HTSM Systems Engineering Roadmap

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Contributors:
This roadmap has been composed by a large number of R&D staff of Dutch academia and industry, on the basis of an agreed reasoning line. It is a major update of the HTSM (High Tech Systems & Materials) Embedded Systems roadmap 2018. A complete list of all contributors is provided in Appendix A, and a process description is provided in Section 4.

1. Societal challenges and economic relevance

This document represents the Roadmap for Systems Engineering 2020 (HTSM-SE roadmap), which is an update to the HTSM Embedded Systems roadmap 2018. This update was done to align with the Top sectors' Kennis- en InnovatieAgenda's (KIAs) based on the 25 missions established by the government in the scope of the Dutch mission-driven Top Sector and Innovation Policy.

The HTSM-SE roadmap addresses current and future industrial needs for design and engineering methodologies for high-tech, software-intensive systems (often called cyber-physical systems) by summarizing strategic focal points for innovation. The roadmap uses a structured analysis process that is identified as 'line of reasoning'. At the center are the needs of the Dutch high-tech equipment industry to maintain their world-leading position seen in the context of their strong role for meeting societal challenges and economic drivers. The industrial needs translate into challenges at product level over the product life, which in turn define the methodological and scientific challenges that embody the key building-blocks of the Systems Engineering roadmap.

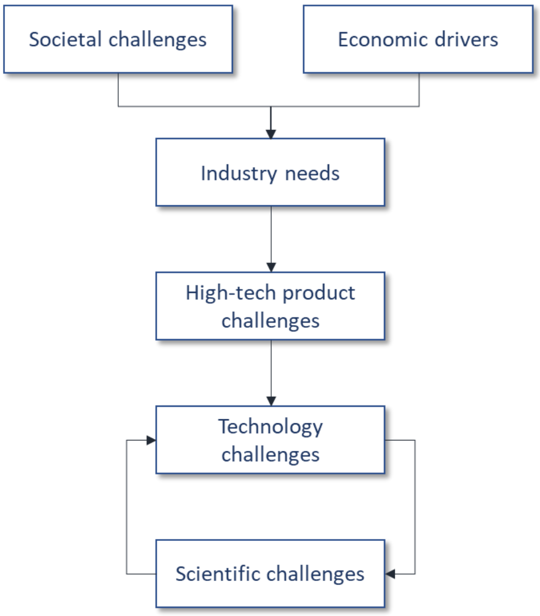

Figure 1: The line of reasoning that is followed to create the foundation of the Systems Engineering roadmap.

Most of the societal challenges as set down in the various KIAs rely in one or more ways on advances in technology that are either directly provided by products of the Dutch high-tech industry, such as medical and analytical instrument equipment, or by technologies that are enabled by such products, such as advanced electronics that crucially relies on the next generation wafer-scanners. In addition, the Systems Engineering methodologies resulting from executing this roadmap may also directly benefit societal sectors that incorporate (digital) systems technology. Such societal sectors are, among others, health and healthcare, transport and mobility, safety and security, energy and environment, but many others could be mentioned. The common denominator within all these areas is that societal innovation has become ever more reliant on deployment of systems technology and their applications. Examples to illustrate the immediate connection between the SE roadmap and the thematic KIA's are the following:

Health and healthcare: Health and healthcare requires innovative value-added, integrated solutions that support customer needs and processes and reduce time and cost. For example, one-day diagnostics, treatment selection and treatment planning for oncology requires integration of various systems, data and value-added services. And in the case of bacterial or viral outbreaks, time to results, the quality of data and validation of data for decision making is determined by mathematical methods and algorithms applied in the architecture of equipment and systems. It is an excellent example of how high-tech equipment, such as medical equipment, is becoming a principal source of data, while for its optimal performance it also gets to rely increasingly on data from its context.

Energy transition and sustainability: To ensure climate-neutral but dependable electrical power supply of the future, present day power grids (production, transmission, transformation, distribution and consumption) need serious rethinking. One of the key challenges caused by increasingly distributed and intermittent energy production (solar, wind , ..), is the enablement of real-time coordination of the control actions in a network of interacting heterogeneous components.

Mobility: future mobility requires automation coupled to safety and security, for example un-manned package delivery in cities using integral traffic planning and autonomous delivery vehicles.

Safety: safety analysis and related actions require a commonly shared situational awareness, analysis and scheduling of related actions. These steps require the combination of sensors, combining various sources of data, communication and activation in a comprehensive and reliable system.

Agriculture, water and food: Information and communication technology is becoming an integral part of agrifood systems, integrating physical dynamics through sensing and actuation with computation and networking. This enables increase of efficiency and quality in a sustainable manner (e.g. limiting CO_2 and NO_x emissions). Similar trends are visible in water management systems.

Common denominator in all these examples is that the solution to these societal challenges invokes the creation of complex, digitalized and highly multi-disciplinary cyber-physical systems where the developments and breakthroughs in Systems Engineering methodologies as described in this roadmap will be indispensable to realize in a reliable and dependable way.

The high-tech equipment industry in the Netherlands has a world-wide leading position, while contributing strongly to the Dutch economy and earning capacity. It also contributes strongly to our innovation power as it has a nearly 60% share in the Dutch private R&D expenditures. Dutch companies like ASML, Philips, Thermo Fisher Scientific, Vanderlande, Thales, Lely and Canon Production Printing, to name just a few, are not only market leaders but often dominate the market with market shares exceeding 50%. It is clear that this sector is a key asset to the country. Their challenge is to maintain its world-wide dominating position, in the face of rising international competition and the ever-increasing complexity of their systems (and the systems it delivers into). Key to the strong position of this Dutch systems industry is the presence of strong competence and knowledge in Systems Engineering. Maintaining a strong industrial position requires maintaining and investing in efficient and effective research into and innovation of Systems Engineering methodologies, tailored to the needs of the Dutch high-tech equipment industry. This explains why the various research and innovation topics addressed in the roadmap can, through the reasoning line, always be traced back to industry needs.

The most prominent objective of the Dutch high-tech equipment industry and other high-tech industries is to develop discriminating and impacting product offerings that addresses rapidly and continuously changing customer needs (the right product/service at the right time and place). This not only requires an efficient, cost-effective, and predictable product creation process, incorporating the latest innovative technologies (or to be a creator of that), but also flexibility, adaptability, agility, strong supply chain integration and customer intimacy.

A key concern underlying this roadmap is the ever-increasing complexity of high-tech system. This ever-increasing complexity cannot be dealt with by the traditional engineering methodologies which are often informal and mono-disciplinary and therefore ineffective in establishing relations and supporting trade-offs among high-tech system qualities. The consequences are visible in daily practice in which industry experiences major challenges in their attempts to efficiently and effectively develop well-performing high-tech systems. As a result, a more fundamental basis of Systems Engineering is required to improve the efficiency, effectiveness, quality and costs of the architecting, design and integration processes and of the resulting products.

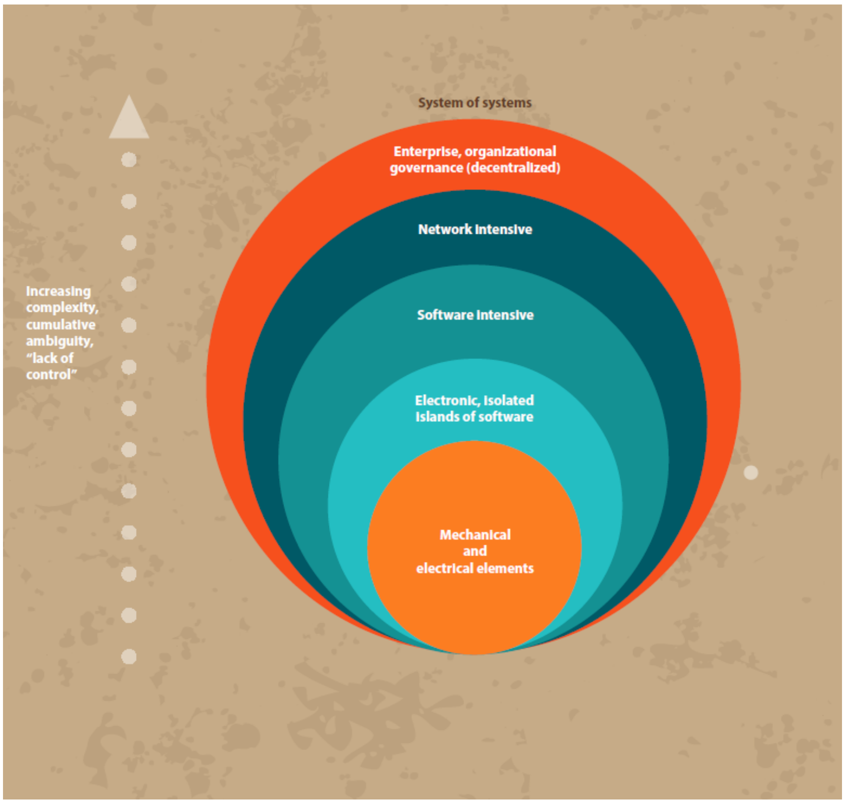

Figure 2: Drivers towards increasing complexity [source: INCOSE].

Many segments in high-tech industry rely on comparable technology building-blocks, methods and techniques which provides opportunities for synergy, knowledge sharing and knowledge exchange. This synergy is the basis for a Dutch and European open innovation system which enables successful cooperation between Dutch and European research partners in which academic organizations, research institutes and industry work together on similar challenges. This roadmap is a key enabler for such an open ecosystem approach.

2. Applications and technologies

The name of this roadmap has changed to "Systems Engineering". Up to 2018 this roadmap carried the name "Embedded Systems" that were defined as "integrated hardware/software (=digital) systems built into systems and devices that are not necessarily recognized as computerized devices or computers". Nowadays, the digital aspect has become a main feature of the systems, rather than it being embedded as if it were a component and a term like cyber physical systems is more appropriate. This roadmap has from its initiation concentrated on the challenges in architecting, design and integration of these increasingly complex and multi-disciplinary digitalized systems and focused on delivering innovations in methodologies to address those challenges. The use and execution of these methodologies is internationally referred to as Systems Engineering, which is defined by INCOSE as "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."

State of the art of Systems Engineering

Systems Engineering as a discipline is practiced currently in tailored and rather siloed ways within various application areas. Formal, static and descriptive methodologies are applied as standard practice in the aerospace and automotive domain, while in the high-tech industry there is a more immature and informal practice in development, often using dynamic and executable models and abstractions. System thinking as an important prerequisite is often still the domain of a few experts, informally embedded into the organisations and often not a scalable practice. The state of practice for design is more mature than for integration and lifecycle management.

State of the Dutch high-tech equipment industry

The Dutch high-tech equipment industry forms a unique eco-system both in size and in market dominance and is one of the key contributors to the Dutch economy. This strong position is attributed to a strong competence-base of inter-disciplinary, pragmatic thinking at system level in an open culture of sharing best practices between leading companies that are mostly not direct competitors. Over the past decades, helped by the execution of the HTSM-ES roadmap, the industry has gradually adopted and shared practices in architecting and model-based system design, successfully applied for instance to system performance optimization in multiple industrial application domains. System thinking is present in a scattered way in the industry, often carried out by a few experts. At the same time, the industry is carrying the burden of three decades of digitalization in the form of legacy, where in many places more than 50% of the SW engineering effort is spent simply on maintaining the existing code-base, which is hampering the bandwidth for innovation.

From societal and industry needs to technical and scientific challenges

Following the reasoning line explained in Figure 1 we identify the methodological and scientific challenges this roadmap aims to address

1. **Societal challenges.** The needs and challenges society is facing at large define the context in which the high-tech equipment industry operates and delivers its products into. In the face of the big challenges in energy transition and sustainable mobility, agriculture, health and security, the solutions are no longer single point solutions but involve often tightly intertwined chains with many products, technologies and players involved. In these chains, high-tech systems often play a key role, and the requirements are strongly influenced by the societal challenges. (Systems Engineering tasks have to deal with a broad variety of Point of Care, Point of Application solutions and shall help with democratization of complex systems.) Examples are hospital equipment that needs to be seamless part of the whole healthcare chain, or automated warehousing solutions that have become part of quickly changing logistic solutions. In addition, the high-tech equipment industry needs to continue contributing strongly to the Dutch economy, earning capacity and high-quality employment. Finally, there is increasing attention for technological sovereignty in Europe, and having world dominating high-tech system players firmly within our borders secures our independence in this respect from other regions in the world.
2. **Economic drivers.** The Dutch high-tech industry is facing an economic and business environment that is characterized by still increasing globalization, affecting both the competition they face, as well as the nature of their customer base and supply chain. Furthermore, there is a shift in how customers appreciate high-tech systems from functionality of the system itself to how the system helps them increase the value they create for their own customers, next in the chain. Systems will be integrated into larger systems-of-systems, e.g. an electron microscope machine as part of a manufacturing plant, and emphasis is on ease of use for operators (in the light of limited availability of qualified workforce), minimization of impact of failures, smart diagnostics, repair and recovery to guarantee maximum uptime, overall systems-of-systems performance, etc. Finally, data is increasingly becoming an asset and thereby an economic and business factor on its own. High-tech systems need to integrate with data, and value extracted from it, both offered and used in the environment the system functions in.
3. **Industry needs.** The overarching need of the industry in scope of the HTSM Topsector, and the HTSM-SE roadmap, is to continue to develop and offer competitive products onto the world market in terms of cost, time-to-market, quality and product features, and to retain their respective market-leading positions. This increasingly translates, among others, into a need for flexibility and adaptability, both

at the product-line as well as at the individual unit level. Customer intimacy and supply-chain intimacy are key, not only during sales acquisition but throughout the full lifetime of the product. The high-tech OEM industry, networks of suppliers, and SME's increasingly form effective and efficient (supply) chains whereby economic need for speed of innovation calls for strategic collaborations and co-development in an open innovation setting. Across the industry we also see an increasing customer demand for total life-cycle management, including upgradeability of legacy systems. In general, finding cost effective ways of dealing with legacy, particularly in software, becomes increasingly urgent. In addition, the high-tech companies need a highly qualified workforce with leading professional capabilities for architecting, design and engineering; demand for qualified workforce generally outstrips the availability. Finally, the industry feels a strong need to find ways to create value for customers from the abundance of data that they are producing, and utilize and monetize this value accordingly.

4. **High-tech product challenges.** The industry needs determine the demands and challenges that need to be addressed by the industry to come up with the right products. These challenges are categorized into: (i) *product/application challenges*, addressing functional and non-functional challenges in design and engineering of high-tech systems and equipment, (ii) *design process challenges*, addressing challenges for innovation processes, methods and techniques to deal with ever-increasing complexity, as well as the challenges for the development of the required human skills and competences.

   (i) product/application challenges

   The need for flexibility and adaptability is a driver for further digitalization of products and solutions, but this continuous increase of digitalization poses new challenges of added complexity and system dynamics. This calls for well-defined architectures and techniques to guarantee and support key system quality attributes, during normal operation but also in corner cases as systems increasingly operate with some level of autonomy and without human oversight. There is also an increasing demand for evolvable, adaptable, platform-based systems and product lines. Providing custom value translates into optimizing life-cycle cost of the product, as well as helping to optimize the customer workflow, to which the product contributes. The scarcity of trained personnel calls for optimized user interaction, ease of use, and in general human centric design. Enabled by ubiquitous connectivity high-tech systems tend to become either more distributed or become part of a distributed system or system-of-systems. Consequently, there is need to have clear strategies how to leverage cloud or edge-based assets, how to integrate (part of) a system into a bigger system(-of-systems), how to guarantee system integrity and how to deal with system evolution, as some parts of the system get updated faster than others. The need to utilize the available data calls for system-integrated data analytics, including mining, analysis, visualization and reasoning). The need for total lifecycle management has highly increased the need for diagnostics in and diagnose-ability of high-tech systems.

   (ii) design process challenges

   From a process point of view the industry challenge can be summarized as: providing more product value, in less time and with less (human) resources. This translates in the need for shared development data, early verification and validation, shorter design feed-back loops, and the ability to fail fast. Such can be achieved by increasingly moving to virtual product development and virtual engineering over the total lifecycle, enabled by multi-disciplinary, model-based, integrated and/or inter-operable tooling with shared product development data facilities. Effectiveness and efficiency require the industry as a whole to further strengthen its knowledge-based leadership in design and engineering in a broad sense, for instance by means of continuous education.

5. **Methodology challenges.** Addressing the system complexity challenges industry is facing calls for innovation and development of system engineering approaches tailored to the needs of the high-tech industry. In this roadmap we consider these approaches to be methodologies, rather than technologies, and the expected deliverables of this roadmap therefore are methodologies, that is generally a combination of formalisms, techniques, methods and tools.

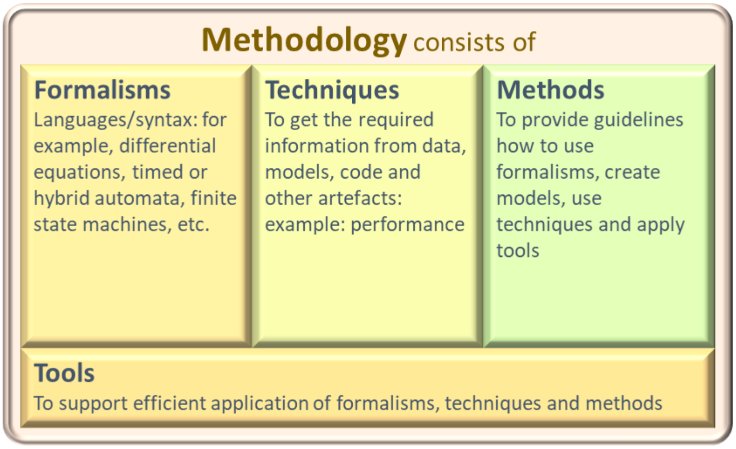

Figure 3: Visualization of what constitutes a methodology

As we have seen the needs of the industry extend themselves across the critical phases of the system total life-cycle including initial architecting, design, realization, integration and operational life-time. Based on these immediate and future needs this roadmap identifies the following methodology challenges that cover all these phases and which we present below in an order which follows the full life-cycle:

1. Virtual, model-based development (models, tooling, higher abstraction levels, languages, …);
2. Systems thinking, including bridging multiple engineering disciplines and scalable modeling details;
3. Architectures for data-intensive and/or AI-intensive system (of systems), including IoT systems;
4. Design for system (of systems) qualities, including safety, security, performance, install-ability, diagnose-ability, sustainability, re-use;
5. Autonomous, self-organizing, self-learning (system of) systems;
6. Design for customer adaptations, incl. adaptability, configurability, flexibility;
7. Design and validation techniques for large scale IoT systems;
8. Automated and highly efficient maintenance of code-base;
9. System (of systems) integration, verification and validation;
10. From data collection to information management and decision support;
11. System health-monitoring, diagnostics and preventive maintenance.

The figure below illustrates the phase in the total system life-cycle to which each challenge primarily relates to.

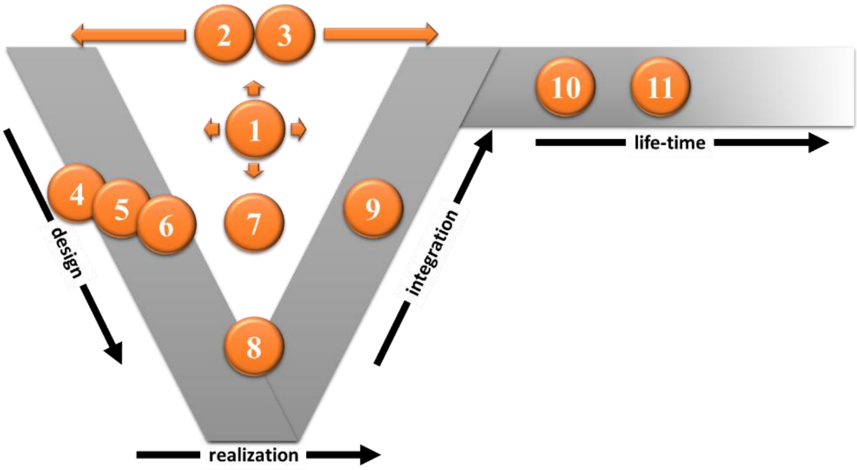

Figure 4: Methodology challenges mapped on tostal system life-cycle phases

These challenges form the key elements of the Systems Engineering roadmap, and also provide an important source of inspiration for the more fundamental scientific challenges.

6. **Scientific challenges.** Scientific challenges, or rather challenges that require an academic scientific approach, provide the fundamental foundation for future methodology innovation. This research is expected to yield breakthroughs in formalism, techniques and methods and combinations thereof,

made available through adequate tooling, as well as general direction, solutions and ideas that will find their way into methodologies that shape future products. The identified scientific challenges are:

- Multi-disciplinary/aspect model-based design techniques (design, analysis, synthesis) and multi-model integration;
- Languages for model-based Systems Engineering;
- Systematic analysis of and design for key system values (e.g. performance, reliability, robustness, security, serviceability, energy);
- Design space exploration (e.g. for power consumption, performance, reliability, adaptability)) and quantified cross-domain design optimization
- Adaptivity and run-time optimization;
- Legacy systems and software refactoring;
- Resource planning and scheduling (incl. multi-criticality, heterogeneous platforms, multicore, software portability);
- Exploiting hybrid compute platforms, including efficient software portability;
- Techniques for low power usage, low emission, low use of natural resources in high-tech system applications;
- Data collection, processing, analytics and visualization;
- Combining multiple external and internal data sources to gain new insights;
- Combining multiple system data sources with system knowledge to gain new insights;
- AI engineering[1], including methods and strategies to decide between moving the intelligence to the edge or cloud;
- Integral security;
- System integration, verification and validation techniques (for functional, non-functional and compliance to standards);
- System health prognostics and failure analysis;
- Efficient system repair and recovery strategies and technologies;
- Remote access and system operation.

As such they represent the medium- and longer-term agenda for the development of new applications and services, thereby providing an important contribution to our future societal needs and competitive positioning.

Human capital

We mentioned above the industry need for qualified workforce trained in state-of-the-art system engineering methodologies and system thinking, which generally outstrips the availability. Special attention must therefore be given to education in this area, through all career stages, starting at universities and HBO but extending to continuous education, and community and peer-group forming.

3. Priorities and implementation

The Systems Engineering roadmap aims to facilitate structural collaboration between Dutch industry, academia and research organizations. The roadmap is well integrated in the set of HTSM roadmaps. The roadmap contains medium-term reasoning and topics for research and innovation that are realized in cooperation between industrial enterprises, academia and research organizations. The roadmap is also strongly in alignment with the KIA Sleuteltechnologieën where it maps on MJP 26 “Systeemarchitectuur en Systeemintegratie”. Furthermore, there are strong links to e.g. MJP 34 “Smart Industry”, MJP 48 “AI enabled Electronic Components & Systems addressing societal solutions”.

To support the realization of the plans, a mixture of fundamental and applied R&D programs is put into place, with funding from industry, academia, NWO, TNO, the Dutch government and the European community. These comprise the following:

1. Industrial and academic investments in plans and programs (direct and co-funded participation);
2. NWO funding (executed by academic partners in cooperation with industry and/or other research organizations);

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[1] Both engineering of systems that incorporate AI technology and the application of AI technology to assist engineering practice

3. European Union funding (executed by individually participating organizations such as industry, academia or research organizations);
4. TNO co-funding (executed by TNO-ESI or other TNO research groups in cooperation with industrial and/or academic partners);
5. B2B funding (research organizations or academia on the basis of assignments);
6. TKI innovation funding. Under certain conditions, the Dutch government adds 30% to an industry cash investment in research in the form of a 'TKI toeslag'. These TKI funds are assigned to participating academic groups or research organizations.

European programs provide an excellent opportunity to firmly connect to- and cooperate in the international innovation community. Aligning with these programs enables us to create a knowledge- and investment multiplier for the HTSM SE roadmap. Knowledge-wise it allows to leverage the Systems Engineering know-how, practice and tooling built-up in other application domains such as automotive, maritime and aerospace, and accelerate developments in the Dutch high-tech equipment industry. Investment-wise, historically European funding has contributed around 35 M€ to execute the research and innovation activities in the context of the HTSM-ES/SE roadmap.

There are two European programs that are closely related to the HTSM-ES roadmap:

1. Horizon Europe. This program, still in its proposal phase, defines the EU's growth strategy for the coming decade.
    - The Horizon Europe proposal is running from 2021 to 2027 with an ambitious €100 billion budget. The EU's program for research and innovation is part of the drive to obtain a sustainable, fair and prosperous future for the people and the planet with a focus on leadership in innovation and entrepreneurship. It focuses its research and innovation on the ecological, social and economic transitions and related societal challenges. Among others, European partnerships is targeted for key digital and enabling technologies.
    - The Horizon Europe program provides important means to internationally anchor the Systems Engineering activities in the roadmap, as systems represents an international playing field, with strong industrial and academic players in countries like Germany, France Sweden, Austria, Finland.
    - Horizon Europe is implemented through, amongst others, public-private partnerships where the partners commit to research and innovation activities of strategic importance to the Union's competitiveness and industrial leadership or to address specific societal challenges. KDT (successor to ECSEL) is such a Joint Undertaking. The KDT program is planned to run from 2021 to 2027 on basis of the European Components and Systems Strategic Research Agenda (ECS-SRA)[2]. The HTSM SE roadmap is well aligned and integrated in the ECS-SRA.
2. EUREKA. This is an intergovernmental industry-led network organization that has the ambition to become the leading platform for R&D-performing entrepreneurs in Europe and beyond. It supports market-oriented R&D and innovation projects by industry, research centers and universities across all technological sectors.
    - EUREKA public-private partnership is organized in EUREKA Clusters, developing generic technologies. The two clusters of importance for the HTSM SE roadmap are ITEA (software-intensive systems and services) and PENTA (micro- and nano-electronics).

4. Partners and process

The HTSM 2020 roadmap for Systems Engineering has been developed in close cooperation with the industrial, academic and institutional R&D community for engineering methodologies for high-tech systems in the Netherlands. Starting point for this roadmap has been the embedded systems roadmap for the year 2018.

On 31 March 2020, a special webex-based (due to the corona-pandemic) workshop was organized in which a broad representation of the Systems Engineering community, the auditor group, was invited to comment on- and add to the reasoning line. In this intensive half-day workshop, with more than 30 attendees, many useful comments, adaptations and extensions were provided. The adapted reasoning line has been redistributed to the auditor group, consisting of roughly 60 persons, for further review and extension. In its current reviewed form, it is presented in Appendix A.

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[2] https://artemis-ia.eu/publication/download/ecs-sra-2020.pdf

On the basis of the review/update of the reasoning line, the current “HTSM Roadmap for Systems Engineering 2020” has been developed. The document has been put forward to a reviewer group representing the auditor group (the bold names in Appendix A). The feedback has been carefully addressed and incorporated.

The current approach has safeguarded a broad and strong foundation for the roadmap. It represents a shared vision on methodologies for Systems Engineering by the majority of the Dutch industry (large industries, suppliers, SME), universities and relevant research organizations.

In the European context, partnership is specifically established through active participation in the ARTEMIS industry association by many in the Dutch ecosystem. Alignment of the contents of this roadmap with the relevant chapters in the ECS-SRA 2021, which was written concurrently with this roadmap, was already mentioned.

This HTSM Systems Engineering roadmap has also been aligned with and validated against the INCOSE SE vision 2025[3]

5. Investments[4]

The investment figures for the involved Dutch industry, academia and research institutes are summarized below, where all amounts are in Million €. The first table includes an estimate on the combined investment in The Netherlands and Europe. The second table provides the investment figures in European programs and is a subset of the first table. In this second table, it can be observed that there is a considerable investment on Systems Engineering in European programs. The tables are based on current indications provided by the various stakeholders[5], which would indicate that the investment figures stay reasonably stable for the coming 4 years. However, in view of the increasing importance of innovation in systems engineering to sustain the economic and societal value created by the Dutch systems industry and to help solve systems issues related to societal challenges, the ambition actually should be for a sustained growth of investments of around 5-10% per annum.

Roadmap Systems Engineering	2020	2021	2022	2023
Industry	**€ 63**	**€ 63**	**€ 65**	**€ 66**
TNO	**€ 2**	**€ 2**	**€ 2**	**€ 2**
NWO	**€ 10**	**€ 8**	**€ 8**	**€ 8**
Universities	**€ 13**	**€ 13**	**€ 13**	**€ 13**
PPS toeslag (TK)	**€ 10**	**€ 10**	**€ 10**	**€ 11**
Departments and regions (excluding TKI)	**€ 27**	**€ 27**	**€ 27**	**€ 27**
European Commission co-financing	**€ 35**	**€ 35**	**€ 35**	**€ 35**
Grand total	**€ 159**	**€ 157**	**€ 159**	**€ 162**

Roadmap Systems Engineering EU	2020	2021	2022	2023
Industry	**€ 29**	**€ 29**	**€ 29**	**€ 29**
TNO	**€ 1**	**€ 1**	**€ 1**	**€ 1**
Universities	**€ 8**	**€ 8**	**€ 8**	**€ 8**
Departments and regions (excluding TKI)	**€ 27**	**€ 27**	**€ 27**	**€ 27**
European Commision co-financing	**€ 35**	**€ 35**	**€ 35**	**€ 35**
Grand total	**€ 100**	**€ 100**	**€ 100**	**€ 100**

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[3] https://www.incose.org/about-systems-engineering/se-vision-2025

[4] R&D in public-private partnership, including contract research; all figures in million euro cash flow per year (cash plus in-kind contribution)

[5] The decision on availability of European funds for 2021-2023 will be taken in the course of 2020.

Appendix A. The auditor group

Name	Affiliation
Sytze Kampen	Airbus DS
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Hans Onvlee	ASML
Ramon Schiffelers	ASML
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Ronald Fabel	Canon CPP
Patrick Brosens	Heijmans
Julien Schmaltz	ICT
Paul van den Broek	Nexperia
Thijs Kniknie	Nexperia
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Gernot Eggen	Philips
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Arjen Klomp	Thermo Fisher Scientific
Jamie McCormack	Thermo Fisher Scientific
Olivier Rainaut	Thermo Fisher Scientific
Maurits Smits	Thermo Fisher Scientific
Paul Havinga	TNO
Gerrit Muller	TNO
Marcin Klecha	TomTom
Fernando Kuijpers	TU Delft
Manuel Mazo	TU Delft
John Schmitz	TU Delft
Eelco Visser	TU Delft
Ton Backx	TU Eindhoven
Twan Basten	TU Eindhoven
Jan Friso Groote	TU Eindhoven
Johan Lukkien	TU Eindhoven
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André Kokkeler	Universiteit Twente
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names in **bold** indicate the review team