TOP 3 PRIORITIES THEME INDUSTRY IN 2017:

1. Policy and strategy concerning digitization and service business models.
2. Facilitating globally distinctive innovation ecosystems in NL.
3. More focus on high(er) TRL applications.
TNO’s Strategic Plan 2015-2018

TNO has perceived and embraced five transitions as the basis for its strategy:

› Healthy Living: from illness and treatment to health and behaviour;
› Defence, Safety & Security: from a wide range of threats to controllable risks;
› Urbanisation: from urbanisation bottlenecks to urban vitality;
› Energy: from conventional sources to sustainable energy systems;
› Industry: from economic stagnation to growth in high technology industry.

Theme Industry Vision

Industrial activity is a determinant of prosperity. The urgency for the Netherlands to be aware of this and take action is enormous, because the other prosperity factors are now no longer valid: baby boom, coal (Limburg), gas (Groningen) and credit bubble.
R&D investments have a positive leverage on economic growth. Therefore we need to (re)develop innovation programs including substantial budgets (one billion euro additional per year) in the Netherlands.

Our efforts are focused on restoring economic growth in the Netherlands by increasing the industrial activity through targeted technological innovations based on increased public and private R&D investment.

Society is transforming through three related trends that unfold at unprecedented speed and scale and lead to *servitization of society*: Cyber-Physical Systems, Internet of Things and Big Data. This ‘digitization’ touches everything, leads to new service business models and determines industrial output. Digitization accelerates solutions for societal themes: Smart Health, Smart Mobility, Circular Economy, Smart Energy, Smart Industry, …
AMBITIONS THEME INDUSTRY FOR 2017

TNO theme Industry is built on five roadmaps combining market demands and technology based solutions:

- Semiconductor Equipment;
- Flexible and Freeform Products;
- Space and Scientific Instrumentation;
- Sustainable Chemical Industry;
- Networked Information.

As well as three cross-sectional programs:

- SME program (TNO-wide);
- Strategies for Industry and Innovation;
- Smart Industry.

6 Theme industry – Annual plan 2017
Smart Industry is dealing with the transition of the industry to a digital world where ICT penetrates deeply into all facets of the production process. Smart Industry is driven by a clever use of ICT allowing machines to be connected with each other and controlled smart. And not only within the company, but also between companies and between companies and customers. It takes a combination of the use of production technology, digitization and networking approach. In the end it comes to smart products, processes and services.

IN THE NETHERLANDS, THE IMPORTANCE OF INDUSTRY IS EXPERIENCED EVER MORE STRONGLY. RIGHTLY SO, ACCORDING TO THEME DIRECTOR ARNOLD STOKKING. ‘INDUSTRY IS A FACTOR WHICH DETERMINES PROSPERITY, CREATING JOBS AND GENERATING 80% OF DUTCH EXPORTS. BUT INDUSTRY CAN ONLY SURVIVE IF IT CONTINUES TO INNOVATE. THEREFORE WE CONSIDER IT OUR JOB TO AID INDUSTRY IN THIS PROCESS, IMPLEMENTING OUR KNOWLEDGE IN SUCH FIELDS AS ICT, SENSORS AND ROBOTICS.’

Arnold Stokking

Theme industry – Annual plan 2017
It is difficult to imagine the modern world without electronics. The internet, electronic banking, mobile communication, GPS, digital archiving and retrieval, and surveillance, to name a few, rely on advanced electronic circuitry, particularly integrated circuits (chips). The trend towards the data-based, service providing industry, the 4th industrial revolution, is speeding up the already increasing need for data transport, processing power, and data storage. Today, about 10% of the total energy consumption in developed countries is already used for ICT. The continuously growing connectivity of modern society urgently calls for the continuation of Moore’s Law towards less power hungry devices, and even game changing computational concepts, such as quantum computing or bio-inspired and photonics-based computing.
In turn, the semiconductor industry plays a key enabling role in multiple ‘grand challenges’. For example, the growing dependency of our society on the world-wide exchange of information requires new ways to secure and protect this communication and information. Examples include the developments related to the ageing society, with more privacy-sensitive medical information being communicated and stored, but also electronic control over critical infrastructure (dikes, airports, power plants), smart grids, and smart industry. On the other hand national security services are using big data and communications more and more. This all requires exchange of roadmaps and information between the Semiconductor and the Safety and Security domains.

TNO aims to secure the position of the Netherlands as leading semiconductor manufacturing equipment supplier to the world, by helping the industry to find solutions to current challenges, as well as by continuously searching for new technological pathways for the near and far future. This will not only bring job security to the Netherlands for the years to come but also enables the electronics industry to play its pathfinder role in solving some of societies largest future challenges.
SEMICONDUCTOR EQUIPMENT

Important milestones for 2017 are:

› EUV BeamLine 2 setup is up and running, and enabling the first 2 commercial projects with international customers.

› Strategic cooperation on ‘defectivity’ (i.e. particle contamination) initiated, leading to a strategic position for TNO similar to and complementary to Optics and Optics Lifetime domains.

› QuTech project description and consortium defined for first ‘QuSpace’ project, i.e., a project leading to application of quantum technologies in Space (i.e., TNO’s Space Roadmap).
FLEXIBLE AND FREE-FORM PRODUCTS

By smart stacking and patterning thin layers of innovative materials, we enable useful and attractive future products that address societal needs and trends, such as:

- Sustainable energy generation and storage (building-integrated solar cells, safe high-capacity batteries and solar-to-fuel devices)
- Cost-effective healthcare (improved diagnostics using new types of wearable sensors)
- Digital manufacturing (mass-customization, on-demand production, design optimization with minimal materials usage)
- Digital innovation (making our daily objects smart, connected and unobtrusively interacting and communicating with their users).

With these topics we will create new industries and new business for existing industry. And how do we do that?
- We innovate in the triangle of new production processes / equipment, new materials and new devices, as our intended innovations can’t be realized by disconnected, separate development in each of these areas.

12 Theme industry – Annual plan 2017
Schematic drawing of a 3D thin-film battery based on an array of micro pillars; the anode, electrolyte and cathode are coated as thin-films around the current collecting pillars.

We connect with industry and academia in globally distinctive innovation ecosystems (such as Holst Centre, Solliance, Brightlands Materials Center, AMSYSTEMS). In these we accelerate innovation and create leverage for our partners, connecting Dutch industry with strong parties worldwide along the knowledge value chain.

We develop our technologies by first addressing a demanding ‘lead application’ and then transferring our built-up expertise and capabilities to new applications, creating additional impact.
FLEXIBLE AND FREE-FORM PRODUCTS

Important milestones for 2017 are:

- Additive Manufacturing: Bring in two new industrial partners in Freeform Electronics / 3D printing.
- Flexible Electronics: JV launched on ‘Spatial ALD for Display’, with international partner plus local industry.
- Flexible Electronics: Deliver first working battery based on 3D concept.
- Thin-film Photovoltaics: Prove feasibility of back-end customization; show improved or equal efficiency on 30x30cm2 cigs module level.
SERIAL 3D-PRINTING WITH PRINT VALLEY
SPACE & SCIENTIFIC INSTRUMENTATION

TNO is a crucial partner in the international Space -and Scientific instruments ecosystems addressing important global environmental and societal issues like climate change, ozone hole, greenhouse gas and air quality monitoring. For scientific applications in e.g. astronomy we enable world leading science by creating atom-level-accuracy optomechatronic systems. In general we take a leading role in design and realization of highly complex systems for extraordinary environments, based upon e.g. state of the art optical and radar technology, where we take along (Dutch) industry developing new (commercial) business opportunities.
M1 SUPPORT STRUCTURE FOR E-EELT
4 LASER GUIDED STAR FACILITY IN CHILE.
SPACE AND SCIENTIFIC INSTRUMENTATION

Important milestones for 2017 are:

› Earth Observation: Contract for ESA Biomass.
› Earth Observation: CDR second generation SPECTROLITE.
› Laser Satellite Communication: Contract for new laser SatCom project (either ICE or Terabit Feeder Uplink).

ESA’s Biomass mission addresses the status and dynamics of tropical forests. Its primary scientific objectives are to determine the distribution of above-ground biomass in these forests and to measure annual changes in this stock over the period of the mission. Studying the world’s tropical biomass is key to our understanding Earth’s climate. The mission will provide the first opportunity to explore Earth’s surface at the ‘P-band’ radar frequency from space. In addition to studying forests, the data are expected to be used for monitoring the ionosphere, glaciers and ice sheets, and for mapping subsurface geology in deserts and surface topography below dense vegetation.
SUSTAINABLE CHEMICAL INDUSTRY

TNO will contribute to a sustainable chemical industry that enables a sustainable society. We design and develop materials and chemicals of which intrinsic properties offer a benefit for an improved sustainability (& functionality) in the use phase and are wherever possible sustainably produced from renewable or recyclable materials like biomass, CO2 or waste.

We focus on two programs:
› Green Chemistry, with Biorizon and VoltaChem as public private partnerships;
› Smart Materials, with Brightlands Materials Center as PPP.
SUSTAINABLE CHEMICAL INDUSTRY

Important milestones for 2017 are:

› Biorizon: Implementation of program financing from province of Noord-Brabant.
› VoltaChem: Embedment in a regional ecosystem (e.g. Rotterdam, Geleen, Groningen).
› Brightlands Materials Center: Organization BMC fully operational with industrial commitment in new building at Brightlands Chemelot Campus.

The VoltaChem program focuses on the transition from oil & gas to electricity as a source of energy and raw material for the production of intermediate and end products in chemistry. The most important industrial stakeholder groups involved in this transition are the chemical sector (topsector Chemistry), electricity sector (topsector Energy) and high-tech equipment manufacturing sector (topsector HTSM).

TNO is responsible for the stakeholder community and content for the research lines ‘selective electrochemical oxidation’ and ‘electrochemical carbon dioxide and oxygen reduction’.
NETWORKED INFORMATION

The digital transformation is taking place in every sector in society as a result of technological developments such as big data, the internet of things and cyber-physical systems. TNO’s Networked Information roadmap aims to guide its industrial and societal stakeholders through the digitization of their business. Networked Information focuses on realizing Data Driven Innovations enabled by the unprecedented volume of data and interconnected devices that increasingly link the virtual and the physical world.

Furthermore Networked Information aims to realize Trusted Connectivity to sustain these developments, for which high quality, secure and reliable networks are essential. Sectors that have our specific attention are Telecom Providers with key account KPN, Government, Media, Financials and Smart Industry with a focus on Agriculture. As most innovation in ICT hardware is coming from Asia and most software (platform) innovation is coming from North America our emphasis is on the application of ICT to keep our (top)sectors competitive.
Smart Dairy Farming develops a system for customized information on cattle nutrition and insemination. It results in more milk production, by providing farmers with tailored information for each cow.
In the area of Embedded Systems we operate the Joint Innovation Center TNO-ESI. As a result of the speed by which today’s innovations take place, a continuously growing gap between available technologies and professional capabilities to effectively leverage on those, has emerged. It can be observed from daily practice that industry experiences major setbacks in their attempts to efficiently and effectively develop well-performing high-tech systems. This is partly due to the fact that the ever increasing complexity of high-tech system design cannot be dealt with by the current, mainly mono-disciplinary design methods, techniques and tools. As a result, a more fundamental basis of embedded systems engineering is required to improve the efficiency, effectiveness, quality and costs of the design processes. Moreover, this requires special attention to be paid to alternative system engineering practices, such as for design virtualization or agile processes, especially those addressing the multidisciplinary aspects of system architecting and design. TNO-ESI focuses on these topics, aiming to create breakthrough innovations for the advancement of industrial innovation and academic excellence in the area of embedded systems engineering.
Important milestones for 2017 are:

- **Data Driven Innovation:** For digital factory we have to bring in one or more OEM in 2017 on the one side to get our solutions accepted through the whole supply chain and on the other side to get a balance between investments by industry and TNO.

- **Trusted Connectivity:** We will create at least one spin off/out (Transient apps, Tiled media or DNS Ninja).

- **TNO-ESI:** In 2016 we have signed an MoU with Fraunhofer IESE. In 2017 we seek for active cooperation. This could be via a joint European research project or via joining forces in the competence development programme.
SME PROGRAM

The 2017 SME program is based on three pillars: In addition to knowledge transfer through Technology Clusters (TC) and Sector Innovation Agenda’s (BIA), the program focuses on co-operation with TekDelta (start-ups) and ‘Technology is looking for entrepreneur’ (TNO technology and IP transfer to entrepreneurs).

SME PROGRAM
Important milestone for 2017 is:
› Three cases submitted for Take-off fund.
STRATEGIES FOR INDUSTRY AND INNOVATION PROGRAM

The TNO theme Industry has a mission to improve the competitiveness and structure of Dutch Industry through innovation. In order to do this, we not only need strong cooperation and interaction with the major industry sector, but we also need to be visible in the innovation debate in the Netherlands. The impact of this program must therefore be: Explicit visibility in and impact on the debate on innovation policy on regional, national and European level, based on an authoritative position.

Set-up discussions on (industrial) innovation policy: ‘Doing things differently’.
SMART INDUSTRY

Smart Industry is smart design, smart production and smart use. This requires smart work (Smart Working innovation) by the company and its employees, but also throughout the manufacturing chain for the benefit of innovation:

1. Production: smart production processes such as automation with robots, among others because of cost savings;
2. Products: as a result of new technologies and/or integration of (existing) technologies and/or new manufacturing processes, new and/or smart products are made according customer demands;
3. Business models: as a result of production and products the business models of companies are changing, but also new business models are developed as driver for production and products.

Our ambition is that the Netherlands in 2020 is among the European leaders on the introduction of (new) ICT technology in the Dutch manufacturing industry and is one of the most competitive in Europe. This means that in the Netherlands production facilities exist able to produce one-off products at very high flexibility, seamlessly, with minimal changeover costs and changeover time.

28 Theme industry – Annual plan 2017
PICK & PLACE ROBOT FOR VEGETABLES
The theme Industry focuses on three approaches that (hopefully will) contribute to a high employee satisfaction:

- **Celebration Moments**: A strong correlation with overall satisfaction. We organize and encourage celebration moments at different levels (theme, roadmap team) and cross-sections of the organization (key order intake, successful completion project, high customer satisfaction score);
- **Open and transparent communication**: To encourage involvement and inspiration we organise jointly with expertise ‘soapbox’ sessions and thematic meetings at the sites, we share decisions of the management team with the employees and we will send an internal newsletter (e.g. about Dutch Optics Centre) out;
- **Burn-out related problems**: Discuss with colleagues and team, attention of the management, planning and capacity (in the context of offerings) tuned with expertise, consultation with staff about support services and processes.
Our four building blocks dominating our actions and decisions.
MARKETING AND COMMUNICATION

We selected 5 topics for the Industry’s Thought Leadership campaign: Smart Industry, Block Chain, Management of Joint Innovation, Electrification of Chemistry, Earth Observation and Air Quality. PR and content marketing will be focused on these topics, supported by ‘white papers’. Improve customer satisfaction and reduce cost of sales by studying customer journey and improving customer experience, is an important goal for 2017. Next to the more ‘traditional’ instruments like conferences, trade shows and (digital) magazines, we will use social media for marketing.
FINANCIALS
The table below shows the external order intake as planned in our 2017 Annual Budget. Of course many uncertainties exist, especially in the Space and Science domain with very large projects. However, this could also create an upswing and we see many opportunities in the market to support our ambition of 100 mio euro order intake in 2017.

<table>
<thead>
<tr>
<th>Roadmap</th>
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<tbody>
<tr>
<td>Semiconductor Equipment</td>
<td>12.011</td>
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<tr>
<td>Flexible and Free-form Products</td>
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<tr>
<td>Space &amp; Scientific Instrumentation</td>
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<td>Sustainable Chemical Industry</td>
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<td>Networked Information</td>
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<td>SME, SII and others</td>
<td>1.900</td>
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<td>Total theme Industry</td>
<td>90.361</td>
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</table>
EXAMPLE OF NEW INNOVATION ECOSYSTEM

DUTCH OPTICS CENTRE

Our goals to facilitate innovative ecosystems and to focus more on high(er) TRL applications is best illustrated by the recently started Dutch Optics Centre, a public-private partnership initiative launched by TU Delft and TNO in the field of optics and optomechatronics. DOC is a valorization accelerator, which helps to bring knowledge to the market through products and thus strengthen the Dutch manufacturing industry.
THEME INDUSTRY

On the topic of Industry, we reinforce the innovative strength of the industry by innovation of ICT, products, processes and value chains, by working together with others on groundbreaking and sustainable equipment, tools and concepts.

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