This presentation is based on the slides used for the INCOSE SE Vision 2025

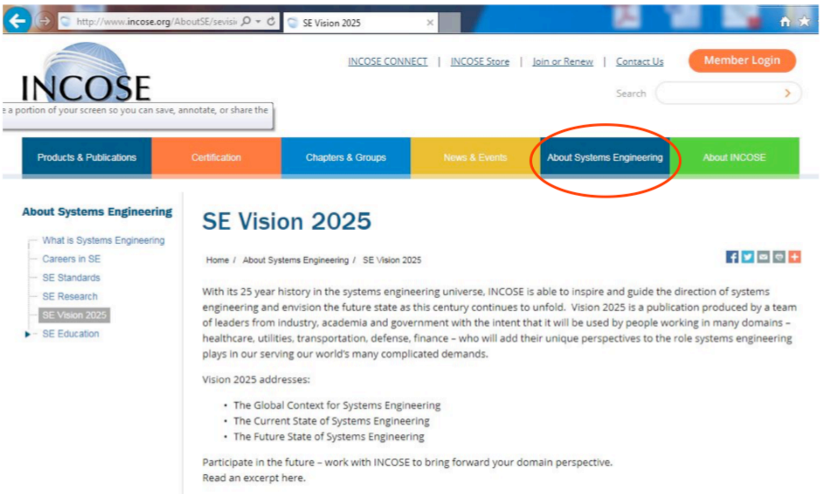
NL SE Vision 25 Outline

- Introduction
- Global Context for SE in NL
- Current State of SE in NL
- Future State of SE for the Netherlands*

- Includes *From/To Statement to* differentiate the Current & Future State

INCOSE SE Vision 2025 Site

Available for download from http://www.incose.org/AboutSE/sevision



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This is where you can find and download the original SE Vision 2025 document

Acknowledgment

The INCOSE Director of Strategy (Ralf Hartmann) under the auspices of the INCOSE Board of Directors sponsored the Systems Engineering Vision Project Team to develop this Vision. The team included:

Bruce Beihoff
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UK Ministry of Defense

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California Institute of Technology

Christopher Oster
Lockheed Martin Corporation

Chris Paredis
Georgia Institute of Technology

Heinz Stoewer
Space Associates

Jon Wade
Stevens Institute of Technology

The team also derived significant inspiration from the 'Systems Engineering AFIS Vision that was presented at the INCOSE International Workshop, 2011, as well as the previous Systems Engineering Vision 2020 that was published by INCOSE in 2007. Charlie Kennel from Scripps Institute of Oceanography also provided invaluable insights. A special thanks to Audrey Steffan from the Jet Propulsion Laboratory for her graphics design support, and to Quoc Do for coordinating the INCOSE Review.

Publication of ***A World in Motion – Systems Engineering Vision 2025*** *was made possible by a generous grant from the INCOSE Foundation.*

Netherlands SE-Vision team

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- Willem-Jan de Vlieger

The Global Context for SE in the Netherlands is the same as for the INCOSE SE Vision 2025. This implies that this section remains unaltered.


Societal Needs
FOOD AND SHELTER
CLEAN WATER
HEALTHY (PHYSICAL) ENVIRONMENT
ACCESS TO HEALTH CARE
ACCESS TO INFORMATION, COMMUNICATION, EDUCATION
TRANSPORTATION AND MOBILITY
ECONOMIC SECURITY AND EQUITY
SECURITY AND SAFETY
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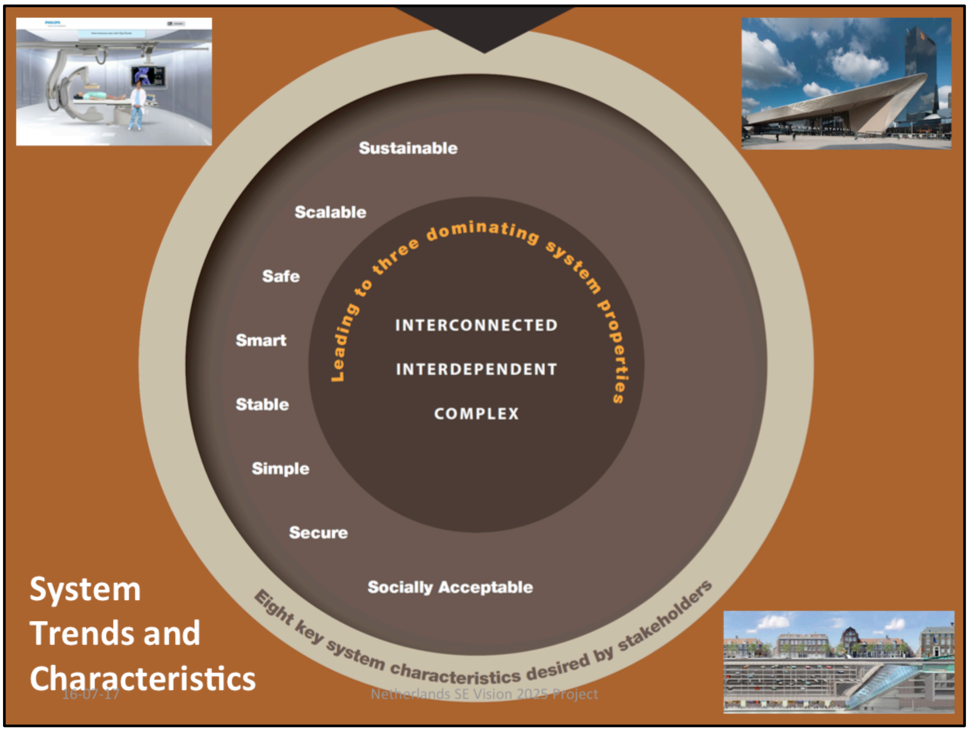
Sustainable
Scalable
Safe
Smart
Stable
Simple
Secure
Socially Acceptable
Leading to three dominating system properties
INTERCONNECTED
INTERDEPENDENT
COMPLEX
Eight key system characteristics desired by stakeholders
System Trends and Characteristics
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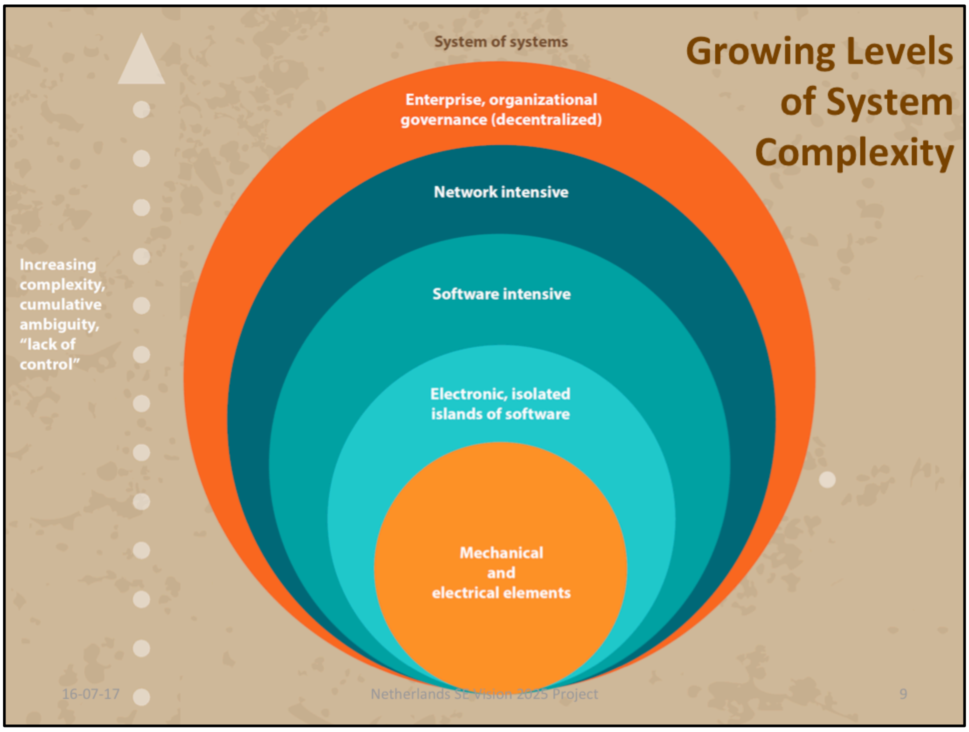
Growing Levels of System Complexity
System of systems
Enterprise, organizational governance (decentralized)
Network intensive
Software intensive
Electronic, isolated islands of software
Mechanical and electrical elements
Increasing complexity, cumulative ambiguity, "lack of control"
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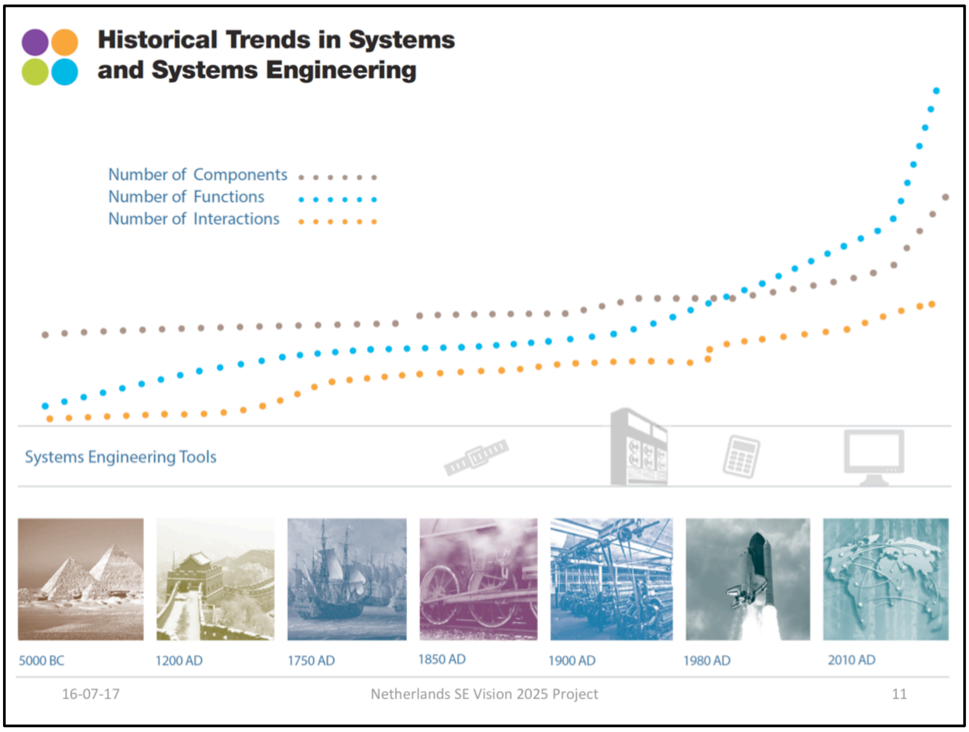
CURRENT STATE OF SE IN THE NETHERLANDS



Systems Engineering was all ready used by the Romans. Through the centuries Systems Engineering helped to realize increasing complex systems.

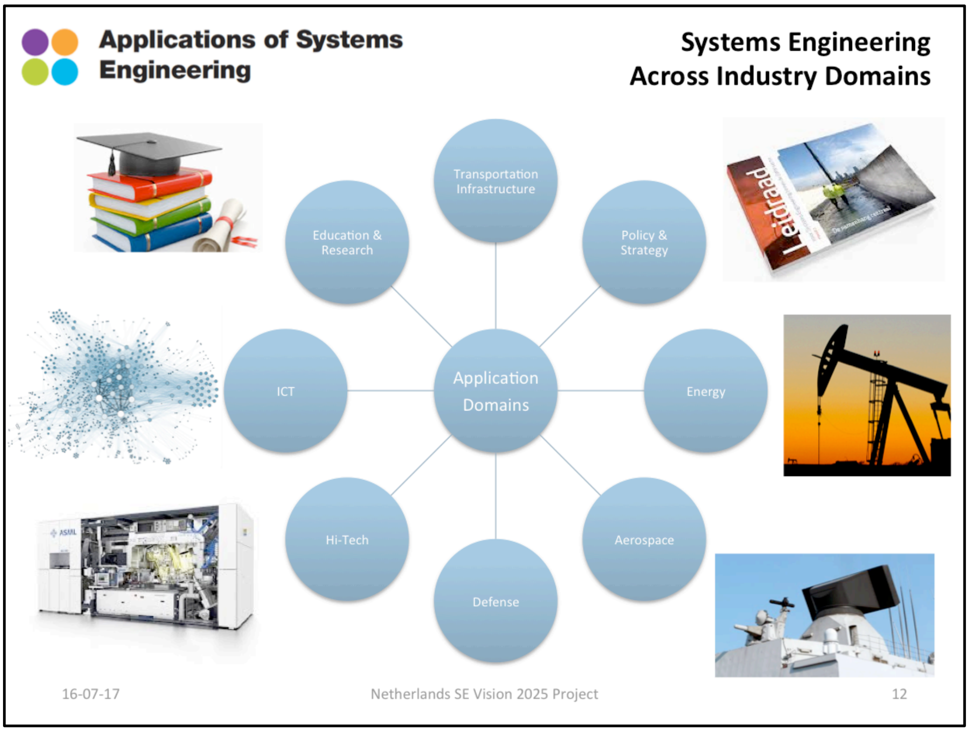
It was only in the late sixties that Systems Engineering was made explicit by the American Aerospace and Defence domains. This is one of the reasons that some people believe that Systems Engineering is a quite young method.

In the early nineties the Dutch Aerospace domain was influenced by the American Aerospace approach to Systems Engineering. Soon this influence spread to the Education and Research domain. At the same time Systems Engineering evolved in domains like the Hi-Tech domain.

Around the mid nineties the Infrastructure domain started to accept Systems Engineering. This development was boosted by the Aerospace domain, which also founded the Dutch Chapter of INCOSE.

In the twenties a Systems Engineering standard was defined in the Infrastructure domain. Also the 2008 International INCOSE Symposium took place in Utrecht, the Netherlands.

Now Systems Engineering is practised in various domains, however the maturity differs.


Applications of Systems Engineering
Systems Engineering Across Industry Domains
Transportation Infrastructure
Education & Research
Policy & Strategy
ICT
Application Domains
Energy
Hi-Tech
Aerospace
Defense
Leidraad
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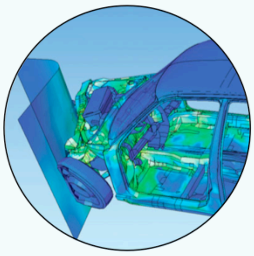
Current Foundations and Standards

CURRENT PRACTICE EXAMPLES

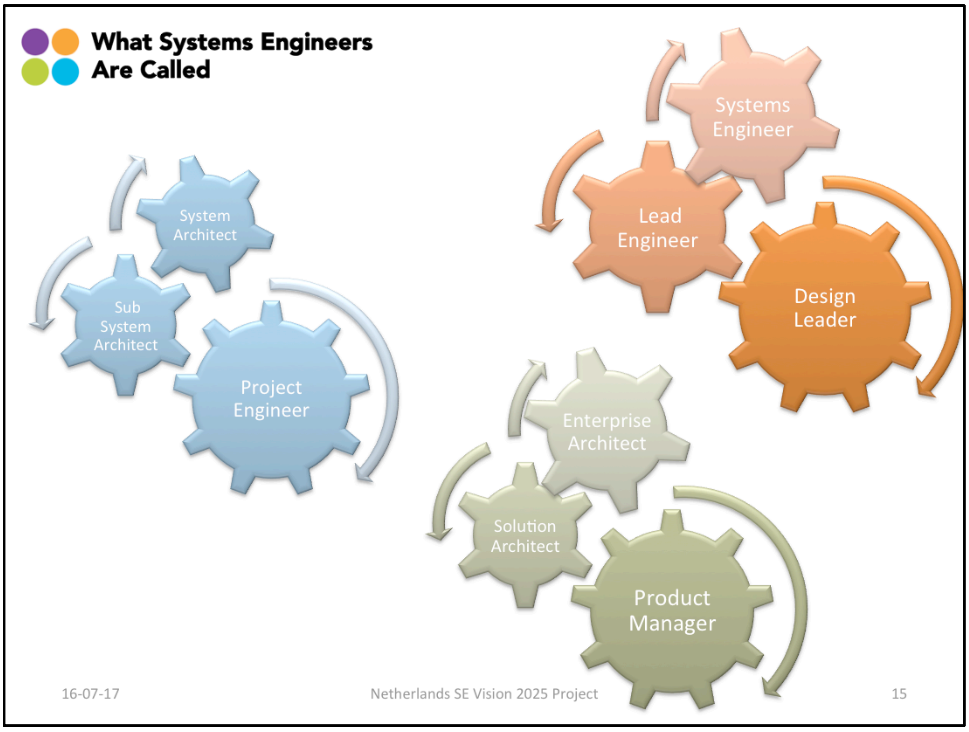
MODELING, SIMULATION, AND VISUALIZATION

SYSTEM OF SYSTEMS ENGINEERING



DESIGN TRACEABILITY BY MODEL-BASED SYSTEMS ENGINEERING

PRODUCT-FAMILY AND COMPOSABLE DESIGN


What Systems Engineers Are Called
System Architect
Sub System Architect
Project Engineer
Systems Engineer
Lead Engineer
Design Leader
Enterprise Architect
Solution Architect
Product Manager
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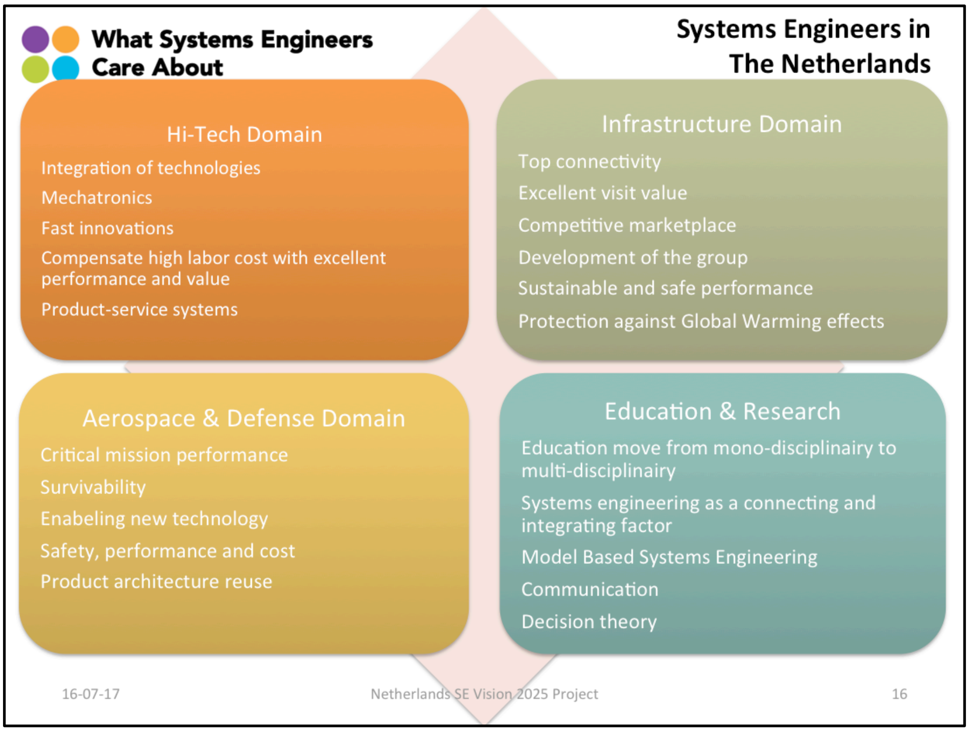
What Systems Engineers Care About
Systems Engineers in The Netherlands
Hi-Tech Domain
Integration of technologies
Mechatronics
Fast innovations
Compensate high labor cost with excellent performance and value
Product-service systems
Infrastructure Domain
Top connectivity
Excellent visit value
Competitive marketplace
Development of the group
Sustainable and safe performance
Protection against Global Warming effects
Aerospace & Defense Domain
Critical mission performance
Survivability
Enabeling new technology
Safety, performance and cost
Product architecture reuse
Education & Research
Education move from mono-disciplinairy to multi-disciplinairy
Systems engineering as a connecting and integrating factor
Model Based Systems Engineering
Communication
Decision theory
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Transforming Systems Engineering

Guidance
UN Long-Term Sustainable Goals

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Current Systems Engineering Practices and Challenges

1 Mission complexity is growing faster than our ability to manage it . . . increasing mission risk from inadequate specifications and incomplete verification.

2 System design emerges from pieces, rather than from architecture . . . resulting in systems that are brittle, difficult to test, and complex and expensive to operate.

3 Knowledge and investment are lost at project life cycle phase boundaries . . . increasing development cost and risk of late discovery of design problems

4 Knowledge and investment are lost between projects . . . increasing cost and risk: dampening the potential for true product lines.

5 Technical and programmatic sides of projects are poorly coupled . . . hampering effective project risk-based decision making.

6 Most major disasters such as Challenger and Columbia have resulted from failure to recognize and deal with risks. The Columbia Accident Investigation Board determined that the preferred approach is an "independent technical authority".

Six Systems Engineering Challenges — Adapted from Todd Bayer, Jet Propulsion Laboratory

Dealing with the increasing complexity of systems Integration of technologies

The system increasing scale and the number off:

- stakeholders,
- interfaces,
- functions,

Connecting Systems Engineering with other methods and techniques

Systems Engineering interacts with:

- Asset Management,
- Lean, Agile, Scrum
- Projectmanagement, etc.

Supporting the development of Policy and/or Strategy with Systems Engineering

Systems Engineering can contribute to improve the overall performance of organizations

Boosting Systems Engineering in all domains

The maturity in the various domains differs from initialy performed to quantatively managed

Focusing on "soft" systems in stead of only "hard" systems.

- The hard systems, where concrete is poured or metal is cut, are often in the spotlights. For soft systems, like organizations, often in the shade, Systems Engineering can be of great value

Current Systems Engineers Challenges in The Netherlands

INCOSE

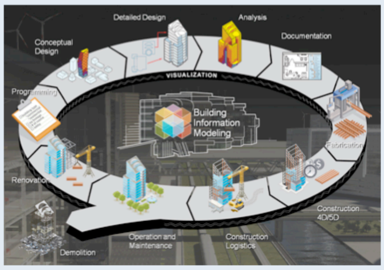
Vision25 Systems Engineering

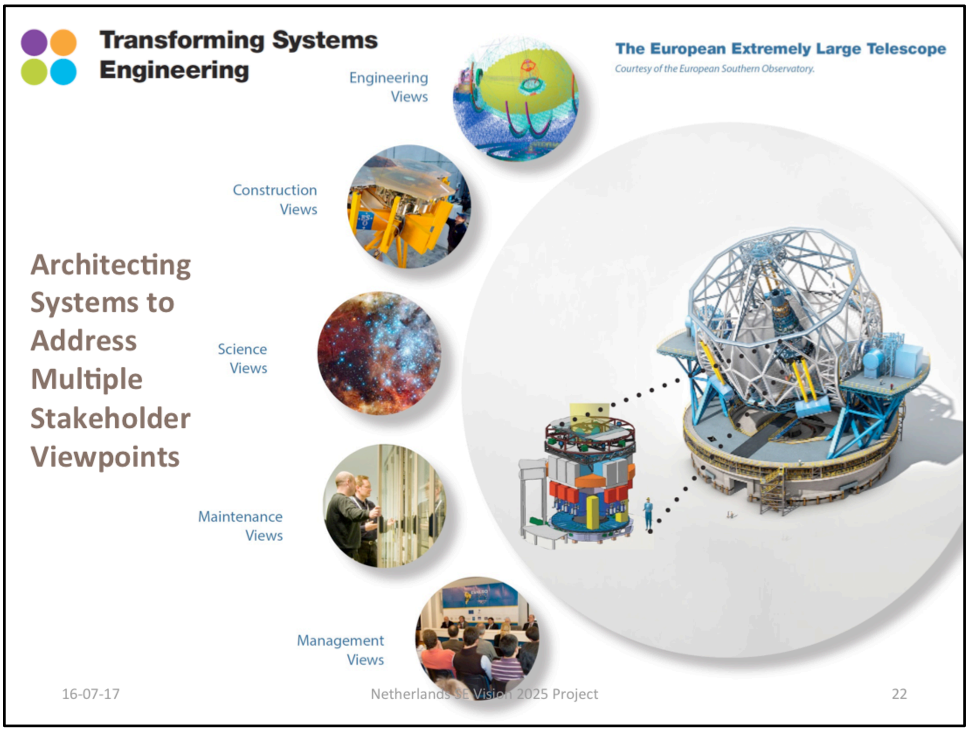
FUTURE STATE OF SYSTEMS ENGINEERING FOR THE NETHERLANDS

Note: the From/To statements marked with * are Netherlands specific

We need to Transform SE Practices

- Collaborative Engineering
- Complex System Understanding
- System of Systems Engineering
- System Architecting
- Composable Design
- Design for Resilience
- Design for Security
- Decision Support
- Virtual Engineering (CAD, BIM, FEA,...) and MBSE




Transforming Systems Engineering
The European Extremely Large Telescope
Courtesy of the European Southern Observatory.
Engineering Views
Construction Views
Architecting Systems to Address Multiple Stakeholder Viewpoints
Science Views
Maintenance Views
Management Views
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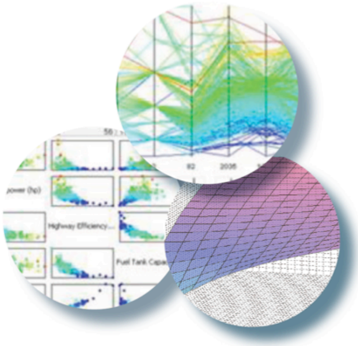
Transforming Systems Engineering

Decision Support

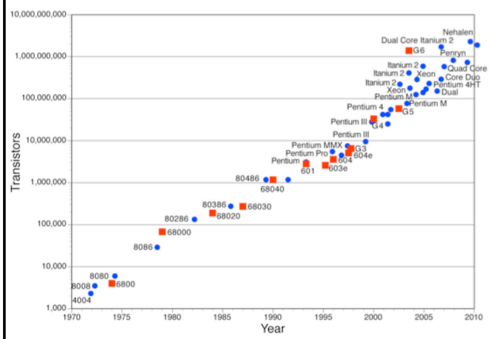
Leveraging Information and Analysis for Effective Decision Making



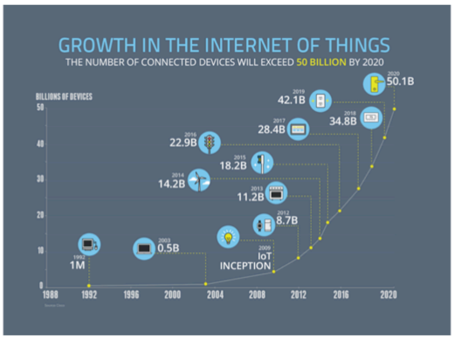
Decision makers will have more information and options from which to draw conclusions.
Systems Engineers' key focus is to enable the decision making process!!!

Transforming Systems Engineering

Extrapolate towards the future



Ref: Moore's law



Similar to the development rate we have seen for the number of transistors implemented in micro-processors, we should be better in predicting the rate of future developments, based on existing trends. AS an example, the number of IoT connected devices is shown.

Systems Engineering
From – To statements

Penetration of SE in the Netherlands*

From:

Systems engineering contributes to faster, cheaper and better systems.

To:

Systems engineering generally recognized and, by default, applied to all systems in the Netherlands.

Systems Engineering
From – To statements

Applying SE Across Industry Domains*

From:

Systems engineering is a recognized discipline within Aerospace (Fokker, Stork), Defense (Thales, Stork, Government) and Civil Infrastructure industry and is applied in many other domains as well. In various industries, practices are often called differently.

To:

Systems engineering is broadly recognized by Dutch economic and business leaders as a value-added discipline related to a wide variety of commercial products, systems and services, as well as government services and infrastructure. This broad community of practitioners result in the sharing and maturation of more robust systems engineering practices and foundations.

Systems Engineering
From – To statements

Applying Systems Engineering to Policy

From:

Public policy decisions are often made without leveraging a well-defined systems approach to understand the diverse set of stakeholder needs and the implications of various policy options.

To:

Systems engineering takes its place with other systems-related, integrative disciplines such as economics, human ecology, geography, and economic anthropology to structure more objective cost, benefit and risk assessments of alternative policy executions. The addition of a formal systems approach helps decision-makers to select cost effective, safe, and sustainable policies that are more broadly embraced by the stakeholder community.

Systems Engineering
From – To statements

Applying Systems Engineering to Social Systems*

From:

Systems engineering is dominantly applied to technical projects, be it often with a social component.

To:

Systems engineering tools and methods are applied for the (re)design of social systems. The process from stakeholder analysis up till validation and verification adds considerable value to these systems and increases acceptability of the solution.

Systems Engineering
From – To statements

Applying Systems Engineering in small & medium enterprises*

From:

Systems engineering is dominantly applied in large enterprises and large projects. This is reflected in the scope and size of tools and methods. Small and medium enterprises are seeing the potential of systems engineering for the quality of their work. They are however reluctant to accept the existing practices and are generally missing the expertise and funding to resize tools and methods to their needs.

To:

Systems engineering tools and methods have been made scalable to the size of the enterprise or project and are made available at an affordable cost. The Systems Engineering tools are adopted widely. The tools are compatible, and partly integrated with, or by preference based on, standard business software. Active training is provided to optimize and maintain these for their intended purpose.

Systems Engineering
From – To statements

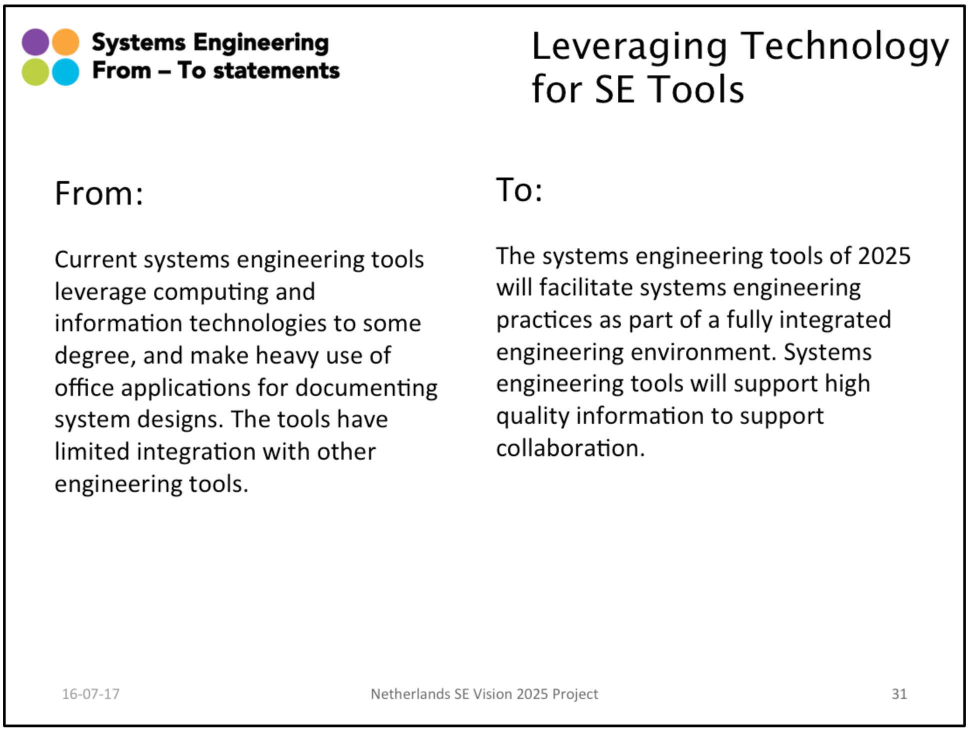
Complex System Understanding*

From:

Today, stakeholders are demanding increasingly capable systems that are growing in complexity, yet complexity-related system misunderstanding is at the root of significant cost overruns and system failures. There is broad recognition that there is no end in sight to the system complexity curve.

To:

In 2025 and beyond, standard measures of complexity will be established, and methods for tracking and handling complex system behaviors and mitigating undesired behaviors will be better understood.



Full text

From: Current systems engineering tools leverage computing and information technologies to some degree, and make heavy use of office applications for documenting system designs. The tools have limited integration with other engineering tools

To: The systems engineering tools of 2025 will facilitate systems engineering practices as part of a fully integrated engineering environment. Systems engineering tools will support high fidelity simulation, immersive technologies to support data visualization, semantic web technologies to support data integration, search, and reasoning, and communication technologies to support collaboration. Systems engineering tools will benefit from internet-based connectivity and knowledge representation to readily exchange information with related fields. Systems engineering tools will integrate with CAD/CAE/PLM environments, project management and workflow tools as part of a broader computer-aided engineering and enterprise management environment. The systems engineer of the future will be highly skilled in the use of IT-enabled engineering tools.

Systems Engineering
From – To statements

System Design in a System of Systems Context*

From:

Limited technical guidance is available to engineer complex systems of systems and assure qualities of service. For some domains (e.g. Defense, Aerospace) current emphasis is on architecture frameworks and interoperability standards where other domains are in the stage of its discovery

To:

Over time, the complexity of systems grows exponentially, while these systems get more and more interconnected and get extensively dependent on each other. A diverse set of stakeholders will increasingly demand SoS to provide information and services, leveraging value from the pieces. The SoS context doesn't only consist of a positive and cooperative behavior but also malicious and evil behavior that needs to be dealt with appropriately.

Systems Engineering
From – To statements

Architecting Systems to address Multiple Stakeholder Views

From:

Systems architecting is often ad-hoc and does not effectively integrate architectural concerns from technical disciplines such as hardware, software, and security, nor does it fully integrate other stakeholder concerns.

To:

Systems architecting methods are well established and address broad stakeholder concerns associated with increasingly complex systems. System architecture, design and analysis is integrated across disciplines, domains and life cycle phases to provide a single, consistent, unambiguous, system representation. This ensures integrity and full traceability throughout the systems engineering process, and provides all stakeholders with multiple system views to address a broad range of concerns.

Systems Engineering
From – To statements

Architecting and Design of Resilient Systems

From:

Fault detection, isolation, and recovery is a common practice when designing systems so they can recover from failures, and/or off nominal performance and continue to operate. Fault detection is based on a priori designation and characterization of off-nominal behavior.

To:

Architecting will incorporate design approaches for systems to perform their intended function in the face of changing circumstances or invalid assumptions.

Systems Engineering
From – To statements

Cyber Security – Securing the System

From:

Systems, personal and national security are increasingly being compromised due to the digitally interconnected nature of our infrastructure. Engineers are hard pressed to keep up with the evolving nature and increasing sophistication of the threats to our cyber-physical systems. Cyber-security is often dealt with only as an afterthought or not addressed at all.

To:

Systems engineering routinely incorporates requirements to enhance systems and information security and resiliency to cyber threats early and is able to verify the cyber defense capabilities over the full system life cycle, based on an increasing body of strategies, tools and methods.

Systems Engineering
From – To statements

Leveraging Information and Analysis for Effective Decision Making*

From:

Systems engineers explore a limited number of design alternatives primarily based on deterministic models of performance, physical constraints, cost and risk.

To:

Tools support systems engineers to efficiently rank alternatives and rapidly explore the most promising of alternatives to maximize overall value, based on a comprehensive set of measures including performance, physical constraints, flexibility, security, resilience, insensitivity to changes, cost and risk.

Systems Engineering
From – To statements

Part of the Digital Revolution*

From:

Model-based systems engineering has grown in popularity as a way to deal with the limitations of document-based approaches, but is still in an early stage of maturity similar to the early days of CAD/ CAE.

To:

A shift towards an integrated, digital engineering environment enables rapid transformation of concepts and designs to physical prototypes through the application of additive manufacturing technologies, such as 3D printers. This capability enables engineers to rapidly and continually assess and update their designs prior to committing costs to production hardware. In addition it provides a powerful tool to verify integrateability and serviceability of the design. Systems engineering practices will leverage this capability to rapidly assess alternative designs in terms of their form, fit and function.

Full text

To: Transforming Virtual Model to Reality . A shift towards an integrated, digital engineering environment enables rapid transformation of concepts and designs to physical prototypes through the application of additive manufacturing technologies, such as 3D printers. This capability enables engineers to rapidly and continually assess and update their designs prior to committing costs to production hardware. In addition it provides a powerful tool to verify integrateability and serviceability of the design. Systems engineering practices will leverage this capability to rapidly assess alternative designs in terms of their form, fit and function.

Systems Engineering
From – To statements

Shoring up the Theoretical Foundation*

From:

Systems engineering practice is only weakly connected to the underlying theoretical foundation, and educational programs focus on practice with little emphasis on underlying theory.

To:

The theoretical foundation of systems engineering encompasses not only mathematics, physical sciences, and systems science, but also human and social sciences. This foundational theory is taught as a normal part of systems engineering curricula, and it directly supports systems engineering methods and standards. Understanding the foundation enables the systems engineer to understand the problem space more broadly and evaluate and select from an expanded and robust toolkit. The right tools for the job.

Systems Engineering
From – To statements

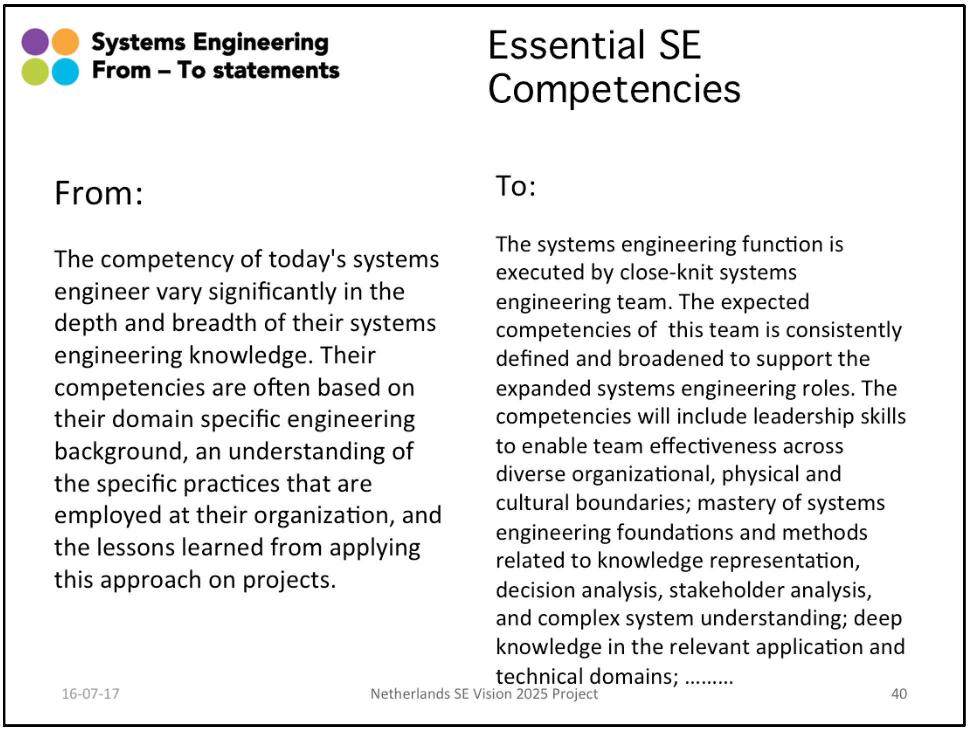
The Broadening role of the Systems Engineer

From:

A typical systems engineering role varies from managing requirements to being the technical leader on a project.

To:

The roles and competencies of the systems engineer will broaden to address the increasing complexity and diversity of future systems. The technical leadership role of the systems engineer on a project will be well established as critical to the success of a project. The systems engineering role also supports and integrates a broader range of socio-technical disciplines, technologies, and stakeholder concerns in an increasingly diverse work environment. Systems engineers will integrate programmatic and socio-technical concerns that span global and cultural boundaries as well as system-of-system boundaries



Full text

To: The systems engineering function is executed by close-knit systems engineering team. The expected competencies of this team is consistently defined and broadened to support the expanded systems engineering roles. The competencies will include leadership skills to enable team effectiveness across diverse organizational, physical and cultural boundaries; mastery of systems engineering foundations and methods related to knowledge representation, decision analysis, stakeholder analysis, and complex system understanding; deep knowledge in the relevant application and technical domains; experience across the full system life cycle including development, operations, and sustainment; and skills in the use of software-based tools needed to support the application of systems engineering to the domain

Systems Engineering
From – To statements

Building the SE Workforce for 2025 and Beyond

From:

The Dutch demand for systems engineering in all application domains is increasing the need for high quality and wide spread systems engineering education and training. A number of academic institutions are offering graduate-level programs in systems engineering.

There are increasing numbers of universities that teach systems engineering at the graduate level, although the total number is still small relative to other engineering disciplines.
………..

To:

The Dutch demand for systems engineering is well understood.
Systems thinking is formally introduced in early education for all engineering disciplines.
Systems engineering is a part of every engineers curriculum and systems engineering at the university level is grounded in the theoretical foundations that spans the hard sciences, engineering, mathematics, and human and social sciences and the needs of the engineering community.

Graduate courses related to systems engineering will be opened up for active practitioners at an affordable cost.

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Full text

From: The worldwide demand for systems engineering in all application domains is increasing the need for high quality and wide spread systems engineering education and training. A number of academic institutions are offering graduate-level programs in systems engineering.

There are increasing numbers of universities that teach systems engineering at the graduate level, although the total number is still small relative to other engineering disciplines. At a limited number of faculties in universities systems engineering has been introduced as an integral part of the undergraduate curriculum, accompanied by actual design projects where SE methods and tools are applied.

To: The worldwide demand for systems engineering is well understood, and an educational, training, and mentoring life-long learning pipeline is in place to support it with individuals and teams of the required quantity and multi-disciplinary capabilities.

Systems thinking is formally introduced in early education for all engineering disciplines. Systems engineering is a part of every engineers curriculum and systems engineering at the university level is grounded in the theoretical foundations that spans the hard sciences, engineering, mathematics, and human and social sciences and the needs of the engineering community.

Graduate courses related to systems engineering will be opened up for active practitioners at an affordable cost.

REALIZING THE VISION

Realizing
the Vision

What’s next.....

Realizing the Vision

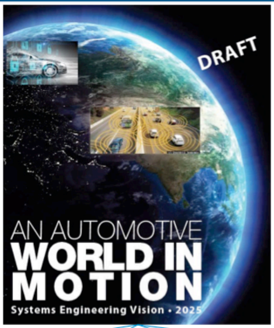
What's next…..

Netherlands SE Vision, what's next?

- The vision will be made available in a pdf / pptx presentation by April / May 2017
- The Vision document will be shared with the Int'l audience
- …..hopefully inspiring other countries to follow the example

- INCOSE-NL (Board) should take the initiative to identify their Mission as well as the Strategies to come to actions to realize this Vision. This can be initiated together with the Dutch Advisory Board members.

Automotive Systems Engineering Vision 2025



Chapter 1
Global Mega Trends driving the evolving demands and need for Automotive Systems Engineers

Chapter 2
Current State of Automotive Systems Engineering

Chapter 3
Future State of Automotive Systems Engineering

Chapter 4
Future State Automotive SE Gap Analysis, Prioritization, and strategic plan of action
- Company Specific SE Enablers/Actions
- Cross Company Enablers/Collaborations

THANK YOU !

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