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FROM BROWNFIELD TO GREENFIELD DEVELOPMENT

Understanding and managing the transition

SAAB

LINKÖPING UNIVERSITY

GREENFIELD DEVELOPMENT

Creating a new platform from scratch

BROWNFIELD DEVELOPMENT

Adding new capabilities on an existing platform

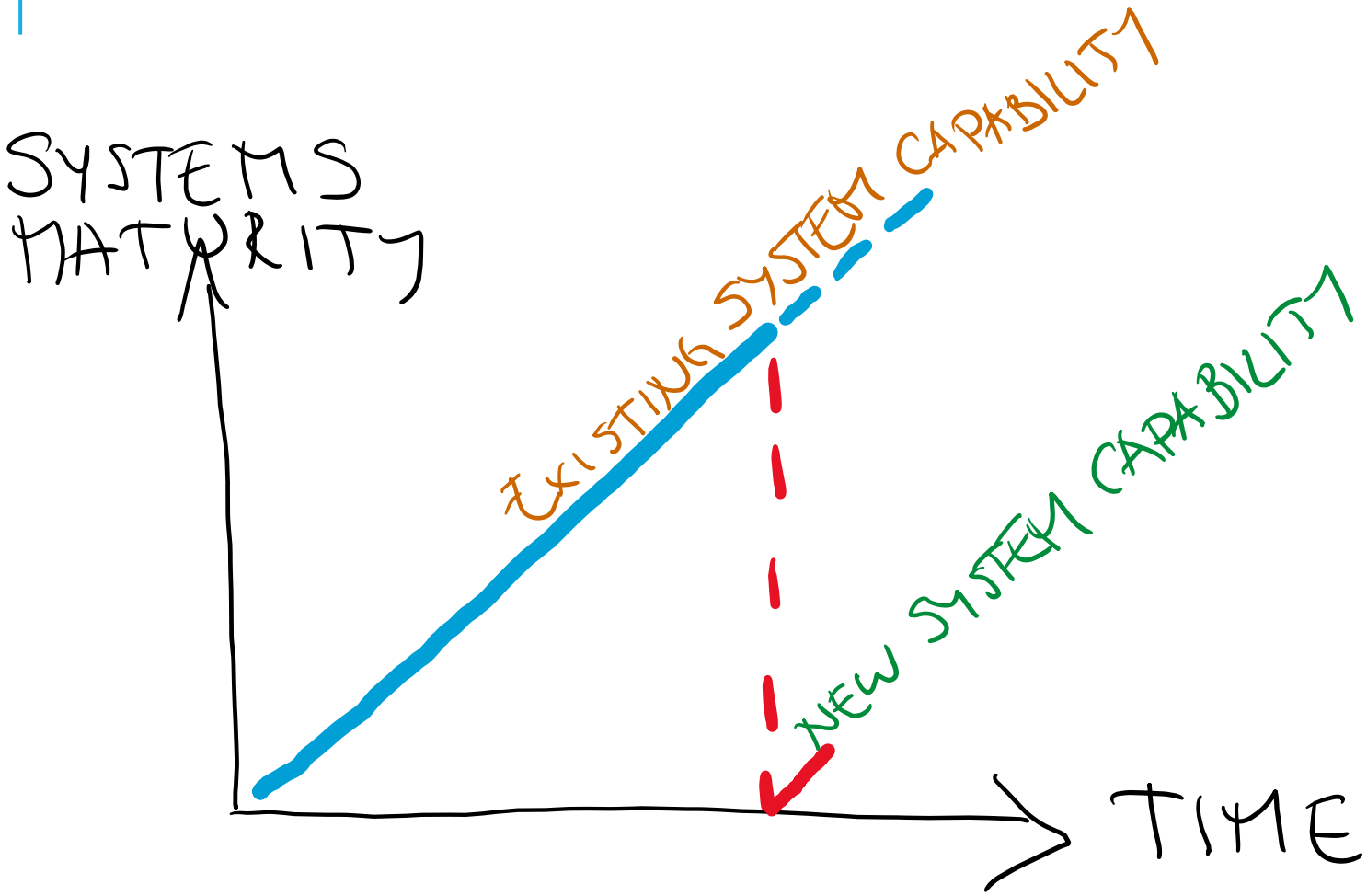
GREENFIELD DEVELOPMENT OF COMPLEX SYSTEMS

…after 30 years of improvement and with the old building staying on the plot

THE FIRST NEW FIGHTER SYSTEM FROM SCRATCH IN 30 YEARS

JAS39 Gripen E

WHAT WE SAW COMING

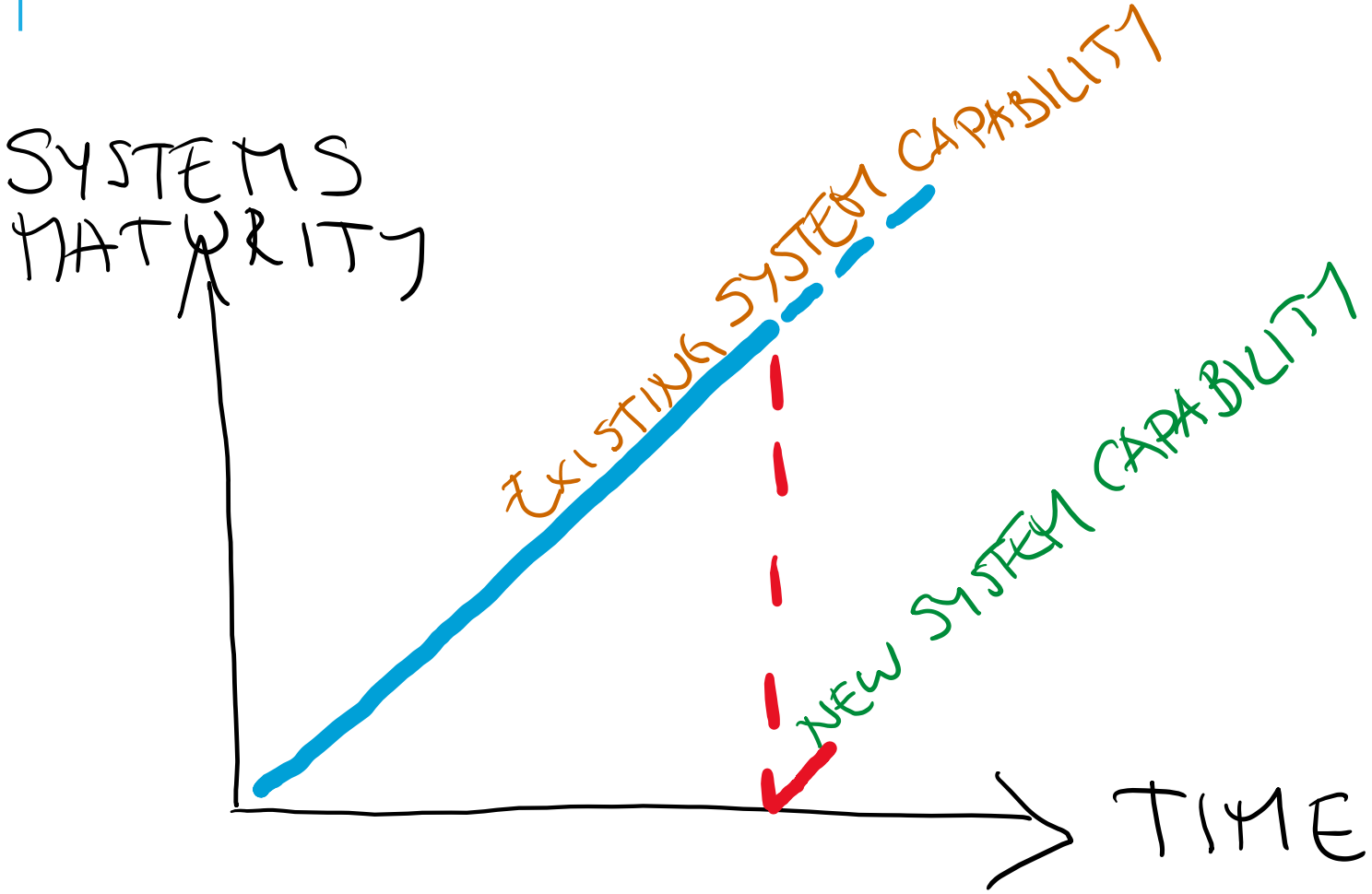


Free from old systems constraints

No dependencies

Can implement and develop state-of-the-art technology

THE THINGS WE DID NOT REALIZE



WHAT ALL THIS IMPLIES

Free from old systems constraints

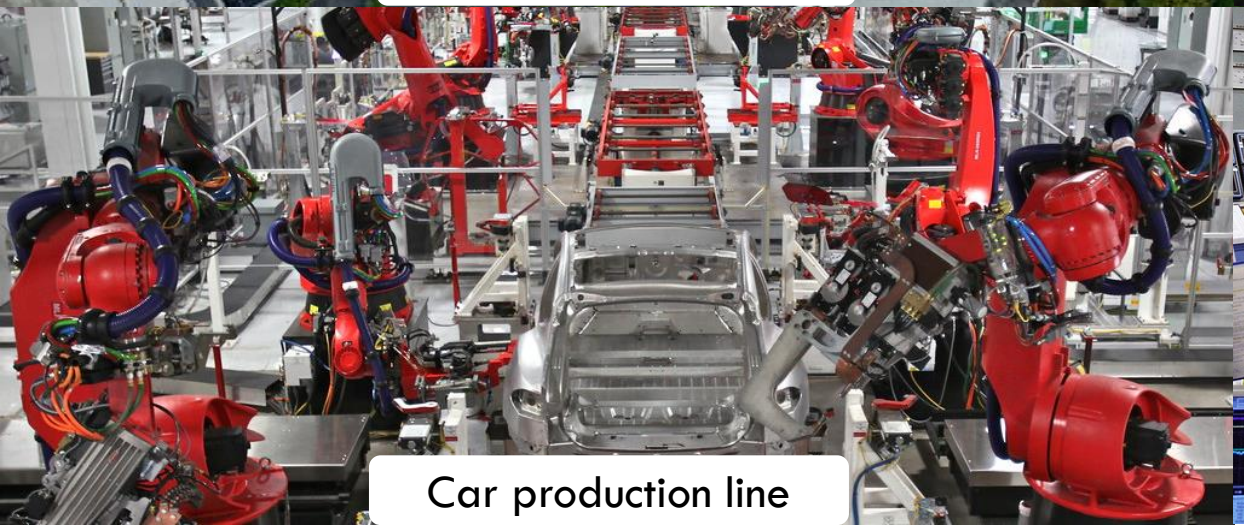
No dependencies

Can implement and develop state-of-the-art technology

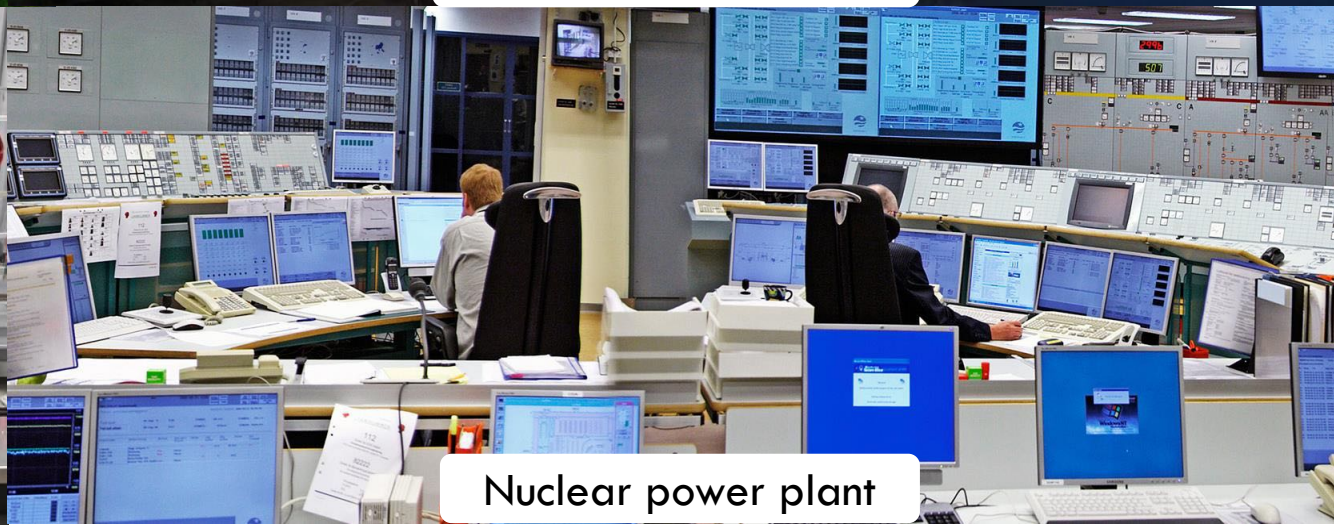
AFTER 30 YEARS OF IMPROVEMENT

New airport

Papermaking pulp mill



Car production line

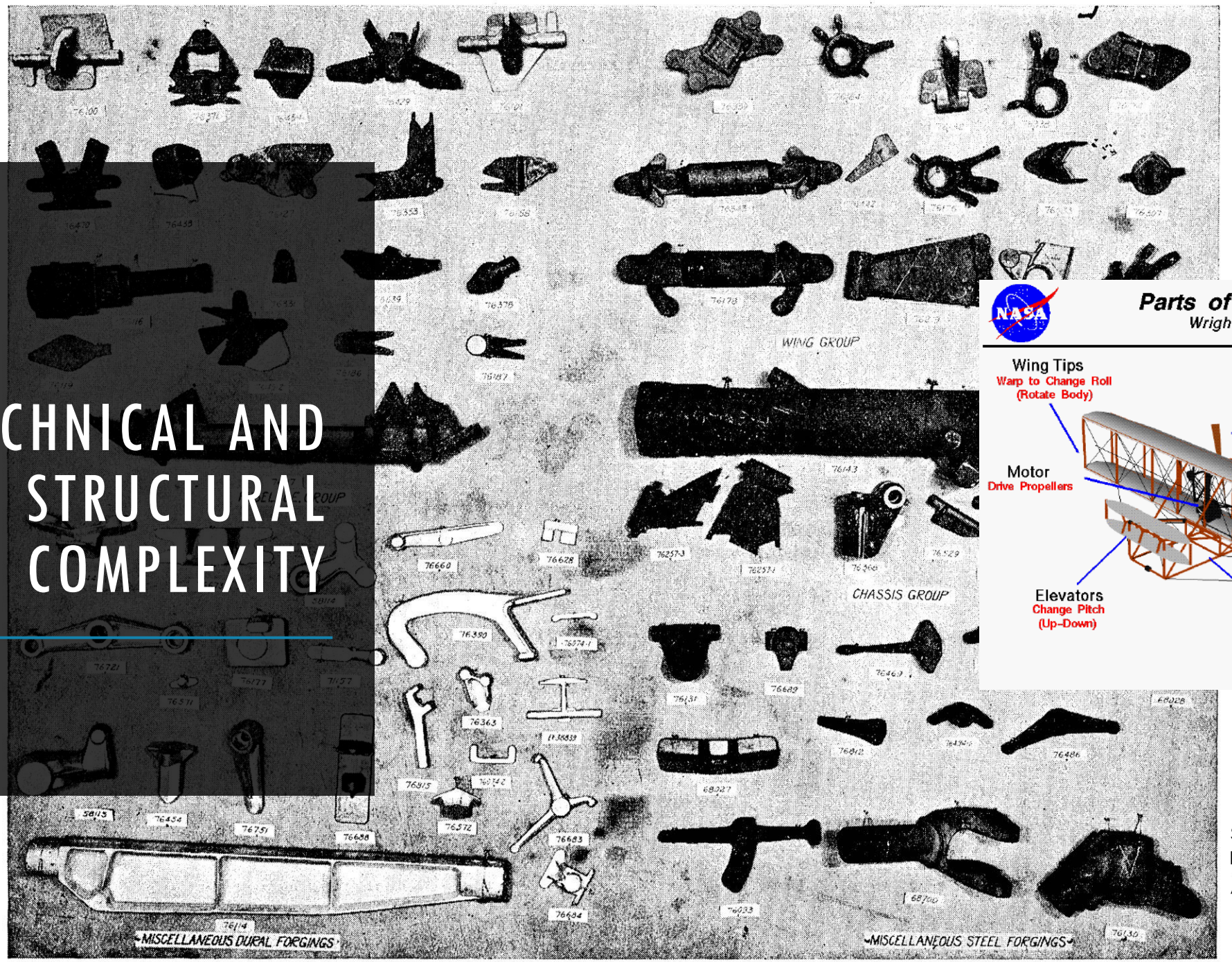


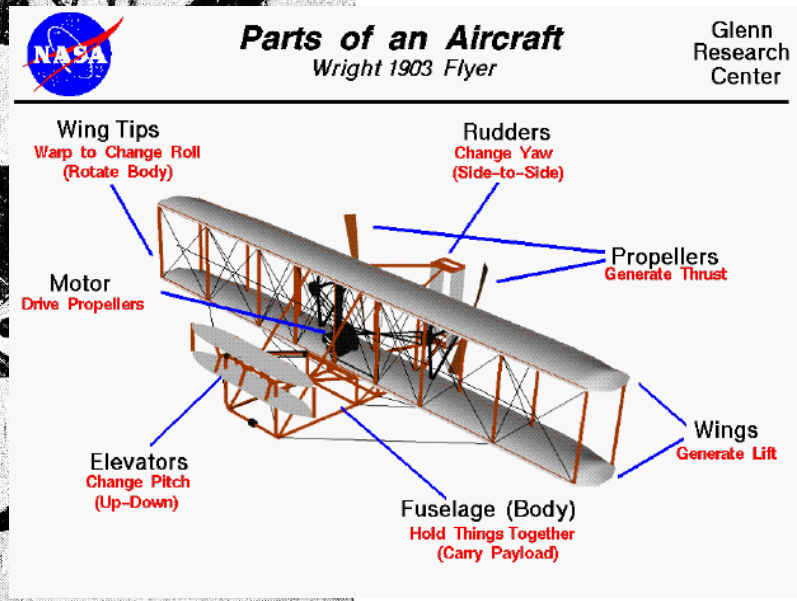
Nuclear power plant

WE ARE NOT THE ONLY ONES

whose complex systems have increasingly longer lifecycles

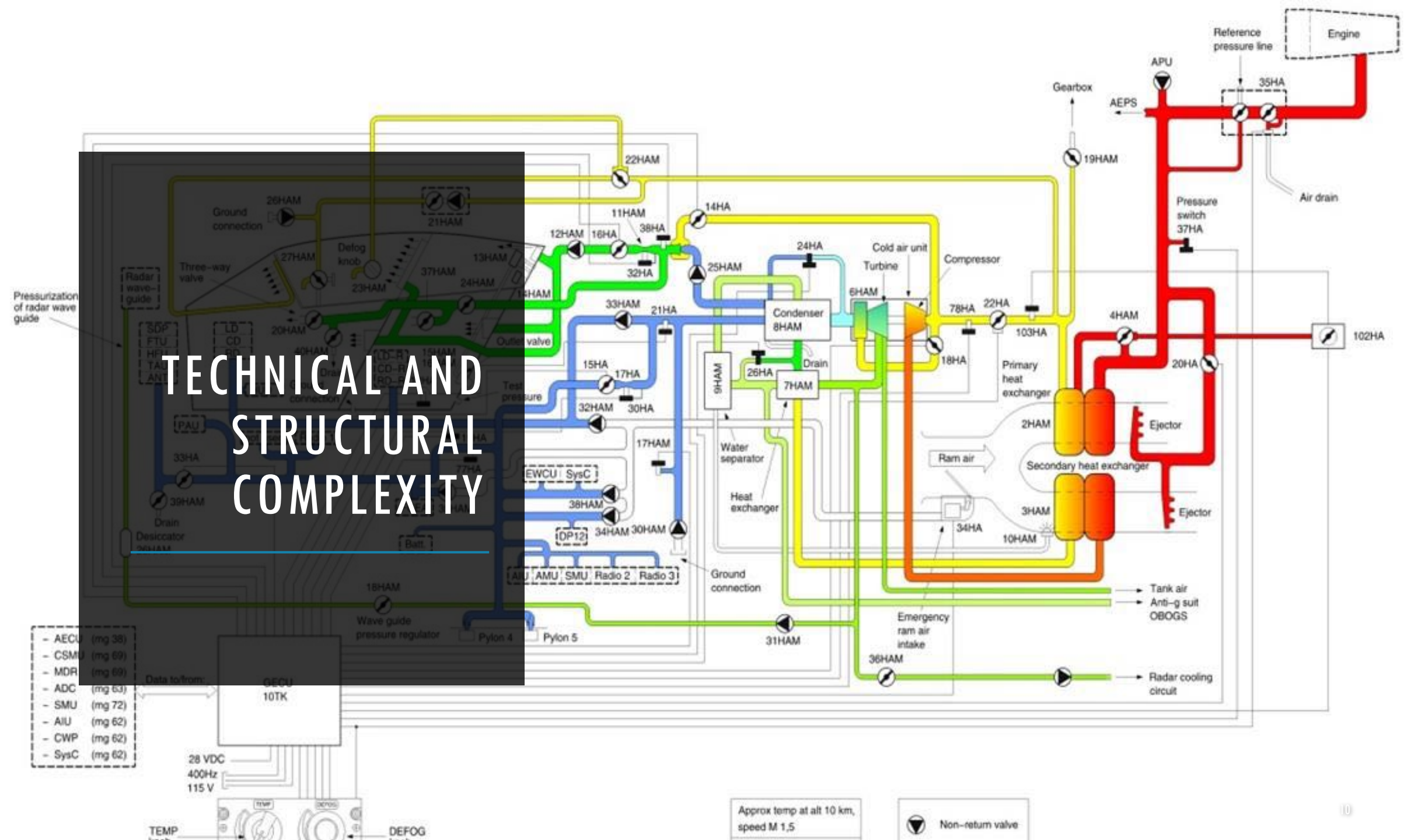
TECHNICAL AND STRUCTURAL COMPLEXITY





See:
https://www.grc.nasa.gov/www/Wright/airplane/flyer.html

TECHNICAL AND STRUCTURAL COMPLEXITY



ORGANIZATION AND INDIVIDUALS

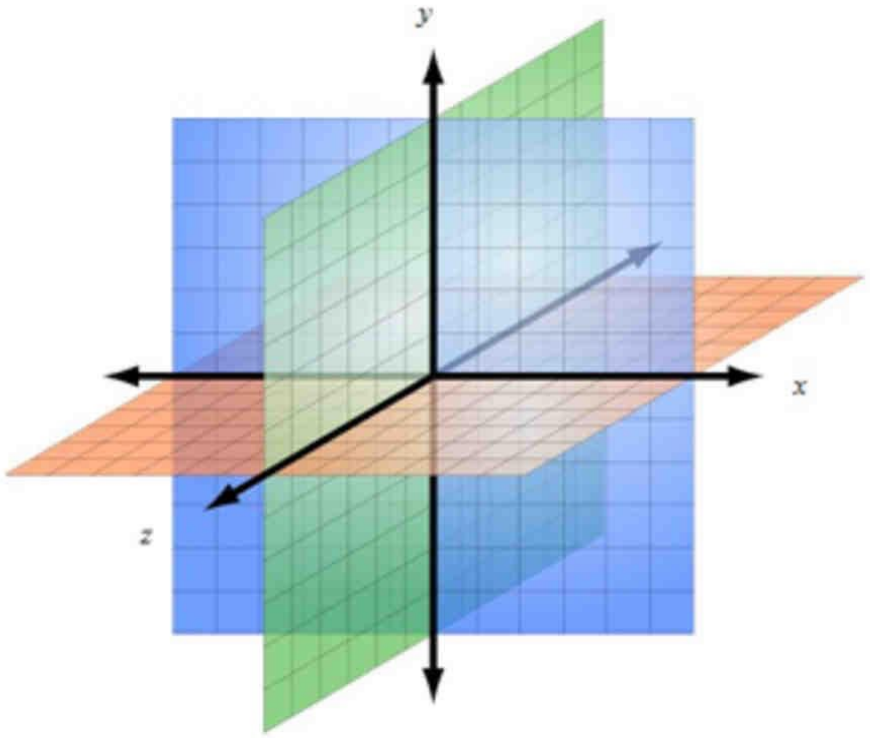
New methodologies and tools...

...and on top of that the attitude towards learning

DIMENSIONS OF THE TRANSITION

TECHNICAL

ORGANIZATIONAL CAPABILITY



INDIVIDUAL COMPETENCE

APPROACH TO **LEARNING**

WHAT DOES IT MEAN TO MOVE TO GREENFIELD DEVELOPMENT AFTER 30 YEARS OF BROWNFIELD DEVELOPMENT?

WHY IS IT DIFFICULT TO TRANSITION?

ERIK BRATT

A pilot and an engineer

Started working at Saab in 1945

SAAB'S FIRST JET FIGHTER J21R

1947

SAAB J29 TUNNAN

1945-1948

SAAB J32 LANSEN

1948-1952

SAAB J35 DRAKEN

1949-1955

SAAB AJ37 VIGGEN

1952-1967

ERIK BRATT

Experienced five system transitions in his career

Led the construction team of Draken and Viggen

Developed key aspects of supersonic flight and the double delta wing concept

ERIK BRATT

Development led by a small construction team

A “master-mind” chief engineer has the systems overview

A passion for airplanes and playful development

Pushing technological limits with great sacrifices

ATTITUDE TO RISK

				
	Tunnan	Lansen	Draken	Viggen
Number of aircraft produced	661	450	606	329
Number of accidents	242	150	125	54
Number of pilots dead in accidents	99	100	34	17

SAAB JAS39 GRIPEN A

1979-1988

ATTITUDE TO RISK

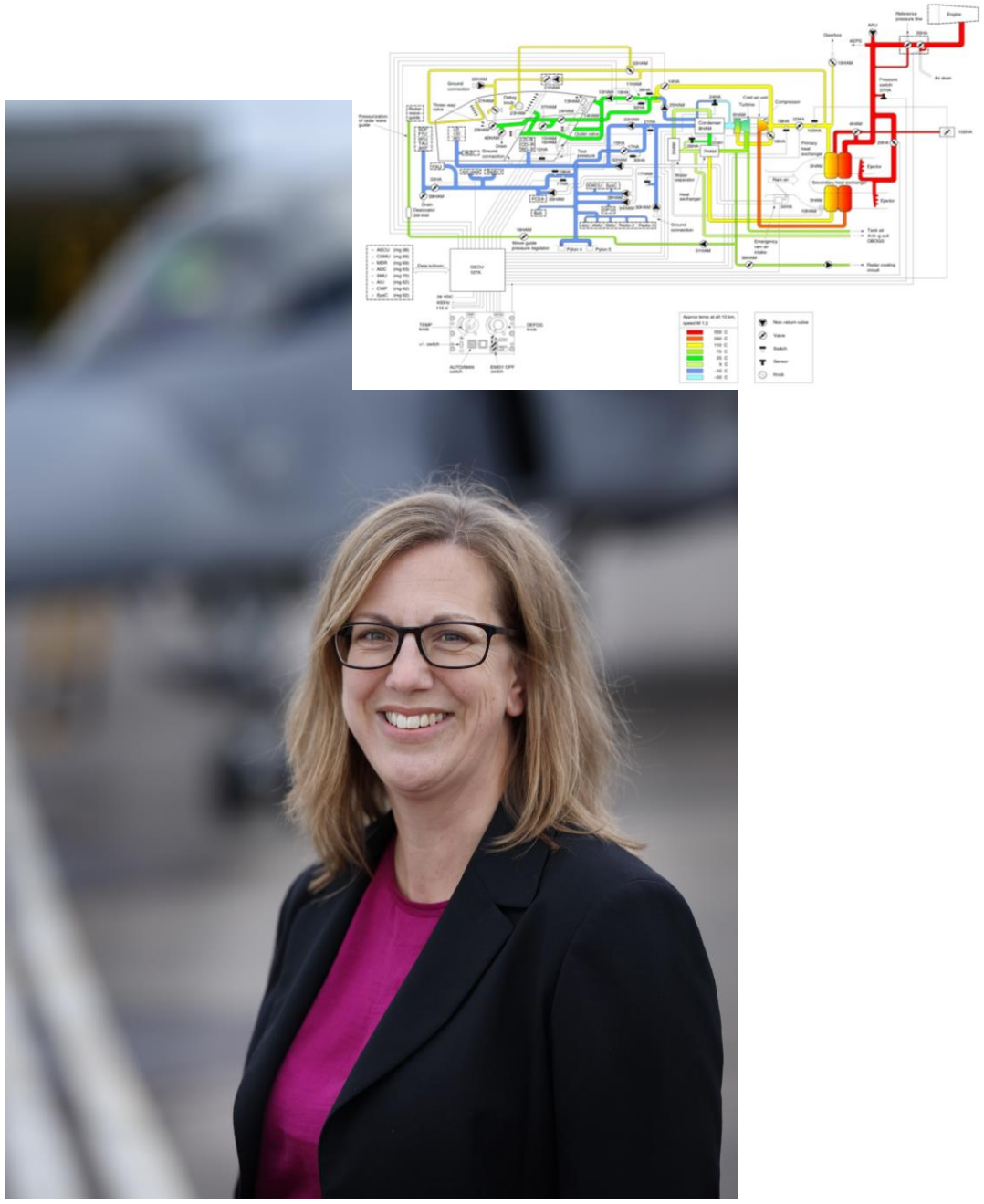
					
	Tunnan	Lansen	Draken	Viggen	Gripen
Number of aircraft produced	661	450	606	329	Around 250 (still in production)
Number of accidents	242	150	125	54	12
Number of pilots dead in accidents	99	100	34	17	1

MARIANNE KLANG

Came to Saab in 2008 after 10 years within thermodynamics

Distinguished engineer in systems engineering – technical manager for environmental control system, project leader for fuel system, part of SEIT team

Marianne is fascinated by the complexity and how all parts work as a whole – and likes all her very competent colleagues!



MARIANNE KLANG

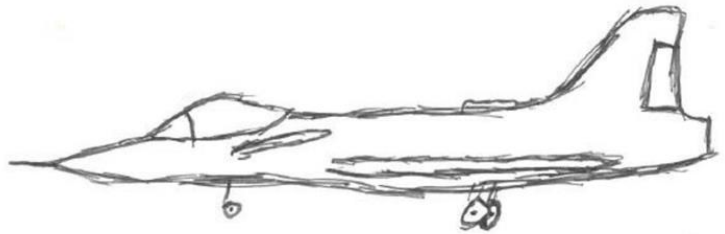
The Gripen was a very mature product – spirit of refining and optimizing in a well-known context

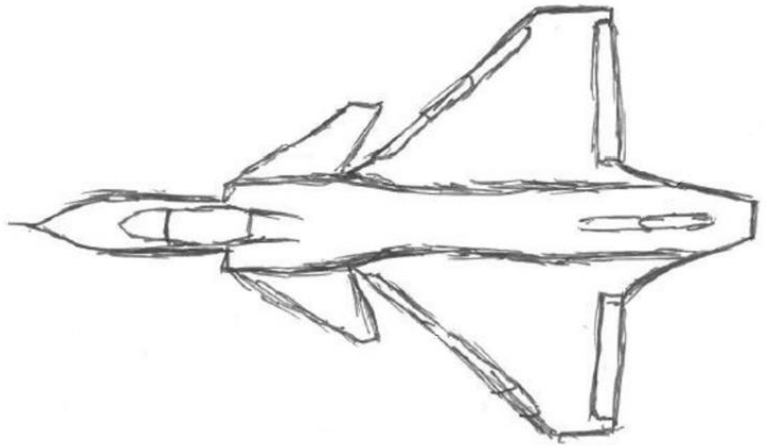
Knowledge of the complex system is distributed among many specialist disciplines – decentralized development

Focus on document reviews and development process rather than being near to the aircraft

WE WANT A COMPLETELY NEW FIGHTER AIRCRAFT (CONTRACT 2013)

– but the old one will still continue to be developed





PICTURE FROM EBBA LINDGREN, ANDREAS BALDHAGEN, KONCEPTUELL FLYGPLANSDESIGN DESIGN AV STRIDSFLYGPLAN FÖR LUFTBUREN SATELLITUPPSKJUTNING, 2018, KTH, SWEDEN

JAS39 GRIPEN E

Longer mission range

New engine

New electronic warfare system

New radar

Wide-screen display in cockpit

Tactical data link

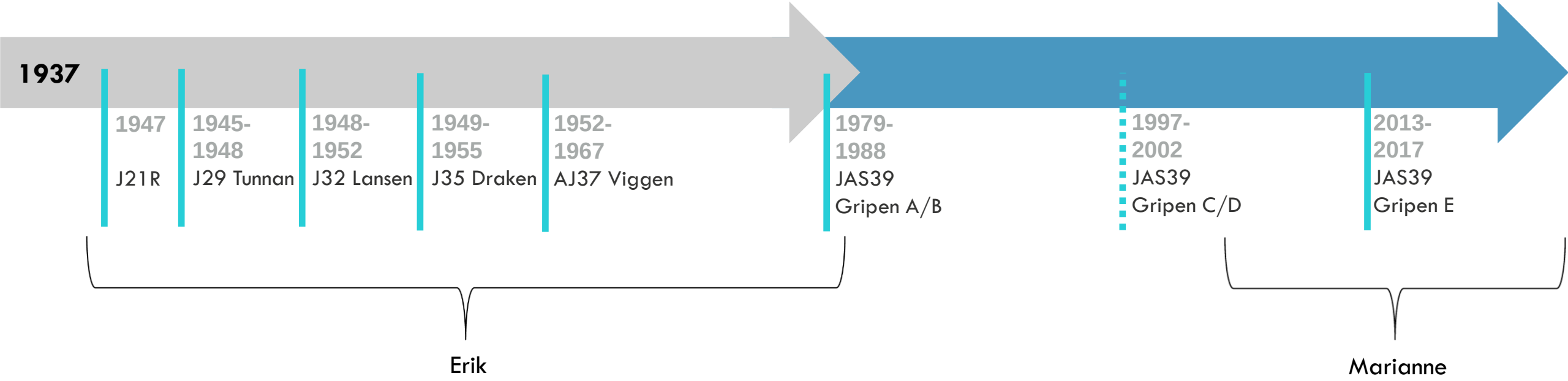
Open, modular avionics architecture

Separation of flight critical and mission critical software

Software generated from models

… … …

TWO VERY DIFFERENT ENGINEERING CAREERS



(Time intervals for start of deveopment to first flight)

BROWNFIELD VS GREENFIELD CHARACTERISTICS

CONCEPT STUDIES	
New capabilities need to interact with a known set of existing ones	Capability interfaces must be carefully designed
Given what is available there is only a small design space when investigating concepts	Given what is open there is a large design space when investigating concepts

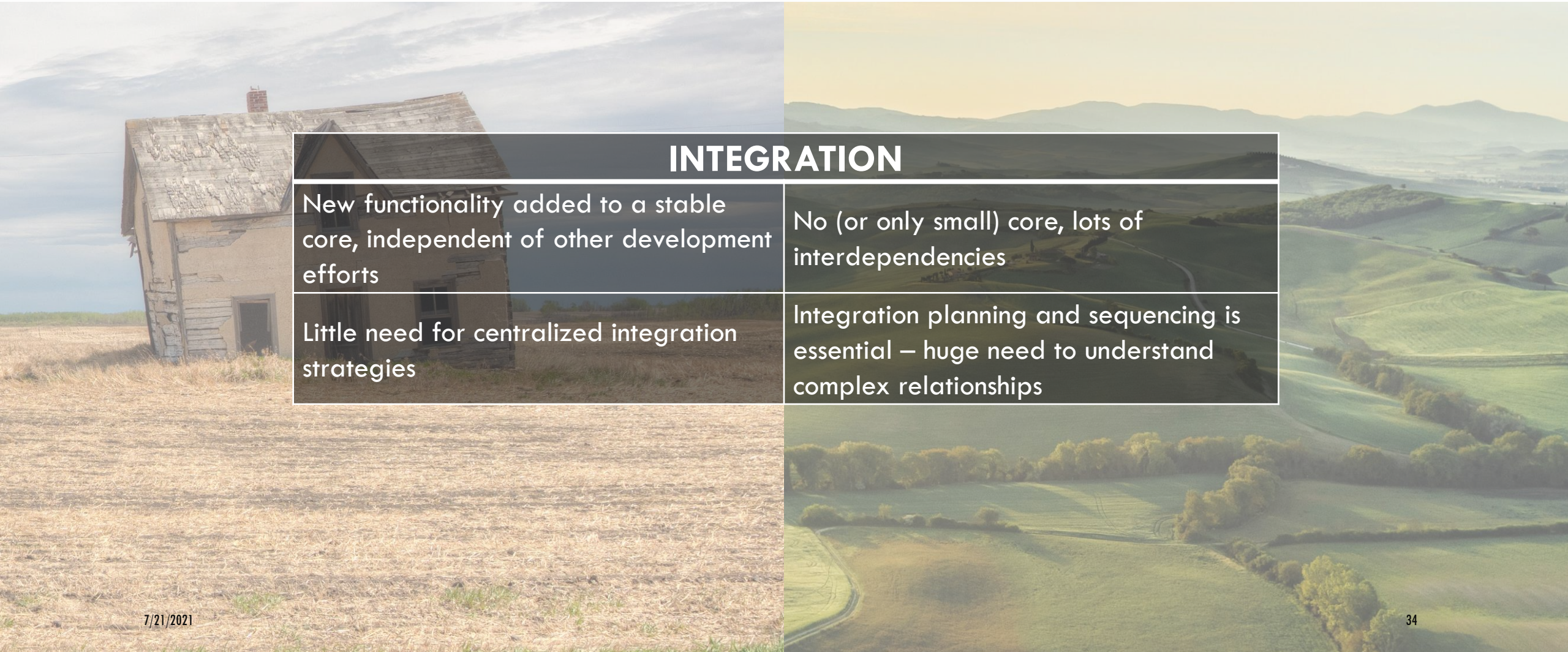
BROWNFIELD VS GREENFIELD CHARACTERISTICS

KNOWLEDGE AND TRAINING	
Gradual adjustment of development methodology, with a known basis to build on	Disruption in development methodology – no common basis exists
Consensus, reliance on passive existing knowledge	Explicit training (courses and on-the-job training) and mentoring to actively build knowledge and its application in product development – for all
Need for specialists, focused on the small (but tricky) details	Need for many generalists with a large view on the overall problem

BROWNFIELD VS GREENFIELD CHARACTERISTICS

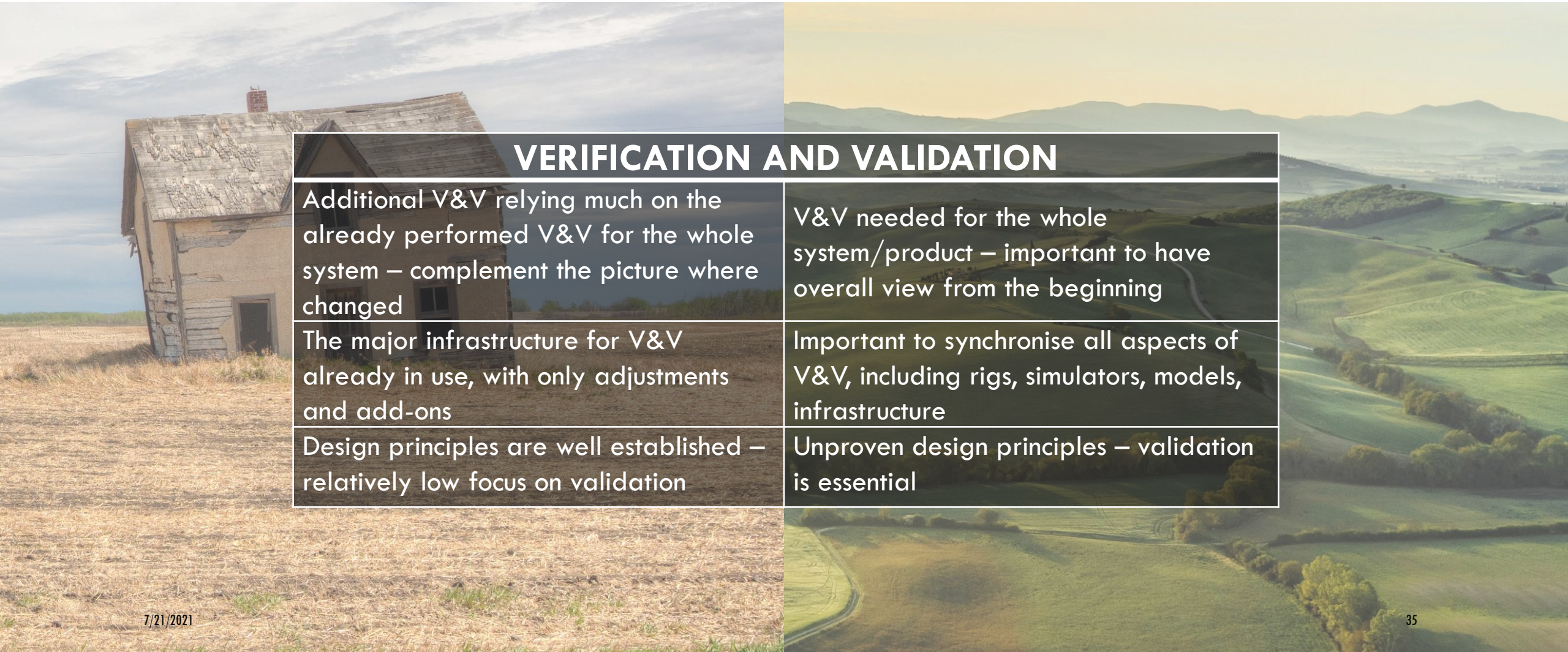
ARCHITECTURE AND ARCHITECTS	
Architecture is set – for good and for bad. Merits and constraints are known	Need to set the architecture and make every team conform to it
Delegated architectural decisions – little need for an independent architecture function	Architecting is a central element in development, constantly evaluating progress and performance

BROWNFIELD VS GREENFIELD CHARACTERISTICS



INTEGRATION	
New functionality added to a stable core, independent of other development efforts	No (or only small) core, lots of interdependencies
Little need for centralized integration strategies	Integration planning and sequencing is essential – huge need to understand complex relationships

BROWNFIELD VS GREENFIELD CHARACTERISTICS

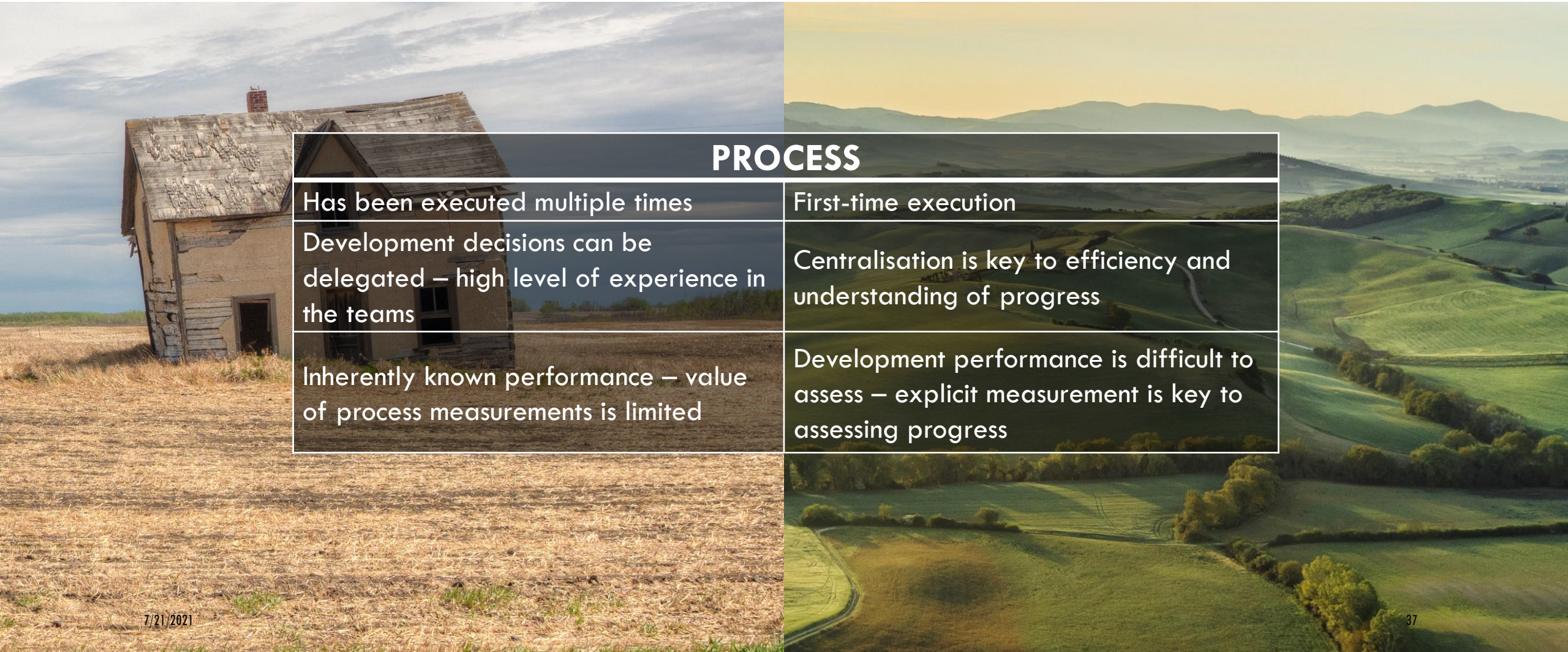


VERIFICATION AND VALIDATION	
Additional V&V relying much on the already performed V&V for the whole system – complement the picture where changed	V&V needed for the whole system/product – important to have overall view from the beginning
The major infrastructure for V&V already in use, with only adjustments and add-ons	Important to synchronise all aspects of V&V, including rigs, simulators, models, infrastructure
Design principles are well established – relatively low focus on validation	Unproven design principles – validation is essential

BROWNFIELD VS GREENFIELD CHARACTERISTICS

LEADERSHIP AND DECISIONMAKING	
Self-managing teams for solving the problems	Teams need help to find solutions to problems
Very few large central decisions to make – local risks	Many central decisions – global risks
Known interfaces	New (unknown) interfaces

BROWNFIELD VS GREENFIELD CHARACTERISTICS

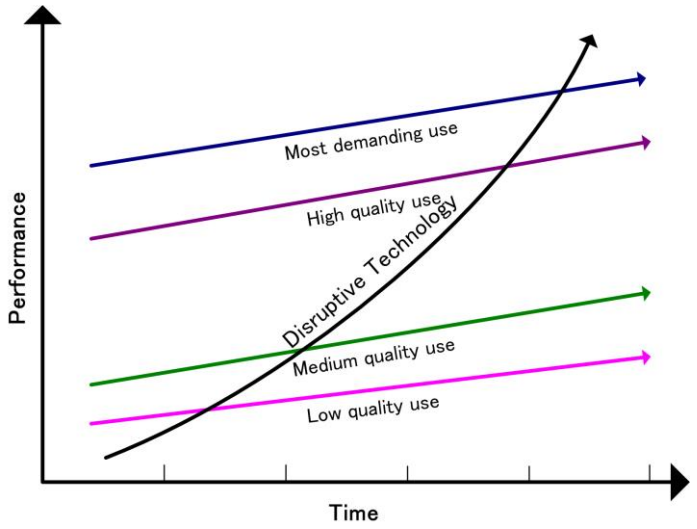


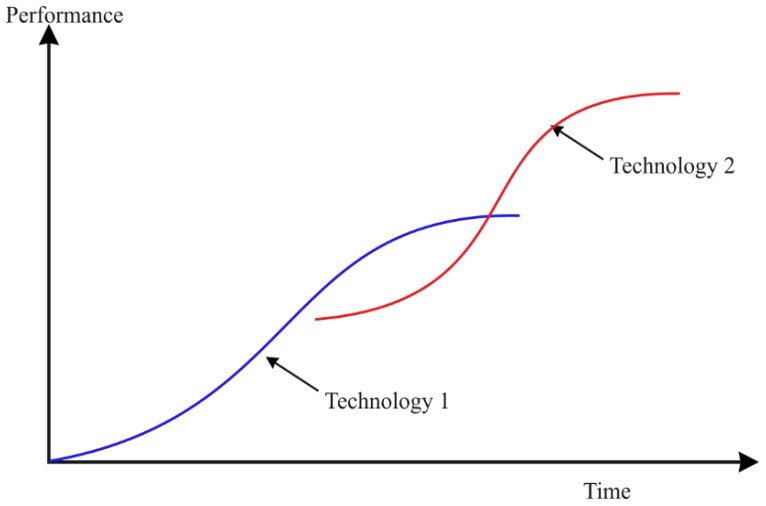
PROCESS	
Has been executed multiple times	First-time execution
Development decisions can be delegated – high level of experience in the teams	Centralisation is key to efficiency and understanding of progress
Inherently known performance – value of process measurements is limited	Development performance is difficult to assess – explicit measurement is key to assessing progress

GREENFIELD DEVELOPMENT OF THE GRIPEN E

After 30 years of improvement of Gripen C/D, where this old system is still under development

CHRISTENSEN'S* INNOVATOR'S DILEMMA





*Christensen, C. M. (2013). The innovator's dilemma: when new technologies cause great firms to fail. Harvard Business Review Press.

MAKES THE NEW SYSTEM LOOK LIKE THIS FOR A VERY LONG TIME

When compared to the old system – and you will be compared!

MARCH'S (2010)* LEARNING DILEMMA

Exploitative Learning

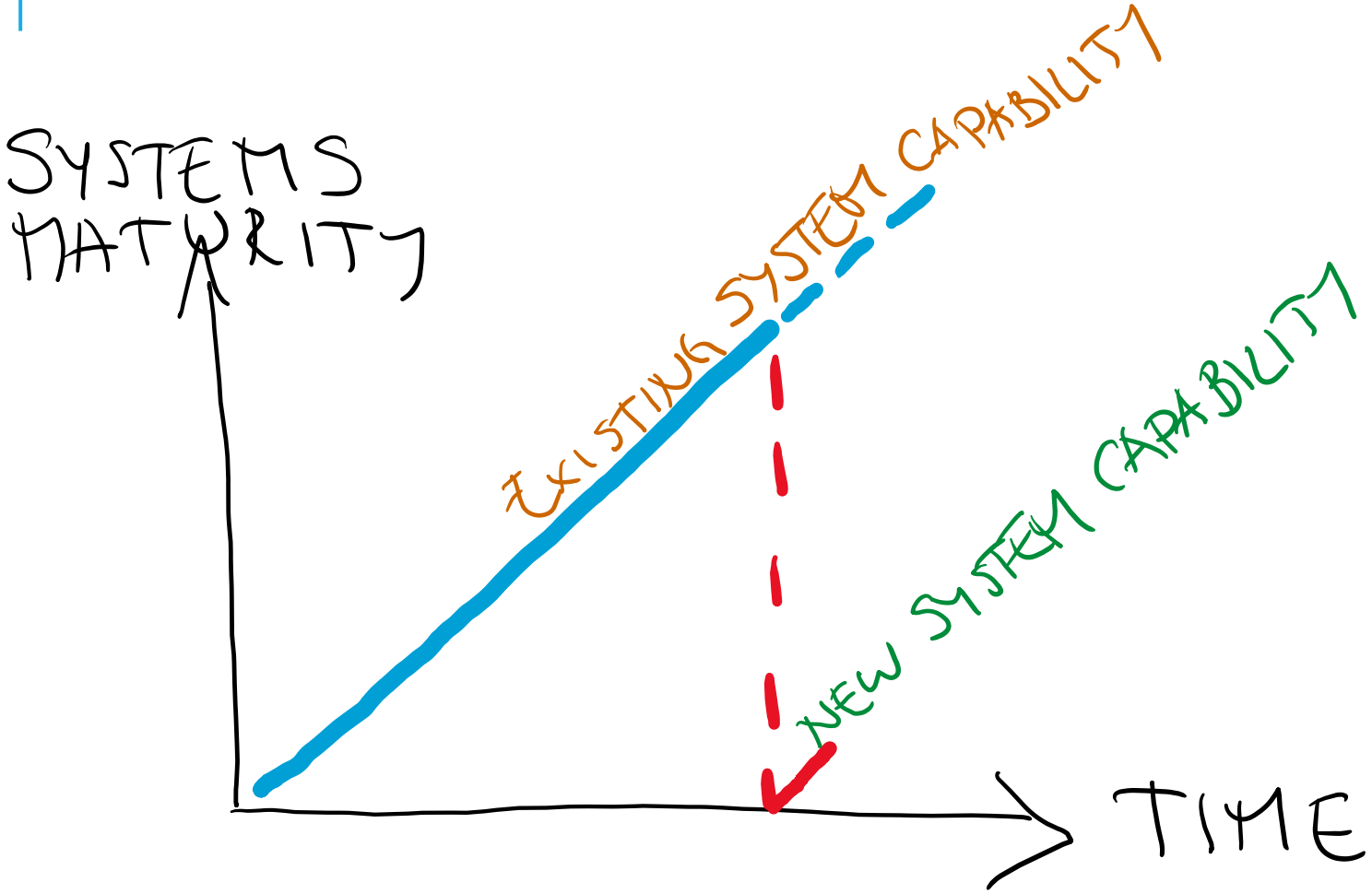
- Exploiting and refining *what is known* (pursuing set goals)
- Mobilizing learning efforts to achieve clearly defined short-term objectives
- Returns: Relatively certain and near in time and space, promotes stability and predictability

Explorative Learning

- Exploring *what might come to be known* (discovering new goals to pursue)
- High uncertainty and ambiguity – difficult to define and measure the merits of outcomes
- Returns: Relatively uncertain and distant in time and space, promotes change

*March, J.G., 2010, The Ambiguities of Experience. Cornell University Press.

THE THINGS WE DID NOT REALIZE



WHAT ALL THIS IMPLIES

Free from old systems constraints

No dependencies

Can implement and develop state-of-the-art technology

AFTER 30 YEARS OF IMPROVEMENT

THE LESSON

There is not a single recipe for systems engineering suitable for all types of development

"Profits from close attention, systematic reason, risk aversion, sharp focus, hard work, training and refined detail." (March 1999, p. 184)

EXPLOITATIVE LEARNING – MARIANNE KLANG'S ORGANIZATION

BROWNFIELD DEVELOPMENT promotes 'exploitative' learning, and the organization therefore expects:

- Learning to be goal-oriented and that expected outcomes and gains can be described.
- Management to reduce slack, facilitate coordination and communication, and to link activities to performance measures that can be monitored.
- Risky choices followed by failures, although they happen, are 'unnecessary'.

"Thrives on serendipity, risk-taking, novelty, free association, madness, loose discipline and relaxed control."
(March 1999, p. 184)

EXPLORATIVE LEARNING – ERIK BRATT'S ORGANIZATION

GREENFIELD DEVELOPMENT

promotes 'explorative' learning where the organization should expect:

- To learn in order to find new alternatives and new goals for development
- Experiments and projects involve high uncertainty and ambiguity, and outcomes and their merits may be difficult to define and difficult to manage
- Success is far from given, however, but failures drive learning and therefore serve a purpose.

GETTING SYMBIOSIS INSTEAD OF A TUG OF WAR

Both are necessary. Exploitation alone leads to obsolescence. Exploration alone leads to frivolity. However…

- **Exploitation** discourages experimentation and variation
- **Exploration** encourages impatience with new ideas, technologies and strategies

BUT WE DO NOT WANT TO RETURN TO THIS

				
	Tunnan	Lansen	Draken	Viggen
Number of aircraft produced	661	450	606	329
Number of accidents	242	150	125	54
Number of pilots dead in accidents	99	100	34	17

IT IS A MATTER OF BALANCE

With a different optimum for different development stages

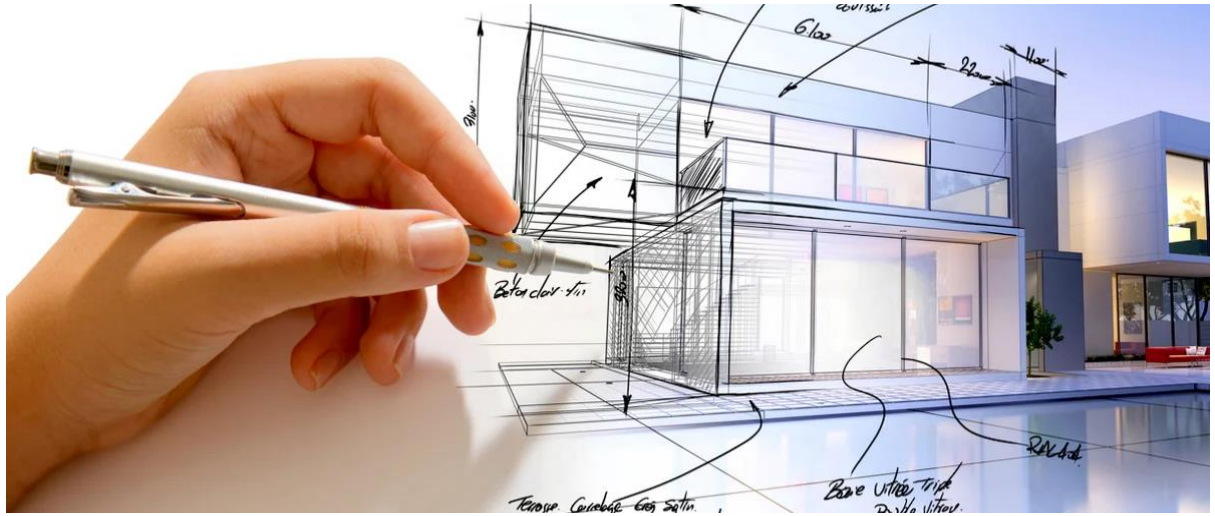
SHAPED BY OUR EXPERIENCE – WE STAYED IN THE BROWNFIELD MINDSET

A state-of-the-art development ‘factory’ – not optimized for Greenfield development

IF CONTINUOUS IMPROVEMENT OF ONE SYSTEM OVER 30+ YEARS IS THE NEW NORM FOR COMPLEX SYSTEMS,

HOW DO WE MORE QUICKLY TURN AROUND THE ORGANIZATIONS' APPROACH TO DEVELOPMENT AND LEARNING WHEN IT IS TIME FOR A TRANSITION?

QUESTIONS FOR MANAGING FUTURE TRANSITIONS



TECHNICAL:
How do we make sure we perform sufficient exploration across all disciplines without putting the whole system at risk?

ORGANIZATIONAL CAPABILITY:
How can we prepare the organization and optimize for something unknown?
How do we prepare such that we can go from exploiting to exploring with minimal friction?

INDIVIDUAL COMPETENCE:
How do we keep competence alive?
How do we prepare individuals for the explorative learning challenges that come with a transition?
Are all exploiters potential explorers?

APPROACH TO **LEARNING:**
How do we train people to see failure as a natural part of learning?
How can we create an understanding that learning (for all) is an essential part of a successful transition?