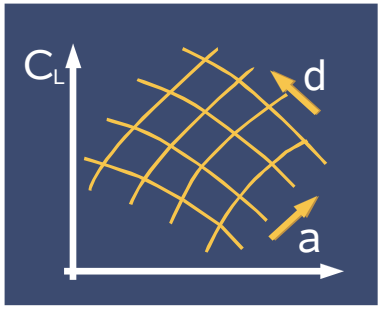


Computational fluid dynamics

Verification



Wind-tunnel testing



Aerodynamic data

- Flight mechanics
- **Control law development**
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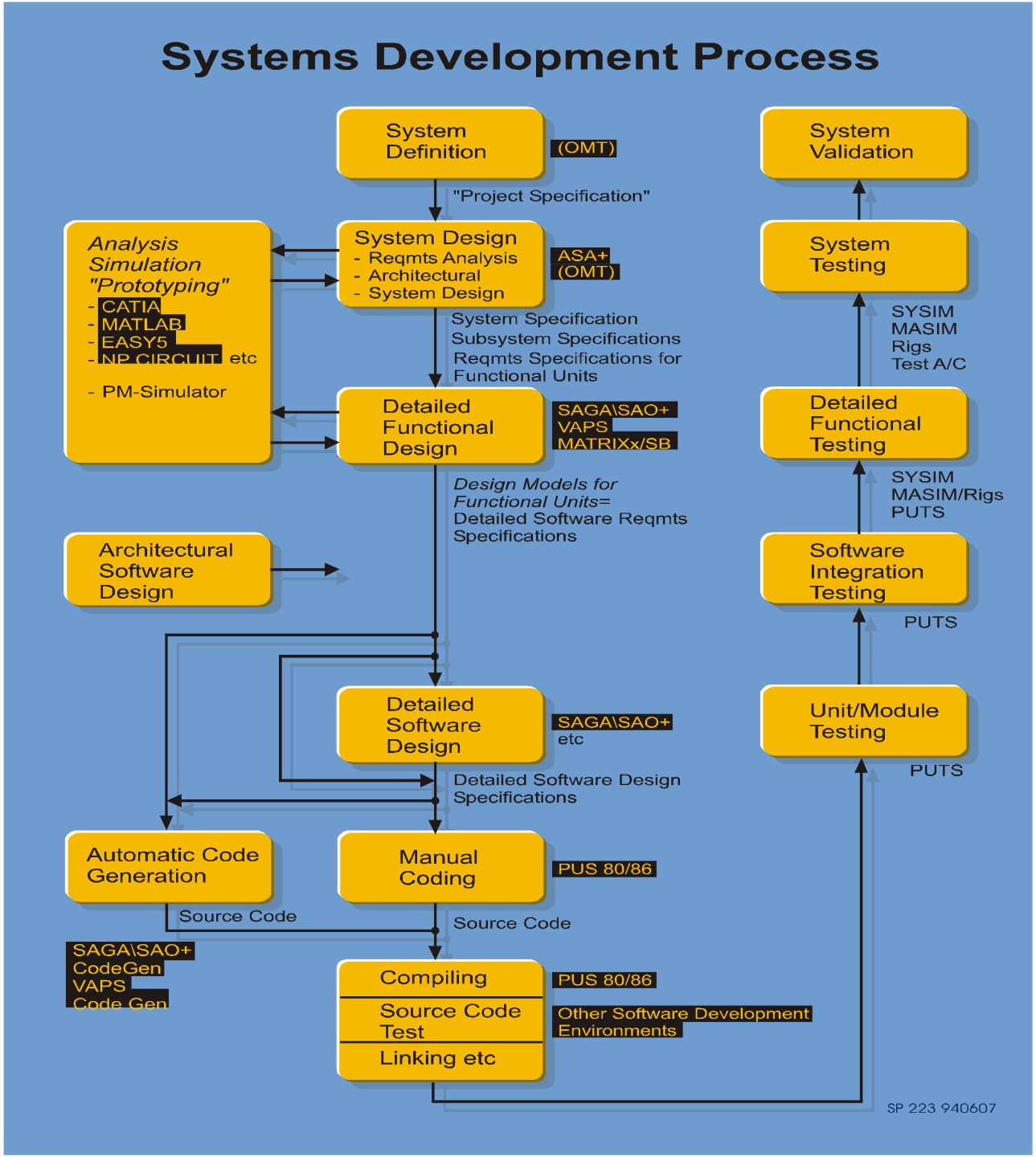
- Performance calculations

Flight Display 6.3.1.1 Flight Simulation 6.3.1.2


Systems Development Process
System Definition
(OMT)
"Project Specification"
System Design
- Reqmts Analysis
- Architectural
- System Design
ASA+
(OMT)
Analysis
Simulation
"Prototyping"
- CATIA
- MATLAB
- EASY5
- NP CIRCUIT etc
- PM-Simulator
System Specification
Subsystem Specifications
Reqmts Specifications for
Functional Units
Detailed
Functional
Design
SAGA\SAO+
VAPS
MATRIXx/SB
Design Models for
Functional Units=
Detailed Software Reqmts
Specifications
Architectural
Software
Design
Detailed
Software
Design
SAGA\SAO+
etc
Detailed Software Design
Specifications
Automatic Code
Generation
Manual
Coding
PUS 80/86
Source Code
Source Code
SAGA\SAO+
CodeGen
VAPS
Code Gen
Compiling
PUS 80/86
Source Code
Test
Other Software Development
Environments
Linking etc
System
Validation
System
Testing
SYSIM
MASIM
Rigs
Test A/C
Detailed
Functional
Testing
SYSIM
MASIM/Rigs
PUTS
Software
Integration
Testing
PUTS
Unit/Module
Testing
PUTS
SP 223 940607

sp223

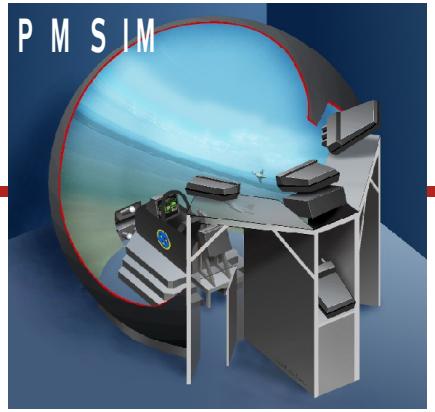
Tools and Methods

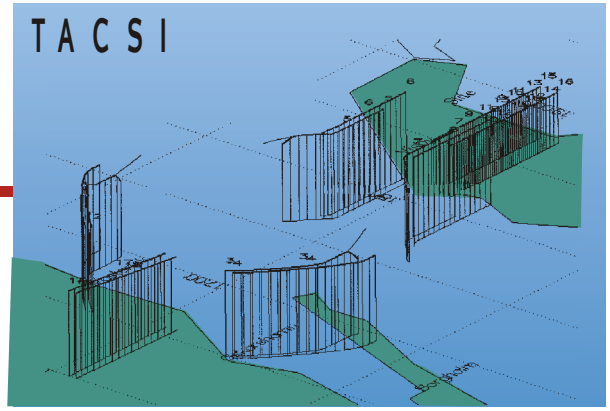
Presentation alternatives

VAPS

Tactical scenarios

TACSI



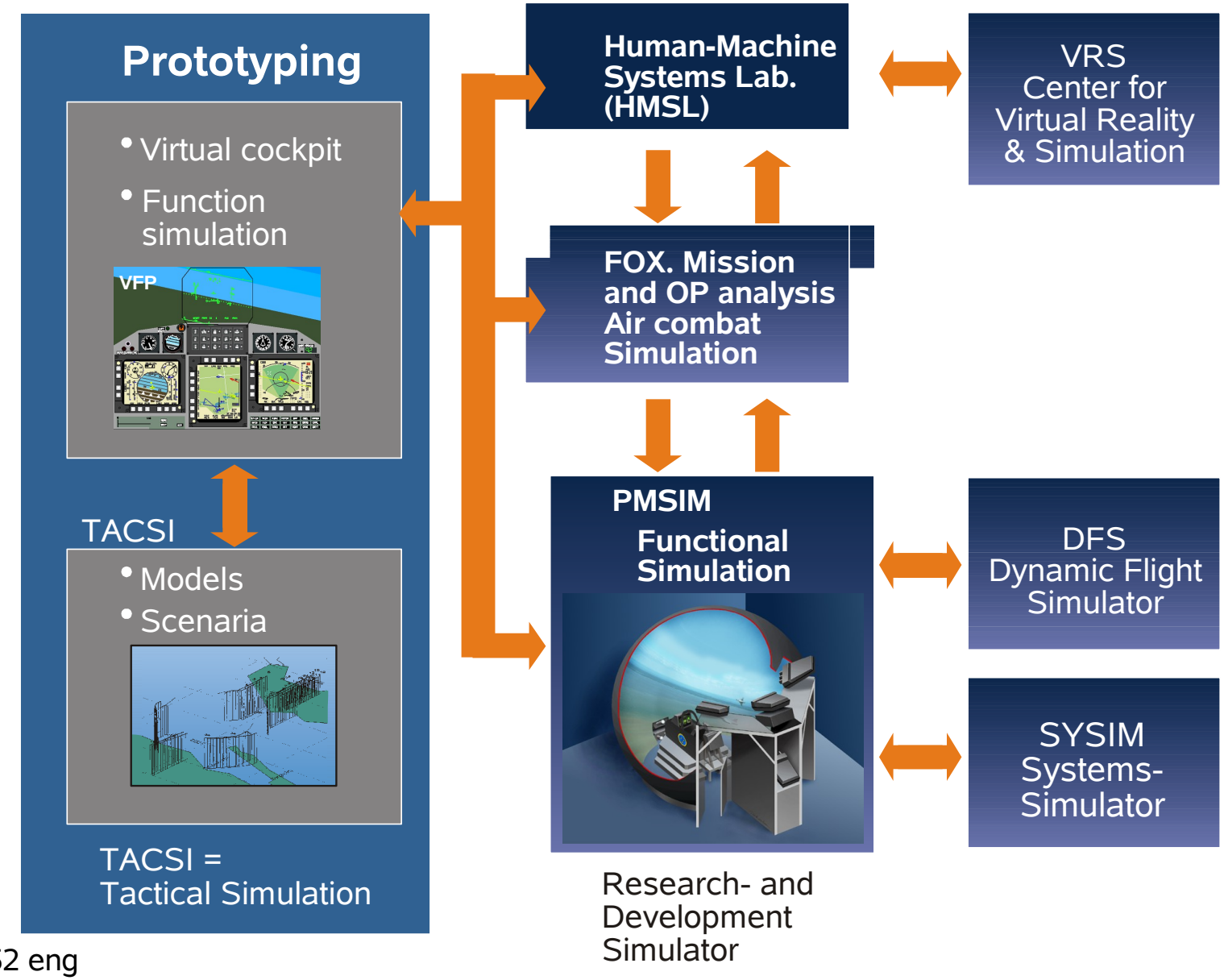


VAPS = Virtual Avionics Prototyping System

VFP = Virtual Front Panel

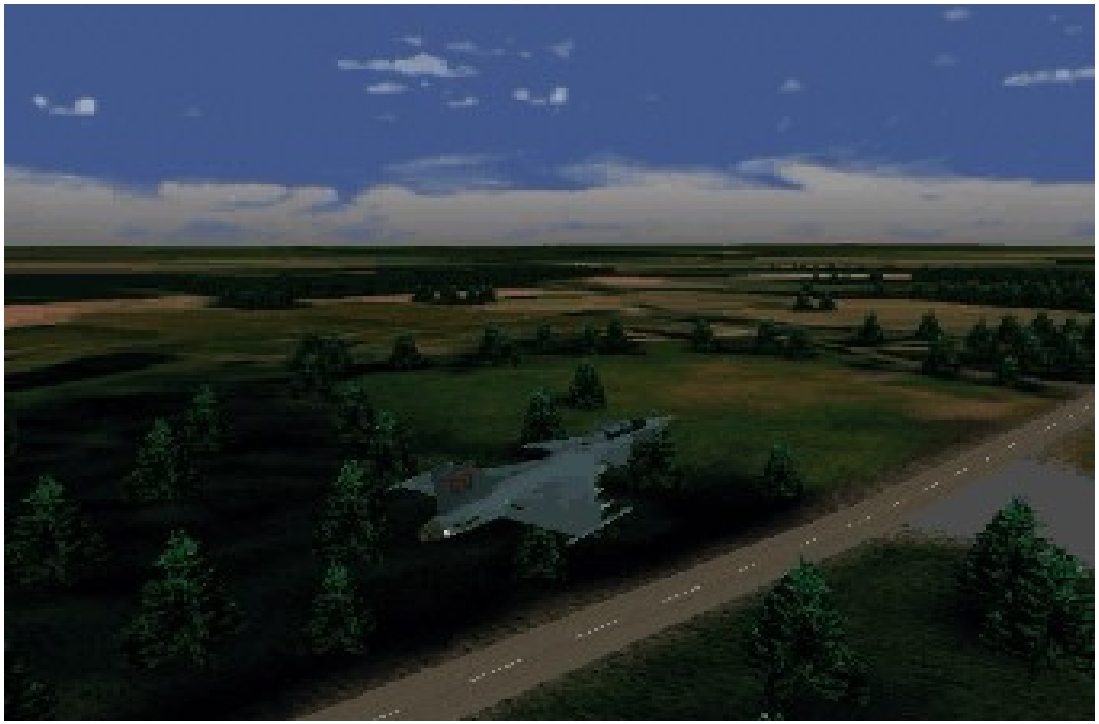
TACSI = Tactical Simulation

Funktionsutveckling. Verktyg och metoder

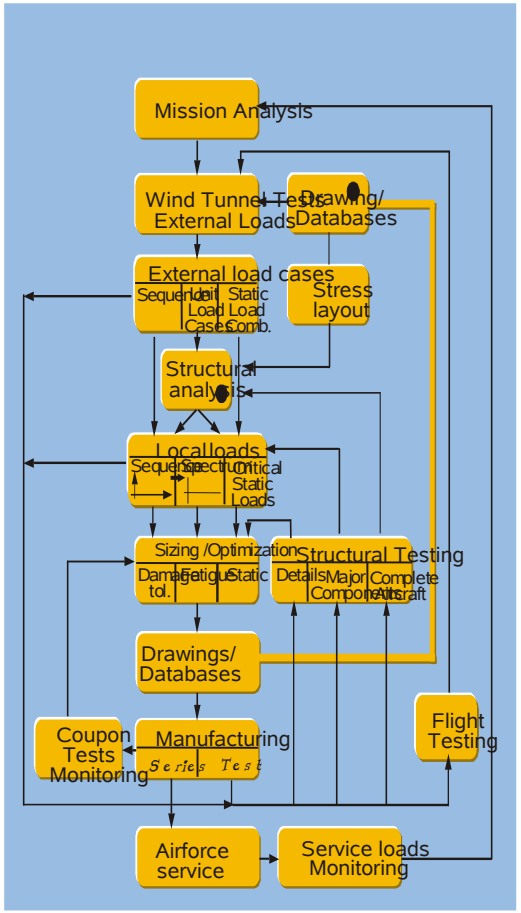


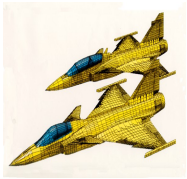
Simulation

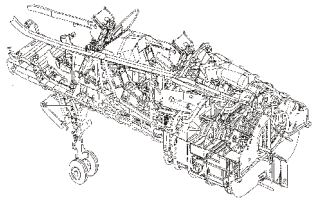
- Film clip from PM-SIM



Modellkonceptet







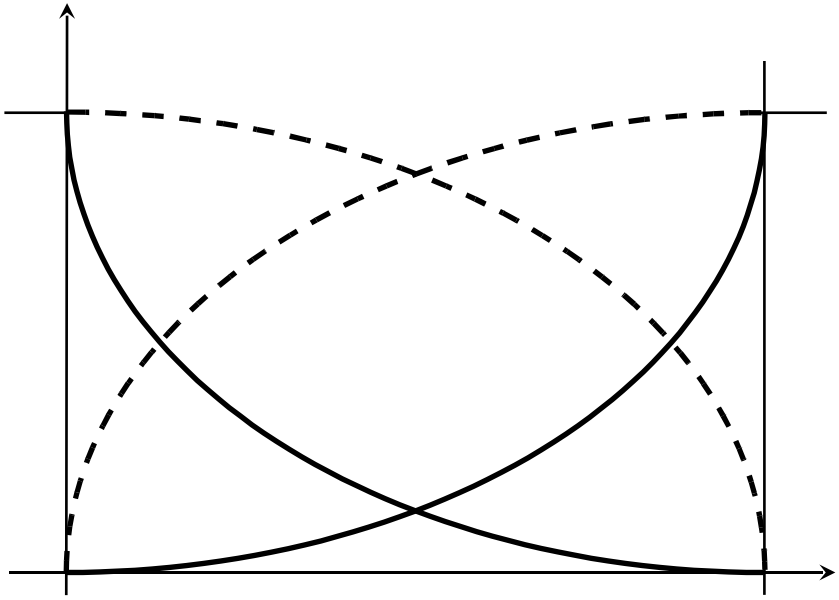
- Effektivitet
- Kvalitet
- Flexibilitet i livscykeln
- Lagring av kunskap
- Etc etc

JAS39Gripen

Two Seater

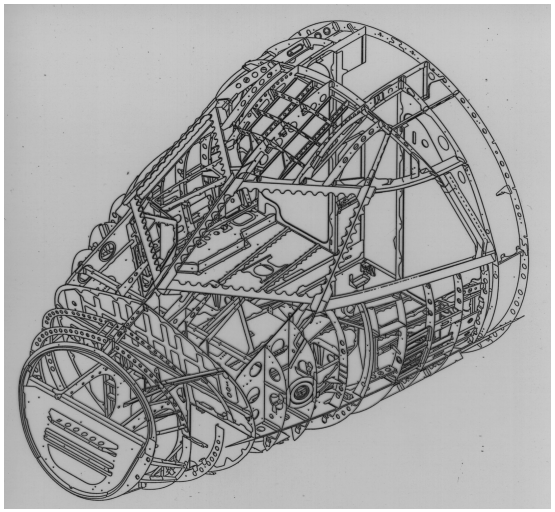
Holistic Integrated Product Development
general

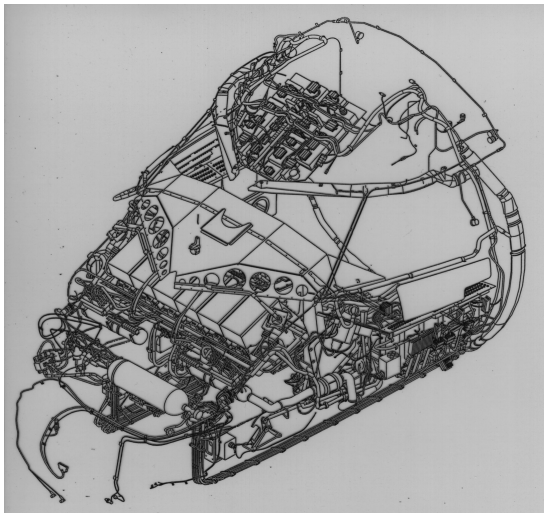
IPD: A way to optimize the contribution from people, processes and tools to achieve product optimality

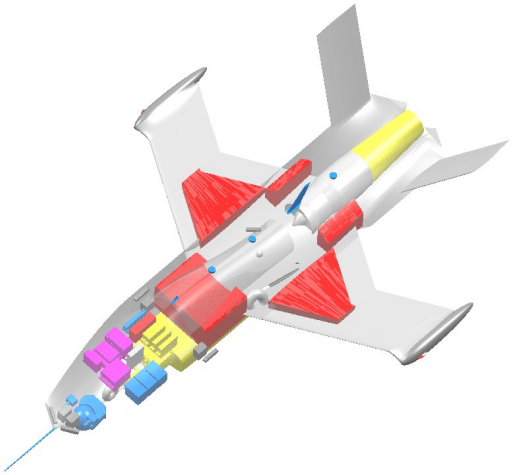


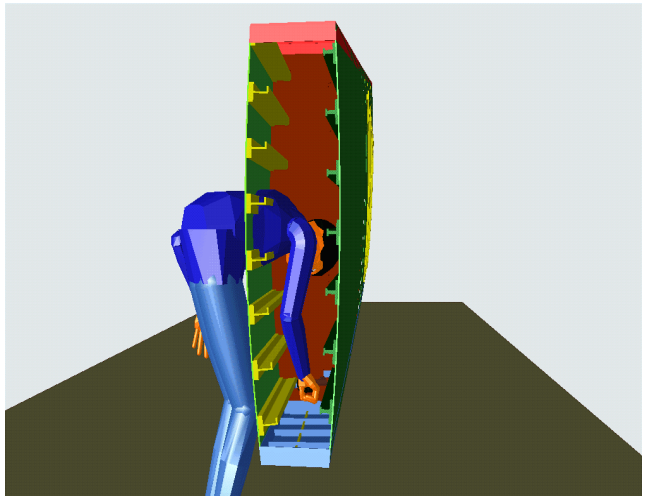
early knowledge and understanding
communication
balanced team
simultaneous product and process
Modeling and simulation

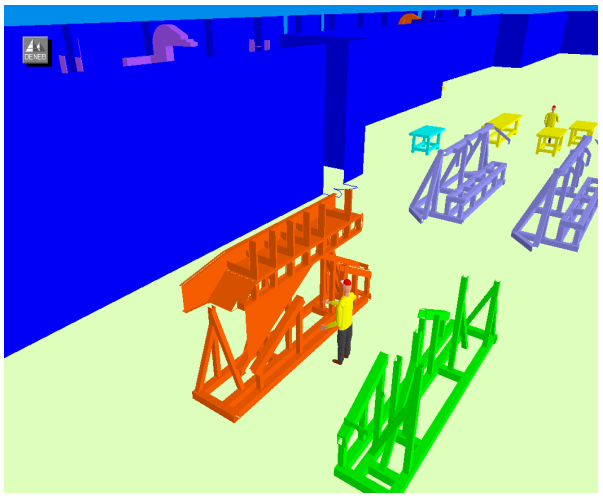
Supporting IPD
The role of the DMU

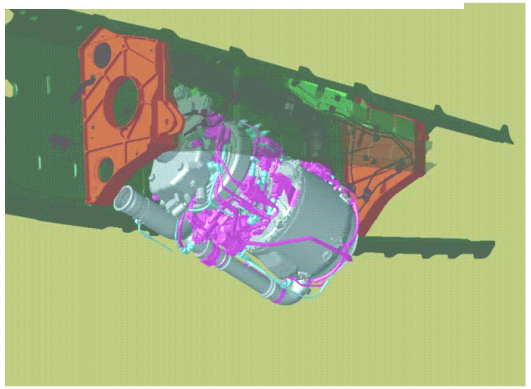




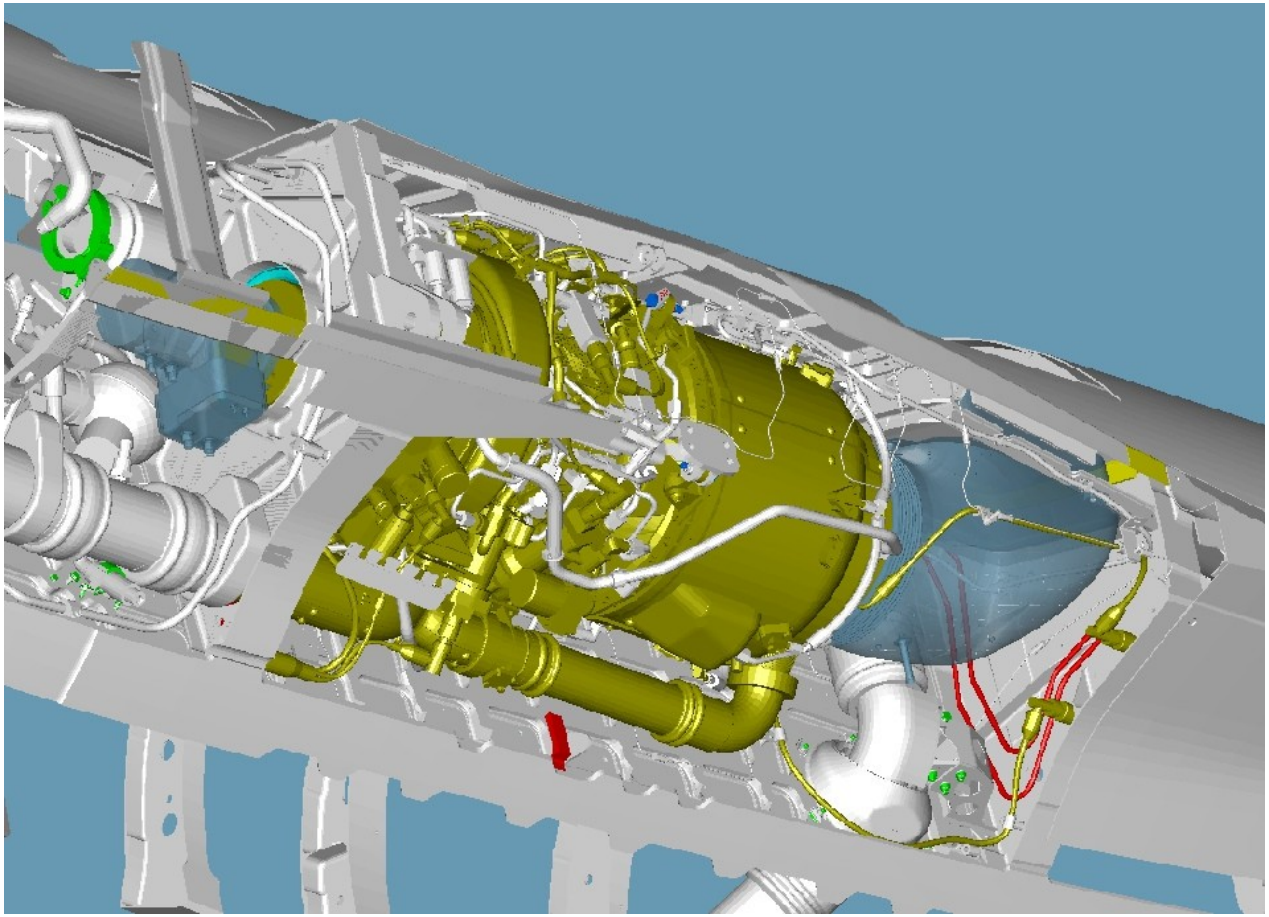








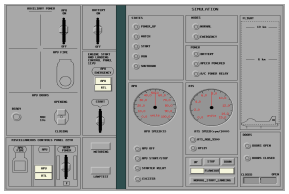
3D Solid CAD
Gripen Auxiliary Power Unit, APU



Collaborative Development

- Saab integrator—Sundstrand (US) supplier
- Subsystem:Auxiliary Power Unit. APU
- Requirements modeling
- Analyzing information flow for communication efficiency
- Communication using models, eg digital mock up, system performance modeling etc

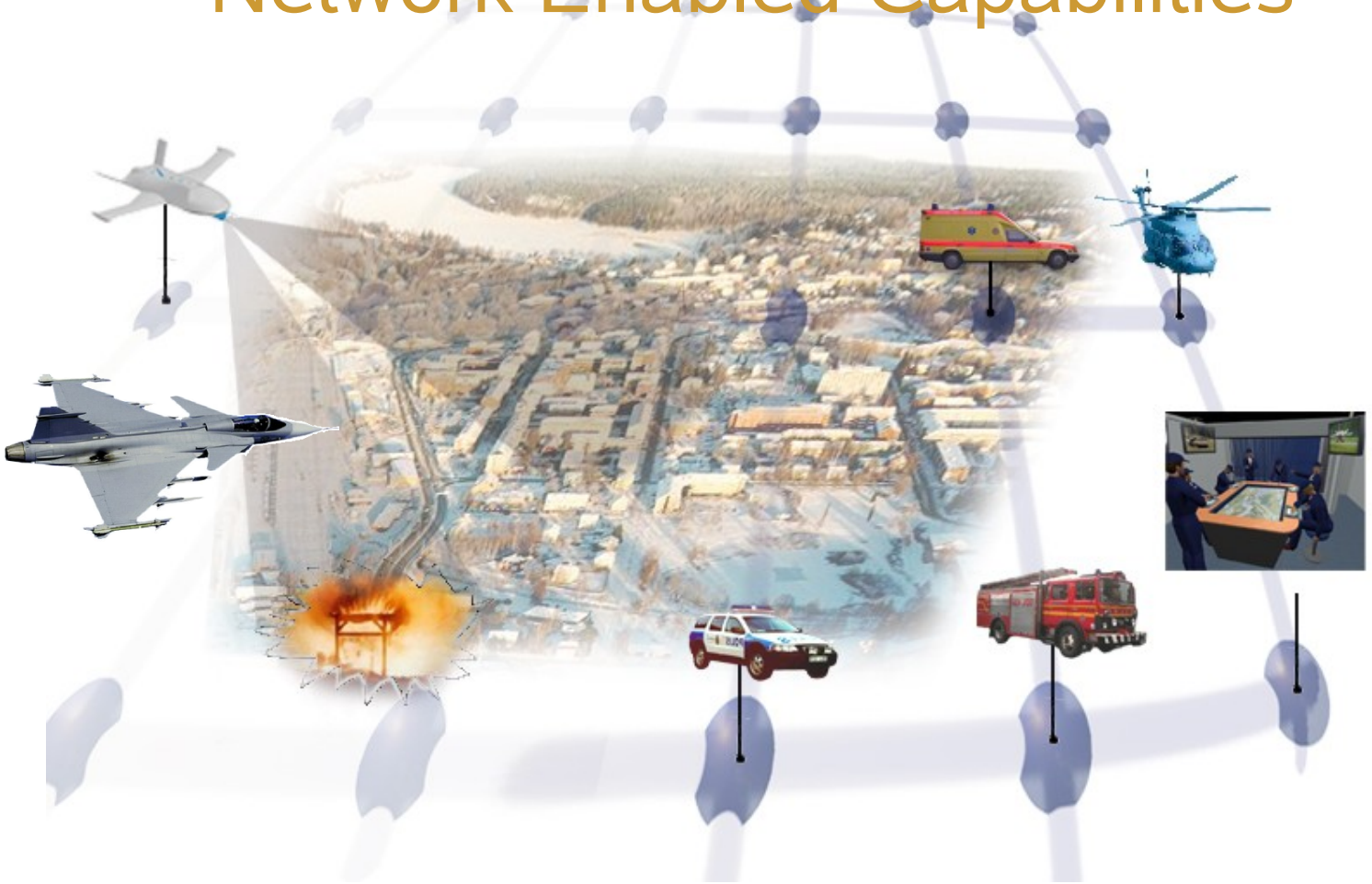
Requirements Performance Modeling



APU

Computer simulation removal APU.

Defense and Civil Security
Network Enabled Capabilities

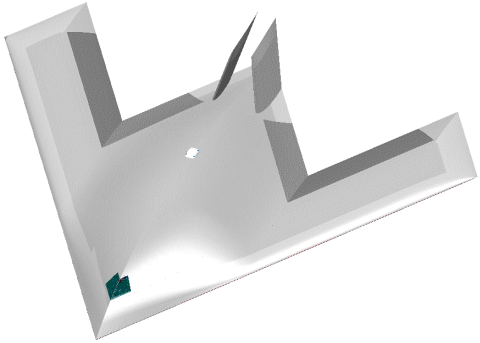


Unmanned Air Vehicles

Some Swedish demonstrators

Baby Sharc *Saab*

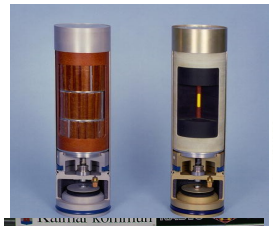
VTOL UAV *WITAS/LiU*

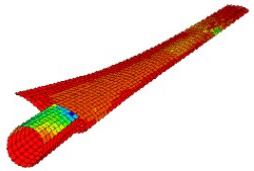


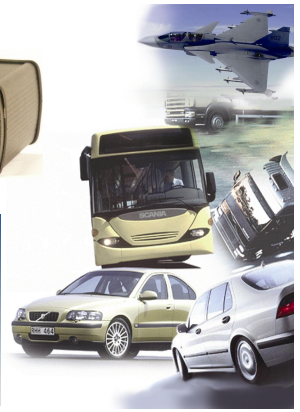
Filur *FMV/Saab*

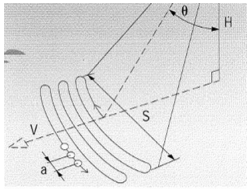
SAAB Venture Capital Council

Leveraging defence R&D by bringing competitive technologies to civil markets in win-win arrangements

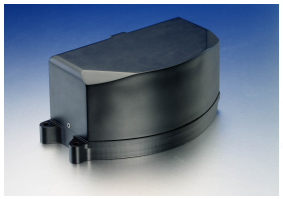




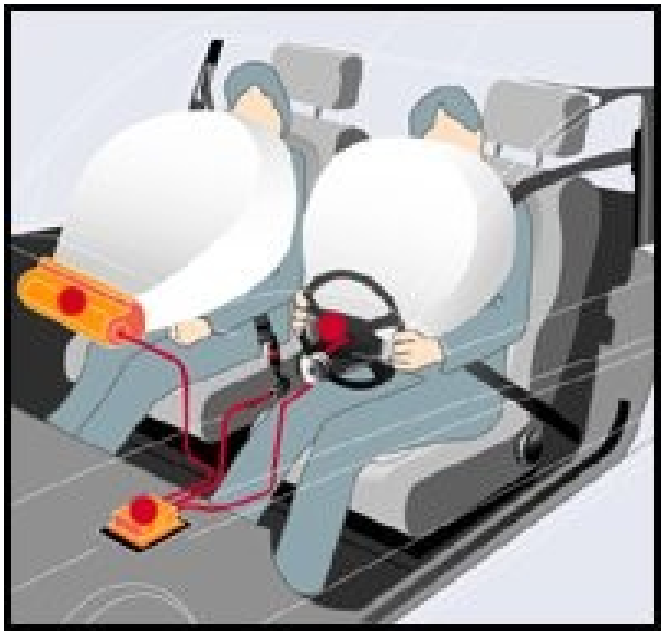


Nobel Biocare

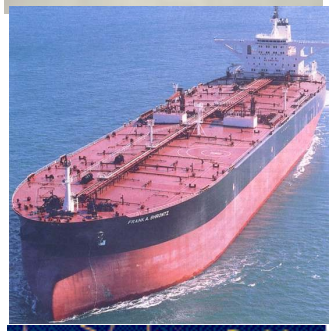
- Bofors Surface Treatment Labs (70-ties) unique surface structure for titanium toth-proteses/implantate compatible with human tissue.
- Series production started in Bofors.
- Nobel Biocare is now on the stock exchange and has 1300 employees.

Safety Airbag

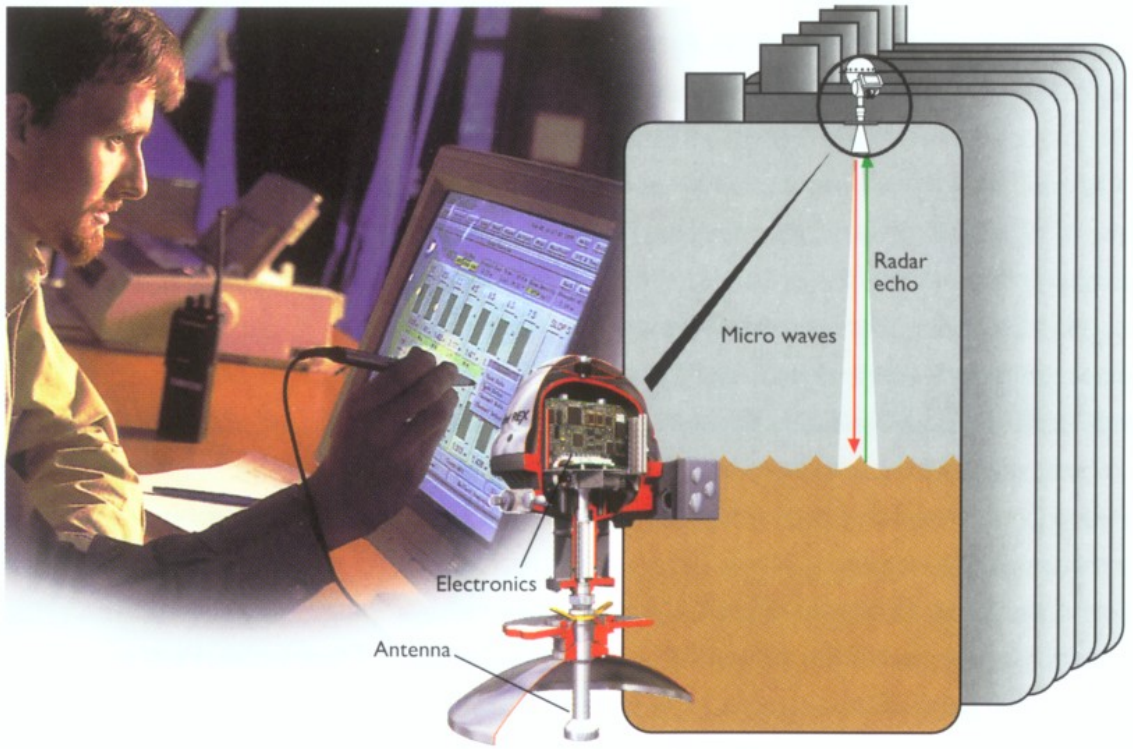
- Originating from military pyro technology
- Military sensors for release of the airbag.
- Airbag in the Draken fighter aircraft-1950-ies.



Saab Marine Electronics



- Turnover 2002 100+MUSD
- Radar-based level gauges



MX Composites

- **MX Composites AB´s** business concept is to provide unique light and high strength components, licenses and know-how based on our patented concept of High Speed Machining of Metal Matrix Composite (MMC) to customers within the Aerospace, Space and Automotive industry.

- MX Composites holds deep experience from production methods, high speed machining, structural mechanics, metallurgy, material analysis, design of combustion engine and aerospace components

Connecting rod for MC

Founded: 2002
No of employees: 4

Brake Components

The technology is used in the Enduro World Championships

MX Composites is supplying connecting rods to the Husaberg Racing Team

- Better acceleration
- Less gyro effect
- Less vibrations

AMM, Active Medical Materials

Spin-off

SAAB

SMM Medical offers multinational medical device companies production and marketing rights of patent protected medical device products based on active materials which is controlled by an electric potential.

The device concept is patented in 80 % of the medical world market and gives customers value growth through cheaper production, new markets and better healthcare.

Today's products (Lunamed)

Examples of active materials

Owners:	Iteksa	48,0 %	Founded: 2002
	Saab AB	52,0 %	Nbr of employees: 3

TRACAB

superior sporting experience

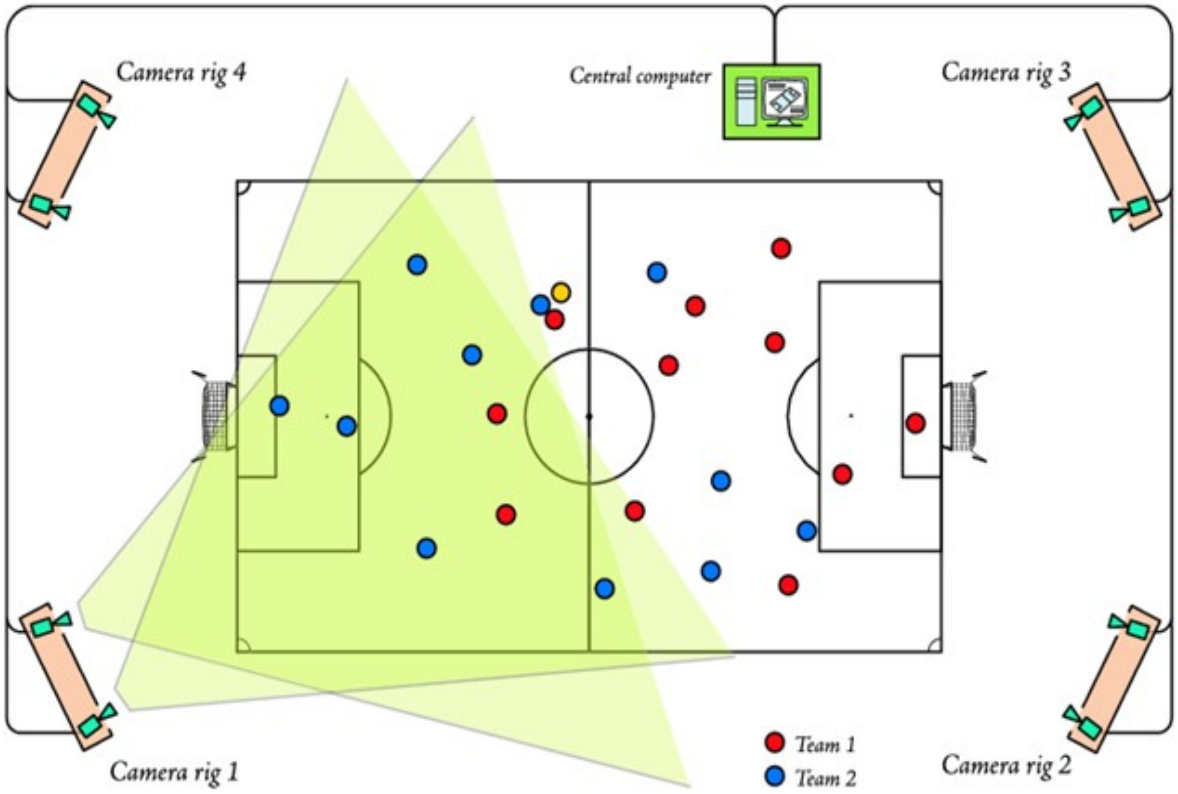
Use of advanced image processing and multiple cameras to analyse several interesting situations in sports events, especially football.

This project brings together competencies from three different actors, which enables new to the world product features within the sporting event market to supply the audience with superior sporting experience.

Owners:	Saab AB	33,3 %
	Hego AB	33,3 %
	RHAG	33,3 %

Project started: 2003

Systemet i korthet



Systemet i korthet