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THE NEW REALITY FOR DUTCH MANUFACTURING

Digitalisation is leading to dramatic changes within the Dutch manufacturing industry. Possibilities are emerging for companies to generate new business by taking advantage of new technologies such as big-data processing, the internet of things, new adaptive robots, 3D printing, nanotechnology, miniaturisation and new sensor technology. These developments are opening up all manner of opportunities to manufacture products more cheaply and with higher quality, as well as to align them much more closely with customers’ needs, as they can increasingly be manufactured on a custom basis.

This new reality goes by the name of Smart Industry and affects both existing companies and start-ups. In some situations it presents a threat, but increasingly it is being seen as an opportunity to increase margins, develop new products and services and tap into new markets. In many cases it is even leading to fundamentally different business models, with new services and ICT applications emerging alongside the physical flow of products.

‘Our ambition is to make industry even stronger and enable it to grow and create jobs. Not participating is simply not an option. Without Smart Industry there is no extra growth and there are no extra jobs.’

Ineke Dezentjé Hamming
Chair of the Smart Industry Team

To boost efforts in this area in a targeted way, the Dutch employers’ organisation FME, TNO (Netherlands Organisation for Applied Scientific Research), the Ministry of Economic Affairs, VNO-NCW (Confederation of Netherlands Industry and Employers), the Chamber of Commerce and the Dutch ICT trade association Nederland ICT have developed the Smart Industry action agenda. This is currently being put into practice within so-called field labs, for example. Field labs are practical environments within which companies and knowledge institutions are developing, testing and implementing Smart Industry solutions in a targeted manner, as well as environments within which people are learning how these solutions can be applied. They also strengthen the links to research, education and policy in relation to a specific Smart Industry theme.

SMART INDUSTRY CALLS FOR COOPERATION AND STANDARDISATION

Smart Industry calls for cooperation between customers and suppliers within a connected network of organisations, but also cooperation in a technological sense between the equipment of different manufacturers (interoperability). In short, cooperation is needed at every level. This cannot be taken for granted, however. To achieve it, clear and generally accepted agreements are required, in the form of standards.

Interoperability allows parties within the supply chain to cooperate more efficiently and effectively. Standardisation makes markets bigger, promotes innovation, provides access to new media, ensures processes and systems work together flexibly and efficiently and stimulates the exchange of information and knowledge inside and outside the supply chain.

Standards are a prerequisite if data is to be exchanged effectively and the necessary level of cybersecurity and the required quality of the ICT infrastructure are to be achieved. These standards may relate to technical protocols, but may also define regulations on questions of quality and security, for example. In some areas standards are already available, while in others they are yet to be developed. Some of this development work is taking place in the Netherlands, but in many cases it is being carried out on an international level.

AN ACTION AGENDA FOR SMART INDUSTRY STANDARDISATION

If Smart Industry is to be a success within Dutch industry, it is therefore important that all existing standards are used in a targeted way (and adapted as required) and new standards are developed where necessary. This action agenda focuses on promoting interoperability and cooperation within the supply chain and encourages the broad application of standards in Smart Industry. It has been developed for and by industry in cooperation
with FME, NEN, TNO and the Ministry of Economic Affairs. The agenda aims to promote the implementation of Smart Industry with the help of standardisation. To achieve this, it is important that:

1. more companies are familiar with Smart Industry standards;
2. more companies are involved in existing and new standardisation activities, e.g. relating to new manufacturing techniques, modern robotics, 3D printing, etc.;
3. the use of Smart Industry standards by companies is encouraged.

This action agenda focuses on the following themes (see Figure 1):

- **Standards within Smart Industry**: which areas are concerned and what is the added value of standards for companies? *(chapter 2)*
- **Action required**: what action is needed to promote the development and use of standards within Smart Industry: who should do what? *(chapter 3)*
- **Background information on the Dutch position**: what is happening on the international stage and how can the Netherlands fit in with this? *(chapter 4)* What developments are taking place in the Netherlands in different sectors and field labs? What trends can be identified? *(chapter 5)*.
2. STANDARDS FOR SMART INDUSTRY COMPANIES

SMART INDUSTRY

Smart Industry is a broad concept that covers a number of technological developments that will change the way companies function and help them improve their competitive position. Many entrepreneurs inside and outside the Netherlands are stressing the importance of standardisation to increase interoperability and innovation and boost the competitiveness of industry.

These technological developments and changes are discussed in this chapter. On the basis of this analysis three areas are defined in which standardisation can play a particularly important role.

TECHNOLOGICAL DEVELOPMENTS AS A BASIS FOR SMART INDUSTRY

The overarching Smart Industry action plan defines three key technological developments that constitute the basis for change within the manufacturing industry (see the inner circle of Figure 2):

1. **Manufacturing technologies**: the emergence of new manufacturing technologies, such as industrial robotics, 3D printing and printed electronics. These technologies make it possible to manufacture with fewer defects and (in many cases) at a lower cost. They also allow many more products to be manufactured on a custom basis.

2. **Digitalisation**: the far-reaching digitalisation of industry by means of sensors and high-quality ICT networks with good exchange protocols and the application of sensor technology to record and control production. Internet-of-things technology is resulting in more and more data sources: all kinds of devices and sensors are being connected to the internet. Thanks to big-data technology, new insights can then be gained from analysing this data: companies have access to more information that can be put to use in the design and production process.

3. **Network centric**: a network approach that involves connecting production equipment and people both within and beyond the value chain. New digital technologies allow data to be shared in a controlled way. That means companies can increasingly specialise in a particular area of production and customers and suppliers can work together on a product more easily.

CHANGES WITHIN COMPANIES

These technological developments are leading to major changes within companies, business processes and business models, including the following (see the outer circle of Figure 2):

1. **High-value information**: Manufacturers can improve their products and processes by analysing the constant flow of usage data from their systems. This may be data from a production process, but also data received from smart sensors on a product that has already been delivered, for example. Manufacturers will therefore be able to monitor the quality of their products more effectively during production, as well as over the life of the product, and in this way respond better to their customers’ needs.

2. **Customer intimacy**: Customer intimacy is increasing, as it is possible to offer greater customisation at a lower cost price and customers are able to participate in the product design process. The product can therefore be tailored entirely to the customer’s needs.

3. **Value chain participation**: Digitalisation is changing production chains and leading to closer cooperation between various parties in the chain. As a result, production chains need to be organised in a different way. New parties may become part of a chain and existing parties may specialise in a particular production process. Parties are also starting to cooperate more closely: customers and suppliers are working together on designs to ensure the product meets the customer’s needs and can be manufactured efficiently.

4. **Flexibilisation**: New manufacturing technologies are making it possible to increase the flexibility of the production process. Using robots, for example, makes it easier to switch from one product to another, allowing custom products to be supplied more easily at a lower cost price.

5. **Improving quality**: The availability of data on the product and process and new manufacturing technologies are improving knowledge of the production
2. STANDARDS FOR SMART INDUSTRY COMPANIES

The value of new technologies increases if they can be easily used as part of an overall system. Take a smart robot, for example. Its value is greatest if it can work together with other machines on a production line. The same applies in the case of digital designs: these are extremely useful during the design process, but their value increases further if the manufacturer can also set to work with them straight away in its own business process.

‘If the set of standards available is incomplete or unsuitable, the next step is to consider if it is worth getting involved in the development of new standards yourself – either as a party that “follows” this process at a distance or, more actively, as one that participates in or even drives it. Experience has shown that it is mainly companies that play a leading role in this area that create market opportunities.’

Henk de Vries
Associate Professor, Erasmus University Rotterdam

This interoperability – between companies, within the factory and between companies and their customers – is therefore key for many Smart Industry firms. To achieve it, you need standards with a broader scope than a single supplier or a single product. If we really want to be innovative and enable Smart Industry to succeed in manufacturing, standardisation within the supply chain is essential.
INTEROPERABILITY, NORMS, STANDARDS

If parties want to work together, they need to agree on certain points. These agreements may cover all kinds of different aspects: legal, technical, processes, etc. Interoperability refers to the ability to work together: the extent to which different organisations (or systems) comply with agreements.

In some cases in the Netherlands we talk about a norm. Although standards and norms are frequently used synonymously, in Dutch a norm refers to a standard that has been set via a recognised standardisation body. In the Netherlands the body in question is NEN (Netherlands Standardization Institute), while internationally this concerns organisations such as ISO. This process gives the user confidence that the standard has been set using a recognised procedure and guarantees the openness of a standard, for example. If reference is made to a standard in legislation, this is therefore often a norm that has been set via NEN. Many standards are set by standards organisations other than formal standardisation bodies. In this action agenda the term ‘standard’ is used: this is intended to refer to all agreements on products, services or processes that have been or will be set both by standards organisations and formal standardisation bodies.

Standards are set in a variety of ways: within sectors, nationally and internationally. Due to the position that Dutch industry occupies on the international stage, it is often advisable to align ourselves with international standards (or vice versa, by putting forward a Dutch initiative within an international standards organisation).

OPEN VERSUS CLOSED STANDARDS

Sometimes the use of a particular standard may be subject to certain restrictions. This may be because a patent has been included in the standard and you have to pay the party who developed it if you want to use the standard, or because the standard is set by a select group of organisations and third parties are not involved in this process. In some cases there are good reasons for taking such an approach, e.g. because very specific technologies are being used. This applies to certain telecom protocols, for example. Often, however, this also gives rise to restrictions, in particular dependence on a particular supplier. Many organisations, including the government, therefore prefer to use open standards.

These are managed using an open and transparent process in which, in principle, anyone can participate. They can also be used free of charge or under non-restrictive conditions. A closed standard is only accessible to the partners concerned. In this case there is consequently a risk of ‘vendor lock-in’: this means that changing supplier is more difficult, as other suppliers do not have access to the standard.
ECONOMIC IMPACT OF STANDARDISATION

Various studies have shown that standardisation has a positive economic impact. A case study by ISO has revealed that standards achieve this impact in the following ways:

1. Streamlining of operational activities: Standards help streamline business processes by reducing the time needed for specific activities, reducing waste, lowering costs and increasing productivity.

2. Innovation and scaling-up to the markets: Standards provide a basis for innovation, enabling companies to expand their network or manage new production lines more effectively. They also reduce the risks associated with launching new products onto the market.

3. Creation of and access to new markets: Standards are used as a basis for accessing new markets (both domestic and export markets), supporting the market launch of products and even creating new markets.

Studies conducted in France and the UK provide an overview of the quantitative impact that standards have had (see Table 1).

Companies say that participating in expert groups in the area of standardisation boosts their competitiveness. Non-financial benefits mentioned include increased safety of employees and product users and the positive impact on the environment.

STANDARDISATION IN SMART INDUSTRY

Standardisation can play a role within Smart Industry in a number of different ways and in various areas. For example:

- **Smart products**: using the internet of things makes it possible to monitor products after they have been manufactured and have left the factory. This creates opportunities in terms of monitoring the performance and maintenance of these products, for example. Standardisation is needed to collect the data from these products and sensors and to record and use it securely and responsibly.

- **Cooperation in production chains**: here we are talking, for example, about standards that enable companies to work together closely with other parties (such as customers) within a value chain to develop products that can be manufactured flexibly on a custom basis. This concerns standards for sharing orders, designs and production data, etc.

- **New manufacturing techniques**: e.g. standards for flexible manufacturing environments, robots and control of 3D printers, but also relating to the quality and safety aspects that are relevant here.

‘A wealth of knowledge and technology is available, but this is not sufficiently transparent or accessible and is often too complex to apply on your own. Standards help here and being actively involved in developing them gives you a real insight into the problems and the choices to be made. This can significantly speed up the process of growth to maturity.’

Leo van Ruijven MSc
Technology Development Manager,
Croon Electrotechniek

The question, however, is what action should be taken? Do sufficient standards already exist, but is there insufficient awareness of them, for example? Or are there areas in which new developments are needed? This is discussed in more detail in the next chapter.

As a consequence of digitalisation, market participants, technologies and data are increasingly converging and the boundaries between products and services, consumption and production, as well as online and offline, are becoming blurred. As far as standardisation is concerned, this means that interoperable solutions are required, based on open systems and interfaces, to ensure an open market.
### ECONOMIC BENEFITS OF STANDARDS

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<th>GDP</th>
<th>EXPORTS</th>
<th>TURNOVER</th>
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<tr>
<td><strong>France - AFNOR Report</strong></td>
<td>+€15 billion</td>
<td>+19%</td>
<td>+20%</td>
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<td>This is the annual impact resulting from the voluntary use of standards on France’s national production (considered on the basis of the total turnover of French companies).</td>
<td>This is the extra export turnover observed at companies that apply standards or participate in standards committees. These companies achieve an export ratio of 18.2% compared with an average of 15.3% for all companies together. In the case of plastic and rubber production, a stagnating sector, the annual export growth of companies participating in the standardisation process is 10%.</td>
<td>Extra annual growth in total turnover at companies that are members of standards committees. Companies that are members of standards committees achieve annual growth of 4% compared with average growth of 3.3% for all companies together, irrespective of whether or not they participate in a standards committee.</td>
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<td><strong>UK - BSI Report</strong></td>
<td>+£8.2 billion</td>
<td>+£6.1 billion</td>
<td>+£33.3 billion</td>
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<td>28.4% of the annual growth in British GDP* can be attributed to the use of standards. *) based on 2014 prices</td>
<td>The additional British exports that can be attributed annually to standardisation range from 0.3% in the energy sector to 9.9% in the food and drink production sector. British exports were strengthened by the use of standards: the chances of exporting products increase by 41% for SMEs, the chances of exporting products increase by 35% for large companies if they use standards.</td>
<td>Annual increase in total turnover resulting from the use of standards in all seven sectors studied. In the case of food and drink production turnover rose by £10.2 million a year.</td>
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2. STANDARDS FOR SMART INDUSTRY COMPANIES

Harmonising global initiatives is essential to ensure compatibility. If there is a proliferation of standards and a diverse range of parties are involved, this can slow down innovation. It is therefore important to have a clear overview of all relevant standards that are available to Smart Industry to prevent new standards from being developed without any knowledge of existing standards relating to the theme in question.

Standards organisations provide such an overview and bring parties together within committees to help identify gaps and develop new standards.
3. ACTIONS FOR SMART INDUSTRY STANDARDISATION

This action plan presents a number of actions that can be taken to promote interoperability and cooperation within the supply chain and encourage the broad application of standards within Smart Industry.

THREE ACTION LINES, 12 ACTIONS
Within the Smart Industry Standardisation action agenda a distinction is made between 3 main themes and 12 actions:

1. **Enhancing existing knowledge** – increasing awareness of the added value of using standards and creating an insight into the standards available within the field of Smart Industry.

2. **Accelerating developments** – creating new standards and updating existing standards to accelerate Smart Industry developments.

3. **Creating a stronger foundation** – structuring knowledge and skills in the area of standardisation and putting these on the agenda when new Smart Industry curricula and/or field labs are being developed.

The breakdown can be summarised as follows (see Table 2):

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<th>ACTION LINE 1  ENHANCING EXISTING KNOWLEDGE</th>
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<td>Action 2</td>
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<th>ACTION LINE 2  ACCELERATING DEVELOPMENTS</th>
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<tr>
<td><strong>ACCELERATE: CUSTOMISATION AND FLEXIBLE MANUFACTURING</strong></td>
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<td>Action 3</td>
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<th><strong>ACCELERATE: SMART COLLECTION, PROCESSING AND SHARING OF DATA</strong></th>
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<td>Action 8</td>
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3. ACTIONS FOR SMART INDUSTRY STANDARDISATION

ACCELERATE: ROBOTISATION

Action 9
Set up a platform and a Dutch standards committee in the manufacturing sectors with a sub-committee for robotisation and support the participation of companies, start-ups, and educational and knowledge institutions.

ACTION LINE 3 CREATING A STRONGER FOUNDATION

Action 10
Encourage competence development in the area of Smart Industry standards

Action 11
Ensure standardisation is a prominent theme in new field labs

Action 12
Set up a Smart Industry Standardisation Platform

Potential action owners are named for each action; these are the parties who are most closely involved with a particular issue and consequently the most logical ones to address the action in question.

The actions have been drawn up based on the results of studies conducted from various perspectives within industry:
- On the basis of European and international developments originating from the various standards committees, European and global standardisation bodies and consortia.
- Amongst the members within the various FME sectors;
- On the basis of developments, wishes and problem areas identified within the Smart Industry field labs;
- On the basis of existing developments in the area of standardisation in the Netherlands.

More detailed information from these studies is provided in chapters 4 and 5.

ACTION LINE 1

ENHANCING EXISTING KNOWLEDGE

This action line mainly involves disseminating existing knowledge on the usefulness of and need for standardisation in relation to Smart Industry. Drawing up the action agenda is an initial step in this regard.

The action line also involves providing an overview of existing standards that are already available. This will avoid reinventing the wheel and allow further steps to be taken to build on this basis. The overview will also serve as a stimulus to promote the use of existing standards.

One point to emerge from the various studies is that SMEs in particular are less aware of the added value of standards and standardisation activities and how these can contribute to the development and implementation of Smart Industry concepts in the technology industry, e.g. robotics, internet of things, etc. SMEs are also less aware of how they can contribute to Smart Industry standardisation, both nationally and internationally. The following goal has therefore been formulated:

Goal: To increase the number of Dutch companies using standards and participating in standardisation processes.

Om dit doel te realiseren zijn de volgende acties geformuleerd:

Action 1
Include standardisation in existing instruments used to disseminate knowledge related to Smart Industry

Bodies including the Chamber of Commerce, TNO and NEN offer instruments that can be used to disseminate knowledge related to Smart Industry. Standardisation should be included in this.
This could be done as follows:

• Including TNO’s Standardisation Scan in the Smart Industry Scan. This Standardisation Scan provides a step-by-step insight into developments in the area of Smart Industry standardisation and the opportunities available to any company.1

• Making information available as part of the online Smart Industry Bootcamp organised by the Chamber of Commerce.2 Here leading experts share their knowledge of the value of standardisation based on information provided by NEN, amongst others.

• Providing information on relevant standards and standardisation processes on the NEN website.

• Using the media made available by the Smart Industry Programme Office and the project partners to disseminate information (e.g. the Chamber of Commerce’s information number and the website of the Smart Industry Programme Office).

• Producing and distributing an introductory film on Smart Industry standardisation.

**Action owners:** Chamber of Commerce, Smart Industry Programme Office and the future Smart Industry standardisation platform.

**Action 2**

Monitor and report on Smart Industry standardisation within Dutch industry

A number of targets have been included in the Smart Industry action agenda, such as:

• increasing the percentage of companies that are aware of Smart Industry to 80% (2018).

• increasing the percentage of companies putting Smart Industry into practice from 14% to 40% by 2018.

As part of the Smart Industry action agenda it is also important to consider the role of standardisation, for example by measuring the number of companies participating in standardisation initiatives and monitoring the number of companies applying Smart Industry standards. Within this context it is useful if companies involved in the area of standardisation are able to find/contact each other to promote the exchange of knowledge.

A survey is being conducted amongst companies to examine the impact of standardisation by determining the extent to which issues relevant to standardisation are on the radar of companies, including:

• Quality, productivity and sustainability of production processes.

• Cost saving

• Data ownership

• Safety and security

• Privacy

• Etc.

**Action owners:** Smart Industry Programme Office, Chamber of Commerce, NEN

**ACTION LINE 2**

**ACCELERATING DEVELOPMENTS**

This action line is all about accelerating the implementation of Smart Industry. Smart Industry is characterised by a number of innovative developments, some of which are new technologies, while others are new business concepts that these technologies make possible.

Standardisation can play a key role in accelerating these developments. Steps taken as part of the Smart Industry programme include setting up field labs within which companies and knowledge institutions are working together to give these developments a boost.

The following goal has been formulated on the basis of the above:

**Goal:** to accelerate new Smart Industry concepts by developing new standards, reusing and updating existing standards.

The studies have revealed that there are a number of areas in which standardisation is particularly promising:

1. **Customisation and flexible manufacturing:** new manufacturing technologies and flexible programming techniques allow products to be manufactured in increasingly small series. Products can therefore be tailored increasingly to the individual customer’s needs, with fewer defects, consistently high quality and a reasonable cost price, creating opportunities to
bring production back to the Netherlands. However, this also means that the product design process has to be handled in a certain way: if every product is unique, every design also has to be adapted to the customer’s needs. It also imposes certain requirements on the manufacturing environment itself: this needs to be configured in an increasingly flexible way to ensure products can not only be manufactured on a custom basis, but also at an acceptable price. This can be achieved using high-quality software to reduce the amount of preparation required and allow the manufacturing environment to configure itself on the basis of a digital design. At present this approach is being tested as part of the ‘Flexible Manufacturing’ field lab.

2. Smart collection, processing and sharing of data: many Smart Industry concepts are based on a close relationship between the customer and supplier: cooperating and sharing information are key. This may be because the supplier offers servicing of the product delivered or because the customer wants to share very specific design data. At the same time, parties are increasingly working together within changing relationships: they can be partners one day and competitors the next. Against this background it is important to ensure data can be shared smartly and securely. The increasing diversity of products, partners and services can only be addressed by means of further-reaching standardisation, as this will ensure the production equipment of different suppliers is better aligned and will avoid the need for a costly implementation project before data can be shared smartly.

3. Robotisation: the development of robots to take over certain tasks that are often performed manually at present is a growing trend in all branches of industry and society. This is a development that brings ICT and mechanical engineering together to create a discipline referred to as mechatronics. Smart control algorithms and the use of big data are allowing robots to become increasingly autonomous. Robotisation is characterised by a combination of numerous parameters to ensure consistently high quality and precision, as well as by the fact that robots can be deployed with no time restrictions.

The development and application of robots has an important role to play in Smart Industry.

Key issues linked to further standardisation in the area of robotisation are:
1. Collaboration protocols between robots and humans;
2. Standardisation of complex robot control programs;
3. Classification to define different types of robot and their fields of application, as well as classification of robots and non-robots.

Numerous start-ups specialising in robotics have emerged around the universities of Delft, Eindhoven and Twente. Robotics is mainly being standardised on an international level. New standards are needed in particular for the new types of robot that interact directly with humans.

The following actions have been defined for each of the three sub-areas (customisation and flexible manufacturing, smart sharing of data and robotisation):

ACTION LINE 2
ACCELERATE: CUSTOMISATION AND FLEXIBLE MANUFACTURING

Action 3
Develop and use standard formats for exchanging digital models and produce a case study

Digital models are the basis for the custom production of goods. It is therefore extremely important that different parties can interpret these models correctly. That is not always the case at present. In the construction sector, for example, steps are already being taken in this area in the form of ‘Building Information Models’. These need to be developed further at European level and more parties, such as suppliers, need to have access to them.

One example is the so-called DSX standard in the metal industry, which has been developed by Federatie Metaalplaat (FDP), an organisation that brings together parties involved in the sheet-metal supply chain. This standard allows companies in the metal sector to exchange designs more easily in the standard STEP format⁴. However, the DSX standard is still not in

3. ACTIONS FOR SMART INDUSTRY STANDARDISATION
widespread use. If it can be implemented successfully, other sectors may also take it up, as the underlying STEP format is used for all kinds of applications – not only metal – in which 3D drawings play an important role. Links could then be sought with these other sectors (e.g. plastic production).

Various tests involving digital models are being conducted in the field labs. One example is the ‘Smart Bending Factory’ field lab, within which an online portal has been developed where customers can upload their model. This is then analysed online and transferred to the manufacturing environment. An important aspect here is a direct link between design and production. This avoids any time-consuming and labour-intensive intermediate steps to translate the design into production language and eliminates any potential “translation errors”.

‘Smart Bending Factory’ is focusing on metalworking, but similar developments are taking place within the ‘Ultra-Personalised Products and Services’ (UPPS) field lab in the areas of fashion & healthcare.

*Action owners: FDP, Smart Bending Factory field lab, UPPS field lab, Koninklijke Metaalunie, NEN*

**Action 4**

Develop and use standards for controlling a flexible manufacturing environment

A flexible manufacturing environment is important to enable organisations to adapt quickly to changing customer needs and keep costs down. This calls for simple and rapid programming that can be applied uniformly across an entire production line and avoids having to link together different production and control software packages. A high level of standardisation is required to prevent the need for a special language for the machine-to-machine control software at each link in the production
3. ACTIONS FOR SMART INDUSTRY STANDARDISATION

chain. This means it is important that digital models are used to control production lines. It should also be possible to load these models into the manufacturing environment without barriers, as is the case with CAM or CNC programming, but also standards used to control individual equipment (e.g. OPC-UA via industrial databus systems). Several standards that could serve this purpose are available and could be developed further. New technologies such as 3D printing (additive manufacturing), for example, need to be incorporated into an automated production process. The use of digital design drawings for the automatic configuration of a production line also has to be considered.

Action owner: Flexible Manufacturing field lab

Action 5
Develop a new reference architecture for the information infrastructure in the factory

Increased digitalisation within the factory means that in future more and more standards from the field of industrial automation and the generic ICT sphere will become interwoven. The traditional structure of ERP-MES and SCADA/PLC systems is changing, due, for example, to the emergence of new internet-of-things standards, robotisation and the continuing integration of external links in the supply chain.

In future a packing robot, for example, will be able to signal to the ERP system that a particular order is ready. Measurement data from the production process will also need to be stored in a big-data environment so it can be analysed to ensure defect-free production.

Action owners: Flexible Manufacturing field lab, NEN

ACTION LINE 2
ACCELERATE: SMART COLLECTION, PROCESSING AND SHARING OF DATA

Smart Industry is enabling companies to specialise to a much greater degree in a particular step in the design or production process, which can then be easily combined with the other links in the production chain. It is also possible for products to be tailored more to the needs of the individual customer, with the customer and manufacturer working together to produce a flexible design for production. The consequence of this development is that production chains are becoming more complex, while, at the same time, coordination between processes needs to be improved.

For many processes the first step will be to collect data more smartly. Good examples here are the drones used to capture images of crops in the agricultural industry, or the milking robots that collect data on the condition of livestock. This data then has to be shared with other stakeholders: the farmer, but also the milk factory, for example.

Standardisation can play an important role in simplifying the collection and processing of data, as well as the sharing of data between companies, e.g. by means of standard interfaces or common ICT systems. At the same time, sufficient safeguards need to be developed in the form of standards on data-sharing security, e.g. to ensure that only authorised persons/organisations have access to this data.

Action 6
Stimulate the development and standardisation of new smart-data-sharing concepts for different field labs

Different field labs are currently working on new concepts that will allow data to be shared smartly. However, they are mainly considering the specific use case that is relevant within the field lab in question. The cross-fertilisation of knowledge and experience acquired within the various field labs could allow these concepts to be applied more broadly and within other environments too in the future.
The study conducted amongst field labs highlighted the following themes that are suitable for sharing within other bodies:

- **Information infrastructure for sensor data and assets:** the ‘CAMPIONE’ field lab is monitoring large infrastructures using asset information systems. These systems have already proven their worth in the area of offshore wind turbines (the DAISY system) and are now also being used in the process industry. Such environments lend themselves to further standardisation, as the use of sensor data for maintenance is important in many areas.

- **Information broker:** within the ‘Smart Dairy Farming’ field lab an information broker is being developed. This keeps a record of which party can supply which data concerning cattle. As a result, there is no need to upload all data to a central platform and each farmer retains control of his data. An information broker concept such as this could probably also be applied effectively in other situations in which sensor data has to be shared.

- **Semantic technology for supply chain cooperation:** Within the ‘Smart Connected Supplier Network’ field lab semantic technology is being used to facilitate the exchange of order and planning data within the production chain. This semantic technology makes it possible to create a link to a new customer or supplier quickly, as the parties are able to work with the same language (semantics) and can therefore interpret each other's information. That makes it easier for parties to work together in dynamic chains to which new parties have to be added on a regular basis.

Standards that are already available need to be tested to determine whether they are suitable to be used for these new concepts. During the process of developing standards it is necessary to consider whether the technologies referred to should also be standardised at international level.

**Action 7**

**Develop security standards and promote their application for data sharing within Smart Industry**

Smart Industry also concerns the sharing of data between companies. In many cases it involves close, but also flexible relationships: working as partners one day and competing with each other the next. For that reason, ensuring good data governance and data protection is an important aspect. Various new technologies are available that could prove useful here. These are being worked on within the field lab ‘The Garden’, for example. However, many companies are not yet aware of the potential risks.

Many standards on the secure handling and sharing of data are already available. In the area of information security there is ISO 27001, for example, a management standard. There are also standards on issues including the protection and privacy of cloud services, and risk management for cloud services, data and cryptography. It is interesting to note that ISO is working on an ‘Information security code of practice for the aviation industry’. This will set out guidelines in the area of information security for a specific industry. Within Smart Industry it is important to clarify which standards can be specifically applied to this field. Once it is clear which standards are lacking, the standardisation process can begin.

Such standard procedures for secure data sharing within Smart Industry could provide Dutch stakeholders with practical guidance when it comes to exchanging data smartly and securely.

**Action owners:** NEN, TNO, Ministry of Economic Affairs, The Garden field lab and the Dutch Standardisation Forum

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*Action owners: Smart Industry Programme Office, Campione, Smart Dairy Farming and Smart Connected Supplier Network field labs, NEN*
3. ACTIONS FOR SMART INDUSTRY STANDARDISATION

**Action 8**
Ensure alignment with European and international developments in the area of ‘Smart Industry Data Spaces’, ‘Digital platforms for manufacturing’ and the ‘Industrial Internet of Things’

It is highly likely that manufacturing companies will become increasingly dependent on ICT firms that supply systems and platforms for handling data. This dependence could take two different forms:

- A portion of the margin could shift from the manufacturing industry to ICT providers, e.g. because orders and schedules are dealt with via an online platform.
- A market dependence on ICT providers could arise (‘lock-in’), e.g. because technology has to be supplied in accordance with a particular standard.

To maintain a level playing field, it is important to consider open technologies and open platforms that could limit this dependence.

Three developments are particularly relevant within this context:

- The **Industrial Data Space Association** is developing standard connectors for data sharing. Security and data governance are key considerations here. This association is being driven primarily by German industry, although a growing number of international parties are also participating in it. It is important to consider the extent to which these standard connectors could also be used within the Dutch context.
- The **Industrial Internet Consortium** is being driven mainly by the US ICT industry. Here the focus is being placed more on the application of cloud and internet-of-things technology in the industrial sphere.
- Within the **European Alliance for Internet of Things Innovation** – a so-called European Technology Platform (ETP) – market parties and knowledge partners are working together to develop roadmaps for the development of technology related to the internet of things. It is extremely important that the specific needs of the manufacturing industry are also highlighted explicitly within this context.

The Netherlands must ensure that it aligns itself with these trends, on the one hand so that it can follow developments and, on the other, to ensure that Dutch use cases (emerging from field labs, for example) and Dutch companies have the opportunity to provide their input.

**Action owners:** TNO, NEN, Smart Industry Standardisation Platform

**ACTION LINE 2**

**ACCELERATE: ROBOTISATION**

**Action 9**
Set up a platform and a Dutch standards committee in the manufacturing sectors with a sub-committee for robotisation and support the participation of companies, start-ups, and educational and knowledge institutions

Production robots have been used within industry for many years now as a way of speeding up processes. The development of robots to take over certain tasks that are often performed manually at present is a growing trend in all branches of industry and society. This is a development that brings ICT and mechanical engineering together to create a discipline referred to as mechatronics. Smart control algorithms and the use of big data are allowing robots to become increasingly autonomous. Robotisation is characterised by a combination of numerous parameters to ensure consistently high quality and precision, as well as by the fact that robots can be deployed with no time restrictions. The development and application of robots has an important role to play in Smart Industry.

One characteristic of robotisation is that robots operate in a protected environment and generally from a fixed position. Such a design ensures they comply with requirements in the areas of (employee) safety, (data-transfer) security and health, as well as machinery regulations.

The new generation of robots to be developed will be characterised by greater mobility and greater interaction with their environment. This will apply not only to factory robots that collaborate with production workers, but also to robots employed in the agricultural and...
horticultural, livestock farming, logistics and healthcare sectors. Many of the safety issues that are relevant in the case of these robots are the same as those that apply to fixed machines. However, the fact that they will be operating in the human environment, along with their power, speed and freedom to manoeuvre, introduces additional risks associated with this interaction.

New automation concepts such as Human-Robot Collaboration (HRC) and Cyber-Physical Systems (CPS) are resulting in changes to production concepts within the manufacturing environment and a need for new standards.

Further developments in this area will need to take the following into account:
• Protocols for collaboration between mobile robots and humans and the level of safety to be guaranteed;
• Standardisation of complex robot control programs;
• Classification to define different types of robots and their fields of application, as well as classification of robots and non-robots.

This results in the following sub-actions:
• Develop the human interaction standards and associated safety standards for (industrial) production and associated safety standards linked to intrinsic electrical safety and mechanical impact. Raise awareness amongst users;
• Develop complex control standards and performance criteria for robots relating to accuracy, speed, output, margins for error, capacities, etc. ISO 9283 can serve as a basis from the traditional industrial robot environment;
• Develop robot modularity and standardise complex robot processes; standards for modules within robotics are important for the development of safety systems, while the standardisation of complex processes will create more flexible programming options;
• Promote cooperation between companies, start-ups, and knowledge/research and educational institutions in relation to the development and coordination of standards for industrial production using robots and the development of new robot products.

Active participation by Dutch companies, both established firms and start-ups, in the development of international standards for robots and robot equipment will help them increase their market share and strengthen their competitive position. As many start-ups are in the first phase of the innovation cycle, the time and money that needs to be invested often presents too great a barrier to participation in a standards committee. It is therefore advisable to facilitate participation by Dutch companies, but also educational and knowledge institutions, in standards committees and consequently in the development of international standards for robotics during this phase of the innovation cycle.

Action owners: Ministry of Economic Affairs, NEN, FME

**ACTION LINE 3**

**CREATING A STRONGER FOUNDATION**

This action line focuses on supporting Smart Industry standardisation in a sustainable way. That means creating a stronger foundation in terms of knowledge and skills. To achieve this, it will be necessary to invest in new knowledge of standards and skills will need to be developed further. The following goal has been formulated on the basis of the above:

**Goal: To create a stronger foundation for Smart Industry standardisation by developing knowledge and skills.**

The following actions can be defined to achieve this:

**Action 10**

**Encourage competence development in the area of Smart Industry standards**

Knowledge of the value of standardisation can be enhanced by incorporating standardisation into curricula, e.g. as part of a ‘competence framework’. This is already happening in some cases: at Fontys University of Applied Sciences students learn to design robots after acquiring knowledge of the relevant standards. It is also recommended that training courses on Smart Industry focus on the importance of standards.
3. ACTIONS FOR SMART INDUSTRY STANDARDISATION

to innovation and on participation in standardisation projects as a strategic instrument.

*Action owners: FME, TNO, NEN, Fontys, Saxion, Smart Industry Programme Office*

**Action 11**
*Ensure standardisation is a prominent theme in new field labs*

Standards are generally recognised as an instrument that can be used to disseminate knowledge acquired during innovation projects. Standardisation has therefore now been included as a theme for the research proposals that can be submitted under Horizon 2020, the European Commission’s programme to stimulate European research and innovation.

Based on past experience (including that acquired from Smart Grid pilots*6*), it is recommended that, from the moment field labs are set up, attention be paid to identifying the standards already available in the area concerned, determining their usability and clarifying where there is a need for new standards. By using the knowledge that has been documented in standards, you can avoid reinventing the wheel when it comes to dealing with implementation issues and coordination problems and can bring the start line nearer.

In the case of groundbreaking pilots, the knowledge developed can be documented in new (preferably European or international) standards, giving Dutch companies a competitive advantage due to the international acceptance of a standard developed by Dutch industry.

*Action owner: Smart Industry Programme Office*

**Action 12**
*Set up a Smart Industry Standardisation Platform*

It is extremely important that standardisation initiatives are coordinated – that companies know where they can go for information in the area of Smart Industry standardisation and that the Netherlands and Europe have a presence in the right places when it comes to international initiatives.

A special sub-group has been set up with this in mind within Germany’s Industrie 4.0 platform.

‘The key question is: can stakeholders turn these effects to their advantage by actively participating? In many cases they can and that is the reason to get involved. I am therefore talking about market parties actively thinking about standards as one of the many tools at their disposal to help them achieve their strategic objectives. That means they need a good insight into what these objectives are, but also into what is going on in the outside world.’

*Paul Coebergh van den Braak*
*Senior Director of Standardisation, Philips IP&S*

This action agenda proposes various actions that are designed to help the Netherlands and Dutch industry to adopt and develop Smart Industry standards. Based on the current developments we have selected a number of themes that are particularly important.

To monitor the implementation of these proposed actions and keep track of developments on an ongoing basis, we are putting forward the idea of a standardisation platform within Smart Industry.

This platform will have the following goals:

1. **To coordinate the Netherlands’ position in relation to international strategic discussions on Smart Industry standardisation**

Some 90% of Smart Industry standards are set internationally, including within the ISO Strategic Advisory Group on Smart Industry/Industry 4.0/Smart Manufacturing and the IEC Strategic Group on Smart Industry. Stakeholders in various countries are endeavouring to strengthen their strategic position by participating in the formulation of standards. International initiatives are, of course, also being developed by market parties such as the Industrial Internet Consortium or Industrial Data Space.
2. To coordinate the various standardisation initiatives
The various industry reference models in force, originating from countries including Germany and the United States, make it clear that Smart Industry can be regarded as a system made up of many different components. For many of these components standards and standardisation activities already exist. Coordinating these standardisation activities and positioning them within a reference model to determine where the issue concerned lies within the complex industrial sphere is therefore an important task.

3. To coordinate the various standardisation initiatives with the Dutch field labs and developments in the sectors
Based on past experience (including that acquired from Smart Grid pilots) it is recommended that, from the moment field labs are set up, attention be paid to monitoring the standards that can be used and where there is a need for new standards. By using the knowledge that has been documented in standards, you can avoid reinventing the wheel when it comes to dealing with implementation issues and coordination problems. In the case of groundbreaking pilots, the knowledge can be documented in new (preferably European or international) standards, giving Dutch companies a competitive advantage (as the new standards will be closely aligned with Dutch interests). A current example is new materials technology, e.g. nanotechnology.

4. To intensify the dissemination of existing knowledge and information on the conditions that apply to standards
A considerable amount of knowledge relating to existing technology has been documented in standards. Standards can be used by companies as a practical guide when resolving all kinds of implementation problems. Often standards form the basis for national and international training and knowledge transfer, as they have proven to be an efficient and effective tool for documenting and subsequently disseminating knowledge. Knowledge could be disseminated using an online tool (see http://smartgridstandardsmap.com/ for an example).

5. To perform a monitoring and coordinating role, rather than drawing up standards itself
Standards (whether international, European or national) are developed within industry consortia and standards committees. The platform could, however, help companies address any new standardisation issues that arise, for example by offering them access to standards organisations.

Examples of activities that the Smart Industry Standardisation Platform could perform include:
- Linking the various standardisation initiatives
- Increasing expertise in the area of standardisation within Smart Industry
- Developing and dealing with a number of actions resulting from the Smart Industry Standardisation action agenda
- Monitoring the actions resulting from this agenda and setting out framework conditions to promote their implementation
- Raising awareness of the importance of standardisation within Smart Industry
- Formulating the Netherlands’ position and putting this forward within international/European standardisation initiatives in the area of Smart Industry
- Prioritising various standardisation themes to be addressed within Smart Industry
- Encouraging the introduction of standardisation themes within the various field labs
- Creating an overview of available standards and standards yet to be developed
- Developing a Dutch architecture or ensuring alignment with an existing architecture

Potential participants in the platform may include: NEN, research and educational institutions, TNO, FME, Metaalunie, industry associations, the Chamber of Commerce, RVO (Netherlands Enterprise Agency), Nederland ICT, ICT standards organisations and the Dutch Standardisation Forum, with an independent chair at the head of the platform.

Further steps in relation to this platform will be worked out in more detail in 2017 in consultation with the project partners and the Smart Industry Programme Office.
4. WHAT ARE THE INTERNATIONAL DEVELOPMENTS?

4.1 THE INTERNATIONAL ENVIRONMENT

The international environment in the area of Smart Industry standardisation is extremely diverse. This can be explained to a large extent by the fact that many different sectors are affected. Some 90% of the standards for industry are developed at global or European level.

Global level
In many cases Smart Industry standardisation is being carried out by formal, global standards organisations (ISO, IEC and ITU, etc.), consortia and associations. An important role has also been reserved for companies. As sectors in which SMEs are strongly represented, such as the machinery and automotive sectors, have a greater focus on ICT implementation, SMEs – with their strong networks – are in an excellent position to transfer their strengths to other sectors, such as the ICT and service sectors. This process could contribute significantly to the development of standards. In addition, active steps are being taken in this area by various companies, such as Google, which announced in 2014 that it was developing an open innovation and research programme linked to the internet of things (IoT), with the aim of further developing open standards. Companies such as SAP, Deutsche Telekom, Siemens, Bosch, Infineon, Volkswagen, ABB and IBM have also come together within Germany’s Industrie 4.0 platform to reach agreements on Smart Industry standards. After all, any party that determines the standards used to allow machines and products to communicate with each other is also in the best position to become a leading player. Internationally, the ambition is to implement Smart Industry with a limited number of new standards. This is in keeping with the principle acknowledged by the EU that no new standards should be created at European level if there is an existing international standard that can be used. That means the EU is actively seeking to align itself with international standards.

European Commission
The European Commission has an active standardisation policy geared towards promoting standards to support the regulation and competitiveness of industry. It has also published various reports in relation to Smart Industry standardisation (e.g. Rolling Plan for ICT standardisation, Advancing Manufacturing – Advancing Europe, Union Work Programme for European Standardisation (UWP), Digitising European Industry – Background Paper, etc.). These reports deal with issues including the importance of and stimulus resulting from using standards to implement Smart Industry.

They indicate, for example, that standards play a key role in accelerating industrial development.

In April 2016 the European Commission presented a priority plan for ICT standardisation as part of a technology package for the Digital Single Market. The European approach consists of an integrated plan including five top priorities for standardisation (cloud computing, internet of things, 5G, cybersecurity and data) and a plan to promote key digital standards on an international level in cooperation with industry and standards organisations. Various technology platforms, such as the Alliance for Internet of Things Innovation (AIOTI) and the 5G public-private partnership, are currently guiding relevant roadmaps. In addition, the European Commission offers funding to the standards organisations ETSI, CEN and CENELEC, and, according to its communication for ICT standardisation, also plans to provide financial support via research and innovation programmes (Horizon 2020 and CEF). The Commission will also be offering financial support to large-scale pilot projects within these priority areas to validate and improve the adoption of standards.

European countries
A number of European countries have drawn up action plans setting out initiatives designed to shape Smart Industry and the related standardisation process. As markets and value chains extend across the globe, it is important that these actions plans are expanded to European and global level. Countries with an action plan in place include Germany (Industrie 4.0), France (Industrie du Futur) and the UK (Catapults, Strengthening UK manufacturing supply chains). These countries are focusing greater attention on Smart Industry standards than countries of a similar size to the Netherlands.

Of the major European countries with an action plan, Germany is investing the most in Smart Industry.
standardisation. This is expressed in the Standardisation Roadmap for Industry 4.0, which was drawn up by the “Standardisation Roadmap” working group, established by the DIN/DKE steering group. This roadmap is intended to serve as an inventory and a means of promoting communication between the parties involved, which come from various technological sectors (such as automation, ICT and manufacturing technology). Germany’s Industrie 4.0 platform will also be coordinating standardisation activities in the area of Industry 4.0 within numerous sub-committees and various organisations and associations. One example of a standardisation initiative that was recently launched is the Industrial Data Space Association, which is focusing on data sharing in industry.

‘Smart Industry is a discipline that is becoming increasingly international, including for SMEs. Standardisation is therefore largely taking place on an international level, via ISO and IEC. The Netherlands is geared more towards exports than many other countries. For that reason the Netherlands is participating in the ISO Industry 4.0/Smart Manufacturing advisory group so we are involved in determining the standardisation themes for Smart Industry on a global level. It is important that Dutch companies participate in international initiatives to ensure their products and working methods are incorporated into standards, as this will help them quickly open up markets and generate sales abroad.’

Bert Nagtegaal Msc
FME

Various initiatives being developed in other countries are seeking to align themselves with the German initiatives, and alliances are being entered into. In October 2015, for example, Industrie 4.0 in Germany and Alliance Industrie du Futur in France joined forces within the framework of a shared action plan. Alliance Industrie du Futur brings parties from science and industry together with the aim of modernising French industry. This Franco/German alliance aims, amongst other things, to promote standardisation and help the economy to flourish within the framework of the EU Single and Digital Single Market strategies. Both initiatives have agreed to focus in the first instance on a common framework derived from the Reference Architecture Model for Industry 4.0 (RAMI model), which is discussed later in this chapter. Themes such as robotics and additive manufacturing will be considered at a later stage. The parties will be making an initial version of a common roadmap for international standardisation available by the end of 2016. On the basis of its Made in China 2025 strategy, China – which is prioritising standardisation in the area of intelligent manufacturing – is also planning to build on sophisticated manufacturing techniques derived from Germany’s Industrie 4.0 initiatives, as well as from the US and the country’s existing domestic internet industry. Another example is the relationship between the German Commission for Electrical, Electronic and Information Technologies (a joint initiative of DIN and VDE) and the SAC (the Standardisation Administration of China), who are planning to work together more closely when it comes to developing and setting standards for Industry 4.0. The South Korean government is also working together with the Fraunhofer Institute and Siemens in Germany, on the one hand, and with the CWC in the US, on the other, to standardise internet of things platforms.

Countries outside Europe
The United States, China, Japan and South Korea are also focusing greater attention on Smart Industry standards than countries of a similar size to the Netherlands. A number of examples of activities in this area are described here. One major initiative launched in the United States is the Smart Manufacturing Operations Planning and Control Program of NIST (National Institute of Standards and Technology), which is focusing on improving innovation in the US and the competitiveness of industry by means of intelligent manufacturing systems, an area in which standards have an important role to play. This programme will enable smart manufacturing based on performance metrics, process control, prognostics, health management (including diagnostics and maintenance), integrated wireless platforms, industrial control security and efficient systems analysis during operations. NIST has drawn up a report entitled ‘Current Standards Landscape for
Smart Manufacturing Systems and has developed a reference architecture model (Smart Manufacturing Ecosystem), which will be discussed later in this chapter.

The ‘Made in China 2025’ strategy is a Chinese initiative that aims to improve Chinese industry in the area of Advanced Manufacturing, with priority given to standards in the area of intelligent manufacturing. This goal will be achieved by accelerating the integration of domestic standards and creating a standardisation system for intelligent manufacturing.

In Japan the “Industrial Value Chain Initiative” has been set up. This was launched in mid-2015 by 30 companies, in response to the German standardisation initiatives in the area of Industry 4.0. This initiative aims to create standards for linking factories and to internationalise Japanese industrial standards. The participants include Mitsubishi Electric, Fujitsu, Nissan Motor and Panasonic.

The Smart Factory Standard Research Council in South Korea is made up of private parties and was established to respond to international standardisation activities and promote locally developed standards in the area of Smart Industry. The South Korean government also has plans to set up a Smart Factory Standardization Forum, to enable it to respond to international Smart Industry standards and ensure compatibility with existing Smart Industry standards.

4.2 REFERENCE ARCHITECTURE MODELS FOR SMART INDUSTRY

Various reference architecture models have been developed for industry, with the US and German models being the most well known. In the United States this is the NIST model (Smart Manufacturing Ecosystem), while in Germany the model in question is the RAMI (Reference Architecture Model for Industry 4.0) model, which has been developed by industry associations.

The NIST model is used as a basis for categorisation and evaluation with a view to applying existing standards to intelligent manufacturing systems, presenting a detailed overview of emerging standardisation activities in the area of smart manufacturing and identifying areas in which new standards are required to implement intelligent manufacturing systems (see Figure 4).

The RAMI 4.0 (Reference Architecture for Industry 4.0) model is intended to provide an overview of existing standards, required standards and any lack of clarity or overlap between standards that needs to be resolved in the area of Industry 4.0.
This model is presented in three dimensions. On the vertical axis are various layers representing different perspectives (such as communication, functional product descriptions and business processes) to illustrate the different angles from which the implementation of Industry 4.0 is being considered. The functional hierarchy, which attempts to clarify the level at which a standard operates, is presented on the horizontal axis. Finally, all this is framed by adding the life cycle, which indicates at which point within the industrial development process a standard applies (see Figure 5).

4.3 EXISTING SMART INDUSTRY STANDARDS

Many standards in the area of ICT are developed by international consortia, often made up of multinationals, which are not part of formal standardisation bodies like IEC, ISO and ITU. However, this in no way diminishes the value of these standards and they are commonly used in industry. IT standards are influenced by standards from the United States, while standards in the area of machines and facilities are generally European. Standards relating to electrical engineering are frequently based on international standards, such as the HD-IEC 60364 series for low-voltage electrical installations. This series is also known as NEN1010, which has broad applications in industry and in the residential and non-residential building sectors.

The various areas of production each have their own standards, but in many cases standards are still lacking between these areas. Due to the trend that Smart Industry is setting in motion, i.e. the creation of connections both within and outside links in the production chain, the development of standards and harmonisation of standards from different sectors are important tasks.

The international study performed has revealed that there are various areas of technology in which Smart Industry standards already exist, such as:

- Information security
- Industrial automation
- Industrial measurement, control and automation
- Open electronic data interchange
- Systems aspects for electrical energy supply
- Communication technologies
- Cloud computing
Standardisation work is also taking place at a global level on the following topics:

- **Robotics (ISO/TC 299):** the ISO/TC 299 technical committee is developing international standards for innovative areas of robotics, such as personal care and service robots, medical robots and industrial robots.

- **Big Data (ISO/IEC JTC 1 WG9):** this working group is focusing on five themes (definition of requirements, use cases, architecture, security and privacy). It is working together with various standardisation groups to ensure existing standards are used to the greatest possible extent.

- **Internet of Things (ISO/IEC JTC 1 WG10):** this working group is working on the identification of use cases, network-level technologies and the areas within the internet of things in which standards are lacking. It also wants to offer other standardisation working groups the opportunity to join in discussions on the development of global standards.

In addition, numerous standards have already been developed for traditional manufacturing and for machines. At present, however, these are still insufficient to make all aspects of smart manufacturing possible. This is the case in particular in the following areas:

- Cyber-Physical Systems (CPS) Security,
- Cloud-based manufacturing services,
- Human-robot collaboration,
- Supply chain integration,
- Interoperability of the manufactured components (internet of things system) with ecosystems,
- Rapid modelling, simulation and testing,
- and data analytics.

### 4.4 OPPORTUNITIES FOR THE NETHERLANDS ARISING FROM THE INTERNATIONAL ENVIRONMENT

In the Netherlands various standards committees are working on international standards that will be relevant for Smart Industry, e.g.:

- **Additive manufacturing (ISO/TC 261; CEN/TC 438)**
- **Cloud computing (ISO/IEC JTC 1 SC38)**
- **Information security (ISO/IEC JTC 1 SC27)**
- **Industrial automation (ISO/TC 184; CEN/TC 310)**
- **Industrial measurement, control and automation (IEC/TC 65; CLC/TC 65CX)**
- **Open electronic data interchange (ISO/IEC JTC1/SC30)**
- **Systems aspects for electrical energy supply (IEC TC 8)**

By aligning itself with these international standards and playing a role in these standards committees, the Netherlands will be able to influence the content of global standards and remain at the vanguard of technological developments in the area of Smart Industry. IEC and ISO have set up strategic advisory groups to gain an insight into the main fields of standardisation that are relevant when it comes to shaping and facilitating Smart Industry:

- **ISO Strategic Advisory Group Industry 4.0 – Smart Manufacturing**
- **IEC Strategic Group 8 Industry 4.0 – Smart Manufacturing**
5. WHAT ARE THE DEVELOPMENTS IN THE NETHERLANDS?

5.1 THE DUTCH ENVIRONMENT

In addition to the international study, a study was also conducted within Dutch industry when this agenda was being drawn up:
- Discussions were held with Smart Industry field labs, who were asked whether developments are taking place within the field lab that are relevant to standardisation and vice versa.
- Via the FME’s clusters, specific developments and their impact on Smart Industry standardisation were examined.
- An inventory was also carried out within the NEN standards committees to determine which themes are already being addressed within standards committees and where the focus should be placed in terms of standardisation within Smart Industry.

Certain themes are very sector-specific, such as the standardisation of smart grids for the electrical industry or food safety requirements in the agrifood sector. At the same time, a number of cross-sector trends have been identified. These emerged in a number of sectors or field labs and were subsequently included in the action agenda.

This chapter briefly outlines the conclusions that can be drawn from this analysis. It ends with a table in which these findings have been used to determine the actions for the action agenda.

5.2 FIELD LABS

A number of field labs were launched in 2015. In mid-2016 these have now reached various stages of maturity. The field labs cover many of the technologies required to make Smart Industry a success.

Some of them are focusing on a concrete standardisation activity. The ‘Smart Connected Supplier Network’ field lab, for example, is working on information standards that can be used to link up companies in the high-tech supply chain. Where possible, use is being made of relevant international standards, with specific additions as required to ensure the needs of this sector are met.

A number of field labs are working on developments that could lend themselves to further standardisation. Examples include:
- The field lab ‘The Garden’, which comprises an important security component for data sharing. Such components (architectures, frameworks, etc.) could be relevant to standardisation.
- Various field labs within which data-sharing architectures are being developed. The ‘Campione’ field lab, for example, is examining data-sharing architectures for maintenance in the process industry, while the ‘Smart Dairy Farming’ field lab has developed an information broker that allows sensor data to be shared throughout the livestock chain. Although these concepts have been specifically developed for the industry concerned, they have the potential to be applied more broadly in other sectors too.
- The ‘Flexible Manufacturing’ field lab, amongst others, is experimenting with a new generation of factory information infrastructure that will make it possible to achieve flexible manufacturing environments that manufacture with zero defects and can switch seamlessly from one product to another. This field lab therefore has the potential to become a hub for standardisation initiatives in this area.
- The ‘Smart Bending Factory’ field lab is one example where digital models are being used to control the manufacturing of metal objects. This ties in with the standardisation initiatives of parties including Federatie Metaalplaat. Such an approach could also serve as a model for other manufacturing technologies and materials.

Lastly, there are a number of field labs in which the emphasis is being placed on a specific technology or product/market combination. These field labs are mainly concerned with the application of standards, rather than looking into developing new standards themselves. In other cases it is still too early to say whether the development in question should be considered for standardisation.

Examples include:
- The UPPS field lab: this is examining the area of ultra-personalised products. It is focusing on cases from areas including fashion and medicine.
The participants are firstly investigating what would be possible and how this could be set up. Looking further ahead, controlling 3D printers could be a potential area requiring standardisation. However, it is most likely that the field lab will apply such a standard, rather than developing it itself.

- The FreshTeq field lab is looking into the possibilities of employing robots in greenhouses. Further standardisation in the area of robotics is important here, but the focus is primarily on applying robots in this specific field and integrating them with existing systems (e.g. greenhouse control systems).

5.3 FME SECTORS

The FME, the employers’ organisation for the technological industry, is divided into a number of sectors. Each of these represents part of the manufacturing industry. Discussions have been held with representatives of the sectors on specific Smart Industry trends and the associated needs in the area of standardisation.

Agrifood

This sector is made up of companies that manufacture machines for, amongst other things, the agrifood sector, which extends from agriculture right through to the processing industry. The trends identified include:

- 3D printing of parts, but also of foods.
- Use of new materials, such as composites.
- Collection of data from the entire chain: from data on the well-being of livestock through to more advanced tracking & tracing of food.
- Increased use of robots (e.g. picking robots in greenhouses) and other autonomous equipment (e.g. unmanned working of the land).

Standardisation is needed to produce digital designs for these machines and new standards are required for measurements during the production process and for the exchange of data. In addition, standardisation in relation to robotics is a particularly important issue in this sector (safety, connection, etc.).

Construction

In the construction sector increasing use is being made of digital models, so-called ‘Building Information Models’ (BIM), for designing, constructing and maintaining buildings.

A number of generic standards (including so-called STEP files) are used as a basis here that are also employed in other fields. These are being expanded to include sector-specific standards for the construction sector.

Design & manufacturing

Digital models are being used to an increasing extent in this sector. The exchange of data via standards is important here, but so too is the security aspect. Model contracts are needed to protect intellectual property. The platforms used to exchange data will also have to comply with the necessary security standards.

Life sciences & health

Data is becoming more and more important in the health sector. This is needed, on the one hand, for patient files, for example, which are increasingly being supplemented with all manner of sensor data. The issues of exchanging and protecting this data are therefore taking on a new dimension. On the other hand, digitalisation is an important theme due to the emergence of all kinds of new equipment, such as surgical robots and care robots. This means new standards are needed in areas including safety and control.

New manufacturing technologies in the area of 3D printing are also bringing about far-reaching changes and are making it possible to print implants digitally, for example. This is another area in which standards are required.

Manufacturing

This sector produces all kinds of machines and factory installations. Robotics has an important role to play here too. However, there is also an increasing focus on the remote monitoring of machines for servicing and maintenance purposes. In addition, machines will increasingly be communicating with each other (machine-to-machine communication and the internet of things). Standardising
the data infrastructure needed within and between factories is therefore a key issue. Attention will also need to be paid to the area of digital skills in this sector, so that machines can be developed, manufactured and maintained, on the one hand, and ultimately put to use in the factory, on the other. This involves processes where people and machines will have to work together, for example.

**Transport and logistics**
The main issue in this sector is the development of all manner of autonomous devices, such as self-driving carts in a distribution centre. Safety standards are important here, as are standards for controlling the equipment and exchanging data.
5. WHAT ARE THE DEVELOPMENTS IN THE NETHERLANDS?

COMPLETE OVERVIEW
The table below provides a complete overview of all actions arising from the action agenda and the specific findings that resulted in these actions. These findings reflect the specific developments and needs in the area of Smart Industry standardisation that have been identified within field labs and the FME’s sectors.

**Tabel 3**
Overview of standardisation themes within field labs and sectors in relation to the actions under the action agenda

<table>
<thead>
<tr>
<th>Field lab/sector</th>
<th>Development</th>
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</tr>
</thead>
</table>
| Flexible Manufacturing | Automatic configuration of a production cell based on a design | - Design (CAD link).  
- Human-robot collaboration, e.g. safety | - Develop and use standards for controlling a flexible manufacturing environment  
- Flexible Manufacturing a potential action owner for action 3 |
| Construction | BIM | Digitalisation of the construction process, including integration at all levels: article classification and uniform object library | - European standardisation of BIM as a standard within the construction process  
- Entire construction-process chain  
- Standardisation of article classification and object library at European level  
- Industry associations for construction industry suppliers |
<table>
<thead>
<tr>
<th>Field lab/sector</th>
<th>Development</th>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>Smart Bending Factory</strong></td>
<td>24/7 web portal for metalworking orders via the ‘SOPHIA’ platform and cooperation within the supply chain</td>
<td>- File formats (STEP files) and standard libraries for metal</td>
<td>- Standard formats for exchanging digital models</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Security issue</td>
<td>- Smart Bending Factory one of the potential action owners</td>
</tr>
<tr>
<td><strong>Ultra-Personalised Products and Services</strong></td>
<td>New ultra-personalised product propositions, e.g. Exo-L (product used to prevent sprained ankles based on a scan). Field lab is focusing on fashion and healthcare</td>
<td>- Limited, main focus is on getting development off the ground</td>
<td>- Develop standard formats for exchanging digital models</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Possible: controlling 3D printers, handling scans</td>
<td>- UPPS the potential action owner</td>
</tr>
<tr>
<td><strong>Smart Connected Supplier Network</strong></td>
<td>Standardisation of high-tech supply chain (orders, schedules, invoices, etc.)</td>
<td>- Set-up of new generation of ERP/PLM</td>
<td>Cross-fertilisation between field labs. Semantic technology used to facilitate the exchange of order and planning data in the supply chain</td>
</tr>
<tr>
<td><strong>Multi-material 3D printing</strong></td>
<td>New 3D printing technologies and associated data management systems</td>
<td>- ICT solutions for managing large data flows and integrating 3D printing into existing production systems</td>
<td>Control of 3D printers as part of a flexible manufacturing environment</td>
</tr>
<tr>
<td><strong>Agrifood sector (livestock farming)</strong></td>
<td>Automated shed Development from a batch-oriented process to a continuous process</td>
<td>Standards for the automated shed ranging from detection systems through to autonomous workers, standardisation of robot installations (feeding, milking, egg collection, cleaning, etc.)</td>
<td>Standards for controlling equipment in a flexible manufacturing environment</td>
</tr>
<tr>
<td><strong>Agrifood sector (horticulture) and FreshTeq field lab</strong></td>
<td>Development of automated greenhouse</td>
<td>- Standards for operations in and design of automated greenhouse (lighting, ventilation, energy use, condition and growth detection, etc.)</td>
<td>Standards for controlling equipment in a flexible manufacturing environment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Standardisation of automated greenhouse – greenhouse design with automated climate control and energy supply</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Standards for climateneutral greenhouse and greenhouse with zero CO₂ emissions</td>
<td></td>
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</tbody>
</table>
## 5. WHAT ARE THE DEVELOPMENTS IN THE NETHERLANDS?

### ACTION 5  Develop a new reference architecture for the information infrastructure in the factory

<table>
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</thead>
<tbody>
<tr>
<td>Region of Smart Factories</td>
<td>Zero-defect manufacturing requires the collection and analysis of considerably more data in the factory</td>
<td>New generation of Manufacturing Execution Systems (MES) in combination with big-data technology</td>
<td>New reference architecture for information infrastructure in the factory</td>
</tr>
<tr>
<td>Manufacturing industry</td>
<td>Digital factory requires insight into digital factory models</td>
<td>Provide an insight into the various models</td>
<td>New reference architecture, participation in relevant international bodies, such as ISO Strategic Advisory Group (SAG) on Industry 4.0/Smart Manufacturing</td>
</tr>
</tbody>
</table>

### ACTION 6  Stimulate the development and standardisation of new smart-data-sharing concepts for different field labs

<table>
<thead>
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</thead>
<tbody>
<tr>
<td>CAMPIONE</td>
<td>Condition-based maintenance for the process industry</td>
<td>Information infrastructure for sensor systems – asset information systems</td>
<td>Campione as an example of cross-fertilisation between field labs: asset information systems appear to be successful and could also be applied elsewhere</td>
</tr>
</tbody>
</table>
| Smart Dairy Farming    | - Information broker concept  
 - Sharing of sensor data from the livestock chain                          | - Information broker concept/ data-sharing architecture  
 - Connection of sensor systems                                               | Example of cross-fertilisation between field labs. Smart Dairy Farming to serve as an example of the information broker concept and be a potential action owner |
| AgriFood               | Collection of agricultural measurement data using drones and sensors to determine status of crops and soil, analyse ground quality, moisture levels and fertilisation, detect diseases, etc | Measurement data parameters, standardisation of data formats                     | - Establishment of standards for measurement technology  
 - Establishment of standards for processing and for measurement data exchange formats (agridiagnostics) |
| Life science and healthcare | Remote healthcare monitoring                                               | Standardisation of medical monitoring systems                                   | Address specifically from within this sector (also has a link to safety)               |
| Construction           | Domotics                                                                   | Develop standards and a platform for domotics to automate the home environment  | Address specifically from within this sector                                          |
### ACTION 7  Develop security standards and promote their application for data sharing within Smart Industry

<table>
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<tbody>
<tr>
<td>The Garden</td>
<td>Secure data sharing between parties, case studies in various areas including Extended Product Lifecycle Management</td>
<td>Security, both standards and technologies</td>
<td>Develop security standards for data sharing within Smart Industry. The Garden as potential action owner.</td>
</tr>
<tr>
<td>Life science and health cure</td>
<td>Patient data file</td>
<td>Establishment of sophisticated healthcare file systems, information storage and healthcare security</td>
<td>Data security in healthcare – continuation of existing standardisation process</td>
</tr>
<tr>
<td>Life science and health cure</td>
<td>Data imaging techniques</td>
<td>Security requirements for data imaging technology, implantable chips, sensors, imaging techniques</td>
<td>Data security in healthcare – continuation of existing standardisation process</td>
</tr>
</tbody>
</table>

### ACTION 8  Ensure alignment with European and international developments in the area of ‘Smart Industry data spaces’, ‘Digital platforms for manufacturing’ and the ‘Industrial internet of things’

<table>
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<tbody>
<tr>
<td>Manufacturing</td>
<td>Remote machine-to-machine control via external network linked to controlled machines</td>
<td>Security requirements and remote machine control IoT networks and machine control</td>
<td>- Standards for M2M control&lt;br&gt;- Standard conditions and organisation of production control via external networks</td>
</tr>
</tbody>
</table>

*In addition to this specific sector, this need is shared by all the sectors and field labs concerned: almost all parties say it is important to ensure alignment with European and international developments where possible.*

### ACTION 9  Set up a platform and a Dutch standards committee in the manufacturing sectors with a sub-committee for robotisation and support the participation of companies, start-ups, and educational and knowledge institutions

<table>
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</thead>
<tbody>
<tr>
<td>Agrifood sector (agriculture)</td>
<td>Development of unmanned agriculture</td>
<td>- Standards relating to safety of autonomous agricultural machines&lt;br&gt;- Agricultural machines that can be controlled remotely</td>
<td>To be addressed as a generic point by the robotisation sub-committee. Could also be addressed specifically within the sub-sector.</td>
</tr>
<tr>
<td>Agrifood sector (horticulture)</td>
<td>Development of ‘pick &amp; place’ robots in horticulture</td>
<td>- Control standards&lt;br&gt;- Safety standards&lt;br&gt;- Design standards</td>
<td>To be addressed as a generic point by the robotisation sub-committee. Could also be addressed specifically within the sub-sector.</td>
</tr>
</tbody>
</table>
### 5. WHAT ARE THE DEVELOPMENTS IN THE NETHERLANDS?

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</thead>
<tbody>
<tr>
<td>Life science and health cure</td>
<td>Development of surgical robots</td>
<td>- Operating standards</td>
<td>To be addressed as a generic point by the robotisation sub-committee. Could also be addressed specifically within the sub-sector.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Safety standards</td>
<td></td>
</tr>
<tr>
<td>Life science and health care</td>
<td>Development of healthcare robots</td>
<td>Safety standards for human interactive robots</td>
<td>To be addressed as a generic point by the robotisation sub-committee. Could also be addressed specifically within the sub-sector.</td>
</tr>
<tr>
<td>Transport &amp; logistics</td>
<td>Autonomous modes of transport</td>
<td>Automated transport on private sites and in factories and warehouses</td>
<td>To be addressed as a generic point by the robotisation sub-committee. Could also be addressed specifically within the sub-sector.</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>Robots that have to collaborate with humans</td>
<td>- Uniform, modular control standards</td>
<td>To be addressed as a generic point by the robotisation sub-committee. Could also be addressed specifically within the sub-sector.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Safety standards for non-stationary robots</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Safety standards for machines that can be controlled remotely</td>
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</tbody>
</table>

**ACTION 10** Encourage competence development in the area of Smart Industry standards

<table>
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</thead>
<tbody>
<tr>
<td>Manufacturing</td>
<td>Greater attention is needed to encourage participation in standardisation and demonstrate its value</td>
<td>Draw attention to information programmes on the role and value of standardisation and the structure of standards</td>
<td>Competence development has also been explicitly included in addition to general awareness-raising actions</td>
</tr>
</tbody>
</table>
### ACTION 11 Ensure standardisation is a prominent theme in new field labs

<table>
<thead>
<tr>
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</thead>
</table>
| All sectors      | When a new field lab is launched, knowledge of standardisation is essential to ensure a good start and good input for the field lab | - Highlight value of standardisation  
- Explain structure of standardisation: provide information on regulations and standards, formal and non-formal standardisation  
- Ensure information on existing standards can be systematically retrieved (e.g. via the intended platform for Smart Industry Standardisation)  
- Guideline for placing new issues on the agenda internationally | - Provide information on the value of standardisation when a new field lab is launched  
- Refer to existing standards and assist with establishment of new ones  
- International standardisation activities focusing on the theme in question |

### ACTION 12 Smart industry standardisation platform

<table>
<thead>
<tr>
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<th>Standardisation</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Design &amp; manufacturing</td>
<td>Alliances require knowledge to be shared. They need a legal structure to ensure conditions relating to the sharing and protection of knowledge can be put in place.</td>
<td>Development of standards on how knowledge is shared and to safeguard knowledge sharing</td>
<td>Model agreements and the sharing and protection of knowledge are also linked to other actions relating to the conditions applicable to Smart Industry in the area of ICT</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>New areas of work mean employees require new skills</td>
<td>The knowledge of employees needs to be safeguarded and standardised internationally</td>
<td>Internationalisation of training requirements and standardisation of training levels for jobs in Smart Industry manufacturing Smart Industry Platform to develop the skills agenda</td>
</tr>
</tbody>
</table>
INVITATION TO PARTICIPATE

This action agenda creates opportunities for companies to promote the sharing of information within the supply chain and to work together on the development of standards. In this way the Smart Industry Standardisation action agenda is making an important contribution to securing a strong manufacturing industry and robust economic growth in the Netherlands.

Standardisation is an industry-driven process based on voluntary participation. Stimulating industry-driven alliances and practical experimental projects is central to the approach taken in this agenda. Companies interested in addressing a shared standardisation problem can draw on the expertise of standards organisations, research institutes, industry associations and/or the government.

We are keen to enter into dialogue with you to find out how you would like to be involved in the development and application of standards within your business process.

Please contact the Smart Industry Programme Office using the details below:

E-mail: info@smartindustry.nl
Telephone: +31 (0)88-585 22 25

For additional and more detailed information please refer to:
www.rijksoverheid.nl/ministeries/ministerie-van-economische-zaken
ACKNOWLEDGEMENTS

This action agenda is the result of a collaboration between the following organisations and individuals:

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TNO: Matthijs Punter, Claire Stolwijk
NEN: Vlora Rexhepi-Van der Pol, Gertjan van den Akker
Ministry of Economic Affairs: Kristel Wattel-Meijers
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FME represents a substantial portion of the manufacturing industry and regards standardisation as an important tool that can improve interoperability between the links in the supply chain and help companies tap into larger markets.

TNO facilitates the application of scientific knowledge in industry. The digitalisation of the manufacturing industry is an important theme here, including areas such as the exchange of information within supply chains, 3D printing and flexible manufacturing environments. Practical environments based on public-private collaboration, so-called field labs, are being used to promote the application of this knowledge within Dutch industry. Standardisation is a key issue within this sphere and in a number of cases TNO is participating in standards organisations on behalf of Dutch industry. TNO also supports sectors with the development of standards, e.g. via its ‘pressure cooker’ tool, which accelerates the development of standards in the area of supply-chain digitalisation.

NEN is the Netherlands Standardization Institute. Founded in 1916, NEN has grown into an organisation with around 280 employees, over 1,400 standards committees and more than 5,000 active committee members who contribute to the content of standards. In the area of Smart Industry a number of major industrial nations are already working to develop standards. DIN, the German Institute for Standardization, has drawn up a German standardisation agenda for Smart Industry.

In the United States, NIST, the National Institute of Standards and Technology, is underlining the importance of standards within the Smart Industry arena. ISO (International Organization for Standardization) and IEC (International Electrotechnical Commission) are working on a strategy to develop international Smart Industry standards. NEN is representing Dutch interests as part of this process. A significant effort is also being made within ISO/IEC to achieve international standards for so-called enabling technologies, such as the internet of things, cybersecurity and big data.

The Ministry of Economic Affairs is promoting standardisation as an important prerequisite for the development of Smart Industry. Standardisation allows business processes, machines and computer systems to be linked in a uniform way. This will help to make markets bigger and production processes more efficient, and is important to safeguard the open, export-oriented nature of the Dutch economy. The field of Smart Industry is developing at lightning speed, with key developments taking place on a European or global level. It is important that Dutch industry aligns itself with these new digital developments and enjoys the benefits they bring. With this action agenda the Ministry of Economic Affairs is placing the emphasis on an industry-driven standardisation process and in this way is promoting the broad application of standards in Smart Industry.