From vague feeling to presentable knowledge

Systems Engineering

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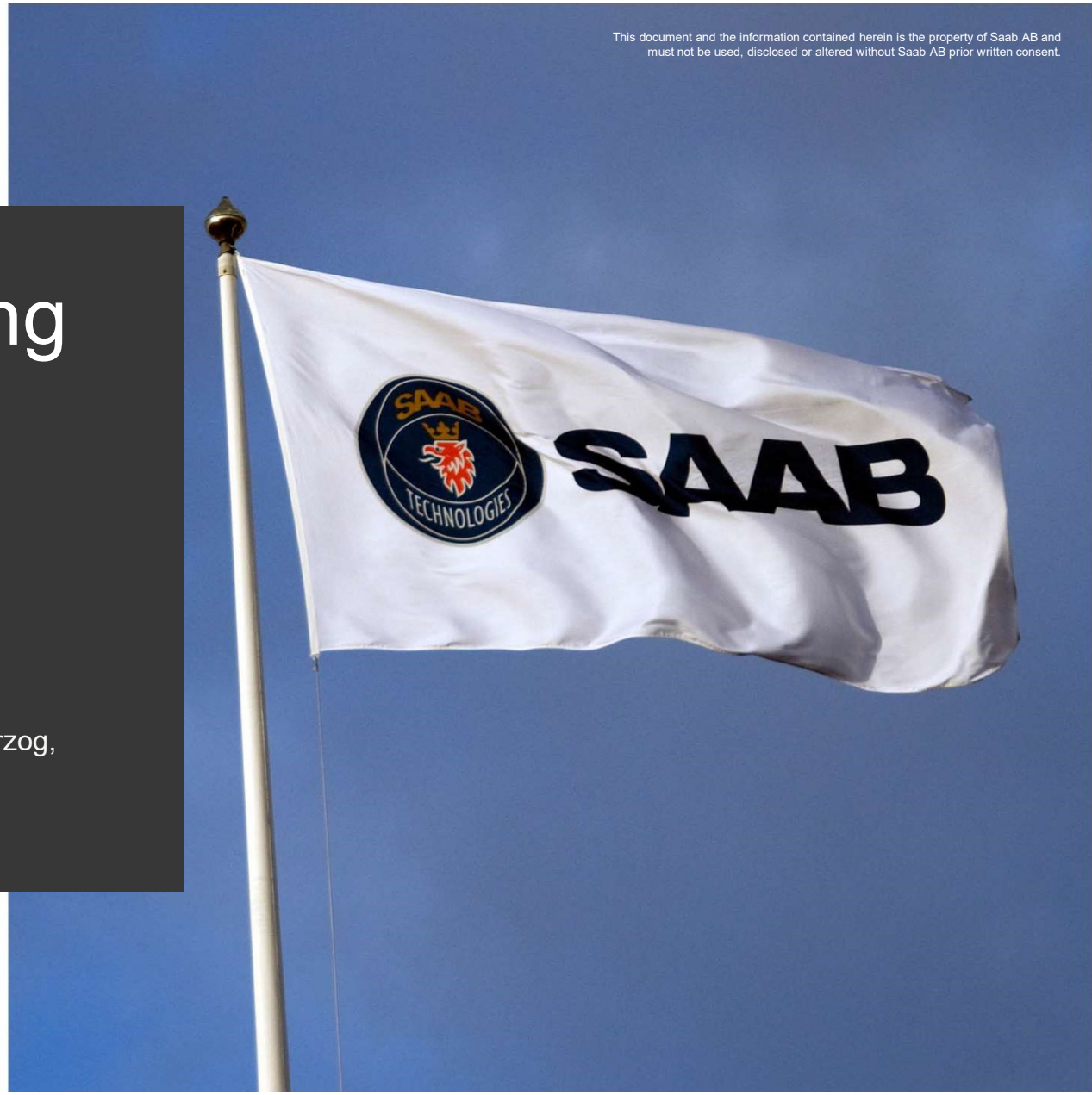

The Gripen Program is a complex multi discipline engineering program

Systems Engineering

- Systems development
- Software development
- Mechanical Engineering
- ”Equipment engineering”

  Specification and integration of purchased systems and equipment
- Production and Installation
- Integrated Logistic Support ILS

Efficient Development Requires Integrated Development Environments (IDE's)

For all Disciplines

- Requirements
- Design
- Realization
- Verification
- Declaration

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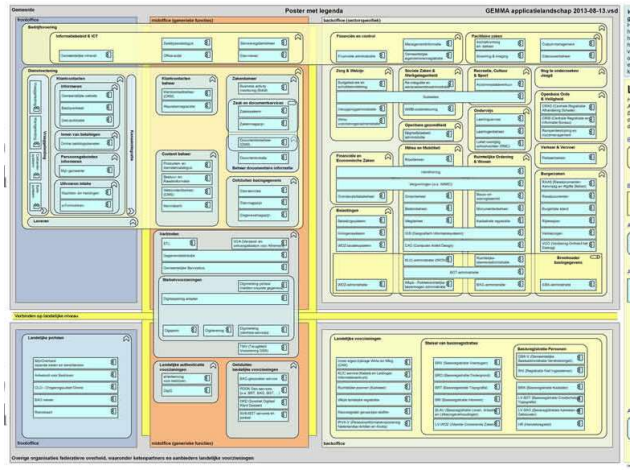
The application Eco System supports the total development process



- Systems Development
- Software Development
- Hardware Development
- .....

No single person fully knows the design data flow between disciplines

Hard to understand the consequences of tool exchanges

Show stopper for real efficiency improvements

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Design dependencies are traditionally realized by centralized PDM system

Centralized PDM systems.

Cross discipline collaboration, coordination and traceability

Discipline specific integrated development environments (IDE)

Development efficiency

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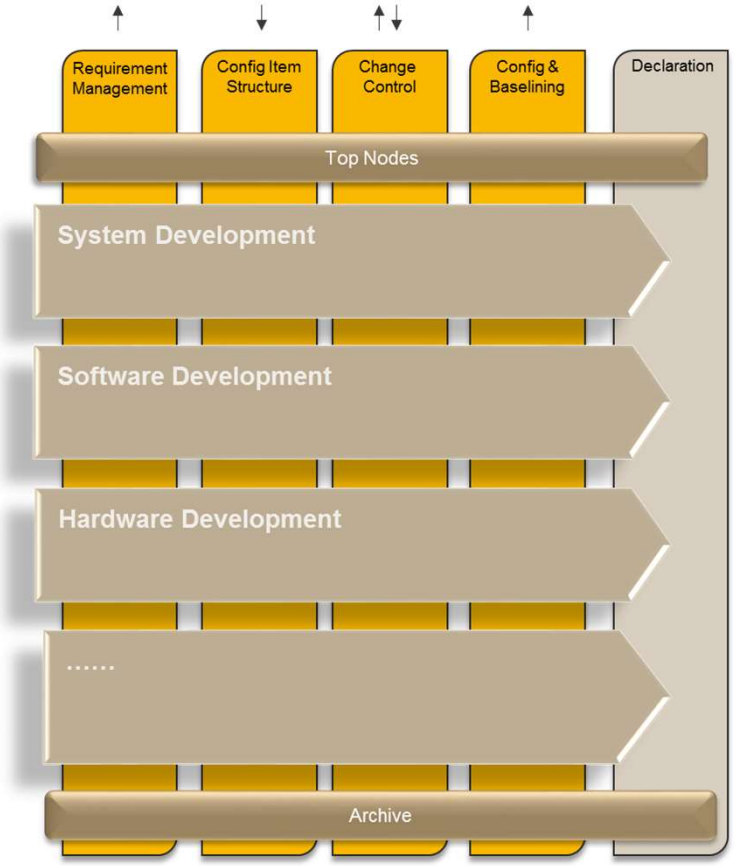
For getting to know the dependencies, the so called traceability dimensions have proven to be an important key



- Requirement Management
- Configuration Item Structure
- Change Control
- Configuration and Baselining

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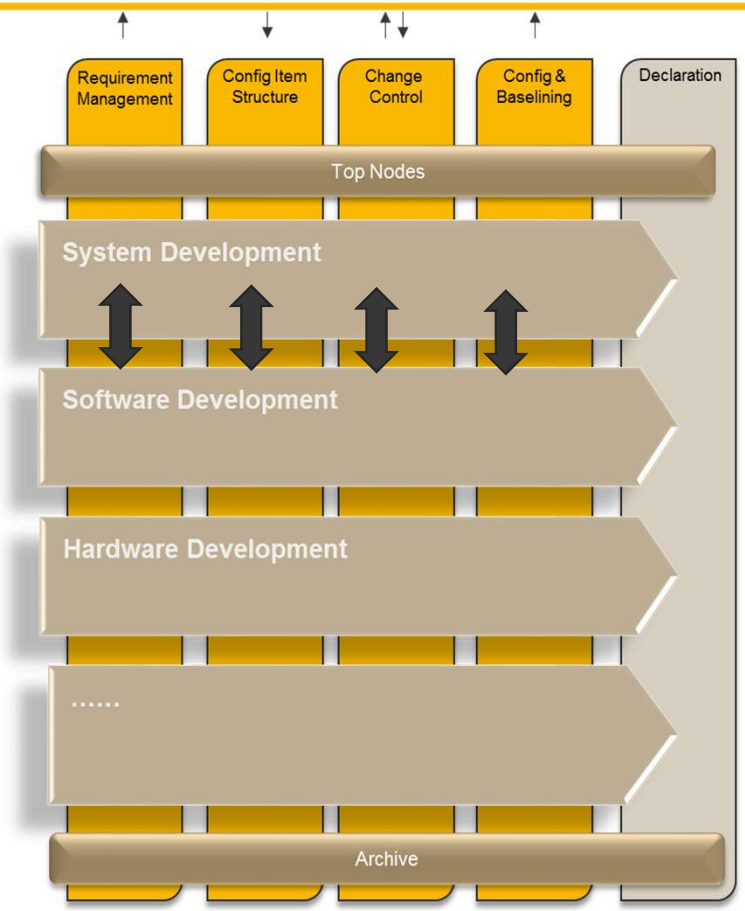
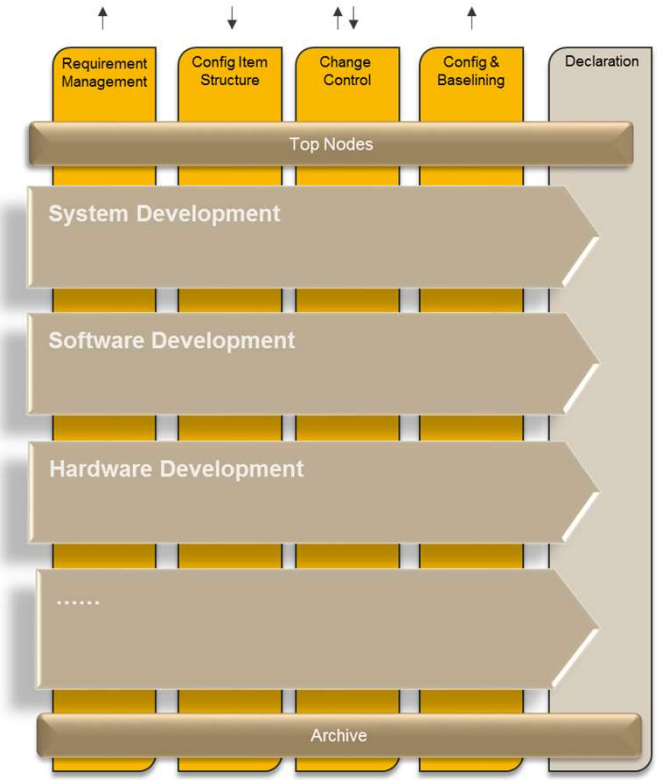
For understanding consequences of tool exchanges the interaction between disciplines needs to be known



Traceability Measuring

	Granularity	Transfer	ID&Version Ctrl
N/A			
0			
1		Man	
2	Coarse-grained	Aut	No ID on included objects
3	Coarse-grained	Aut	ID on included objects
4	Fine-grained	Aut	ID
5	Fine-grained	Aut	ID and version control

An Interaction Evaluation Method has been developed analyzing the four traceability dimensions



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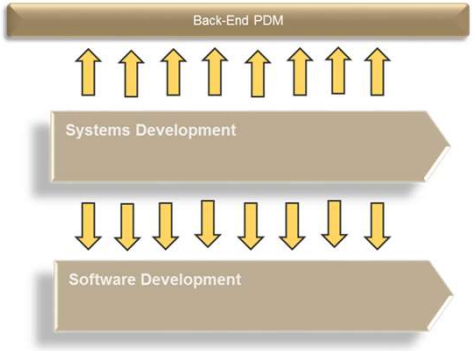

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	Back-bone		SE		SW	
Utv.plan	-	4				
	4	-				
SE	3	1	4	2		
	1	2	0	4		
SW	3	1	4	2	-	-
	4 2	2	0	0		4
CM						

2

Analyze the four dimensions and measure according to the following value table:

Req	Str
Chg*	Conf

from the perspectives

- Granularity
- Transfer method
- Identity alignment & version

	Granularity	Transfer	ID&Version Ctrl
N/A			
0			
1		Man	
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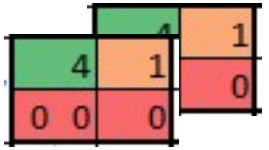
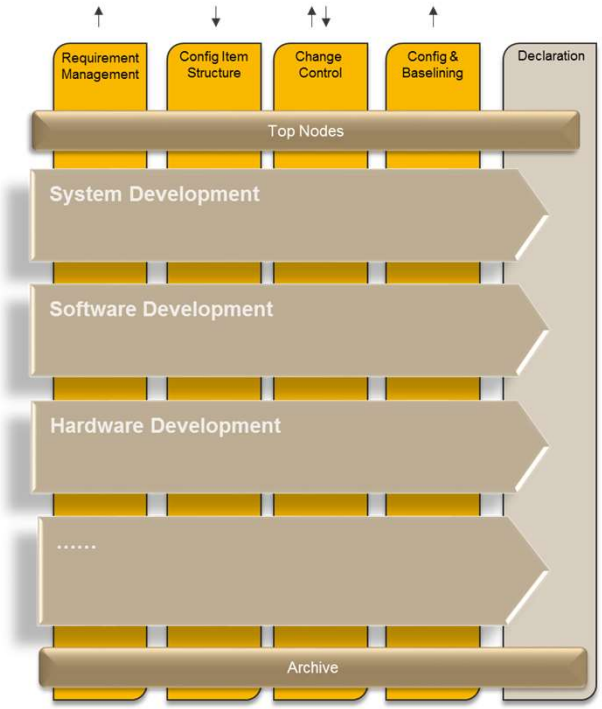


A number of evaluations has been performed both to evaluate the method and to get interesting results



	Back-End PDM		Sys Dev		SW		ADI		Installation		Production		Equip	
System Development														
Software Development														
Airframe Development														
Equipment														

By understanding the interactions, an understanding of the overall development efficiency can be obtained

The result from the Discipline specific analysis may form basis to several efficiency improvement projects

Interaction Analysis

	Back-End PDM		Sys Dev		SW		ADI		Installation		Production		Equip	
System Development	3	1			4	1	4	0					1	0
	0 1	1			0 0	0	0 0	0					0 0	0

Internal Analysis

APPLICATION	Requirement	Design	Realization	Verification	Declaration	Change
Teamcenter - Back End	x	x		x	x	x
Doors	x	x		x		
Rhapsody		x				
Dimensions		x				
Teamcenter - Archive	x	x	x	x	x	x

Observations	***In the dicipline***	No local change management
	Towards Back End PDM	For ensuring the structure node correspondence between Back End PDM and SysDev - manual review required.
	Towards SW	The current strength is entirely due to DOORS being used for requirement management both in SW and SE All other integration is either manual or non-existent
		The Change and structure traceability is entirely dependent on manual review
	Towards ADI	Doors is used for requirement management in ADI - but it is not integrated to the IDE; i.e VPM
	Towards Equipment	DOORS is generally not used for EQS documentation When it is used the traceability to system requirement is weak
Urgent Need		A correspondence between the node structures in SE and in Back-End PDM must be established
Need		DOORS needs to be replaced
Future Plans		Establishment of an Integrated Systems Development Environment

Traceability analysis shows how lose the interactions are, and has built understanding of how it is compensated

Change Control

- Integration between Mechanical Engineering & Production is very tight which gives a very good change traceability
- Top down change management traceability is lost in the interfaces between
  - Back -End PDM – Systems Engineering
- Bottom up change management traceability is not maintained at all

Requirement Management

- Requirement are automatically transferred between the engineering disciplines and the Back-End PDM System
- The requirement synchronization is coarse.

Configuration & Baselining

- There is an automatic realisation Config traceability between
  - Mecahnical Engineering - Production
- Between all other diciplines the realisation Config traceability is done manually

Config Item Structure

- Product structure is managed in Back End PDM
- The product structure is manually connected to Mechanical and Software PDM systems.
- No product structure management in the other disciplines
- There is high risk of inconsistencies due to the poor tracability of product structures

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Now we know why things are as they are and has drawn some conclusions

Vertically

Requirement traceability strong thanks to DOORS used in all disciplines

Poor bottom up traceability of change.

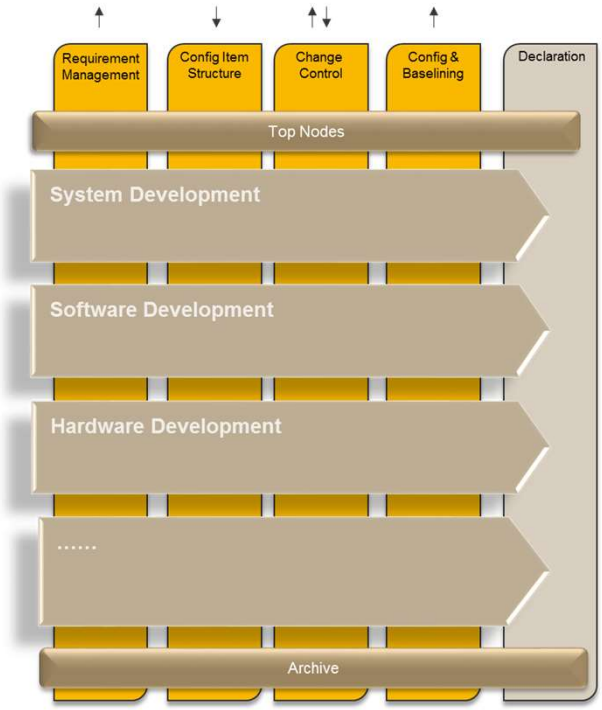
Changes must be manually closed.

The manual closing forces workload for reviewing in order to guarantee quality.

Horizontally

The mechanical engineering development environment is very good thanks to full covering IDE support

The analysis emphasis that the equipment development also needs to be considered as a engineering discipline by itself and consequently in the need of an IDE



Process, Methods & Tools

Non-existing IDE:s is most likely the largest impediment for efficiency in the overall development process.

Overall efficiency is also very much dependent on Information traceability

People

The tool ineffectiveness is compensated or hidden by competent, loyal and reliable employees.

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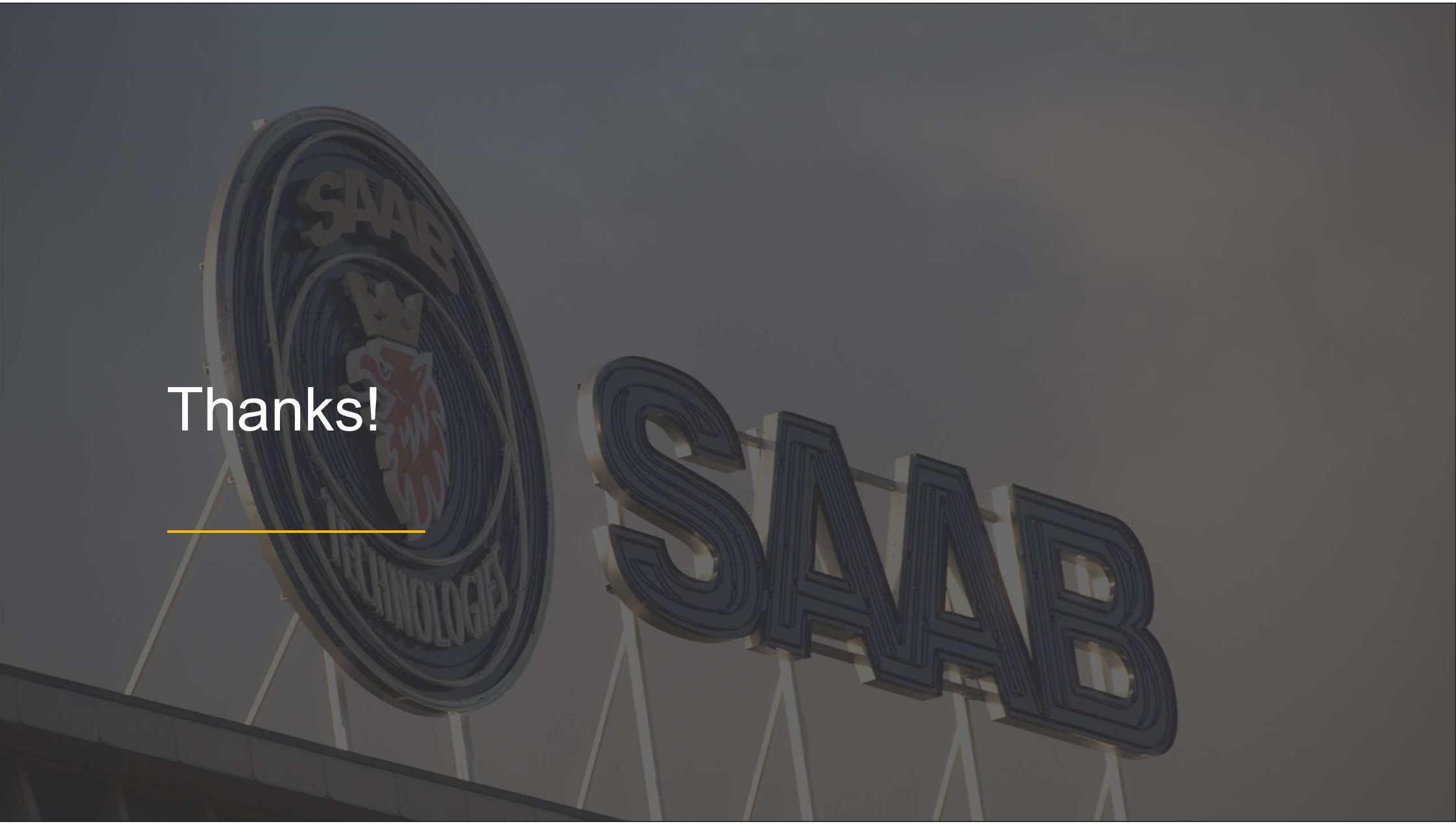
Both the systematic way of analyzing interaction and the results themselves has gained great interest

Eye opener in the understanding of the overall PDM Landscape

Insight that the overall efficiency is very much dependent on traceability between disciplines

Summary

- Simple model for obtaining an objective understanding of the engineering tool landscape within an organisation
  - Based on the process model
- Allows for quick analysis of current capabilities and consequences of modifications to the tool landscape



Thanks!