

Action Agenda for Systems Engineering

Author: Innovation domain Systems Engineering



Holland High Tech
Global Challenges, Smart Solutions

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Table of contents

Executive summary 4

Intended audience for this action agenda 5

Structure of this action agenda 5

1 Introduction: Systems Engineering as an enabling discipline 6

1.1 The discipline and its three pillars 7

1.2 INCOSE SE Vision 2035 8

1.3 SE across sectors 9

2 European and national trends 10

2.1 Five challenges in the unique Dutch ecosystem 12

2.2 Future SE needs in the National Technology Strategy 14

2.3 The risks of not applying SE 16

3 Strengthening Systems Engineering in the Netherlands 18

3.1 SE method innovation 20

3.2 SE adoption 23

3.3 SE education and lifelong learning 25

4 Action agenda 27

4.1 SE method innovation 28

- Managing increasing complexity 28
- Digital engineering and productivity 28
- Ecosystems and supply chains 28
- Trustworthy, resilient, and sovereign systems 28
- AI-enabled systems 28
- Sustainability and emerging challenges 28

4.2 SE adoption 30

- Introducing SE into existing organizations 30
- Evidence-based SE adoption 30
- SE for growing organizations 30

4.3 SE education and lifelong learning 32

- Expanding the SE talent base 32
- Accelerating SE competence development 32
- Continuous learning for digital and societal transitions 32

References 34

Appendix A. SE applied to the National Technology Strategy 35

Glossary 42

Colophon 46

Executive summary

Global competition, geopolitical pressure, and the climate transition all demand higher engineering productivity and faster innovation. Systems Engineering (SE) is the discipline that makes this possible. It provides the integration, coordination, and lifecycle control that complex systems need. This holds across high-tech equipment, infrastructure, energy, defense, and emerging technology domains. Applied well, SE shortens development time, reduces integration problems, speeds up industrialization, and strengthens competitiveness.

The Netherlands has a strong position in the development of complex systems, and SE underpins it across these sectors. The National Technology Strategy (NTS) (Ministry of Economic Affairs and Climate Policy, 2024) identifies ten priority technologies. All ten are developed within complex systems, which makes SE a cross-domain condition for the success of the strategy.

That condition is not yet met. Systems are becoming more interconnected, software-driven, and multidisciplinary. Complexity is growing faster than the methods available to manage it. SE adoption is uneven: some domains already rely on mature practices, others are still moving from discipline-specific and project-based approaches. Innovation now happens across ecosystems of organizations, which makes coordination, integration, and governance harder. Supply chain fragmentation, dependence on foreign technology, and rising sustainability requirements add to the demand for system-level engineering.

This action agenda responds with three priorities: SE **method innovation**, SE **adoption**, and SE **education and lifelong learning**. For each, it sets out a long-term vision, an assessment of the current state and concrete actions.

The agenda is a framework for investment programs, collaborative initiatives, and implementation road maps. It asks industry, knowledge institutes, government, and professional associations to align their SE initiatives around these three priorities. That is what turns the technological ambitions of the National Technology Strategy into products, systems, industrial capability, and lasting competitiveness.

Intended audience for this action agenda

This action agenda provides a frame of reference for:

- **Governmental and institutional policy makers:** this document shows that strategic investments in Systems Engineering will have a positive impact on competitiveness of Dutch industry.
- **Chief executives and chief technology officers in the high-tech sector:** this document provides insight into how to improve productivity and innovation in an ever more competitive and interconnected world, while strengthening on key challenges such as security, resilience, independence, and sustainability.
- **Lead engineers and Systems Engineering practitioners:** this document provides the insight needed to propose strategic improvements in the company's daily operations that connect with nationwide trends in Systems Engineering. It identifies which skills and competencies need to be developed to achieve that.
- **Academic researchers and tool vendors:** this document sets out the key challenges to address and resolve in the next decade.

Structure of this action agenda

This action agenda is organized into four chapters.

Chapter 1 introduces Systems Engineering as a discipline. It also presents INCOSE Vision 2035 as the key roadmap this agenda builds on. Furthermore, chapter 1 explains its relevance for addressing major societal and technological challenges.

Chapter 2 analyzes the European and Dutch context, including key trends and challenges within the Dutch innovation ecosystem. The chapter also analyzes the role of Systems Engineering in the National Technology Strategy, and the risks of insufficient adoption and innovation.

Chapter 3 translates these challenges into a strategic agenda organized around three complementary themes: Systems Engineering method innovation, Systems Engineering adoption, and Systems Engineering education and lifelong learning.

Chapter 4 presents the action agenda itself. It defines concrete objectives, actions, and roadmaps for each of these three themes, all aimed at strengthening the role of Systems Engineering in the Netherlands.

1. Introduction: Systems Engineering as an enabling discipline

Systems Engineering (SE) is an enabling discipline across Dutch industry and engineering.

The Netherlands holds a strong position in engineering complex systems, which are increasingly software-intensive and cyber-physical. These systems are used in sectors such as high-tech industry, infrastructure, energy, and defense.

Continued development of SE methods and practices remains necessary to keep that industry competitive.

This Holland High Tech (HHT) action agenda addresses needs in SE innovation, adoption, and education. It builds on international sources and adapts them to the Dutch context. It sets out a coordinated course of action for the Dutch SE community, aligns strategies, and sets priorities. It also serves as a reference framework for building, steering, and evaluating innovation and investment proposals. The National Technology Strategy identifies ten priority technologies. SE plays a cross-domain role, because all of these technologies are developed within complex systems. This document connects both perspectives to strengthen their combined impact.

Dutch industry policy (the Dutch technology innovation agenda) aims to strengthen six focus markets (Ministry of Economic Affairs and Climate Policy, 2025): Semiconductors, Machine Building, Defense, Biotechnology, Digital Services, and Innovative Chemistry. The key technologies are mapped onto these markets. This action agenda clarifies why SE is an essential enabler for success in all of them.

1.1. The discipline and its three pillars

Systems Engineering is a discipline that emerged from the space and defense industry. It is now widely practiced in the high-tech equipment sector and in infrastructure development. The International Council on Systems Engineering (INCOSE) defines it as follows (INCOSE, 2025):

Systems Engineering is a transdisciplinary and integrative approach to enable the successful realization, use, and retirement of engineered systems, using systems principles and concepts, and scientific, technological, and management methods.

This definition captures the key aspects of Systems Engineering. It emphasizes a lifecycle perspective, from cradle to grave. It also combines different viewpoints to support convergence across goals.

The Systems Engineering Body of Knowledge (SEBoK, 2026) describes it more intuitively:

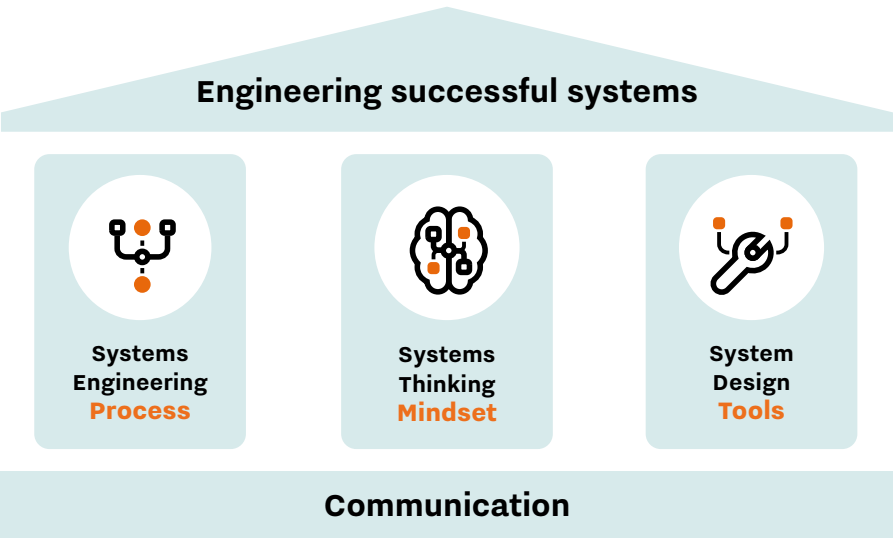
A systems engineer helps ensure the elements of the system fit together to accomplish the objectives of the whole and ultimately satisfy the needs of the customers and other stakeholders who will acquire and use the system.

Systems Engineering differs from other engineering disciplines in its focus on integrating domains into the whole, and on maximizing the value of the delivered system. It starts from stakeholder needs and an initial problem statement, and it gives structure to cross-engineering and socio-technical domains. Rather than the individual parts, SE addresses the development, realization, and lifecycle management of the complete system.

Systems Engineering relies on three pillars:

- An established **process** for developing systems.
- A **toolset** that supports exploring and communicating the system under design.
- Systems Thinking as the connecting element: the **mindset**.

These pillars help organizations deal with system complexity, and they turn multidisciplinary challenges into opportunities. They only work when they stand on a strong **communication** foundation.



1.2. **INCOSE SE Vision 2035**

The **SE Vision 2035** from INCOSE (INCOSE, 2021) outlines a future in which Systems Engineering evolves into the discipline that connects and coordinates stakeholders, engineering disciplines, and organizations through digital engineering and model-based collaboration.

This section **summarizes the SE Vision 2035** and shows how Systems Engineering, as envisioned there, contributes to the goals of the National Technology Strategy.

According to this vision, Systems Engineering by 2035:

- is **Model-Based**. Modeling, simulation, and visualization to specify, analyze, design, and verify systems.
- is driven by **Artificial Intelligence**. Supporting systems engineers in delivering solutions.
- is infused with **Data Science techniques**. Analyzing data and assessing systems.
- is reinforced by **Human Systems integration**. Designing systems that interact with humans.
- is underpinned by **Theoretical Foundations**. Based on science and mathematics.
- is supported by **Education and Training**. Across engineering and management.
- is adopted by a wider range of SMEs. Evolving to manage system complexity, driving **increased Market Value**.

This action agenda takes the INCOSE SE Vision 2035 as its basis. Its long-term goals are not repeated in detail here, but they are considered part of this agenda.

1.3. **SE across sectors**

SE is used across a wide variety of application domains. In all of them, SE aims to enable the successful realization, use, and retirement of engineered systems. The emphasis within SE varies with the nature of the domain, and so do the benefits it delivers. SE must therefore always be considered within its application context.

In the **high-tech sector** (the professional equipment industry), SE integrates precision mechanics, electronics, and software into systems that deliver value to stakeholders. It facilitates multidisciplinary teams, manages complexity, and supports market-driven innovation, which strengthens competitiveness (Acur & Hendriks, 2024).

In the **energy sector**, SE supports the integration of renewables, smart grids, and energy infrastructure, including conversion and storage assets. The market is shifting toward decarbonization, decentralization, and digitalization. It also helps organizations address challenges such as aging infrastructure, regulatory change, grid resilience, and cybersecurity (Hendriks & Marincic, 2025).

In **infrastructure**, SE guides maintenance and upgrades by aligning new solutions with existing systems, which reduces operational risk. It helps organizations manage complexity and cut failure costs in civil engineering projects (Whyte, 2018).

In **security and defense**, trends toward autonomous systems, surveillance, and integrated command platforms require SE to address reliability, adaptability, and interoperability between technologies.

Emerging markets such as **digital health** and **smart cities** need SE to manage technological change and uncertainty. SE also helps them deploy integrated solutions.

Across these domains tailored SE practices are needed to manage complexity, ensure security, and deliver value, particularly in the domains experiencing rapid technological change. This is essential to maintaining the Netherlands' position in high-tech industry, infrastructure, and the energy transition. The country's innovation culture and export-driven economy call for wider adoption and continuous innovation in Systems Engineering. That is what makes it possible to integrate technologies, maintain competitiveness, and address societal and environmental challenges.

2. European and national trends

The global context is changing. Geopolitical tensions, reliance on digital technologies, cybersecurity threats, energy prices, and dependence on materials are forcing Europe and the Netherlands to reassess their technological and industrial foundations.

Europe faces stagnating productivity growth, as highlighted in the Draghi report (Draghi, 2024) and in Dutch national analyses by TNO (TNO, 2025) and the Wennink Report (The Wennink Report, 2025). These reports all call for European action to:

- *Increase engineering productivity and innovation speed*
- *Strengthen autonomy and security*
- *Transition to a circular economy*

These developments converge into one challenge: Europe and the Netherlands must simultaneously improve **engineering productivity** and **innovation speed** to remain competitive, autonomous and secure, and do so with a **sustainability** perspective.

Engineering Productivity. Future systems deliver more functionality and are becoming more software- and data-intensive. They are multidisciplinary, distributed, and incorporate AI, which pushes complexity beyond what can be managed with traditional approaches.

At the same time, there is a shortage of engineers with system-level expertise. Improvements must therefore come from better ways of engineering systems.

Innovation speed. This is no longer determined by individual technologies or isolated teams. It has become a system-level engineering capability: the ability of organizations and ecosystems to collaborate in designing, integrating, operating, and evolving systems. To remain competitive, organizations must shorten time-to-market, speed up technology integration, and enable upgrades without losing control over safety, security, reliability, and lifecycle costs. These challenges reach beyond a single company, so system responsibility becomes a shared concern. This concern calls for governance and business models that can define and manage it.

In both the EU and the Netherlands, **sustainability** is increasingly treated as part of economic resilience. Moving toward a low-carbon system helps keep the European and Dutch economy competitive and secure in the long term. The question is how to address these challenges and reach these goals as quickly as possible and at minimal cost. A system perspective is required, and that is what Systems Engineering provides.



2.1. **Five challenges in the unique Dutch ecosystem**

The National Technology Strategy requires Systems Engineering to be applied more broadly than before. However, SE in the Netherlands faces a set of challenges rooted in the Dutch way of working and governing.

1. The “Polder-Complexity” (stakeholder management)

Dutch innovation operates through the Triple Helix model, in which government, academia, and industry interact to drive development. Stakeholders are managed through collaboration: knowledge institutions do the research, industry commercializes the technology, and government offers regulatory and financial support.

Challenge: In the Dutch “polder” model, consensus must be reached continuously between equal partners with conflicting interests. Think of the academic drive to publish versus time-to-market and the protection of intellectual property.

Consequence: System development is delayed by misalignment and administrative overhead, which stretches time-to-market.

Systems Engineering can act as a common language across stakeholders. It helps government, industry, and academia align objectives, coordinate innovation, and make informed trade-offs while maintaining ecosystem coherence across organizational boundaries.

2. Scarcity of system architects (human capital)

The Netherlands has a large pool of specialists, but few professionals who combine that depth with a broad command of SE.

Challenge: In many fields, scientists must become systems thinkers. PhD programs train people to optimize components, whereas System Architects make trade-offs to maximize value at system level. That requires broader knowledge and a different skill set.

Consequence: Innovative projects stall in the lab phase and never reach scale.

Systems Engineering can act as a capability multiplier. It helps organizations develop system-level competencies and grow specialists into T-shaped professionals who can take on system architecting roles.

3. Integrating legacy systems with deep tech

The Netherlands has a large base of infrastructure, such as power grids, waterways, and IT systems.

Challenge: New technologies such as Energy Materials or AI & Data must be integrated into existing systems.

Consequence: Brownfield engineering adds complexity and can lead to performance problems or delays.

Systems Engineering can act as an integration enabler. Through architecture and lifecycle engineering, it helps organizations introduce new technologies into existing systems while maintaining continuity, reliability, and operational performance.

4. Fragmentation of the SME landscape

Dutch industrial strength lies in a dense network of highly specialized Small and Medium-sized Enterprises (SMEs).

Challenge: SMEs supply components but often lack the resources to adopt the methods and tools their larger partners use. System integrators are then left to combine a patchwork of solutions.

Consequence: A digital divide opens up between Original Equipment Manufacturers (OEMs) and their suppliers, creating gaps in expertise and digital models, and holding back improvements in engineering and procurement.

Systems Engineering can act as a collaboration framework. Common architectures, interfaces, and engineering practices enable effective cooperation across supply chains and allow SMEs to participate more effectively in larger innovation ecosystems.

5. Sovereignty versus open innovation

The NTS aims at strategic technological independence, yet the Dutch industry ecosystem is rooted in openness and international supply chains.

Challenge: How do you design a “sovereign” system while being dependent on the global market for components and tools, such as US-based software, cloud, and AI solutions?

Consequence: SE must now treat resilience to geopolitical risk as a “system requirement”. This has never been on an engineer’s agenda before.

Systems Engineering can act as a strategic gatekeeper. Modular design lets the Netherlands and Europe draw on global innovation, while keeping sovereign control over the architecture of critical systems and their cybersecurity.

2.2. **Future SE needs in the National Technology Strategy**

This section summarizes the role of Systems Engineering across the ten technology domains of the NTS. As technologies grow more complex and systems more interconnected, innovation is shifting from developing individual technologies and prototypes toward realizing integrated systems, value chains, and ecosystems. That shift raises the need for lifecycle-oriented engineering, system integration, interoperability, verification and validation, and coordination between organizations. SE therefore moves from a supporting discipline to a central enabler of the NTS objectives.

The maturity and application of SE differ per technology domain, which creates specific gaps that must be closed before the full economic and societal impact can be realized. Table 1 sets out, for each NTS technology, the desired future state and the main Systems Engineering gap, as aligned with the respective NTS technology teams. Appendix A describes the role, relevance, and current application of Systems Engineering in each domain in detail.



Table 1. Future state and Systems Engineering gap per NTS technology domain.

NTS Technology	Future state	Main SE gap
Semiconductor Technologies	Semiconductor innovation enabled by multidisciplinary co-design, model-based engineering and digital twins across chips, packages, equipment, manufacturing, testing and applications, with compliance-by-design and industrialization.	Building and maintaining system-level coherence across semiconductor design, packaging, equipment, manufacturing, testing and applications, while meeting growing performance, energy-efficiency, sustainability, cybersecurity and regulatory requirements.
Quantum Technologies	Deployable quantum technologies and manufacturing platforms enabled by aligned architectures, lifecycle engineering and supply chains that deliver fit-for-purpose, reliable, and manufacturable components.	Moving from experiment-driven development toward industrial-scale SE, supported by improved capabilities and stronger alignment of architecture, manufacturing, quality and supply chains around fit-for-purpose components.
Optical Systems & Integrated Photonics (OSIP)	Scalable OSIP applications through coordinated integration and transition from prototypes to production across technologies, organizations, and value chains.	Moving from implicit project-level SE toward coordinated architecture, integration, validation and standardization that supports scaling across the OSIP ecosystem.
AI & Data	Trustworthy socio-technical systems in which data, AI models, agents, infrastructure, domain knowledge and human decision-making function as a coherent, governable and understandable whole.	Establishing architectural and lifecycle foundations for integrating, validating and governing trustworthy AI-enabled socio-technical systems, ensuring traceability, accountability, and human oversight.
Cybersecurity Technologies	Secure-by-design as an AI-assisted, system-wide engineering approach that integrates specialist cybersecurity and embeds cybersecurity, resilience and trustworthiness across lifecycles and value chains.	Integrating cybersecurity into Systems Engineering and advancing secure-by-design, system-level assurance, and governance across distributed systems and supply chains while addressing rapidly evolving AI-enabled threats.
Mechatronics & Optomechatronics	A model-centric and increasingly automated way of engineering complex high-tech systems, including robotics (physical AI), through multidisciplinary co-design and integrated verification and validation.	Improving control over growing system complexity and an expanding landscape of engineering models through model interoperability, co-simulation, supervisory control and a model-centric way of working.
Imaging Technologies	Domain-specific image-to-action ecosystems integrating sensing, image formation, AI-enabled interpretation and decision support, with cross-fertilization across application domains.	Enabling domain-specific imaging platforms to become interoperable through systems-of-Systems Engineering, ecosystem collaboration and trusted AI-supported workflows.
Process Technology	Scalable and economically viable circular industrial systems integrating processes, infrastructure, energy, water, digital twins and supply networks across the lifecycle.	Moving from individual process optimization toward widespread adoption of Systems Engineering for circular value chains, industrial clusters and resource networks as an integrated whole.
Energy Materials	Integrated battery and electrolysis value chain engineering linking requirements, architectures, materials and production, while balancing performance, sustainability and scalability.	Transferring lifecycle, requirements and model-based engineering practices across a fragmented battery and electrolysis ecosystem, while enabling verification and trusted model sharing across value chains.
Biomolecular & Cell Technologies	Predictable, scalable and reproducible engineering of biological products and processes through model-based design, automation and AI-supported workflows.	Transitioning from predominantly experiment-driven development toward model-based, automated and AI-supported engineering workflows with predictable, scalable and reproducible outcomes.

Table 1 shows that the future ambitions of the NTS depend on closing gaps in Systems Engineering capabilities (Appendix A gives the full details). The desired future states differ per domain, but **every NTS domain needs advances in Systems Engineering practices, methods, and adoption**. Closing those gaps is therefore a condition for realizing the economic and societal impact of the strategy.

The next section examines the risks of insufficient application, adoption, and evolution of Systems Engineering in the NTS domains. What is at stake if we fail to close these gaps?

2.3. **The risks of not applying SE**

Systems Engineering underpins the NTS. So what happens if it is not applied or scaled, or if innovation in SE methods slows down? In that case, the NTS risks becoming a set of isolated initiatives without measurable societal or economic impact. The consequences fall into four failure factors.

1. The “complexity wall” and project failure

Without advances in Systems Engineering, the scale and interconnectedness of modern systems may outgrow our ability to engineer them. E.g. extreme ultraviolet (EUV) lithography machines, quantum networks, and energy grids involve billions to trillions of interactions. Traditional engineering approaches can no longer manage that.

- **Consequence:** Systems behave unpredictably or fail outright during integration. Errors surface only in the final testing phase, such projects in e.g. the semiconductor and photonics sectors can face major cost overruns and years of delay.
- **Impact:** The Netherlands loses its reputation as a reliable supplier of high-tech systems.

2. Fragmented innovation (siloeing)

The NTS depends on cross-pollination between technologies, such as AI combined with imaging. Without the shared language of SE, these domains stay stuck in their own silos.

- **Consequence:** Technological islands emerge. We may develop the world’s best AI algorithms and its best sensors, yet fail to combine them into a working medical robot or an autonomous energy system.
- **Impact:** The Netherlands cannot offer integrated solutions for societal challenges such as the energy transition or affordable healthcare

3. Loss of strategic autonomy

A core pillar of the NTS is reducing dependence on superpowers such as China and the US.

- **Consequence:** If we do not stay master of system architecture, we depend on foreign platforms and standards to make our own components work. We become part suppliers instead of system builders and OEMs.
- **Impact:** The Netherlands loses influence over critical technologies, systems, and infrastructure. That makes the country more vulnerable to external technological, economic, and geopolitical developments.

4. Inability to achieve circularity and sustainability

Sustainability is an essential property of every system, now and in the future. It must therefore be designed in from the very first design phase.

- **Consequence:** Without SE methods that cover the full life cycle (life-cycle engineering), we keep designing products that cannot be recycled. For Process Technology and Energy Materials, that means we will not meet the 2050 climate goals.
- **Impact:** Industry loses its license to operate in a world that demands strict circularity.

Without further innovation in Systems Engineering, our national technology programs may become a collection of black boxes: we understand the parts, but no one grasps or controls the whole. Table 2 summarizes that impact.

Table 2. Potential consequences if Systems Engineering capabilities do not keep pace with the evolving NTS needs.

SE not keeping pace	Potential consequence for the NTS
Time-to-market	Delayed by recurring integration issues and late discovery of design errors.
Costs	Explosive increases due to inefficient interfaces and redesigns.
Reliability	Decline; systems become vulnerable to unforeseen scenarios.
Competitiveness	Overtaken by nations that do invest in Systems Engineering.
Sustainability	Losing license to operate by failing to comply with regulations.

In short: Systems Engineering is the **architecture of success**. Without this foundation, the ambitious structure of the National Technology Strategy may collapse under the weight of its own complexity.

3. Strengthening Systems Engineering in the Netherlands

The analysis in Chapter 2 shows that current Systems Engineering capabilities are not yet sufficient to meet future demands for scale, innovation speed, resilience, and lifecycle management.

At the same time, Systems Engineering itself is evolving. Advances in Model-Based Systems Engineering (MBSE), digital engineering, simulation, artificial intelligence, digital twins, automation, and data-driven engineering open up new ways to raise engineering productivity and innovation speed. Realizing opportunities takes more than technological innovation. New methods must be developed, adopted throughout organizations and sectors, and supported by a workforce with the right skills and competencies.

To strengthen Systems Engineering for the Netherlands, this chapter focuses on three complementary themes:



SE method innovation

Strengthening the methods, tools, systems thinking capabilities, and practices needed to engineer ever more complex, digital, and interconnected systems.



SE adoption

Widening the effective application of Systems Engineering within organizations, in all technology sectors.



SE education and lifelong learning

Developing the talent, competencies, and lifelong learning capabilities required to build and sustain the future Systems Engineering workforce.

Together, these three themes translate the challenges identified in the National Technology Strategy into a coordinated portfolio of method innovation, adoption, and education initiatives.

Each section follows the same structure: it opens with a long-term vision of the desired future state, then assesses the current state and the trends that make change urgent. On that basis, each section defines a set of main goals with the future states that go with them.

3.1. SE method innovation

Long term vision

The Netherlands will have a new generation of Systems Engineering methods that can master the growing complexity of software-intensive, multidisciplinary, and system-of-systems challenges. Systems Engineering will be fully digital, model-driven, and supported by data analytics, simulation, and artificial intelligence. Engineers will be able to predict the consequences of design decisions early in the lifecycle, explore alternatives quickly, and make informed trade-offs between technical, economic, societal, and sustainability objectives. The focus will shift from managing documentation to enabling innovation, resilience, sustainability, and strategic autonomy throughout interconnected ecosystems.

Current state and need for change

Systems Engineering has evolved considerably over recent decades. It is now widely applied in sectors such as high-tech systems, infrastructure, defense, and energy. Methods including MBSE, simulation, digital twins, and lifecycle engineering have improved engineering effectiveness and system quality. Engineering data, however, is still fragmented between disciplines and organizations. Model-based approaches are applied inconsistently and the ability to predict lifecycle outcomes and system behavior early in development remains limited.

Chapter 2 and the Systems Engineering gaps identified per NTS technology domain in Table 1 show the same picture. The Netherlands is under growing pressure to improve engineering productivity, innovation speed, strategic autonomy, and sustainability, while innovation now takes place in interconnected systems, supply chains, and ecosystems. Future systems are becoming more software-intensive, data-driven, autonomous, and continuously evolving. This creates challenges beyond the reach of many existing Systems Engineering approaches.

The INCOSE SE Vision 2035 (INCOSE, 2021) identifies model-based engineering, data-driven engineering, artificial intelligence, digitalization, and human-system integration as the main directions for the future of the discipline. Seizing these opportunities calls for continued innovation in Systems Engineering methods. Methods that support ecosystem collaboration, digital engineering, lifecycle decision-making, and the development of trustworthy, sustainable, and sovereign systems. Without such advances, Systems Engineering itself risks becoming the limiting factor in building future systems and innovation ecosystems.

Goals for Systems Engineering method innovation

Based on the long-term vision and the need for change set out above, this section defines six goals for Systems Engineering method innovation in the Netherlands. Together they address the main challenges in the National Technology Strategy. These are complexity, improving engineering productivity, strengthening collaboration between ecosystems, delivering trustworthy and sovereign systems, engineering AI-enabled systems, and meeting emerging challenges such as sustainability.

The six goals are introduced below and elaborated into a concrete action agenda in Chapter 4.

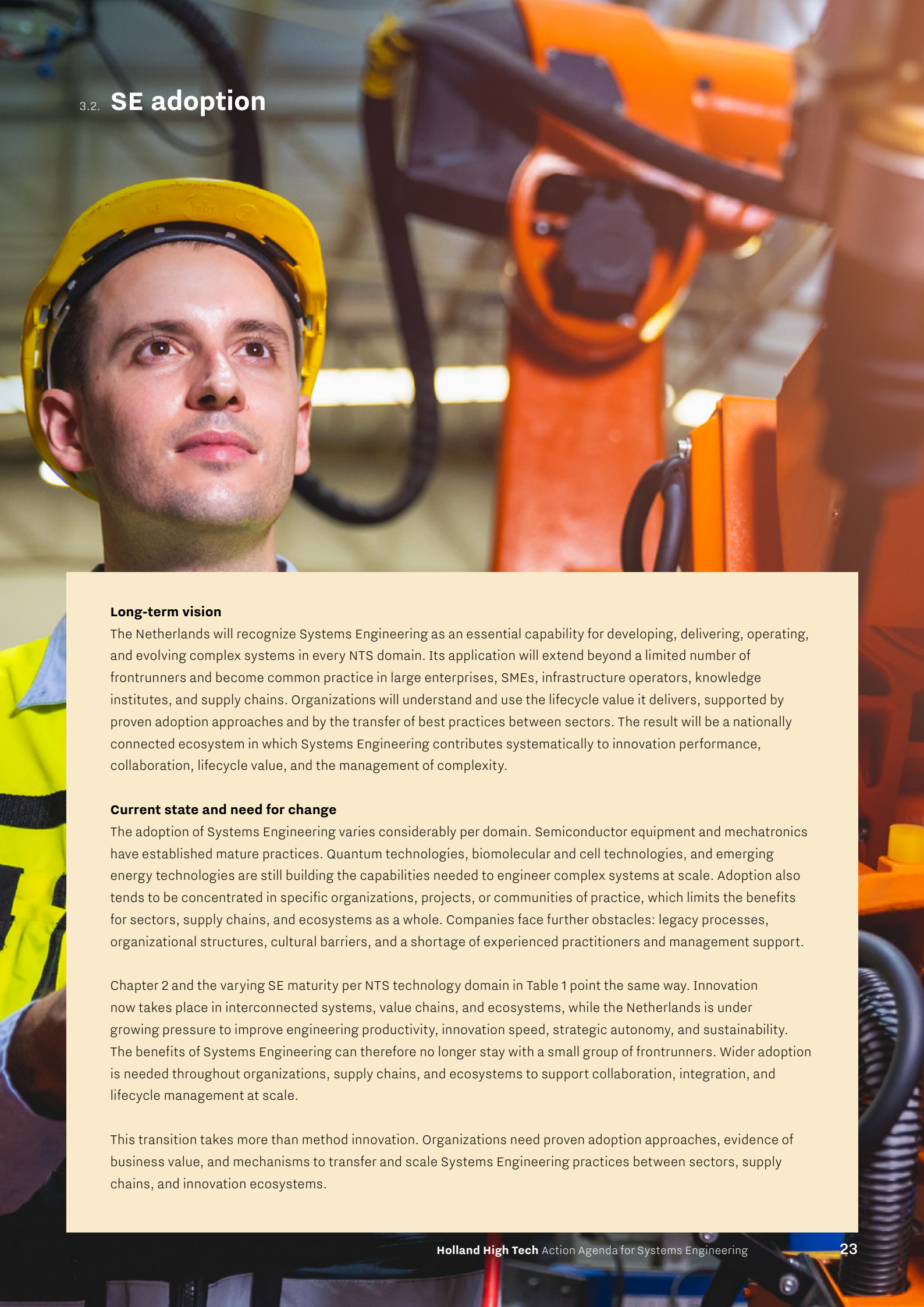
Table 3. Six goals for Systems Engineering method innovation

	Main goal	Future state
Managing complexity Improving Systems Engineering methods for ever more complex technical, organizational, and societal systems.	Strengthen Systems Engineering methods to effectively manage the increasing technical, organizational, and societal complexity of future systems.	• Systems Engineering methods integrate technical, organizational, cultural, and human aspects of complex socio-technical systems. • Data-driven Systems Engineering supports quantitative decision-making throughout the engineering lifecycle. • Early prediction of system qualities, business value, lifecycle outcomes, and societal impact supports informed decision-making and trade-off analysis. • System-of-Systems engineering methods support the understanding and management of autonomy, interaction, and emergent behavior across ecosystems. • Systems Engineering methods enable the design of scalable, evolvable, adaptable, and future-proof systems. • Systems Engineering methods support the transition from experimental, prototype, and research-oriented systems to scalable, operable, and maintainable systems deployed in real-world environments.
Digital engineering and productivity Accelerating engineering through digital engineering, automation, and artificial intelligence.	Strengthen Systems Engineering through digital engineering, automation, and artificial intelligence to improve engineering productivity and innovation speed.	• Model-Based Systems Engineering forms the foundation of engineering practice throughout the lifecycle. • Connected digital models support a shared engineering environment across disciplines and organizations. • Digital Engineering environments support integrated design and trade-off analysis across multiple engineering domains, including mechanical, electrical, software, optical, and data-driven systems. • Automated testing, verification, validation, and virtual engineering environments significantly reduce development and validation cycles. • AI assistants (SE4AI) support systems engineers in design-space exploration, trade-off analysis, diagnostics, root-cause analysis, and decision support. • Human-AI teaming becomes a standard engineering practice, enabling engineers to focus more on innovation, creativity, and architecting.
Ecosystems and supply chains Enabling effective collaboration, interoperability, and lifecycle management across organizations and value chains.	Strengthen Systems Engineering capabilities that enable effective collaboration, coordination, and lifecycle management across organizations, supply chains, and innovation ecosystems	• Harmonized engineering practices, standards, and frameworks enable effective collaboration between organizations. • Shared digital engineering environments based on open standards enable interoperability across disciplines, organizations, and sectors. • Cross-disciplinary collaboration and communication are seamlessly integrated into engineering processes. • Systems Engineering methods support co-development, co-ownership, and lifecycle management across supply chains and ecosystems. • Systems Engineering methods support the efficient development, evolution, and validation of platforms and product families across extended supply chains. • Lifecycle thinking is embedded throughout value chains, balancing performance, resilience, sustainability, and cost across all lifecycle phases.

	Main goal	Future state
Trustworthy, resilient, and sovereign systems Embedding security, trustworthiness, resilience, and strategic autonomy into engineering practices.	Strengthen Systems Engineering methods that keep systems secure, resilient, trustworthy, and under control in increasingly uncertain and interconnected environments .	- Trustworthiness, safety, security, resilience, and cyber-resilience are systematically integrated into Systems Engineering practices. - Advanced model-based verification, validation, testing, and assurance methods support increasingly complex and adaptive systems. - Systems Engineering methods support assurance and allocation decisions across distributed edge, cloud, and cyber-physical environments. - Methods for diagnostics, prognostics, and operational learning continuously improve system performance and reliability. - Systems are designed for graceful degradation, adaptive reconfiguration, and predictable recovery under disruption. - Systems Engineering enables strategic autonomy by supporting robust engineering across critical technologies, infrastructures, and supply chains.
AI-enabled systems Extending Systems Engineering methods for the engineering, assurance, and governance of AI-enabled systems.	Strengthen Systems Engineering methods that enable the development, deployment, operation, and evolution of AI-enabled systems under appropriate levels of assurance, governance, and human oversight.	- Systems Engineering provides methods to design, verify, qualify, and govern AI-enabled systems and federated data ecosystems throughout their lifecycle. - Adaptive and learning systems can be validated, monitored, and controlled throughout their operational lifecycle. - Human-centered engineering approaches ensure transparency, accountability, traceability, and appropriate human oversight. - Assurance frameworks, stress-testing methods, and governance mechanisms support safe deployment of AI in mission- and safety-critical systems.
Sustainability and emerging challenges Extending Systems Engineering methods to address sustainability, circularity, and future technological and societal challenges.	Strengthen Systems Engineering methods that support sustainability, circularity, and other emerging technological and societal challenges throughout the system lifecycle .	Future state for sustainability: - Sustainability and circularity are treated as first-class system qualities throughout the lifecycle. - Lifecycle engineering methods support circular value chains, resource efficiency, and long-term societal value creation. Future state for emerging challenges: - Systems Engineering provides mechanisms to systematically incorporate new technological, societal, regulatory, and geopolitical challenges into engineering processes and decision-making. - Systems Engineering acts as an adaptable engineering framework capable of accommodating future technologies, uncertainties, and societal priorities that cannot yet be fully anticipated.

The goals in this section aim to establish a new generation of Systems Engineering methods that can handle the complexity, scale, and pace of future technological and societal change. By advancing methods for complexity management, digital engineering, and ecosystem collaboration, the Netherlands can strengthen its engineering productivity, innovation capability, and strategic autonomy. The same holds for methods for trustworthy systems, sustainability, circularity, AI-enabled systems, and other emerging challenges. Together they form the methodological foundation for broader SE adoption and for developing future SE talent. That, in turn, feeds the long-term competitiveness, resilience, and prosperity of the Dutch innovation ecosystem.

3.2. SE adoption



Long-term vision

The Netherlands will recognize Systems Engineering as an essential capability for developing, delivering, operating, and evolving complex systems in every NTS domain. Its application will extend beyond a limited number of frontrunners and become common practice in large enterprises, SMEs, infrastructure operators, knowledge institutes, and supply chains. Organizations will understand and use the lifecycle value it delivers, supported by proven adoption approaches and by the transfer of best practices between sectors. The result will be a nationally connected ecosystem in which Systems Engineering contributes systematically to innovation performance, collaboration, lifecycle value, and the management of complexity.

Current state and need for change

The adoption of Systems Engineering varies considerably per domain. Semiconductor equipment and mechatronics have established mature practices. Quantum technologies, biomolecular and cell technologies, and emerging energy technologies are still building the capabilities needed to engineer complex systems at scale. Adoption also tends to be concentrated in specific organizations, projects, or communities of practice, which limits the benefits for sectors, supply chains, and ecosystems as a whole. Companies face further obstacles: legacy processes, organizational structures, cultural barriers, and a shortage of experienced practitioners and management support.

Chapter 2 and the varying SE maturity per NTS technology domain in Table 1 point the same way. Innovation now takes place in interconnected systems, value chains, and ecosystems, while the Netherlands is under growing pressure to improve engineering productivity, innovation speed, strategic autonomy, and sustainability. The benefits of Systems Engineering can therefore no longer stay with a small group of frontrunners. Wider adoption is needed throughout organizations, supply chains, and ecosystems to support collaboration, integration, and lifecycle management at scale.

This transition takes more than method innovation. Organizations need proven adoption approaches, evidence of business value, and mechanisms to transfer and scale Systems Engineering practices between sectors, supply chains, and innovation ecosystems.

Goals for Systems Engineering adoption

Based on the long-term vision and the need for change set out above, this section defines three goals for strengthening Systems Engineering adoption in the Netherlands. Together they address the main challenges: introducing SE into organizations, demonstrating its value through evidence, and scaling SE practices as organizations, supply chains, and ecosystems grow. The three goals are introduced below and elaborated into a concrete action agenda in Chapter 4.

Table 4. Three goals for Systems Engineering adoption

	Main goal	Future state
Introducing SE into Existing Organizations Accelerating the adoption and institutionalization of Systems Engineering across organizations and sectors.	Strengthen the ability of organizations across all NTS domains to adopt, institutionalize, and scale Systems Engineering as an integral part of their way of working.	• Proven methods exist to accelerate the integration of Systems Engineering into organizations and supply chains facing obstacles such as legacy structures, established cultures, or conflicting incentives. • Successful Systems Engineering approaches are systematically transferred between organizations and NTS sectors through communities of practice and “pockets of excellence.” • Employees actively recognize and request the use of Systems Engineering, while organizations provide management commitment, governance, and enabling conditions to support adoption. • Systems Engineering practices are widely adopted by SMEs (MKB), supported by accessible tools, shared infrastructures, training, and scalable implementation approaches. • Systems Engineering is recognized as a normal and expected part of engineering practice across the Dutch innovation ecosystem.
Evidence-Based SE adoption Strengthening the evidence base for Systems Engineering through measurable business, engineering, and societal outcomes.	Strengthen the understanding and demonstration of the value of Systems Engineering through evidence, measurable impact, and proven business benefits.	• Systems Engineering is recognized across industries and NTS domains as an essential capability for managing complexity and improving lifecycle outcomes. • The impact of Systems Engineering is quantified and demonstrated through measurable improvements in system performance, organizational capabilities, and ecosystem effectiveness. • Shared benchmarks, assessment approaches, and maturity models enable organizations to understand and improve their Systems Engineering capabilities. • Evidence-based business cases support investment decisions and provide organizations with the means to justify and accelerate adoption. • Sectors with high Systems Engineering maturity serve as sources of best practices and lessons learned for sectors where adoption has historically been lower.
SE for Growing Organizations Enabling Systems Engineering practices to scale with organizational growth, ecosystem development, and increasing system complexity.	Strengthen Systems Engineering practices to support organizational growth, ecosystem development, and increasing system and supply-chain complexity	• Organizations understand how Systems Engineering practices evolve during organizational growth and scale-up. • Systems Engineering practices support sustainable growth, increasing organizational maturity, and the management of larger and more complex development ecosystems. • Organizations can tailor Systems Engineering practices to their context while maintaining alignment with common principles and standards. • Cross-sector collaboration continuously drives the evolution and adoption of Systems Engineering practices. • Open standards, reference practices, and shared frameworks are adopted where possible, while allowing domain-specific tailoring where needed. • Systems Engineering contributes to the effective coordination of complex ecosystems spanning multiple organizations, supply chains, and technology domains.

The ambitions in this section aim to make Systems Engineering a broadly used capability throughout the Dutch innovation ecosystem. That means widening its use in sectors and supply chains, accelerating organizational change, and demonstrating its value through evidence and shared experience. Together these strengthen the Dutch ability to develop and operate ever more complex systems. Broad adoption is also what turns method innovation and education into results. It lets organizations and ecosystems reach higher innovation performance, greater resilience, and sustainable long-term competitiveness in every NTS domain.

3.3. SE education and lifelong learning

Long-term vision

The Netherlands will embed Systems Engineering in a lifelong learning pathway that starts in early education and continues throughout professional careers. Systems Thinking will be a widely developed competency throughout society, while future Systems Engineers and Systems Architects will reach professional proficiency earlier than is possible today. Educational institutions, industry, and professional training providers will collaborate in a flexible ecosystem for learning, upskilling, and continuous development. As a result, the Netherlands will have a larger, more capable, and more diverse Systems Engineering workforce, equipped for the technological and societal transitions ahead.

Current state and need for change

Engineering complex systems is fundamentally a team effort. Systems are developed across organizational and disciplinary boundaries, and more and more often across ecosystem boundaries too. Systems Engineering competencies are therefore needed not only by Systems Engineers and Systems Architects, but also by a wider community of engineers, managers, specialists, and stakeholders. Dedicated Systems Engineering roles continue to play the central integrating function in complex development efforts (Sheard & Pickard, 2025).

Today, advanced Systems Engineering expertise is concentrated in a small group of professionals and is mostly acquired through years of practice rather than formal education (Stoewer & D. Nichols, 2022). Some sectors introduce dedicated Systems Engineering roles early, but many organizations still rely heavily on learning on the job.

Chapter 2 and the Systems Engineering capabilities required per NTS technology domain in Table 1 lead to the same conclusion. Realizing future NTS ambitions depends on a larger Systems Engineering workforce covering a wider range of roles. Growing system complexity, software-intensive systems, ecosystem collaboration, digitalization, artificial intelligence, and rising demands for sustainability, security, and strategic autonomy all add to that need. At the same time, the current way of developing Systems Engineering expertise is becoming a constraint: it cannot scale at the pace technological and societal change demands.

Strengthening Systems Engineering education therefore means both expanding the talent base and accelerating competence development. Education must also evolve from a one-off activity into a lifelong learning pathway. That pathway keeps pace with emerging technologies, engineering practices, and societal challenges, in line with initiatives such as the Dutch Approach to Systems Engineering (DASE), (NXTGEN Hightech, 2025).

Goals for Systems Engineering education and lifelong learning

This section defines three goals for strengthening Systems Engineering education in the Netherlands. They follow from the long-term vision, the current state of that education, and the trends and needs for change set out above. Together they address the need to expand the talent base, accelerate competence development, and enable continuous learning as technology and society change.

The three goals are introduced below and elaborated into a concrete action agenda in Chapter 4.

Table 5. Three goals for Systems Engineering education and lifelong learning

	Main goal	Future state
Expanding the Systems Engineering Talent Base Increasing Systems Thinking and Systems Engineering competencies across education, industry, management, and society.	Strengthen the availability of Systems Engineering talent by expanding Systems Thinking and Systems Engineering competencies across education, industry, management, and society	• Systems Thinking starts in primary education and is reinforced throughout secondary and vocational education. • Systems Engineering is embedded in higher education, including universities and universities of applied sciences, across multiple disciplines. • Systems Thinking extends beyond engineering, becoming part of management, policy, and leadership education. • SE is fully embedded across all educational levels, supported by innovative teaching methods and learning technologies. • The overall SE workforce grows substantially, supported by broader participation across sectors and disciplines.
Accelerating Systems Engineering Competence Development Reducing the time required to develop Systems Engineering expertise and enabling professionals to assume SE roles earlier in their careers.	Strengthen the development of Systems Engineering expertise by reducing the time required for professionals to reach proficiency and by accelerating experience building throughout their careers.	• SE education is structured as a lifelong learning pathway that develops Systems Engineering capabilities throughout a career. • Systems Engineers combine strong technical foundations with transdisciplinary communication and collaboration skills. • Experience building is accelerated, enabling talented professionals to take Systems Engineering and Systems Architecting roles earlier in their careers. • Time-to-proficiency is reduced, allowing more professionals to reach Systems Engineering mastery significantly earlier than today. • SE professionals are prepared for specialized roles in large-scale and complex projects, in sectors such as high-tech, defense, infrastructure, and the energy transition.
Continuous Learning for Digital and Societal Transitions Ensuring that Systems Engineering professionals can adapt to new technologies, engineering practices, and societal challenges.	Strengthen lifelong learning capabilities to ensure Systems Engineering professionals can continuously adapt to technological innovation, societal transitions, and evolving engineering practices.	• Educational programs can continuously adapt to developments in AI, digital engineering, sustainability, resilience, and socio-technical systems. • Innovation in SE education is achieved through structured cooperation between educational institutions, industry, and professional training providers. • Professional training and upskilling are widely available, including online learning, classroom training, coaching, mentoring, and experiential learning. • SE education equips professionals with the competencies needed to engineer and govern systems undergoing digital, societal, and sustainability transitions, including the ability to manage uncertainty, complexity, and long-term system evolution. • The DASE vision (NXTGEN Hightech, 2025) of a national lifelong learning ecosystem for Systems Engineering is realized, enabling continuous development across all career stages.

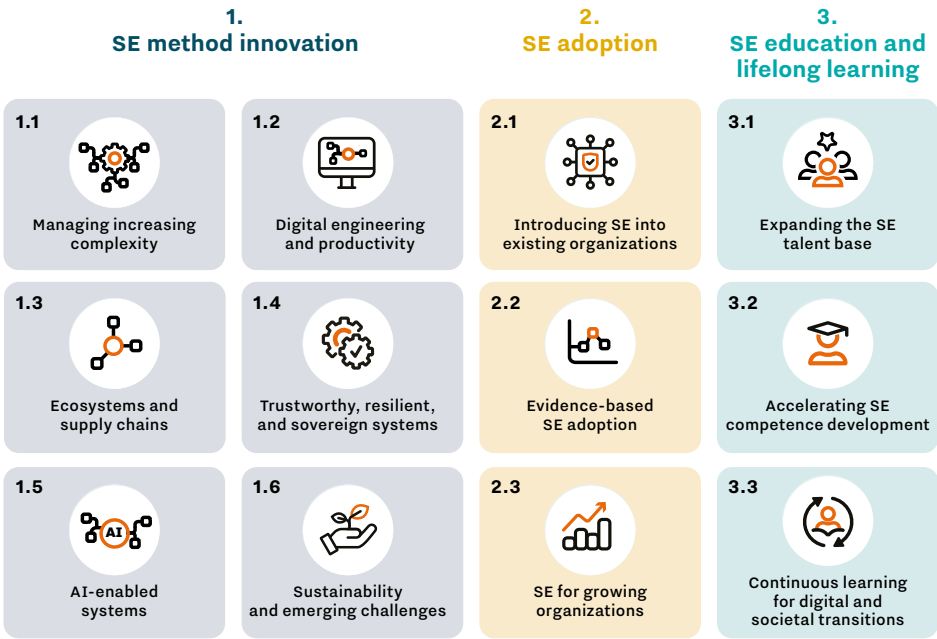
The ambitions in this section together aim to establish a strong and sustainable Systems Engineering learning ecosystem for the Netherlands. That means broadening participation in Systems Thinking and shortening the time needed to develop Systems Engineering expertise. It also means creating mechanisms for continuous professional development, so the country is better equipped for the challenges ahead. These educational ambitions underpin both the innovation of Systems Engineering methods and their adoption in the NTS domains. That is what delivers long-term competitiveness, resilience, and technological leadership.

4.Action agenda

The action agenda is intended as a framework for future investment programs, collaborative initiatives, and implementation roadmaps. It identifies priorities where coordinated action by industry, academia, government, and professional organizations can accelerate the impact of Systems Engineering in the Netherlands.

The action agenda is structured along three complementary themes: **Systems Engineering method innovation, Systems Engineering adoption, and Systems Engineering education and lifelong learning.** The following sections detail the action agenda for each theme.

Action agenda framework



4.1. SE method innovation

Long-term vision

The Netherlands has a new generation of Systems Engineering methods, able to engineer ever more complex, digital, sustainable, resilient, and interconnected systems in every NTS domain.

Table 6. Implementation action agenda SE method innovation

Area	Main goal	Current state	Action Agenda			Concrete actions
			Short term	Medium term	Long term	
1.1 Managing increasing complexity 	Strengthen Systems Engineering methods to effectively manage the increasing technical, organizational, and societal complexity of future systems.	Current Systems Engineering methods provide insufficient support for managing ecosystem-scale complexity, socio-technical interactions, and adaptive systems.	Research socio-technical systems engineering, complexity modeling, lifecycle modeling, and predictive engineering approaches.	Develop and validate methods for quantitative decision-making, trade-off analysis, early prediction, and System-of-Systems Engineering.	Establish mature methods and theoretical foundations for engineering adaptive, ecosystem-scale, and socio-technical systems.	a. Develop complexity modeling approaches. b. Develop methods for early prediction of lifecycle impact. c. Develop methods for socio-technical engineering. d. Establish cross-domain validation pilots. e. Develop System-of-Systems modeling frameworks. f. Develop data-driven decision-support methods. g. Develop model-based trade-off analysis methods. h. Develop architecting methods for scalable systems. i. Develop methods that support industrialization, scale-up, and the transition from prototype to operation.
1.2 Digital engineering and productivity 	Strengthen Systems Engineering through digital engineering, automation, and artificial intelligence to improve engineering productivity and innovation speed.	Digital engineering capabilities exist but remain fragmented across disciplines, tools, and organizations.	Advance MBSE, digital twins, simulation-based engineering, digital threads, and AI4SE concepts and demonstrators.	Develop integrated digital engineering methods linking models, simulation, verification, operational data, and AI support.	Establish state-of-the-art digital engineering and AI-supported Systems Engineering methods spanning the full system lifecycle.	a. Define functional requirements for next-generation digital engineering environments. b. Identify priority tooling developments for MBSE, Digital Engineering and AI4SE. c. Build digital engineering demonstrators and reference implementations. d. Develop model-driven design-space exploration methods. e. Establish cross-domain pilot environments. f. Define interoperability requirements between engineering tools. g. Develop reference architectures for digital engineering environments. h. Build integrated digital engineering environments that support lifecycle collaboration. i. Develop highly automated verification and validation approaches. j. Develop human-AI engineering workflows.
1.3 Ecosystems and supply chains 	Strengthen Systems Engineering capabilities that enable effective collaboration, coordination, and lifecycle management across organizations, supply chains, and innovation ecosystems.	Most Systems Engineering methods remain focused on individual organizations and provide limited support for engineering across supply chains and ecosystems.	Develop methods for ecosystem and supply chain engineering, interoperability, lifecycle coordination, and cross-organizational collaboration.	Validate approaches for platform engineering, product family engineering, co-development, and ecosystem lifecycle management.	Establish mature methods, frameworks, and reference architectures for engineering across complex supply chains and ecosystems.	a. Develop common engineering standards. b. Develop reference models for co-development and supplier integration. c. Develop collaboration and communication frameworks for multi-stakeholder engineering. d. Build shared engineering environments. e. Develop platform engineering reference practices. f. Develop interoperability frameworks. g. Develop lifecycle governance approaches for ecosystems. h. Develop methods for controlled sharing of engineering information across organizational boundaries. i. Develop approaches for verification, validation, and assurance across organizational boundaries and value chains. j. Pilot ecosystem engineering approaches across sectors.
1.4 Trustworthy, resilient, and sovereign systems 	Strengthen Systems Engineering methods that ensure systems remain secure, resilient, trustworthy, and under control in increasingly uncertain and interconnected environments.	Current methods focus largely on prevention, safety, and security, with limited support for resilience engineering, adaptive recovery, and sovereignty concerns.	Research methods for cyber resilience, diagnostics, prognostics, operational learning, and assurance engineering.	Develop and validate methods for adaptive recovery, cyber-physical assurance, edge-cloud assurance, and resilience-driven engineering.	Establish comprehensive Systems Engineering frameworks for trustworthy, resilient, and sovereign systems and infrastructures.	a. Develop resilience engineering methods. b. Integrate secure-by-design fully into model-based design methods. c. Develop model-based assurance techniques. d. Develop diagnostics and prognostics methods. e. Develop cyber-physical resilience frameworks. f. Develop sovereignty assessment frameworks. g. Develop graceful degradation and recovery methods. h. Develop continuous operational learning approaches. i. Develop edge-cloud assurance approaches.
1.5 AI-enabled systems 	Strengthen Systems Engineering methods for the engineering, assurance, governance, and lifecycle management of AI-enabled systems.	Current Systems Engineering methods provide limited support for architecting, validating, assuring, and governing adaptive AI-enabled systems and federated data ecosystems operating across complex socio-technical environments.	Research methods for architecting, integrating, assuring, and governing AI-enabled systems, including traceability, accountability, explainability, and human oversight.	Develop and validate integrated approaches for AI-enabled systems, continuous assurance, operational monitoring, and lifecycle governance.	Establish mature SE methods, frameworks, and reference architectures for trustworthy AI-enabled systems and ecosystems throughout their lifecycle.	a. Develop reference architectures for AI-enabled systems and federated data ecosystems. b. Develop AI qualification processes. c. Develop assurance frameworks for adaptive AI-enabled systems. d. Develop stress-testing approaches for AI-enabled systems. e. Develop methods for traceability, explainability, and human oversight. f. Develop lifecycle monitoring and validation methods for AI-enabled systems. g. Develop governance artifacts for AI-enabled systems.
1.6 Sustainability and emerging challenges 	Strengthen Systems Engineering methods that support sustainability, circularity, and the integration of emerging technological and societal challenges throughout the system lifecycle.	Existing Systems Engineering methods provide limited support for sustainability-by-design, circularity engineering, and the systematic incorporation of emerging technological and societal challenges into engineering processes.	Research methods for sustainability-by-design, circularity engineering, lifecycle sustainability assessment, and the incorporation of emerging technological and societal challenges into engineering decision-making.	Develop and validate integrated methods for lifecycle sustainability and circular systems; enable the systematic assessment of emerging technological and societal developments.	Establish mature SE methods that enable sustainable and circular systems while accommodating emerging technologies, system paradigms, and evolving societal priorities.	a. Develop sustainability-by-design methods, including circularity engineering approaches. b. Develop lifecycle sustainability assessment methods. c. Develop methods for integrating emerging regulatory and societal requirements into engineering processes. d. Develop systematic technology assessment approaches for Systems Engineering. e. Develop Systems Engineering approaches that accommodate emerging technologies and system paradigms.

4.2. SE adoption

Long-term vision

The Netherlands recognizes Systems Engineering as an essential capability for developing, delivering, operating, and evolving complex systems in every NTS domain.

Table 7. Implementation action agenda SE adoption

Area	Main goal	Current state	Action Agenda			Concrete actions
			Short term	Medium term	Long term	
2.1 Introducing SE into existing organizations 	Strengthen the ability of organizations across all NTS domains to adopt, institutionalize, and scale Systems Engineering as an integral part of their way of working.	Systems Engineering adoption remains uneven across sectors and is often limited to frontrunner organizations and projects.	Demonstrate effective adoption approaches, implementation guidance, and organizational transformation strategies.	Scale adoption across sectors, supply chains, SMEs, and communities of practice.	Institutionalize Systems Engineering as normal engineering practice across the Dutch innovation ecosystem.	a. Develop SE adoption playbooks. b. Create management awareness campaigns. c. Develop SME-tailored adoption approaches. d. Develop SE adoption strategies for start-up and scale-up organizations. e. Build shared knowledge infrastructures. f. Establish communities of practice. g. Create sector-specific adoption guidance. h. Develop governance models supporting SE adoption.
2.2 Evidence-based SE adoption 	Strengthen the evidence base for Systems Engineering by demonstrating measurable improvements in productivity, innovation performance, industrialization, competitiveness, and lifecycle outcomes.	Evidence for the value and economic impact of Systems Engineering exists but remains fragmented and difficult to compare across sectors.	Develop assessment approaches, benchmarks, maturity models, and value frameworks.	Quantify impact through pilots, case studies, and cross-sector evidence collection.	Institutionalize evidence-based decision-making and accepted maturity frameworks supporting SE investments.	a. Develop maturity assessments. b. Establish cross-sector benchmarking. c. Develop business-case templates. d. Collect quantitative evidence. e. Publish best-practice repositories. f. Perform impact studies across NTS sectors.
2.3 SE for growing organizations 	Strengthen Systems Engineering practices to support organizational growth, ecosystem development, and increasing system and supply-chain complexity.	Organizations have limited guidance on how Systems Engineering practices should evolve as scale and complexity increase.	Demonstrate scaling patterns and identify growth-related Systems Engineering challenges	Scale governance models, standards, and reference practices for growing organizations and ecosystems.	Institutionalize scalable Systems Engineering practices supporting large ecosystems and complex value chains.	a. Develop SE maturity roadmaps for scale-up companies. b. Develop governance patterns for growing ecosystems. c. Define open standards. d. Develop reference organizational models. e. Identify growth-related scaling patterns. f. Develop tailoring guidelines and reference practices.

4.3. SE education and lifelong learning

Long-term vision

The Netherlands has a large, highly capable, and continuously developing Systems Engineering workforce supported by a national lifelong learning ecosystem.

Table 8. Implementation action agenda SE education and lifelong learning

Area	Main goal	Current state	Action Agenda			Concrete actions
			Short term	Medium term	Long term	
3.1 Expanding the SE talent base 	Strengthen the availability of Systems Engineering talent by expanding Systems Thinking and Systems Engineering competencies across education, industry, management, and society.	Systems Engineering expertise remains concentrated in a relatively small community of practitioners and specialists.	Introduce Systems Thinking throughout primary, secondary, vocational, and higher education.	Expand Systems Engineering curricula across disciplines and sectors.	Sustain a broad national talent base in which Systems Thinking and Systems Engineering are embedded throughout society.	a. Develop a national SE education framework. b. Introduce Systems Thinking across educational levels. c. Embed SE foundations in engineering curricula. d. Extend Systems Thinking to leadership and management education. e. Establish a national SE education network. f. Promote Systems Engineering career pathways.
3.2 Accelerating SE competence development 	Strengthen the development of Systems Engineering expertise by: - reducing the time required for professionals to reach proficiency - accelerating experience building throughout their careers.	Systems Engineering expertise is still acquired predominantly through lengthy on-the-job experience.	Build competency frameworks, learning pathways, and role profiles.	Accelerate experience building through mentoring, coaching, industrial exposure, and advanced learning environments.	Sustain accelerated career paths that enable earlier Systems Engineering and Systems Architecting proficiency.	a. Develop competency frameworks. b. Define learning pathways. c. Create mentoring programs. d. Develop architecting career paths. e. Establish industry rotation programs. f. Develop experience-acceleration mechanisms. g. Develop communication and collaboration training for systems engineers.
3.3 Continuous learning for digital and societal transitions 	Strengthen lifelong learning capabilities to ensure Systems Engineering professionals can continuously adapt to: - technological innovation - societal transitions - evolving engineering practices.	Educational programs adapt slowly to rapidly evolving technologies and societal challenges.	Build educational capabilities covering AI, digital engineering, sustainability, resilience, and socio-technical systems.	Accelerate lifelong learning through industry-academia collaboration, professional training, and upskilling mechanisms.	Sustain a national lifelong learning ecosystem consistent with the DASE vision for Systems Engineering.	a. Create national lifelong-learning framework. b. Establish industry-academia training collaboration. c. Develop transition-oriented curricula. d. Develop AI and Digital Engineering training modules. e. Create modular upskilling programs. f. Develop experiential learning and coaching programs.

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Appendix A. SE applied to the National Technology Strategy

This appendix describes the relevance of Systems Engineering in more detail, following the ten technologies of the National Technology Strategy. As technologies grow more complex and systems more interconnected, the role of SE increases: it evolves from a supporting discipline into a factor in achieving the NTS objectives.

The relationship between the National Technology Strategy and Systems Engineering is essential: the success of the NTS depends on how SE evolves per domain. The current state of practice differs per technology, which creates gaps that must be closed to realize the impact of each one.

In the following table, we present the relevance and impact of Systems Engineering, and a gap analysis, for each NTS technology.

Table 9. Relevance and impact of Systems Engineering (SE) and a gap analysis for each NTS

	Vision	Key actions	Goal	Now	Future	Gap
Semiconductor Technologies	The Netherlands as a global leader in chip design, advanced packaging, and semiconductor manufacturing equipment. This rests on a strong innovation ecosystem, European collaboration, and world-class engineering capabilities.	Developing next-generation chip design, advanced packaging technologies, semiconductor manufacturing equipment, and future chiplet- and system-level architectures. Alongside these: strengthening the supporting ecosystem, infrastructure, and knowledge base.	Strengthen the international competitiveness, technological leadership, and strategic relevance of the Dutch semiconductor industry and ecosystem.	SE is already a core capability within the Dutch semiconductor ecosystem. It supports the development of complex semiconductor manufacturing equipment, advanced design environments, packaging technologies, and integrated supply chains. Dutch leadership relies heavily on multidisciplinary system integration across mechanics, electronics, software, materials, optics, and manufacturing technologies.	As semiconductor technologies evolve toward heterogeneous integration, chiplet-based architectures, advanced packaging, AI-enabled semiconductor design, and ever more complex manufacturing systems, SE becomes even more critical. Future innovation will depend on multidisciplinary co-design, model-based engineering, and digital twins spanning chips, packages, equipment, manufacturing processes, and application systems. SE becomes a key enabler for managing complexity, verification and validation, compliance-by-design, and the industrialization of next-generation semiconductor solutions.	Realizing the ambitions of the Semiconductor Technologies agenda requires advances in model-based engineering, digital twins, multidisciplinary co-design, verification and validation, lifecycle engineering, and supply-chain integration. The key challenge is to maintain system-level coherence across chip design, packaging, equipment development, manufacturing, testing, and application integration. That has to happen while performance, energy-efficiency, sustainability, cybersecurity, and regulatory requirements keep rising.
Quantum Technologies	The Netherlands as a global leader in quantum technologies, through strategic control points in international value chains. That leadership rests on a world-class innovation ecosystem, an industrial base, and a strong position in quantum components and manufacturing.	Developing industrial-scale quantum computing systems, deploying national and international quantum communication infrastructures, advancing quantum sensors for high-impact applications. Alongside these: strengthening quantum manufacturing capabilities and accelerating the development of quantum software, applications and industrial ecosystems	Create economic and societal value, enable strategic autonomy, and establish internationally competitive Dutch positions in quantum computing, communication, sensing, component manufacturing and software.	SE is applied primarily within individual quantum experiments, prototype systems, and enabling subsystems such as cryogenic infrastructures and control electronics. Strong capabilities exist in high-tech engineering, system integration, and component development, but these practices are not yet consistently applied across the quantum value chain.	As quantum technologies move from laboratory demonstrators toward deployable quantum computers, communication networks, sensors, and manufacturing platforms, SE becomes more important. Future progress will depend on aligning components, manufacturing, software, and applications through system architectures, lifecycle engineering, and supply-chain coordination, so that components are fit-for-purpose, manufacturable, and reliable. SE becomes a key enabler for the industrialization of quantum technologies.	Realizing the ambitions of the Quantum Technologies agenda requires a shift from experiment-driven development toward industrial-scale Systems Engineering. The key challenge is to complement strong scientific expertise with capabilities in full-stack architecture development, system integration, lifecycle engineering, manufacturing excellence, quality management, and supply-chain coordination. And it has to happen while quantum components stay fit-for-purpose for future applications.
Optical Systems & Integrated Photonics (OSIP)	By 2035, the Netherlands is a global leader in next-generation OSIP, with a strong ecosystem that creates both economic value and societal impact.	Executing application-driven innovation programs in eight application domains, from agri-food to optical communication, and strengthening seven OSIP technology domains.	Establish leadership and accelerate the innovation and scaling of OSIP technologies. The aim is economic growth, strategic autonomy, solutions for societal challenges, and a doubling of the sector turnover by 2035.	SE serves as an enabling engineering discipline in OSIP projects. It is nearly always applied locally rather than as a coordinated ecosystem capability, and it is often implicitly assumed rather than deliberately organized.	Progress in OSIP depends more and more on integration, both between technologies and across value chains and organizations. Those integration challenges translate into scaling challenges, including the transition from prototype to scalable production and fully functional applications. SE must provide the methods and the common approach for collaboration, architecting, design, integration, and testing.	Today, SE appears mainly, and often implicitly, as a project-level engineering practice within individual organizations. To realize the OSIP ambitions, Systems Engineering capabilities must support cross-disciplinary integration, system architecture, validation, standardization, and ecosystem-level coordination.
AI & Data	Building an AI industry based on “fair tech” principles and federated data and cloud solutions, enabling sectoral innovation, strategic autonomy and new economic growth.	Developing sector-specific foundation models, federated data and cloud infrastructures, trustworthy AI technologies, and neuromorphic computing capabilities, while accelerating AI adoption in key economic sectors.	Establish a globally competitive Dutch AI & Data ecosystem that strengthens innovation, digital sovereignty and strategic autonomy through trustworthy AI, federated data sharing and domain-specific foundation models.	SE currently plays a limited role in AI & Data initiatives, primarily supporting the integration of digital technologies into existing products, services and infrastructures.	AI is evolving from isolated applications toward foundation models, autonomous agents, and interconnected ecosystems. That makes SE ever more important for integrating data, AI models, cloud infrastructures, human decision-making, and domain-specific knowledge into trustworthy socio-technical systems. SE will provide the architectural foundations that keep AI-enabled systems understandable, traceable, governable, and aligned with their intended purpose.	Current AI development focuses largely on algorithms and data. Realizing the ambitions of the AI & Data agenda requires new SE approaches for architecting, integrating, validating, and governing AI-enabled systems and ecosystems. The key challenge is to move from developing AI models in isolation toward engineering trustworthy AI-enabled systems, in which data, models, agents, infrastructure, and human decision-making work together coherently. That calls for architectural foundations that provide traceability, accountability, human oversight, and European values such as fairness, privacy, and digital sovereignty by design.

Table 9. Relevance and impact of Systems Engineering (SE) and a gap analysis for each NTS (continued)

	Vision	Key actions	Goal	Now	Future	Gap
Cybersecurity Technologies	The Netherlands is intrinsically digitally safe by 2035 through the development and large-scale adoption of secure-by-design technologies, methods and products, while strengthening competitiveness, cyber resilience and strategic autonomy.	Accelerating the transition toward secure-by-design and resilient-by-design products and systems. The means: technology development, sector-wide adoption, supply-chain collaboration, secure engineering methods, quantum-safe security technologies, AI-enabled cybersecurity, and supporting innovation infrastructure.	A globally competitive Dutch cybersecurity ecosystem that combines technological leadership with broad deployment of secure-by-design, resilient-by-design digital products, services, and infrastructures.	SE supports the development of cyber-secure products, systems and infrastructures through requirements management, system integration and lifecycle engineering, but cybersecurity is still often addressed separately rather than by design.	SE will play a critical role in embedding cybersecurity, resilience, and trustworthiness into the design, development, operation, and evolution of digital products, systems, and value chains. Secure-by-design will become AI-assisted and evolve from a cybersecurity practice into a system-wide engineering approach. Supporting that transition are supply-chain assurance, model-based security, digital twins, continuous verification and validation, and the management of distributed and AI-enabled systems. Regulations such as the European Cyber Resilience Act are a major driver for adoption.	The primary challenge is to move cybersecurity from a specialized discipline to an integral Systems Engineering concern. Many secure-by-design principles are already understood. Substantial innovation is still needed in system-level assurance, supply-chain engineering, digital twins, continuous validation, and the engineering of distributed and AI-enabled cyber-physical ecosystems. Concretely, that means engineering cybersecurity, resilience, and governance as system properties by design. It also means keeping pace with rapidly evolving AI-enabled threats across ever more interconnected infrastructures and value chains.
Mechatronics & Optomechatronics (M&OM)	The Netherlands as a global leader in M&OM. This calls for a stronger position in the design, integration and production of complex high-tech systems and by extending the mechatronic approach into new strategic application domains.	Advancing next-generation mechatronic and optomechatronic systems through innovation in system design, automation, robotics (physical AI), precision instrumentation, autonomous systems, advanced manufacturing and multidisciplinary engineering methods.	Maintaining and expanding Dutch technological leadership in high-tech equipment and automation, while creating new strategic positions in emerging application domains and supporting European strategic autonomy.	SE is deeply embedded in the Dutch mechatronics and optomechatronics ecosystem. The mechatronic approach itself is rooted in systems thinking, integrating mechanics, electronics, software, control engineering and optics into coherent high-performance systems. This capability underpins the international success of Dutch high-tech equipment manufacturers and their supply chains.	As system complexity keeps growing, the boundaries between M&OM and SE may blur. Future innovation will depend on advanced model-based engineering, automated design processes, multidisciplinary co-design, modular architectures, digital engineering, and integrated verification and validation. That is most urgent in emerging domains such as robotics (physical AI), where the number of interacting disciplines and system states is rising fast.	Current engineering approaches struggle to keep pace with the growth in system complexity, in the number of interacting disciplines, and in the landscape of engineering models. Realizing the ambitions of the M&OM agenda requires advances on several fronts: model-based Systems Engineering, digital engineering, supervisory control, and design automation. It also requires progress in model interoperability and co-simulation, modularity, verification and validation, and lifecycle optimization. The key challenge is no longer integrating disciplines, but keeping control over growing system complexity while reducing development time, cost, and engineering effort.
Imaging Technologies	Establishing the Netherlands as a world-leading ecosystem for imaging technologies that create value through advanced sensing, imaging, interpretation and action across health, safety, science, sustainability and agri-food.	Developing mobile and modular imaging systems, ultra-high-resolution imaging, multispectral and multimodal imaging, and image-guided interventions while strengthening the supporting innovation ecosystem, infrastructure and industrial value chains.	Deliver scalable, interoperable, and commercially viable imaging solutions that improve healthcare, strengthen societal resilience and safety, and reinforce the international competitiveness of the Dutch imaging ecosystem.	SE is already a foundational capability within the Dutch imaging ecosystem. It enables the development and integration of complex imaging solutions that combine sensing technologies, hardware, software, AI, data processing and operational workflows. Strong capabilities exist in the design and integration of advanced imaging platforms, but these are still predominantly organized within domain-specific value chains and application ecosystems.	As imaging technologies evolve from standalone instruments toward integrated image-to-action ecosystems, Systems Engineering becomes critical. Future imaging solutions will require seamless integration of sensing, image formation, AI-enabled interpretation, and decision support, while enabling knowledge transfer and cross-fertilization between application domains and organizations. SE will play a central role in architecting interoperable platforms, integrating heterogeneous technologies, and enabling trusted AI-supported workflows. It also orchestrates ecosystem collaboration and speeds up deployment from research environments into operational practice.	Realizing the ambitions of the Imaging Technologies agenda requires advances on several fronts: system-of-Systems Engineering, interoperability-by-design, model-based engineering, and AI-system integration. It also requires progress in verification and validation of hybrid human-AI workflows, lifecycle management, and ecosystem orchestration in complex value chains.
Process Technology	The Netherlands as the circular raw materials hub of North-West Europe for sustainable carbon and critical materials through advanced process technologies, industrial integration and circular value chains	Developing and scaling process technologies for sustainable carbon, critical materials and water treatment, while accelerating industrial integration, electrification, circularity and AI-driven process optimization across value chains.	Combine sustainable carbon processing, critical materials recovery, and integrated industrial value chains to strengthen economic resilience, strategic autonomy, and resource security.	SE contributes primarily through process design, plant integration and industrial system optimization.	As industrial systems evolve toward integrated circular value chains. SE will therefore play an ever more important role in coordinating technologies, infrastructure, energy systems, water systems, digital twins, and supply networks across the entire lifecycle. Model-based engineering, AI-enabled optimization, and system-of-systems approaches will be essential for designing scalable and economically viable circular industries.	The key challenge is the widespread adoption of SE in ever more integrated and circular industrial ecosystems. The transition from optimizing individual processes toward engineering entire value chains, industrial clusters, and resource networks requires Systems Engineering to become common practice throughout the process industry.

Table 9. Relevance and impact of Systems Engineering (SE) and a gap analysis for each NTS (continued)

	Vision	Key actions	Goal	Now	Future	Gap
Energy Materials	Advanced materials, components, and production technologies that enable a resilient, affordable, and sustainable energy transition. In the Netherlands the focus is on battery cell technology ("Li-ion and beyond") and on electrolysis technology at cell and stack level.	Seven innovation programs. Four cover batteries: production equipment industrialization, digital production optimization, flexible Dutch cell-production infrastructure, and a strategic innovation chain. Three cover electrolysis: proton exchange membrane (PEM), flexible alkaline, and solid oxide electrolysis (SOE). The Battery Competence Cluster NL (BCC-NL) and the envisaged Electrolysis Competence Centre NL (ECC-NL) coordinate them.	By 2035, secure control points in the European battery and electrolysis value chains as a supplier of materials, components, and production equipment. And reduce dependence on critical raw materials along the way.	SE is applied within machines and production lines, focusing on manufacturability, yield and process integration, while engineering in material-focused start-ups and scale-ups remains largely discipline- and experiment-driven.	Energy Materials must increasingly be engineered as integrated value chains in which application requirements, cell and stack architectures, materials, and production processes are tightly coupled. SE contributes by allocating requirements across these interconnected layers, enabling model-based and data-driven production engineering, and embedding circularity, reparability, and resilience alongside performance, sustainability, and scalability.	For batteries and electrolysis, the main challenge is adoption and transfer. Established lifecycle, requirements, and model-based engineering practices must reach a fragmented ecosystem of start-ups, scale-ups, and knowledge institutes. The remaining method gaps concern cross-chain requirement allocation, design-time verification of sustainability and circularity requirements, and secure sharing of engineering models between organizations.
Biomolecular & Cell Technologies (B&CT)	The Netherlands as a global leader in B&CT through scalable innovations for precision health, sustainable food production and biomanufacturing.	Advancing synthetic biology, AI-enabled experimentation, digital twins, biomanufacturing scale-up and biotechnology innovation pathways from lab to market.	Accelerate the transformation of biotechnology breakthroughs into market-ready solutions and economic value.	SE is not yet a central organizing capability in B&CT, but its principles are increasingly visible in digital twins, modular biomanufacturing, process scale-up, validation, standardization and end-to-end innovation chains.	As Biomolecular & Cell Technologies evolve toward ever more programmable biological systems, SE will become more important in the design and operation of synthetic biology workflows. Model-based design, modular biological architectures, AI-supported experimentation, automation, and digital twins will enable more predictable, scalable, and reproducible development of biological products and processes.	The key challenge is to transform biological innovation from a largely trial-and-error process into a disciplined engineering practice. Realizing the ambitions of synthetic biology means integrating model-based design, modular biological building blocks, automated experimentation, and AI-supported testing. Together these must form coherent development workflows that deliver predictable and scalable outcomes.

The common trend in the NTS technology domains is a shift from individual technologies, components, and prototypes toward integrated systems, value chains, and ecosystems. This requires model-based and lifecycle-oriented engineering, digital twins, verification and validation, system-level assurance, interface standardization, and collaboration across organizational boundaries. At the same time, strategic autonomy, sustainability, circularity, trustworthiness, and resilience are becoming explicit system requirements.

Although the importance of Systems Engineering is recognized in every domain, its level of adoption varies considerably. Several domains already rely on mature Systems Engineering practices. Others are still moving from discipline-specific, experimental, or project-based approaches toward more systematic system-level engineering throughout their innovation ecosystems.

Addressing these challenges requires coordinated action in Systems Engineering method innovation, adoption, and education. The action agenda presented in this document translates the identified gaps into a concrete roadmap for strengthening Systems Engineering capabilities in every domain of the National Technology Strategy. In doing so, it aims to accelerate innovation, improve engineering productivity, strengthen strategic autonomy, and increase the economic and societal impact of Dutch technology development.

Glossary

This glossary explains the abbreviations and specialist terms used in this action agenda. Terms are listed alphabetically.

AI

Artificial intelligence.

AI4SE

AI for Systems Engineering: using artificial intelligence to support the work of systems engineers, for example in design-space exploration, trade-off analysis, and decision support. The mirror image of SE4AI.

assurance

The evidence and argument showing that a system meets its requirements for safety, security, and reliability, together with the activities that produce them.

B&CT

Biomolecular & Cell Technologies. One of the ten key technologies of the National Technology Strategy.

BCC-NL

Battery Competence Cluster NL. The Dutch battery ecosystem, bringing together companies, knowledge institutes, and other organizations working on battery technology and its applications.

brownfield engineering

Developing or upgrading a system inside an existing environment, where legacy components, interfaces, and constraints have to be taken as given. The opposite of greenfield engineering, which starts from a clean sheet.

chiplet

A small, separately manufactured functional block that is combined with other chiplets into one package, instead of building a single large chip.

circularity

Designing products and processes so that materials and components are reused, repaired, or recovered rather than discarded.

co-design

Designing two or more parts of a system together rather than one after the other — hardware and software, for instance, or a chip and its package — so that the trade-offs between them are made deliberately.

communities of practice

Groups of professionals from different organizations who share methods, experience, and lessons learned around a common practice.

compliance-by-design

Building regulatory and standards requirements into a design from the start, instead of demonstrating compliance after the fact.

DASE

Dutch Approach to Systems Engineering. A Dutch Systems Engineering approach for the high-tech equipment industry. It brings together the business and system context, SE processes, roles and responsibilities, competencies, system decomposition and requirements, and the interaction between OEMs, suppliers, and other stakeholders.

design-space exploration

Systematically generating and evaluating alternative designs to find the ones that best balance the requirements, usually with models and simulation.

digital engineering

An engineering approach in which connected digital models and data, rather than documents, are the authoritative source of information throughout the lifecycle.

digital thread

The connected flow of data and models that links every phase of a system’s lifecycle, from requirements through design and production to operation.

digital twin

A model of a physical system that is kept in step with the real system using operational data, and is used to analyze, predict, and improve its behavior.

ECC-NL

Electrolysis Competence Centre NL. The Dutch electrolysis competence center, focused on developing and scaling electrolysis technology, including hydrogen production.

ecosystem

In this agenda: the network of companies, knowledge institutes, and public bodies that together develop a technology and bring it to market. Used for collaboration that crosses organizational boundaries.

EUV

Extreme ultraviolet. Refers here to EUV lithography, the technique used to manufacture advanced semiconductor chips.

federated data

Data that stays with its owners and is used across organizations through agreed interfaces and rules, instead of being gathered in one central place.

fit-for-purpose

Good enough for the use intended, rather than optimized in the abstract. Used here for components that have to meet the real requirements of the application they end up in.

graceful degradation

The property of a system that keeps delivering its most important functions, at reduced performance, when parts of it fail.

heterogeneous integration

Combining separately manufactured components of different types and technologies into one package or system.

HHT

Holland High Tech. The Dutch high-tech innovation ecosystem, covering areas such as semiconductor technology, advanced manufacturing, energy, and high-tech systems.

human-AI teaming

A way of working in which engineers and AI tools carry out an engineering task together, each doing what it does best.

INCOSE

International Council on Systems Engineering. The international professional body for the discipline.

interoperability

The ability of systems, tools, or organizations to exchange information and actually use it, without a custom conversion for every pair.

lifecycle

The whole life of a system, from the first idea through design, realization, and operation to decommissioning.

lifecycle engineering

Engineering that weighs every phase of the lifecycle in the design decisions, including operation, maintenance, and end of life.

M&OM

Mechatronics & Optomechatronics. One of the ten key technologies of the National Technology Strategy.

maturity model

A scale describing the successive stages an organization goes through in mastering a practice, used to assess where it stands and what to improve next.

MBSE

Model-Based Systems Engineering. A way of working in which connected models, rather than documents, carry the specification, design, and analysis of a system.

neuromorphic computing

Computing hardware whose architecture is modeled on the way the brain processes information, aimed at far lower energy use for AI workloads.

NTS

National Technology Strategy. The Dutch government strategy that identifies ten key technologies and sets the priorities for strengthening them.

OEM

Original equipment manufacturer. The company responsible for the machine or system as a whole. It holds a central Systems Engineering role, because it manages the interfaces, requirements, and architecture, and integrates the subsystems and components supplied by others.

OSIP

Optical Systems & Integrated Photonics. One of the ten key technologies of the National Technology Strategy.

PEM

Proton exchange membrane. Refers here to PEM electrolysis, which uses a proton exchange membrane to produce hydrogen from water.

physical AI

Artificial intelligence embodied in systems that act in the physical world, such as robots, rather than only processing information.

polder model

The Dutch practice of reaching decisions through continuous consultation between equal partners until consensus is found.

prognostics

Predicting when and how a system will fail, so that maintenance can be planned before it does. The counterpart of diagnostics, which explains failures that have already happened.

quantum-safe

Resistant to attack by a future quantum computer. Said of cryptography that has to stay secure once such machines exist.

requirements

The documented, verifiable statements of what a system must do and what properties it must have. They translate stakeholder needs into something that can be designed and tested against.

resilience

The ability of a system to absorb disruption, keep functioning, and recover. Distinct from robustness, which is about not being disturbed in the first place.

SE

Systems Engineering. See the INCOSE definition in section 1.1.

SE4AI

Systems Engineering for AI-enabled systems: applying Systems Engineering to systems that contain artificial intelligence, covering their architecture, assurance, governance, and lifecycle management. The mirror image of AI4SE.

SEBoK

Systems Engineering Body of Knowledge. The reference work describing accepted practice in the discipline.

secure-by-design and resilient-by-design

Building security, and the ability to recover from disruption, into a system from the first design decisions onwards rather than adding them afterward.

SME

Small and medium-sized enterprise.

socio-technical system

A system in which the technology and the people and organizations working with it form one whole, and cannot be designed separately.

SOE

Solid oxide electrolysis. High-temperature electrolysis using solid-oxide technology.

sovereignty and strategic autonomy

The ability to develop, build, and operate critical technologies and systems without depending on parties outside Europe for the decisions that matter.

system-of-systems

A set of systems that each function on their own but together deliver something none of them can deliver alone — an energy network, for instance, or an integrated command platform.

systems architect

The engineer responsible for the structure of a system as a whole: how it is divided into parts, how those parts interact, and which trade-offs are made between them.

systems thinking

The habit of looking at the whole and at the interaction between the parts, rather than optimizing the parts separately. One of the three pillars of Systems Engineering.

T-shaped professional

A specialist with deep knowledge in one discipline — the vertical bar — and enough breadth to work with other disciplines, the horizontal bar.

time-to-market

The time between the start of development and the moment a product is available to customers.

TNO

Netherlands Organisation for Applied Scientific Research. The Dutch organization for applied research.

Triple Helix

The model in which government, academia, and industry together drive innovation, each contributing what the others cannot.

trustworthy system

A system that can be relied on to do what it is supposed to do, and that can show it: safe, secure, reliable, transparent and accountable.

value chain

The sequence of organizations and activities that together turn raw materials and components into a finished product for the end user.

verification and validation

Verification asks whether the system was built right, against its requirements. Validation asks whether the right system was built, against what the stakeholders actually need.

Colophon

HHT Innovation Domain Systems Engineering | Action Agenda for Systems Engineering 2026

Version

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Initiative

This action agenda was developed by the Holland High Tech Systems Engineering community. It is a contribution to the National Technology Strategy (NTS) and the associated NTS Technology Action Agendas.

Process

This action agenda was developed as an update of the HHT SE Roadmap (2020). It draws on an analysis of the state of Systems Engineering in the Netherlands and internationally. It also draws on an analysis of the National Technology Strategy and the NTS Technology Action Agendas. The agenda was further refined through expert workshops, consultation with representatives of the relevant technology domains, and iterative review cycles involving industry, knowledge institutes, and government.

Status

This action agenda reflects the views of the HHT Systems Engineering community. It is intended to support future investments, programs, and collaborative initiatives related to Systems Engineering in the Netherlands.

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