Lucht- en Ruimtevaart Nederland

ROADMAP AERONAUTICS 2018 – 2025

Lucht- en Ruimtevaart Nederland

Topsector HTSM

Roadmap Aeronautics 2018 - 2025

March 2018

Roadmap Committee:

Peter Kortbeek (Fokker Technologies; roadmap leader)	for industry
Collin Beers (NLR)	for research institutes
Xavier Weenink (NWO)	for universities

CONTENT Page

1. SOCIETAL CHALLENGES AND ECONOMIC RELEVANCE

Aviation is recognised as one of the top advanced technology sectors in Europe and generates innovation that benefits society at large. With an annual turnover of €4,6 billion, the Dutch aviation sector is Europe's 6th largest and offers employment to 16.900 employees[1]. The sector focuses primarily on the development and supply of high-quality components and software applications in international innovation and production chains and is specialized in aircraft manufacturing and in maintenance of aircraft. The sector provides high-quality employment.
Aviation plays a key role in serving society's needs for safe, secure and sustainable mobility in the Netherlands, Europe and all over the world. Its impact on the economy is significant and must be sustained. With an anticipated continuous growth in demand for air transport until 2050 and beyond it is essential that travel remains safe, secure, fast, affordable and environmentally friendly.

Societal challenges

The Advisory Council for Aviation Research and Innovation in Europe (ACARE) has developed a strategic research and innovation agenda (SRIA[2]) to meet the challenging goals set by Flightpath 2050[3]. Research and innovation in aviation is the key to tomorrow's mobility and prosperity as well as environmental and energy challenges. The Dutch aeronautics sector can greatly contribute to formulating answers to these challenges and to develop solutions to support the Flightpath 2050 goals in order to satisfy mobility needs of Dutch and other European citizens in a sustainable manner, to strengthen the economy and to ensure that the industrial lead in this advanced technology sector is maintained.

Protecting the environment and the energy supply

The international nature of aviation leads to setting targets on a European level for 2050. The aim is to reduce CO_2 by 75%, NO_x by 90% and noise by 65% (all relative to the year 2000)[3]. Lighter aircraft, new propulsion concepts, more efficient engines and new systems are needed. Recycling and minimising the use of chemical substances will also contribute to achieving the targets and will contribute to REACH. REACH is the Regulation on Registration, Evaluation, Authorization and Restriction of Chemicals and streamlines and improves the former legislative framework on chemicals of the European Union.
Lightweight aerostructures based on new materials, more efficient engines, novel rotorcraft concepts and improved and new propulsion concepts, such as (hybrid-)electric flying, will diminish the consumption of fuels. Focus is on the development of green technologies and products, including the use of biofuels. Life-cycle analysis, from concept to end-of-life using circular economy methodologies, contributes to the reduction of the consumption of energy, waste and emissions in production, assembly and maintenance operations.

Ensuring safety and security

While aircraft safety depends to a large extent on the further minimization of human errors, new aircraft systems and materials will further improve the safety of air transport, strengthening European efforts.
The primary function of military aviation is to play a role in the security of the population, locally and globally. Research into the integration of sensors in aircraft will improve peace keeping operations.

Maintaining and extending industrial leadership

Target setting by ACARE is not only done to meet the societal challenges mentioned above, but also to strengthen industrial competitiveness and extend leadership. Competition comes from established players but

[1] NAG international brochure 2017
[2] Strategic Research And Innovation Agenda 2017 update, volume I
[3] Flightpath 2050 - Europe's Vision for Aviation, report of the High Level Group on Aviation Research

also from emerging challengers that receive national support. Substantial investment is required in innovation, research and technology with the appropriate, strong, positive supporting policies. Leadership in innovation is a major competitive differentiator, notably in domains of energy and environmental performance. The market demands ever-shorter cycles for technology integration with, at the same time, aggressive pricing. A major challenge is to significantly reduce development and non-recurring cost and increase manufacturing flexibility, for which automation and digitization are key technologies that need to be embraced.

Prioritising research, testing capabilities & education

The aeronautics sector is characterised by high demands on research and innovation and a long time-to-market (5 to 7 years) and breakeven period (15 to 20 years). Decisions on research and technology development may have consequences on the future of the sector decades after they have been made. The aeronautics sector must therefore be supported by world class capabilities and facilities in research, development, test and validation. It should provide a top-level education to the current and future employees of the aeronautics sector that is adapted to its needs.

Meeting societal and market needs

In 2050 passengers, freight forwarders and shippers must be the clear focus of the transport sector in which aviation is a key player, which requires a paradigm shift from a perspective centred on the service provider to a perspective in which the customer comes first.

Market size

In line with the growing demand for air transport, the global demand for new civil aircraft will grow at an average yearly rate of 4.4%[4] - 4.7%[5] (20 year world annual traffic growth, see also Figure 1). Airbus and Boeing forecast a global market demand for about 34,150 to 37,750 new aircraft (large civil aircraft with 100 passengers and more, excluding freighters) by 2036. Oliver Wyman predicts that the size of the in-service commercial airline fleet will be over 35,000 aircraft in 2027[6]. The global turnover represented by these new civil aircraft represents a value of US$5-6 trillion. The fleet growth will also drive the size of the MRO business, which Airbus expects to double, from US$60 billion to more than US$120 billion a year by 2036.

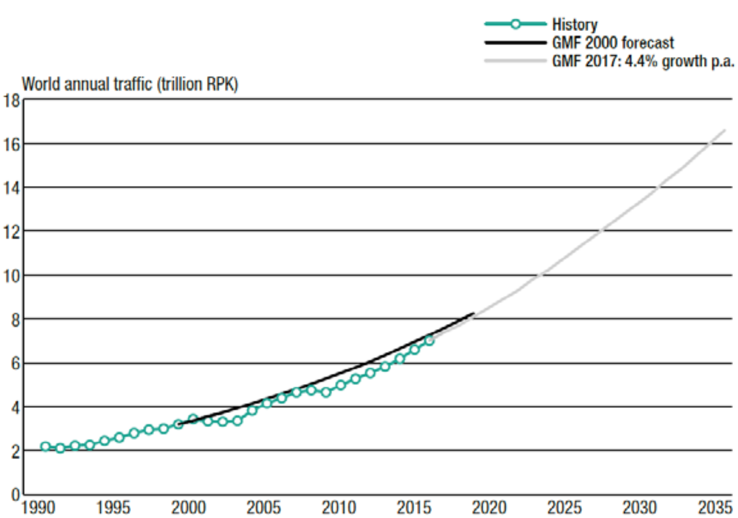

Figure 1 Airbus GMF predicting long term demand (source: ICAO, Airbus GMF 2017)

4 Airbus Global Market Forecast 2017-2036 – Growing Horizons

5 Boeing Current Market Outlook 2017-2036

6 Oliver Wyman Global fleet & MRO market forecast summary 2017 -2027

In Europe the aeronautics sector employs over 552,000 persons (direct employment, of which 2/3 civil and 1/3 military) and the turnover level (including civil and military activities) represents €161.7 billion[7]. The European MRO market is forecasted by Airbus to grow from about US$14 billion a year in 2016 to US$24.5 billion a year in 2036. The R&D expenditure in the aeronautics sector is €16 billion.
The Dutch aviation sector is Europe's 6th largest (annual turnover of €4.6 billion, 70% from export) and employs 16.900 employees[8] (Figure 2). The annual growth of the sector is 5.4%. R&D investments equals 5.5% of the total turnover. More than 100 companies, large-scale industry, SMEs and research institutes are involved. They are part of the supply chain of almost all aircraft manufacturers (OEMs) worldwide. The Maintenance Repair and Overhaul (MRO) market, crucial for the Netherlands, grows slower, but promises a growth of 3.8% per annum[9]. New market opportunities will arise in composite MRO with a forecasted growth of over 10%.

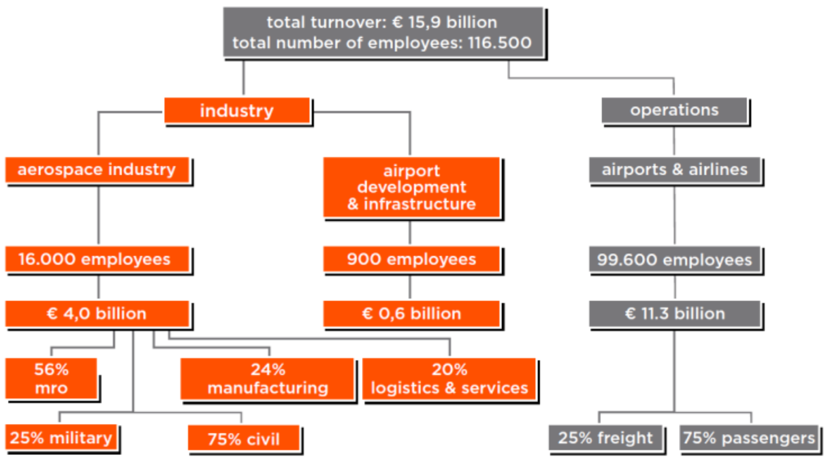

Figure 2 Facts & figures 2016: Dutch aerospace & airport industry (source: NAG)

Competitive position of Dutch ecosystem

The Netherlands is recognized around the world for its knowledge-driven products, services and concepts. Its high-tech systems and materials sector has high-end job opportunities for skilled workers. The Netherlands is attractive for the high level of connectivity to the rest of the world and its high level of education. It offers a centre of excellence for research and development in the area of technology and innovation, and promotes collaboration and technology partnerships. The Netherlands offers excellent business and industrialization conditions for domestic and foreign technology companies and is an attractive place to live and work for aeronautics entrepreneurs, researchers and students. The support of national and regional government is key for this success.
The ambitions of the Dutch aeronautics sector are to double its market share by: (i) achieving global market leadership in aerospace materials, (ii) participating in new aircraft platforms, with special attention to emerging economies, (iii) delivering complete systems and integrated products and services, and (iv) reaching an international leading position in the worldwide maintenance market through revolutionary maintenance concepts. To meet this ambition the sector needs to be competitive at a global level. This can only be reached through research, the development of new technologies, the application of the achievements of R&D in new products and processes and collaboration. The aeronautics sector is a sector in which manufacturing programmes and industrial applications run for a very long period of time in a global market. These long

[7] AeroSpace and Defence Industries Association of Europe (ASD) - Key facts & figures 2015
[8] NAG international brochure 2017
[9] LRN factsheet Marktgrootte

business cycles (business for generations) lead to a need for the sector of credit facilities (revolving, long payback time), demonstration projects and a dedicated aeronautics programming.

2. APPLICATIONS AND TECHNOLOGIES

State of the art for industry and science

The Dutch aeronautics sector operates in market niches and its competitive position is based on advanced knowledge and innovative technology development. In 2017 a number of key technologies have been identified that are needed for these developments.[10] The key technologies that are directly relevant for the aeronautics sector are advanced materials, advanced manufacturing systems and processes, and measurement and detection technology. The key technology ICT is also very important as it allows the aeronautics sector to automate and digitise processes to work faster and cheaper on better products. Niche positions lead to five well defined technology and innovation themes for the aeronautics sector that fit in the key technologies identified above.

- **Aerostructures**: The Dutch aeronautics sector has a strong position on tail sections, wing boxes, movable wing parts, landing gears and other structural parts. It has excellent capabilities in designing and manufacturing composite and fibre metal laminate components and structures and has a solid reputation as global supplier of advanced materials and coatings.
- **Engine subsystems and components**: Strong industrial position on subassemblies for high pressure compressors, Auxiliary Power Units (APUs) and parts (blisks, impellers, casings, seals, shrouds, turbine blades, and engine starters). The knowledge infrastructure offers key know-how on the aircraft and the powerplant integration and offers therefore optimization opportunities.
- **Maintenance Repair and Overhaul**: Well positioned as well. The Dutch MRO activities are ranging from overhaul of aero engines to composite repair, new concepts to reduce life cycle costs, corrosion, (prognostic) health monitoring from components and systems up to complete aircraft, utility and VIP conversion activities.
- **Aircraft systems**: The sector has an excellent position on aircraft interconnection systems and aircraft interior systems.
- **Future concepts**: Next generation (self-healing, multifunctional) materials and new aircraft integration and certification (thanks to Fokker heritage in aircraft manufacturing, presence of DNW and many second tier suppliers with a worldwide customer base), Remotely Piloted Aircraft Systems (RPAS, with Dutch companies selling and operating RPAS worldwide), Unmanned Aerial Vehicles (UAVs), roadable aircraft and (hybrid-)electric aircraft are strong points for Dutch industry.

The Dutch position in aeronautics is often a direct result of intense collaboration between the Dutch knowledge infrastructure (universities and research institutes), which generates innovative concepts, offers state-of-the-art mathematical modelling and experimental testing of key behavioural aspects, and Dutch industrial companies taking validated technologies to industrial production. Such an intensive collaboration is unique in the world and it enables the Dutch aeronautics sector to compete globally. Again, the support by national and regional government is key for this success.

Developments in present and future markets and societal themes

Collaboration within the five technology and innovation themes offers many opportunities for successful academic research (fundamental and applied) that leads to new applications and industrial productivity. The following table shows the link between the societal challenges, developments in present and future markets and the technology and innovation themes.

[10] Kennis- en Innovatieagenda 2018-2021 - Maatschappelijke uitdagingen en sleuteltechnologieën (December 2017)

Table 1 Link between societal challenges, developments in present and future markets and technology and innovation themes

Societal challenges	Developments in future markets	Technology & innovation themes	NL strenghts 2018- -2025
Energy and CO_2	Less energy consumption / lighter	Aerostructures	• Materials (composites, including thermoplastics and FML, new resins, metals for additive manufacturing) • Advanced manufacturing of complex composite parts (thermoplastic) • Smart, multifunctional, light materials and structures • Virtual testing • Digitalization and automation of manufacturing processes • Interior/airframe integration • Assembly concepts
		MRO	• Design for maintenance
	More efficient	Engine subsystems and components	• Blisks & seals • High temperature components • Direct manufacturing concepts and MRO concepts
		Aircraft systems	• Layout for (hybrid-)electric aircraft • New electric data, control and power systems
		Future concepts	• New propulsion concepts • Power and thermal management • Innovative smart wing and empennage • Alternative fuel sources
	Reduction of CO_2	Aerostructures	• Light materials and structures
		Aircraft systems	• Layout for (hybrid-)electric aircraft
		Future concepts	• New propulsion concepts • (Hybrid-)electric aircraft
Climate and water	Reduction of NO_x and noise	Engine subsystems and components	• Geared turbofan • In-flight in-situ acoustic absorption
		Aerostructures	• Innovative smart wing and empennage • Aero-acoustics
	Toxity	Aerostructures	• Cr-free (research-sunset roadmap)
Circular Economy	Longer life	MRO	• Design for maintenance • Self-healing materials • Coatings • Composite repairs, NDI • Maintenance optimization software
	End-of-life	Aerostructures	• Design for reuse or recycling • Composites recycling processes (thermoplastic and thermoset) • Smart end-of-life management
	Reduction of life cycle costs	Aerostructures	• PMA parts
		Aircraft systems	• Additive manufacturing • Design for manufacturing and maintenance • Composite repairs • Component maintenance and pools supported by innovative business concepts
Mobility and Transport	Payload effectivity and efficiency	Future concepts	• Innovative smart wing and empennage • New wiring concepts • Innovative cabin layouts and systems • (Hybrid-)electric aircraft, RPAS, UAVs, personalized air mobility • Very low level ops/urban airspace
Safe society	Passenger safety	Aerostructures, MRO	• Structural Health Monitoring (SHM) • Certification and qualification
		Aircraft systems	• Sensoring and sensors • Inflight connectivity • Novel automation, intelligent flight control systems
	Social security	Aircraft systems	• Remotely Piloted Aircraft Systems (RPAS) • Military transport systems

3. PRIORITIES AND IMPLEMENTATION

ACARE has developed an ambitious strategic research and innovation agenda to meet challenging goals set by Flightpath 2050. This includes already on-going programmes and projects, for which funding has been secured, as well as new ones, for which funding has to be found. Priorities are set towards 2025 by the stakeholders of the roadmap for each of the five technology and innovation themes described in the previous chapter.

Technology and innovation themes - priorities

Aerostructures

Subthemes	Research topics	2018 - 2025
Materials	Composites	New composite materials / effect of (automated and digital) manufacturing processes on mechanical performance of composites / thermoplastics / next generation FML
	Coatings	Environmentally friendly materials / next generation coatings for high tech materials / corrosion and erosion resistant coatings, easy to clean / functional coatings
	Metals, ceramics	Additive Manufacturing / new alloys for direct manufacturing
Product development	Design methods & tools	Knowledge Based Engineering (KBE) / new certification and qualification philosophy (smart building block) / topology and shape optimization / virtual integration lab and virtual twin development / design for manufacturing technologies / performance assessment tools / design for repair
	Virtual testing	Mechanical testing process simulation / behaviour simulation
	Structures design, smart structures and systems	Integration of structures and wiring / cost modelling / aircraft loads estimation and composites allowables
System engineering	(Embedded) sensoring	Structural health monitoring / Landing gear noise (flaps)
Manufacturing	Robotizing	Automated composite manufacturing technologies / faster & cheaper Resin Transfer Moulding / press forming / digitization
	Bonding technologies	New assembly and joining technologies
	NDI	Next generation NDT technologies / smart and automated quality assurance for manufacturing
	Fibre Placement Technology	Next generation fibre placement technologies / effects of defects
	Smart factory	Virtual manufacturing / innovative metal forming manufacturing technology / digital twin concepts for smart manufacturing units / automation and digitization

Engine subsystems and components

Subthemes	Research topics	2018 - 2025
Materials	High Temperature Materials	Environmental impact on high temperature materials / advanced high temperature resistant materials and coatings
Product development	Engine subsystems	Gas turbine combustion systems / powerplant integration / (hybrid-)electric systems
	Design methods & tools	Design for manufacturing technology / design and development of engine assemblies / design knowledge for improved gas turbine cycles
System engineering	(Embedded) sensoring	Prognostics and health management of gas turbine components (incl. life assessment, sensors)
Manufacturing	Composites	Manufacturing of composite parts / Coating application methods
	New manufacturing technologies	Application technologies / additive manufacturing / advanced manufacturing technologies for complex parts / automation and digitization

Maintenance Repair and Overhaul (MRO)

Subthemes	Research topics	2018 - 2025
Product and process Development	Re-engineering, PMA parts, retrofitting	Improved product & process development
	(Prognostic) health monitoring	Further automation NDI inspection methods / in-service damage assessment, SHM / predictive maintenance simulation / condition based maintenance / big data applications / software to predict and optimise maintenance

Subthemes	Research topics	2018 - 2025
Manufacturing	Repair	Composite repair, determination design airworthiness strategy, damage tolerance / 3D printing and repair (3D printing for repair and repair for 3D printing) / repair of hybrid (metal/composite) structures
	Corrosion	Anti-corrosion, surface treatments, mobile diagnostic equipment / effect of fungus on structural performance

Aircraft systems

Subthemes	Research Topics	2018 - 2025
Product development	Systems for green aircraft	Modular systems (avionics, electro-mechanic actuators, electric driven subsystems) / integrated wiring systems / antenna systems / control systems / training and simulation systems / user experience
	Systems for safe aircraft	Communication, navigation and surveillance (CNS) systems / sensor systems (radar, optic, acoustic) / display systems / protection systems / flight management systems / user experience
System engineering	System design methods and tools	Airworthiness rule making / smart system certification / instrumentation systems / model based design, software and simulation technologies / connectivity solutions

Future concepts

Subtheme	Research topics	2018 - 2025
Materials	Future materials	Multifunctional / 3D printed / cost efficient high performance / hybrid materials / next generation FML / high temperature composites
	Bio-inspired materials	Bio inspired, self-growing, self-healing materials
	Materials life cycle	State-of-the-art and future material development, production, testing, qualification, certification, sustainment, recycling
Product development	Future aircraft structure	Patchwork aircraft structure, bionic design, optimized load paths, sound-fire-impact resistant structure, integrated structures for fast rotorcraft (compound helicopter, tilt rotor), morphing structures, sensors
	Design methods	Future intuitive analysis & design methods, certification requirements and interpretations, future production and assembly technologies, short turnaround time and low cost, multiscale simulation techniques, virtual integration
	Smart wind tunnel testing and sensor technology	Miniaturized remote controls of wind tunnel (WT) models, smart WT correction methods, aero-elastically scaled WT models, cost-reduction WT models, rapid prototyping of wind tunnel models with embedded sensors (3D printing), accurate balances with temperature compensation, sensors and HUMS validity for maintenance optimization
	Future aircraft systems	Remotely piloted aircraft systems (RPAS), impact more electric on systems, integrated systems for fast rotorcraft, cheap aircraft weight and balance system
New aircraft	Development new aircraft, propulsion integration, and demonstrators	Future aircraft concepts, propulsion concepts, multi-disciplinary engine-airframe integration, future aircraft design - certification - validation methods, multidisciplinary optimization of aspect ratio 10-15 wing, future concepts for passenger cabin, (active) noise reduction technologies, laminar wing, user experience, alternative energy sources
	Integral life-cycle cost	Technology development constrained by life-cycle cost
	Future cockpit	Integral safety assessment of cockpit and ATM in integrated air-ground-space system-human machine interface, future cockpit and control concepts, human factors & resilience of future complex systems (incl. cockpits), connected cockpit, training and simulation
Aircraft in a new environment	Development of new ground systems, procedures and concepts	Remote Tower / ATC systems / flight procedures / very low level ops, concepts, procedures and supporting systems

While some of the research topics may be addressed in other roadmaps as well, they form the core business of the aeronautics domain. As in the past, desired cross-overs often lead to spin off and spill overs for other industries and markets.

Implementation in public-private partnerships and ecosystems

The realization of the roadmap Aeronautics depends on the implementation mechanisms available for the so-called "triple helix". Each development phase in the innovation cycle (from knowledge via technology to product development and industrialization) requires different approaches. *College Lucht- en Ruimtevaart Nederland* (LRN) plays a central role in the Dutch aeronautics sector involving industrial companies, SMEs, knowledge institutes and government. Different public-private partnership initiatives, both national and international, are part of the TKI programme[11] according to the five technology and innovation themes. Under these themes, the different key technologies and their R&D&I needs have been and will be translated into collaborative research projects.

The Dutch aeronautics sector also looks beyond national borders and is heavily involved in international cooperation at five levels: (i) strategic alliances, (ii) international sharing of facilities, (iii) transnational and international institutional cooperation, (iv) joint industry participation in international collaborative R&D programmes, and (v) participation in and through international professional societies.
The sector participates widely in EU programmes. The main value of participating in EU-projects is to develop excellent scientific knowledge for the benefit of Dutch society, cooperation with OEMs, a large international network and new commercial opportunities. To be able to realize its ambitions in the future, the aeronautics sector needs the Dutch government to actively pursue a ring fenced/dedicated budget for aviation under national and EU programmes due to the specificities of the sector, as well as governmental support for continuation of a best practice public private partnerships such as Joint Technology Initiative Clean Sky. Clean Sky is the largest European research programme developing innovative, cutting-edge technology aimed at reducing CO_2, NO_x emissions and noise levels produced by aircraft and contributes to strengthening European aero-industry collaboration, global leadership and competitiveness.

The Memorandum of Understanding (MoU) with Airbus is an additional tool to promote international cooperation. The Airbus MoU defines a joint research and technology programme of common interest with the objective to extend and increase the international business relations between parties involved. This aircraft MoU has been agreed between Airbus, Fokker and the Netherlands Aerospace Group (NAG), consisting of more than 100 Dutch aerospace companies and representing the entire Dutch aerospace sector (production, maintenance, education, engineering, R&D and science). The sector is looking for new MoUs with aircraft manufacturers.

[11] TKI = Top consortium for Knowledge and Innovation

4. PARTNERS AND PROCESS

Partners in this roadmap

Industrial partners involved

The main industrial partners (including SMEs) involved in this roadmap are the partners who are affiliated with the Netherlands Aerospace Group (NAG, see Appendix A for an overview of the NAG members). The roadmap Aeronautics has strong links to the roadmaps Smart Industry and High Tech Materials.

Scientific partners involved

The aeronautics sector is a high-tech sector which employs highly skilled people with a large variety of disciplines. The major scientific partners of the aeronautics sector are the Faculty of Aerospace Engineering of TU Delft and Netherlands Aerospace Centre (NLR) as the applied research institute of the sector. Collaboration of research institutes, universities and industry has materialised in TPRC, FMLC and MESA+. The Materials innovation institute (M2i) is another significant scientific partner in aeronautics. On the applied research side, cooperation exists with TNO and its Holst Centre. Several parts of the roadmap are being studied after proposed and awarded in the Open Technology Programme and annual HTSM call of *Nederlandse Organisatie voor Wetenschappelijk Onderzoek* (NWO). These are public private partnerships in which multiple industrial partners are involved to enhance knowledge dissemination.

Process followed in creating and maintaining this roadmap

The highest level of coordination of the implementation of this roadmap is the responsibility of *College Lucht- en Ruimtevaart Nederland*, representing the Dutch aeronautics sector. The roadmap has been prepared and maintained by the roadmap committee of this roadmap, consisting of representatives of the industry and SMEs, applied research institutes and universities, in close consultation with the Dutch aeronautics sector.

The programmatic implementation of the Aeronautics roadmap is realised by a combination of different programmatic, national and international partnerships as has been exposed in *Chapter 3 - Priorities and implementation*.

At European level the implementation of this roadmap will be realised through collective R&D activities within European programmes, covering all topics related to Flightpath 2050 targets, and directed towards a programmatic approach as defined in ACARE´s Strategic Research And Innovation Agenda. The topics mentioned in *Chapter 3 - Priorities and implementation* fit within the European R&D programme. Therefore it is also essential that European and national (industry) policy are aligned as far as possible. Representatives of the Dutch aeronautics sector also play an active role in the aeronautics related bodies in the EU.

5. INVESTMENTS

Estimate for overall investment in embedded systems R&D, as applicable to the roadmap (all figures are in M€ per year):

<table>
<tr><th>Roadmap</th><th>2015</th><th>2016</th><th>2017</th><th>2018</th><th>2019</th></tr>
<tr><td>Industry</td><td>28,5</td><td>30,5</td><td>32</td><td>33,5</td><td>35</td></tr>
<tr><td>TNO</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>NLR</td><td>2</td><td>2</td><td>2</td><td>2</td><td>2</td></tr>
<tr><td>NWO</td><td>6</td><td>6</td><td>6</td><td>6</td><td>6</td></tr>
<tr><td>Universities</td><td>9</td><td>9,5</td><td>10</td><td>10,5</td><td>11</td></tr>
<tr><td>Departments (excluding TKI)</td><td rowspan="2">2,5</td><td rowspan="2">2,5</td><td rowspan="2">2,5</td><td rowspan="2">2,5</td><td rowspan="2">2,5</td></tr>
<tr><td>Regions</td></tr>
<tr><td>Grand total</td><td>48</td><td>50,5</td><td>52,5</td><td>54,5</td><td>56,5</td></tr>
</table>

European agenda within Roadmap	**2015**	**2016**	**2017**	**2018**	**2019**
Industry	13	14,5	15,5	16,5	17,5
TNO					
NLR	1	1	1	1	1
NWO	0,2	0,3	0,3	0,3	0,3
Universities	5	5	5	5,5	5,5
EZ-co-financing of EU-programmes	1,1	1,5	1,7	1,9	2
European Commission	6	6	7	7	8

APPENDIX A: NAG MEMBERS

3D-Metal Forming
AAR Aircraft Component Services
ADSE
Aeronamic
Aerovantage
Airborne
Airbus Defence and Space Netherlands B.V.
Aircraft End-of-Life Solutions (AELS)
Aircraft Maintenance & Training School
AIS Europe
AkzoNobel
AmEuro Metals
Amsterdam Airport Area
ATS Applied Tech Systems
Avans Hogeschool
Aviall Services
Aviation Competence Centre
AviaVox
Avio-Diepen
Aviolanda Aerospace Woensdrecht
Avion Group
B/E Aerospace
Belgraver
Bell Helicopter Supply Center
Benchmark Electronics
Boeing
Brabant Development Agency (BOM)
Chromalloy
Cimcool Industrial Products
Clear Flight Solutions
Colson Europe
Custers Hydraulica
Daedalus Aviation Group
Deerns
Dejond
Dutch Thermoplastic Components (DTC)
Dutch-Shape
DutchAero
eezeetags
Egmond Plastic
Embraer Netherlands
EMS
FlowCut Waterjet Cutting
Fokker Technologies
German-Dutch Wind Tunnels (DNW)
GMT Benelux
Goudsmit Magnetic Supplies
Hauck Heat Treatment Eindhoven
Hogeschool Inholland Delft
Hogeschool van Amsterdam, Aviation
IBM Nederland BV
Keonys
KLM Engineering & Maintenance
KMWE Precision
Kuehne + Nagel
KVE Composites Group
Logistiek Centrum Woensdrecht (LCW)
LR Systems
M.E.P.
Maastricht Maintenance Boulevard
Marshall Aerospace Netherlands
MBO College Airport
NACO, Netherlands Airport Consultants
NCIM Groep
NEDAERO
Neitraco Engineering
Netherlands Aircraft Company
NLR – Netherlands Aerospace Centre
Oerlikon Metco Netherlands
PM Aerotec
Pontus HeatTreatment BV
Possehl Aannemingsmaatschappij
Qualitair Aviation Group
SABA Adhesives & Sealants
SACO Airport Equipment
SAMCO Aircraft Maintenance
Schiphol Real Estate
Siemens Industry Software
SII Netherlands
StandardAero Netherlands
Straaltechniek International
Stratagem Group
Sun Test Systems
Surface Treatment Nederland
Technobis Fibre Technologies
TenCate Advanced Composites
TiaT Europe
TNT Express
TTL group
TU Delft (Faculty Aerospace Engineering)
UTC Aerospace Systems
Vanderlande
VDL GL Precision
VIRO
WFS PRO
Zodiac Aerospace

Source: https://nag.aero/members/ (February 1st 2018)

Lucht- en Ruimtevaart Nederland