

Research Collaboration for Future Capabilities

Petter Krus

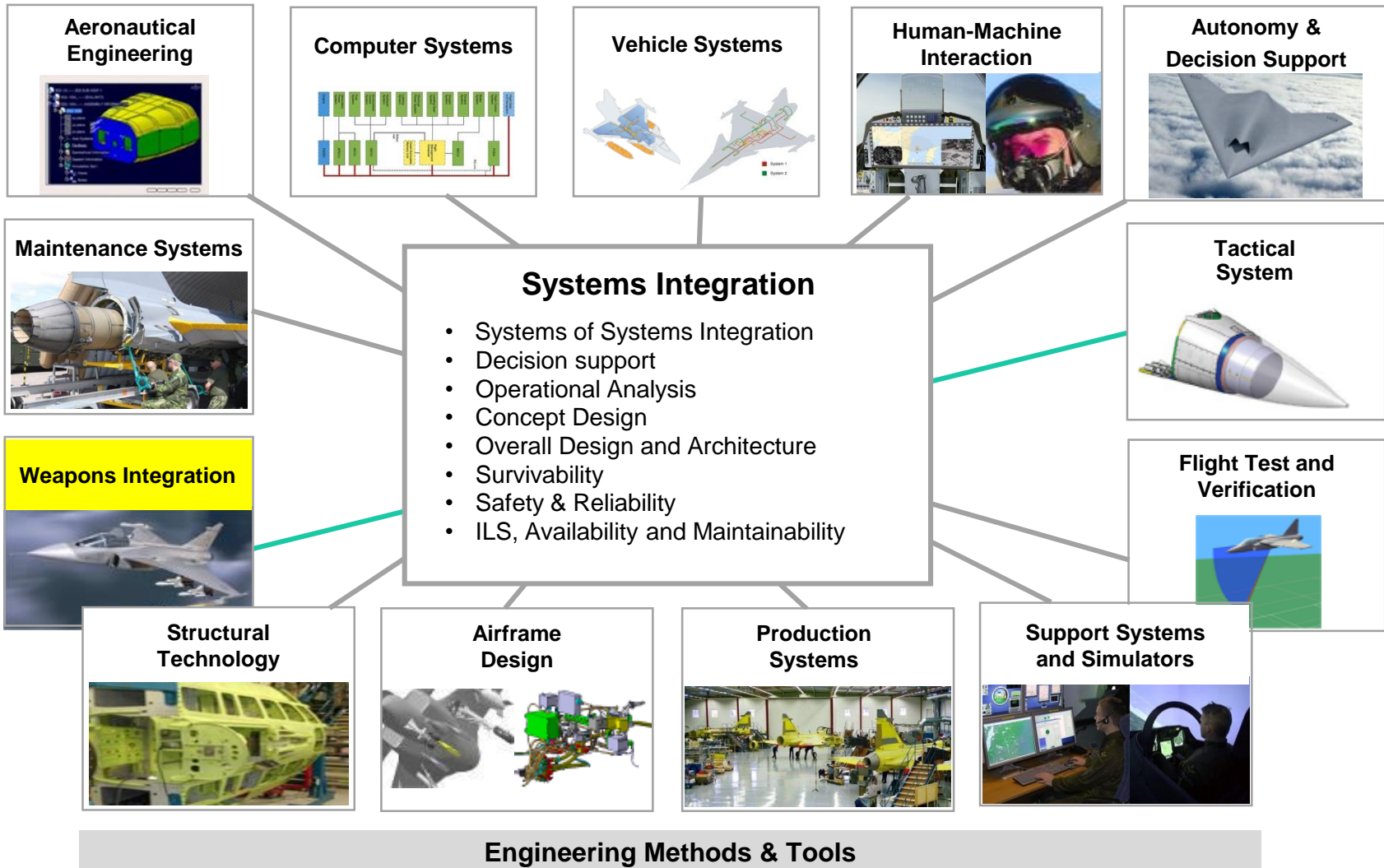
Swedish Aeronautics Chair at ITA/

Fluid and Mechatronic Systems

Department of Management and Engineering

Linköping University

WHAT DOES AERONAUTICS CONTAIN ?



Classical Research

Fundamentals subjects

Fundamentals subjects

Fundamentals subjects

Fundamentals subjects

Research for innovation

Integrating subjects
E.g Aircraft Design

Integrating subjects

Integrating subjects

Fundamentals subjects
E.g. Aerodynamics

Fundamentals subjects

Fundamentals subjects

Fundamentals subjects

Research for innovation

Integrating subjects
E.g Aircraft Design

Integrating subjects

Integrating subjects

Fundamentals subjects

E.g. Aerodynamics

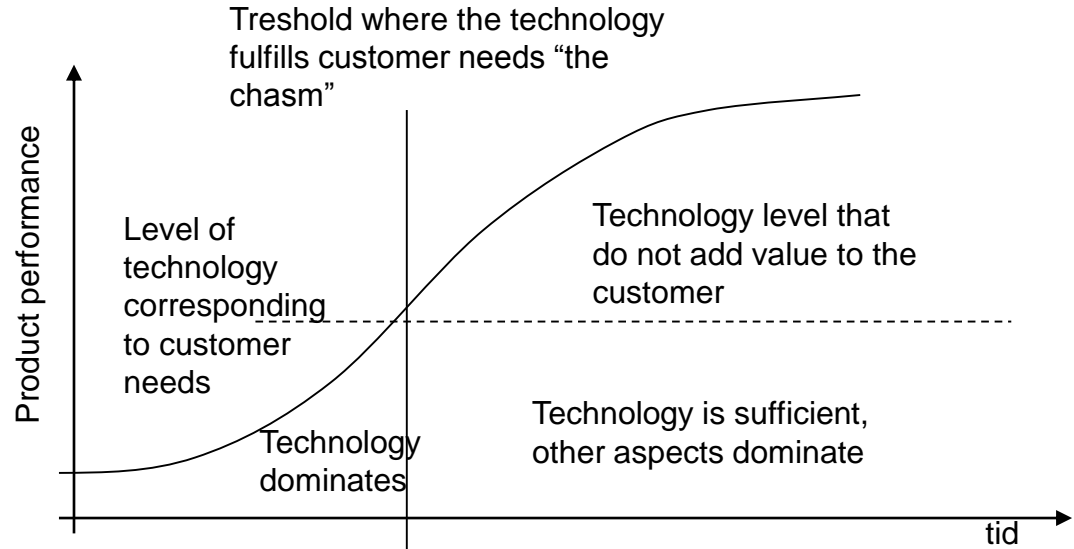
Fundamentals subjects

Fundamentals subjects

Fundamentals subjects

Integrating disciplines
E.g. Systems Engineering,
Innovation Management

Development phases

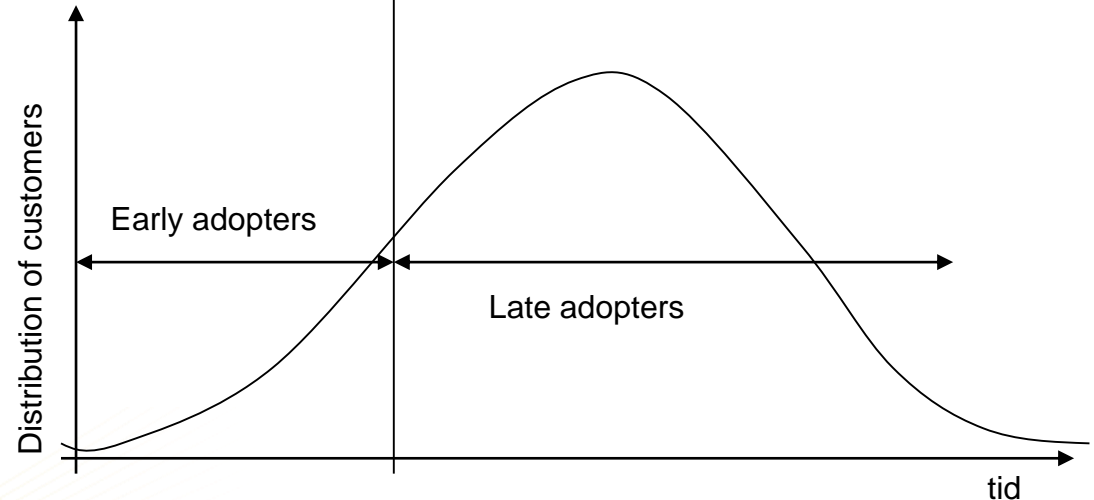


High technology

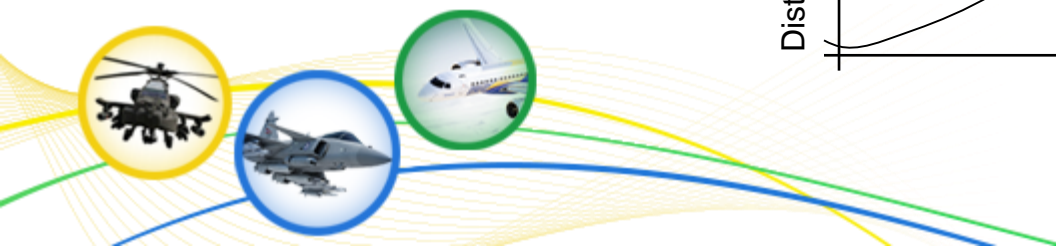
Customer wants higher level of technology

Standard product

Customer wants reliability, low cost, userfriendly, comfortable



- A car costs ca 10 \$/kg
 - (Like a hamburger)
- A military aircrat costs 1000 times more



Computer hardware speed up

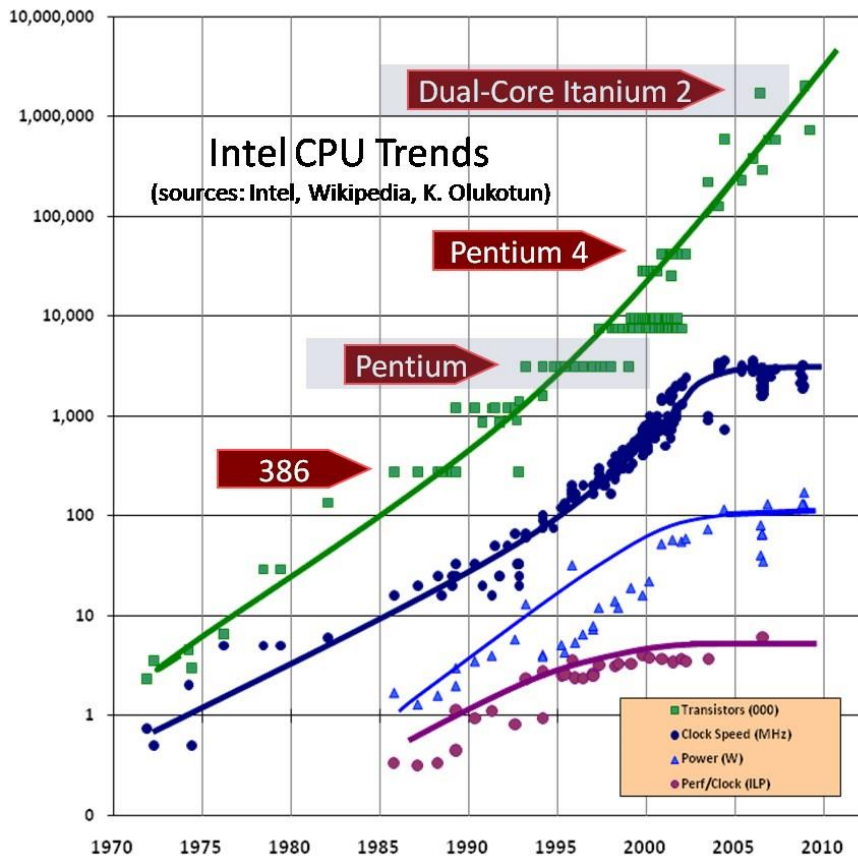
The Free Lunch is Over
A Fundamental Turn Toward Concurrency
in Software. By Herb Sutter (2005)

"We have left the golden era of scaling of the nineties.

Concurrency is the only way to take advantage of computer development."

Engineering problems in general are well suited for parallelization.

Will there be jumps into a new technologies, e.g. Quantum computing?



Conceptual Aircraft Design (LiU/Saab)

SIZING AND AERODYNAMICS

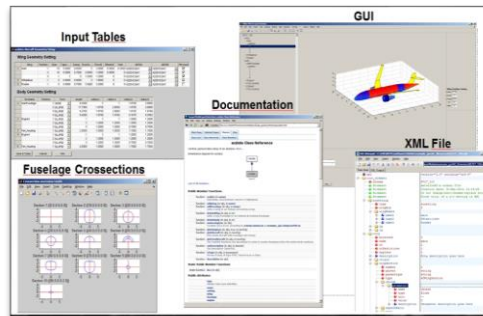
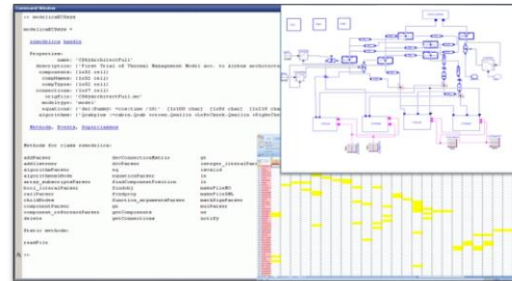
Matlab

- **Tango** - Aircraft sizing
- **Tornado**- Aerodynamics

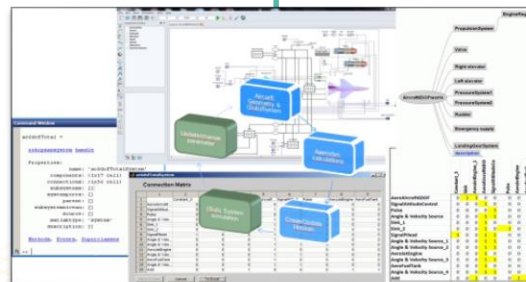
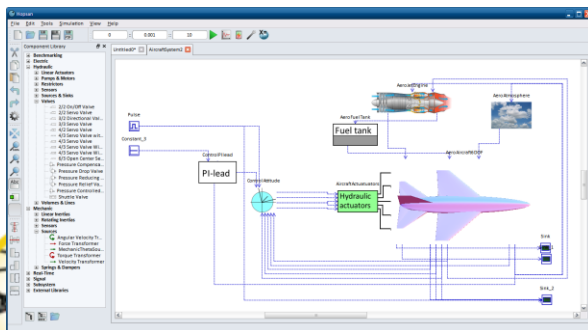
Modelica (Dymola)

CATIA

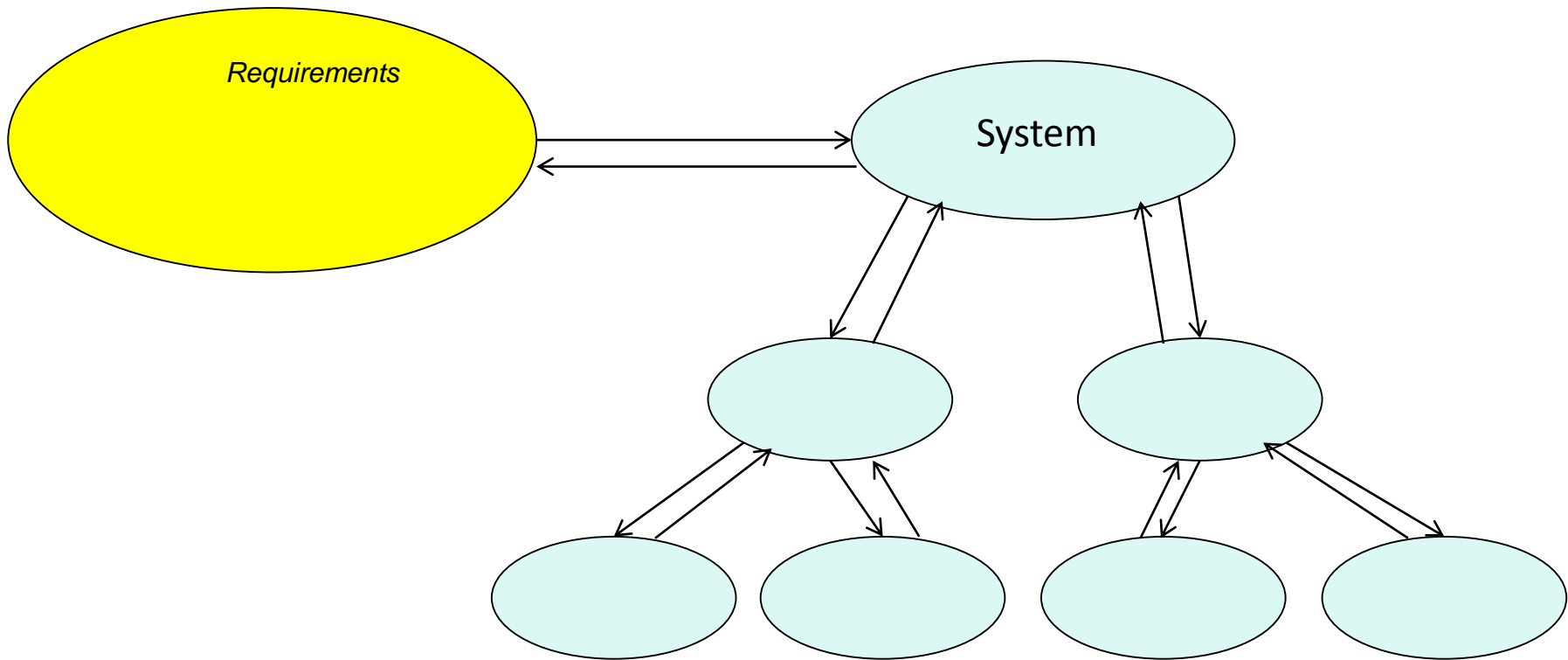
RAPID



Hopsan



Traditional System Development



Integrated Analysis and Design

System Characteristics	Actual value	Target value	Utilization	System Characteristics	Actual value	Target value	Utilization
10 Range	2103.21	5000.00	0.42	1.50	0.62	1.11	0.00
11 Liftoff distance	599.00	900.00	0.67	2.02	1.39	1.69	0.00
12 Landing distance	181.66	900.00	0.20	2.01	0.50	0.38	0.00
13 Takeoff weight	3763.18	10000.00	0.38	0.66	0.56	0.35	0.00
14 payload	0.94	1.00	0.94	0.04	0.41	0.28	0.00
15 speed	213.42	900.00	0.24	0.68	0.25	0.17	0.00
16 Landing speed	38.35	70.00	0.55	1.00	0.25	0.17	0.00
17 Liftoff speed	46.04	70.00	0.66	1.00	0.25	0.17	0.00
18 Stall speed	76.07	90.00	0.84	1.00	0.25	0.17	0.00
19 Emissions	12000.00	10000.00	1.20	0.00	0.00	1.00	0.00
20 Noise	1011.56	1000.00	1.01	0.00	3.48	0.00	1.00
21 Cost	40436.10	40000.00	1.01	0.00	0.74	0.27	0.00

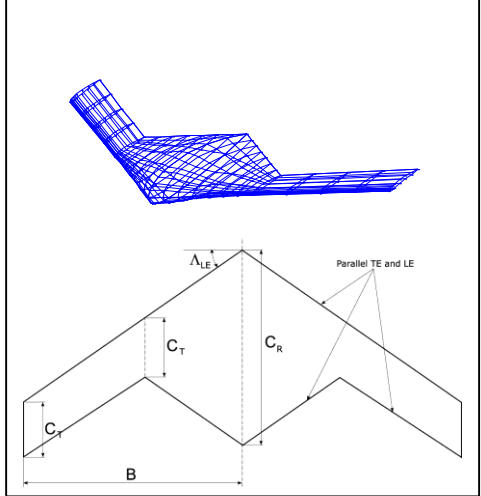
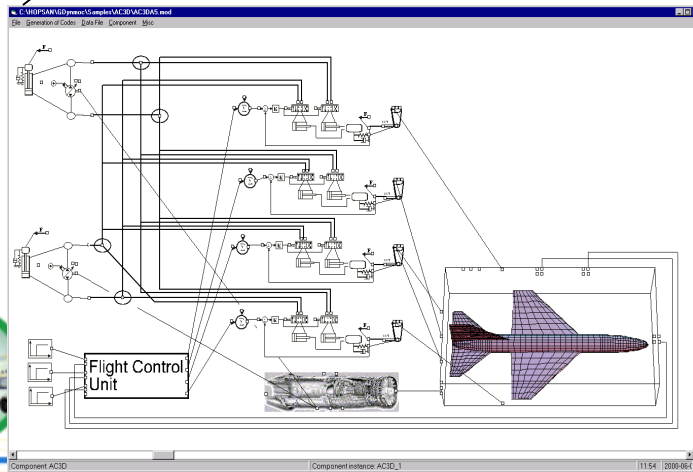
Spread sheet with design analysis and optimization tools

Integrated system model

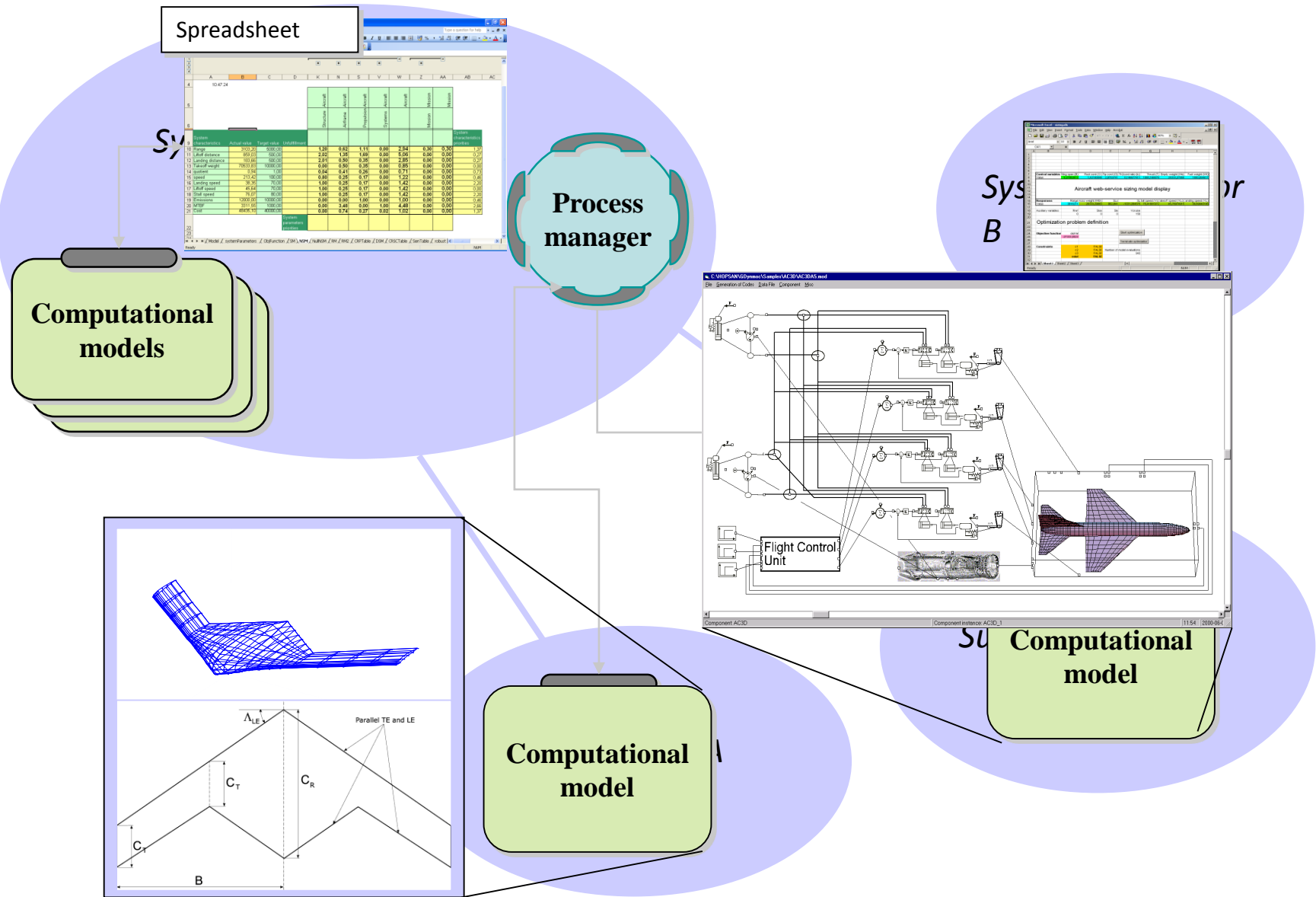
Simulation model

Other analysis model

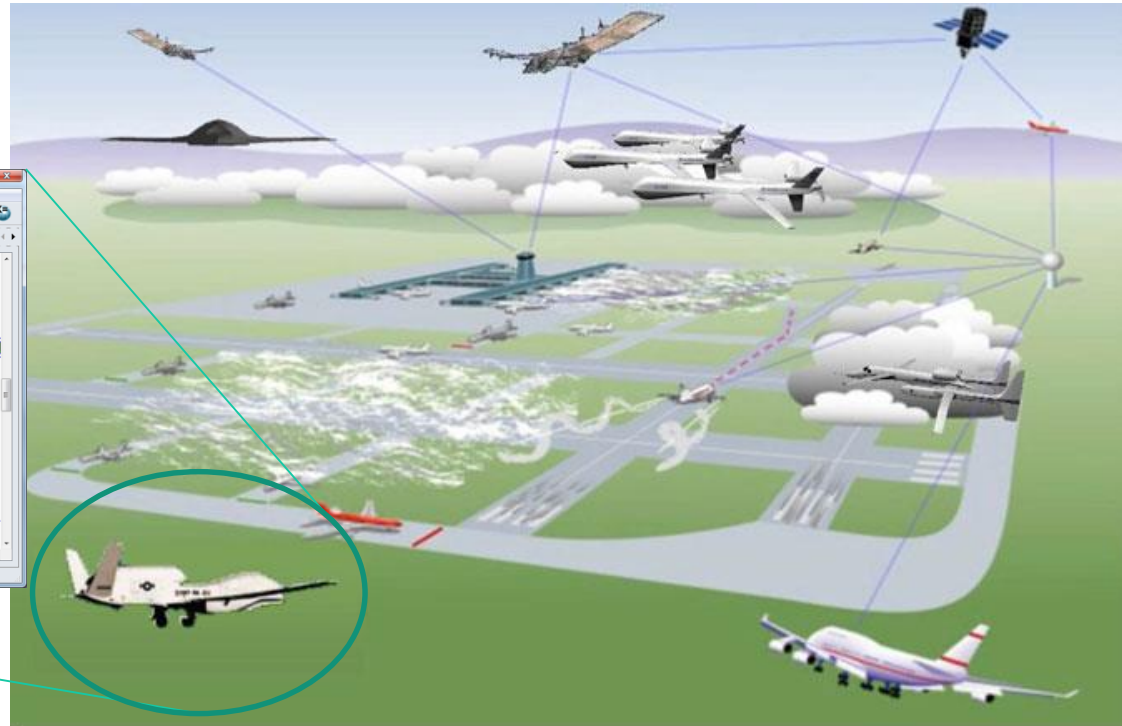
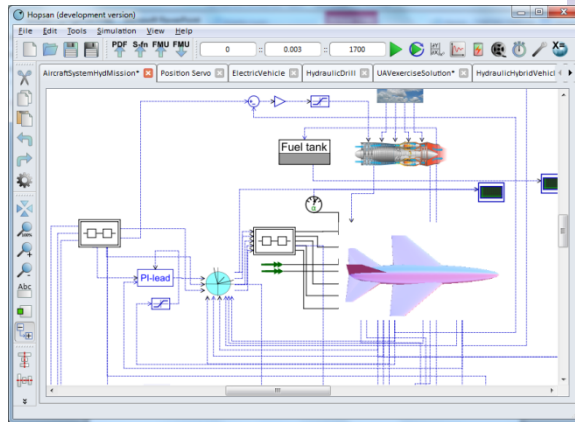
Integrated system analysis of an aircraft with both a aerodynamic model and a simulation model



System development for the extended enterprise

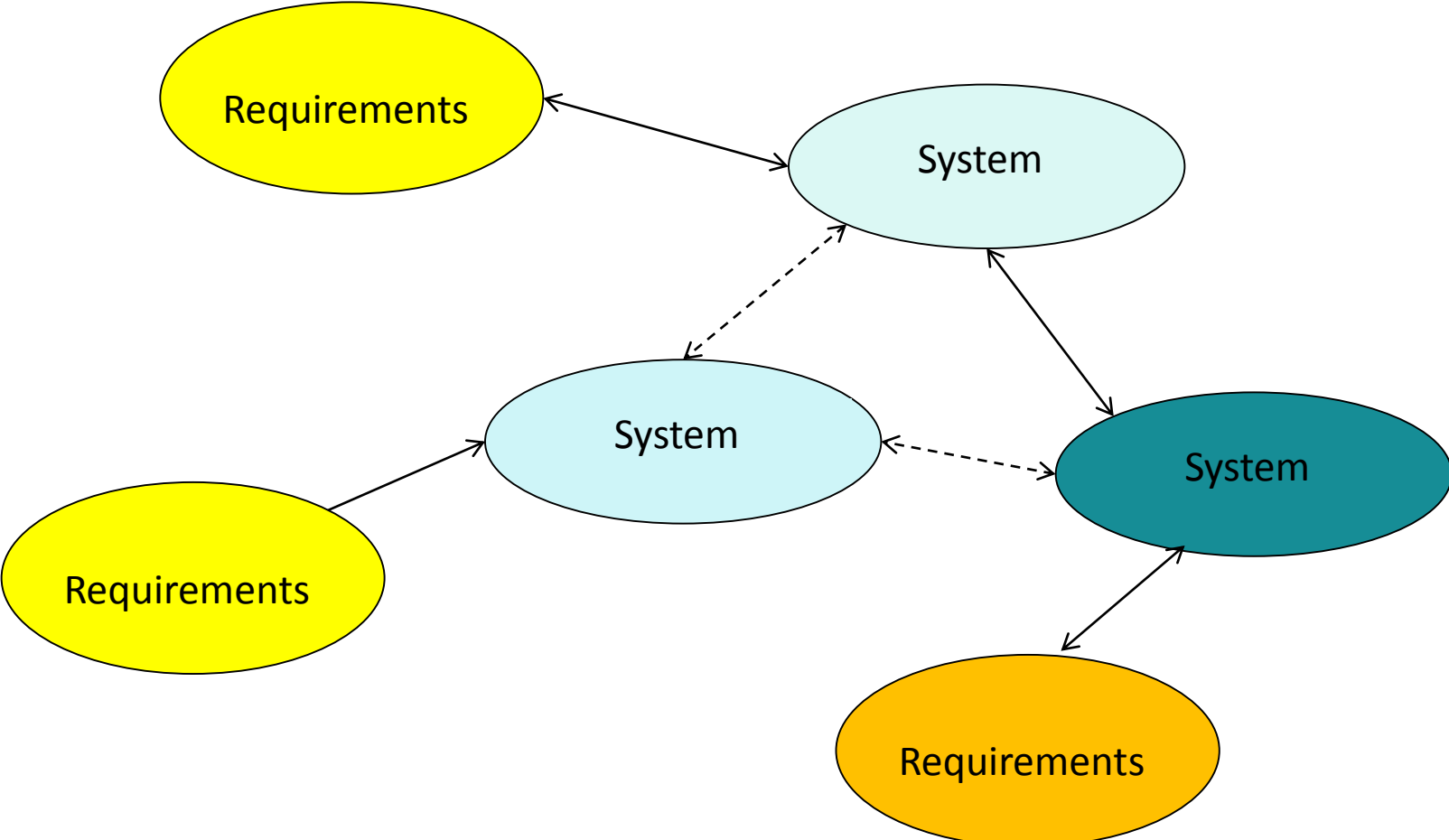


System of systems



Simulation for operational analysis
and subsystem verification

System of systems with Dynamic Architecture



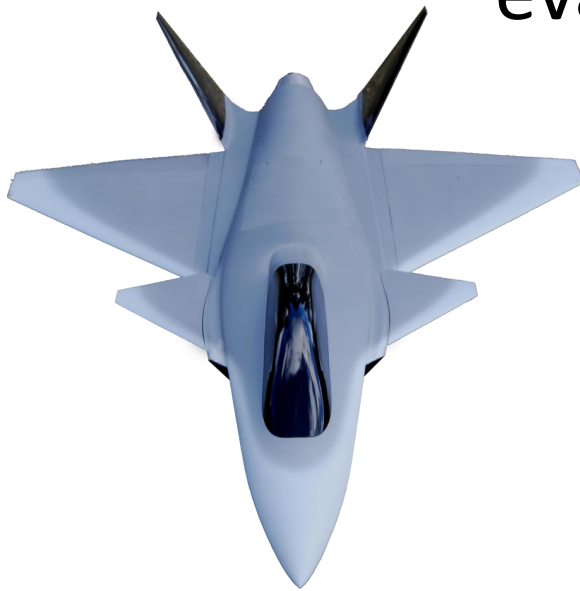
Bilateral Research Project

- FADEMO - Future Combat Aircraft Design Study and Demonstration
 - MSDEMO- Methods for Scaled Demonstrator Development
 - Swedish subset (Innovair)

New Project: Future Combat Aircraft Design Study and Demonstration, FADEMO



- Subscale flight testing for early evaluation of new concepts

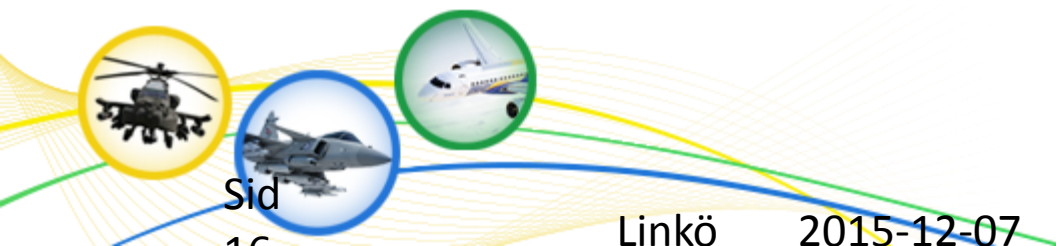


Generic Future Fighter (GFF) Subscale Demonstrator



Concept developed by Saab
Subscale demonstrator build on
request from FMV and Saab at
Linköping University

Real Jet Engine with
170 N thrust a
Length 2.4 m
Span 1.5 m
Weight 15 kg
13% scale



Subscale Flight Test Model of Hypothetical Next Generation Fighter Aircraft

Real Jet Engine with
170 N thrust a
Length 2.4 m
Span 1.5 m
Weight 15 kg



FADEMO/MSDEMO

Near Term Plan

2015

- Initial open data set of the GFF established
- Initial flight testing of GFF-Subscale
- Modelling of GFF in both fullscale and subscale in different tools at ITA using open data.
- Reiteration for Brazilian prototype

GFF data					
	Subscale	Fullscale	Fullscale	Fullscale	
		MASSIMO	MASSIMO		
	Summary	Summary	Summary	7.0310208	
Operating empty weight_GDW	kg	14.85	1%	10000	0%
Internal fuel weight	kg	2.9	1%	4200	0%
Maximum weight	kg	2.11	10%	2300	0%
Landed weight	kg	17.065	10%	15400	0%
Maximum weight_MTDW	kg	20	0%	23000	0%
Wing weight_GDW	kg			0	
Wing length	m	2.4	0%	18.842	0%
Reference CG	m	1.185	2%	9.115	1%
Wing root chord	m	2.460	1%	18.842	1%
Reference wing area 1	m ²	0.747	0%	44.215	0
Reference wing 1 + body area 1	m ²	0.843	0%	36.215	0
Reference area	m ²	NA		0	
Reference wing 1 span	m	1.165	0%	10.5	0%
Mean aerodynamic chord MAC	m	0.845	1%	4.960	1%
Aerodynamic reference position (wing)	m	-1.05	2%	14.156	0%
Reference position	kg/m ³			1.225	0%
Altitude	m			100	0%
Angle of attack	rad			0.162466	0%
CL	0%			0.291016	0%
CL1	0%			0.046474	0%
CL2	0%			-0.042674	0%
CL3	0%			0.001866	0%
CD	0%			0.003819	1%
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FADEMO as a Vehicle for Collaboration



- FADEMO could be an application and thematic area for other projects in aeronautics.
- By having a common target aircraft research projects will be more aligned, and a greater sense of community can be obtained.
- A open dataset based on open information for the GFF has been created, that can be shared among researchers and students and that can be used for various projects.

Thanks!

