

# VALUE CHAINS IN THE AUTOMATION INDUSTRY

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A Study Based on the Example of Automation Valley Northern Bavaria  
Report on the Findings of the Study Carried out on Behalf of the Nuremberg  
Chamber of Commerce and Industry



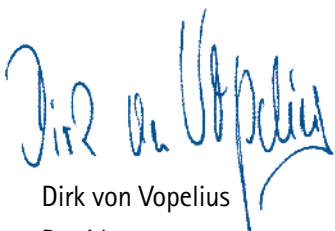
## EDITORIAL

The European Metropolitan Region of Nuremberg (EMRN), with around 3.5 million inhabitants, a GDP of €110 billion, more than 150,000 companies and a labour force of 1.8 million, is one of the strongest economic areas in Germany. The "automation and production technology" field of expertise is one of the seven technological core competencies that have been identified in the WaBe (Growth & Employment) model for sustainable growth and employment in the Metropolitan Region of Nuremberg. It is precisely in this field that the Nuremberg Chamber of Commerce and Industry performs a very active role in managing "Automation Valley Northern Bavaria".

Automation is an interdisciplinary technology that links mechanical engineering, electrical engineering and information technology. In addition, automation contributes to the international competitiveness of the manufacturing industry and offers excellent potential for ensuring value creation at a location whose labour costs are high by international standards.

With a view to the targeted strengthening of this interdisciplinary expertise, the Nuremberg Chamber of Commerce and Industry commissioned the Fraunhofer Working Group for Supply Chain Services (SCS) to make the regional industry structures for the Automation Valley transparent and thereby to pinpoint spheres of activity in which to further expand the field of expertise. An in-depth knowledge of the companies and establishments that are making a contribution to value creation in the field of expertise in terms of research, development, supply and manufacture as well as sales, monitoring, maintenance and repair or other services will enable the potential for new business processes as well as for co-operative ventures and investments to be identified and implemented.

The study therefore provides a consolidation and further development of the EMRN's WaBe model, using the field of expertise of automation & production technology as an example. It is addressed to members of the "Automation Valley Northern Bavaria" network as well as to potential investors and partners at political and administrative levels in the Metropolitan Region and in the Free State of Bavaria. The best way, after all, of developing the core competencies of the Metropolitan Region of Nuremberg as a home for the creative is through joint action.



Dirk von Vopelius  
President



Markus Löttsch  
Chief Manager



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# SUMMARY

## BACKGROUND

Automation technology is one of the keys to the global competitiveness of Germany as an industrial location. Northern Bavaria has industrial, service-oriented and scientific potential of international importance in this field. A wide range of providers of installations and technologies as well as service providers cover all important business segments. These include, for example, the fields of electrical drive technology, instrumentation and control technology, software for automation, system integration and end-to-end solutions for factory automation. The "Automation Valley Northern Bavaria" initiative promotes the strengthening of competitiveness and the innovativeness of Northern Bavarian automation technology.

According to the Prognos study, "Future Markets in 2020", "automation & production technology" is and will continue to be one of the most important international markets up to the year 2020. Automation is an interdisciplinary technology that links mechanical engineering, electrical engineering and information technology. Electrical automation technology alone has around 40,000 employees in more than 300 companies in the region – "Automation Valley Northern Bavaria". In addition, automation contributes to the international competitiveness of the manufacturing industry and offers excellent potential for ensuring value creation at a location whose labour costs are high by international standards.

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## OBJECTIVE

Targeted strengthening of this interdisciplinary expertise begins, in the view of the Nuremberg Chamber of Commerce and Industry, with the performance relationships in our "Automation Valley" – i. e. with the value chains and networks. To this end, the Nuremberg Chamber of Commerce and Industry has commissioned the Working Group Supply Chain Services (SCS) of the Fraunhofer Institute for Integrated Circuits IIS to carry out the present study. The aim of the study is to use an objective view, supported in both quantitative and qualitative terms, as a basis for making the regional industry structures for the Automation Valley transparent and for pinpointing spheres of activity with which to further expand the field of expertise.

## ISSUES TO BE ADDRESSED

- Which companies, products and tasks does the automation area cover?
- What do the value networks in the automation area look like and who are the relevant suppliers for this economic activity?
- Are there »white spots« in the value network of the Metropolitan Region of Nuremberg or in the supplier landscape and, if so, in which locations/for which products?
- Where can potential for new business processes as well as for cooperative ventures and investments be identified and implemented?

## APPROACH

This study is based on analyzing value chain structures and determining the attractiveness of the respective value chains. Parameters for assessing attractiveness include economic indicators like import or export volumes, sales indicators, market growth and the volume of goods flows. The goods flows within the value creation stages are derived via an input/output calculation. This enables those sub-markets that make a particularly strong contribution to the automation area to be identified. "White spots" are determined using data on locally based companies available at the Chamber of Commerce and Industry and in relevant corporate databases. To provide qualitative enhancement and substantiation of the indicators that were determined on a quantitative basis, interviews with experts were conducted.

## FINDINGS

A classic value chain, in which linear processes are linked together in support of a value network, is not typical in the automation industry: Very rarely can value creation in the interdisciplinary automation industry be represented as a linear chain; as a rule, it is to be seen as a value network. Typically, one and the same company can act both as a supplier and a consumer of products and solutions.

Services along the process steps are becoming more and more important. Respondents in the study already estimate the proportion of services in the automation industry of the Metropolitan Region of Nuremberg at approx. 30 percent. What is common to all companies interviewed is that services are mostly offered in connection with a physical product. These then are what are known as "product-related services". Consultancy and design services are of particular importance here, as, in some companies, they are the decisive factor in winning orders.

There are, however, lines of business which, though highly attractive, have not yet been covered. Based on a methodical evaluation, the study identifies a broad and differentiated range of product manufacturers in Automation Valley Northern Bavaria. The study assessed 98 sectors that already have a connection to automation in respect of their product and service portfolio.



## AREAS WITH POTENTIAL IN AUTOMATION VALLEY NORTHERN BAVARIA

An analysis of the attractiveness indices revealed that, despite the diversity of provision in the manufacturing industry, there are still gaps in expertise; the study cites the following by way of example here:

- the manufacture of batteries and accumulators,
- the manufacture of hydraulic and pneumatic components and systems,
- the manufacture of communication equipment and
- the manufacture of cooling and ventilation equipment.

Sensible additions on the service side, in particular, would be players from the areas of:

- artificial intelligence
- man-machine interfaces

These lines of business with high attractiveness are scarcely represented, if at all, in Automation Valley Northern Bavaria.

## CONCLUSION

Strengthening the profile and image of Automation Valley Northern Bavaria can ensure better recognition value and international visibility. Member companies could become even more intensively involved in developing the Automation Valley brand here.

Over and above this, it would be possible to further increase networking and presence at Nuremberg's leading international trade fairs that have a direct link to the automation community.

The scientific spectrum of the R&D landscape can be conveyed in an even more transparent and needs-oriented manner.

The Automation Valley in the Metropolitan Region still has many opportunities to offer. Although no acute gaps in the value network have become apparent, attractive areas with potential can be identified in the field of expertise.

## 1. INTERRELATIONSHIPS IN A COMPLEX INDUSTRY ENVIRONMENT – BACKGROUND AND OBJECTIVES OF THE STUDY

The automation industry, in its function as an interdisciplinary sector for the manufacturing industry, constitutes an important branch of economic activity in Germany and is a key element in the local sectoral mix, particularly with regard to the Metropolitan Region of Nuremberg. Automation Valley Northern Bavaria, which has around 220 members from research, industry, trade and specialized service providers, gives the automation industry in the region a strong network. The members act as intermediaries for local industry, but also for contact persons from outside the industry, so as to provide effective support for specialist exchanges as well as internal and external networking. At the beginning of 2013, the Nuremberg Chamber of Commerce and Industry, as one of the initiators and supporters of Automation Valley Northern Bavaria, prompted an investigation into the structural characteristics and value chain interrelationships of the local industry, carried out in a study together with the Fraunhofer Working Group for Supply Chain Services (SCS).

Core questions addressed by the study were:

- What is meant by the term "automation"?
- How is the automation industry in the Metropolitan Region of Nuremberg / Automation Valley Northern Bavaria organized?
- How is the local automation industry supplied and what products and supplies are required?
- What product-enhancing services are offered by companies in the automation industry?
- Are there "gaps" in the local value chain and, if so, by what kinds of expertise could they be filled, if necessary?

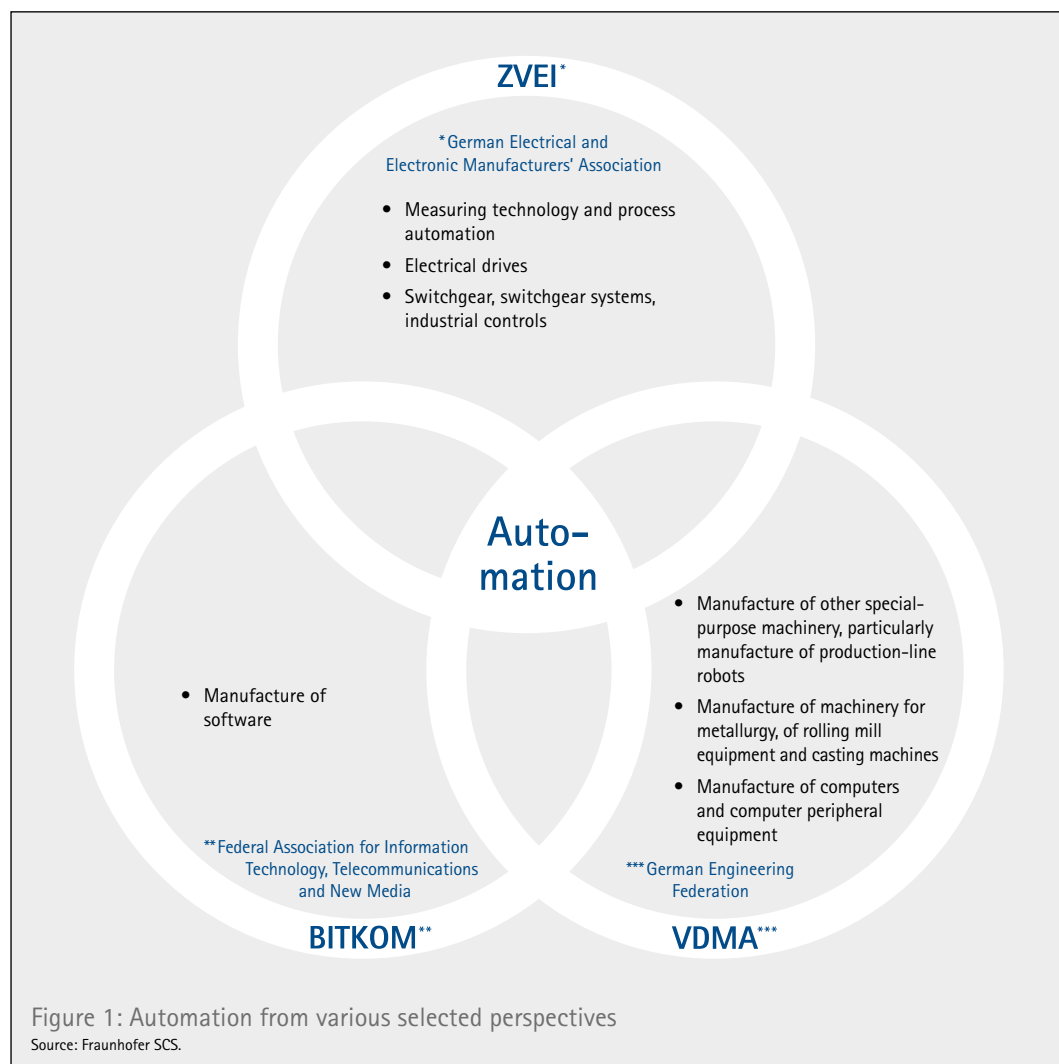
The following statements address the findings of the study in the form of a brief outcome report. The primary aim is to analyze the value chains or networks in which the local industry (in Automation Valley Northern Bavaria) is embedded. In methodological terms, the findings are based on quantitative statistical evaluations, database analyses and qualitative data collected as part of a project-related series of interviews with selected representatives from local companies.

## 2. DELIMITATION OF THE MARKET OF THE AUTOMATION INDUSTRY ...

### 2.1 ... from the perspective of various associations

The automation industry is characterized by a wide variety of activities and interrelationships with a large number of supplier and consumer sectors. This fact makes it relatively difficult to provide a uniform definition of the economic areas affected by "automation" expertise.

According to DIN V 19233, automation is "equipping a device so that it operates as intended, either entirely or in part, without human intervention".<sup>1</sup> This definition is scarcely geared to individual manufacturing industries and deliberately provides a relatively broad interpretation of the "automation" concept. The VDI (Association of German Engineers) makes a further attempt at reconciling all the characteristics of "automation", summarizing it as the "... use of automation technology's concepts, methods, tools, products and solutions in processes or products – both for business purposes and in practical implementation".<sup>2</sup>



1 Deutsches Institut für Normung e.V.: DIN V 19233: Control Technology – Process Automation – Automation with Process Computer Systems, Definitions.

2 Vgl. VDI 2009.

The associations active in the overlapping area of automation, on the other hand, define the term from their own perspective in each case. Thus, for the ZVEI (German Electrical and Electronic Manufacturers' Association), the focus of analysis is on the segments of "electrical drives", "switchgear, switchgear systems, industrial controls" and "measuring technology and process automation".<sup>3</sup> The perspective of the association is strongly oriented towards the actual components that the manufacturing industry produces in these segments. The VDMA (German Engineering Federation) primarily assigns areas from classical mechanical engineering to "automation". BITKOM (Federal Association for Information Technology, Telecommunications and New Media), for its part, sees the manufacture of software as a central component of automation.

The area of overlap between these three individual perspectives, each with the focus of an automatic process or product function, can therefore be viewed as a first approximation to a comprehensive definition of the concept.

## 2.2 ... and from the perspective of the automation industry of Automation Valley Northern Bavaria

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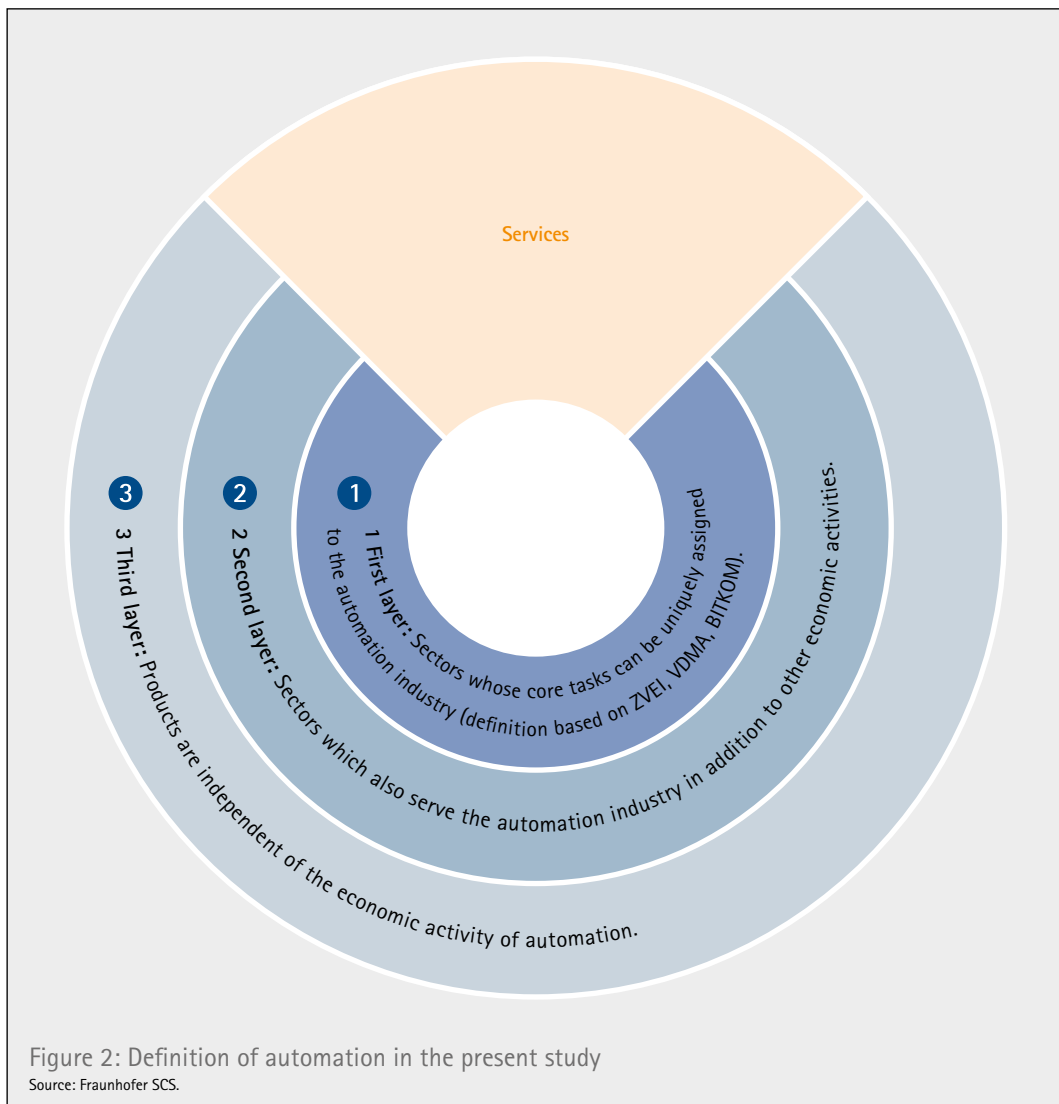
The contact persons from business and research in the Metropolitan Region of Nuremberg and Automation Valley Northern Bavaria likewise adopt different definitions and views. "Automation" was usually defined in a deliberately pragmatic manner from the corresponding perspective as the "means to an end", as the "replacement of human work by machine", as all areas in which "IT is used in production or in process control", or as "other industries' facilitator or vicarious agent". The multi-layered nature of the industry, which is hard to pin down in a single core statement, also soon becomes visible here. The study therefore developed a layer model, which represents the complexity of the automation industry and is designed to support the following observations.

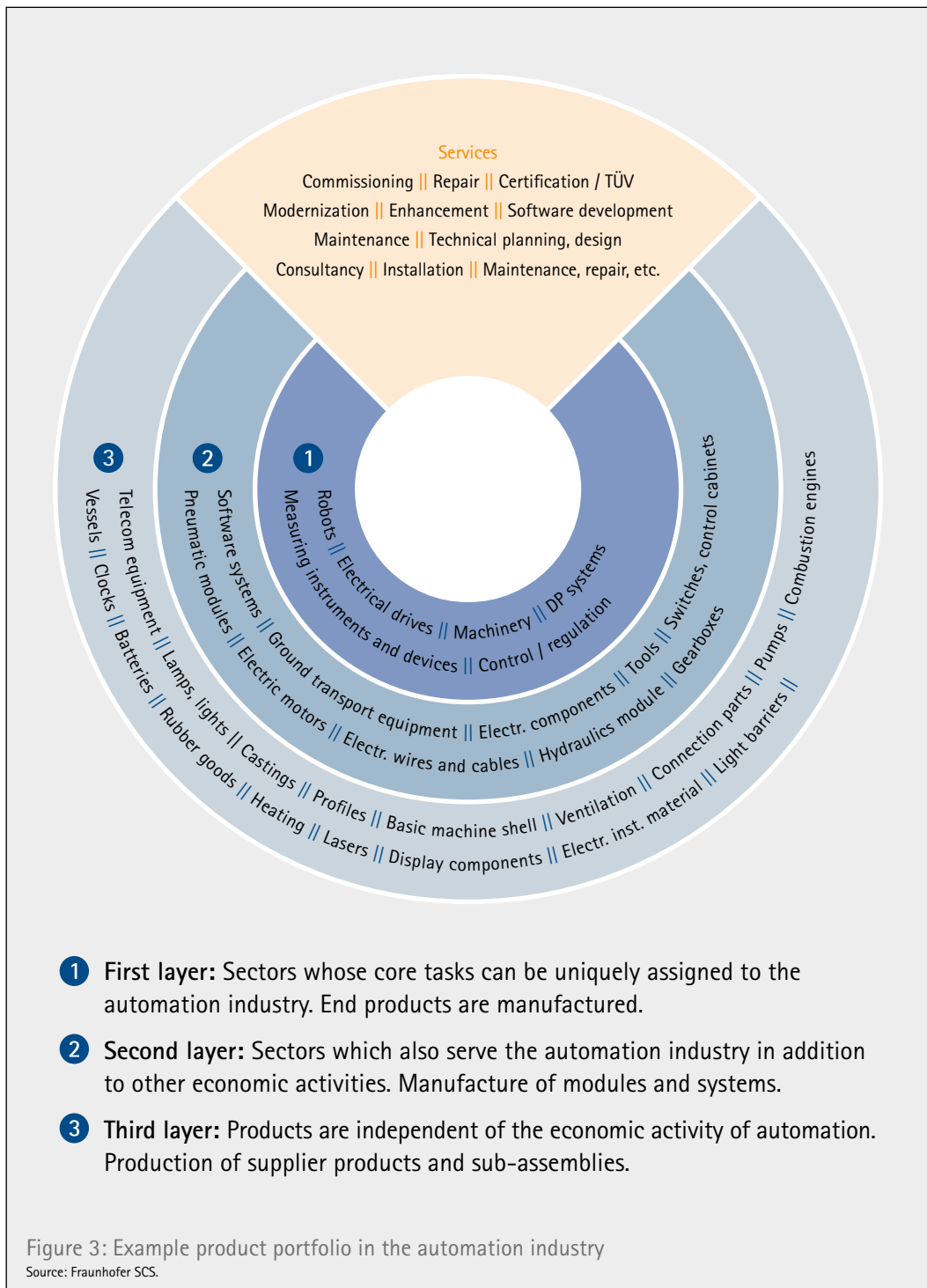
There are therefore sectors and branches of economic activity that can be uniquely (but usually not completely) assigned to the interdisciplinary industry of automation (first layer). In addition, there are sectors that serve automation as one of several branches of economic activity (second layer) as well as industries whose products can be assigned to automation only indirectly or as preliminary services (third layer). The diversity in respect of the assignment of sectors that these three layers make apparent is also shown, in particular, in the automation industry's product range.

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3 Cf. Kegel, 2012; Zieseimer, 2009.

Figure 3 below attempts to assign the various goods, some of which are more strongly linked to automation than others, to the layers that have already been introduced. The multi-layered services that are provided by automation industry companies as supplements to the products offered must not be ignored in this context. These services, however, cannot be assigned to an individual layer, but are generally available across products as value-added services.





The circular graphic comprises (by way of example) raw materials, semi-finished goods, sub-assemblies and individual components as well as finished parts and systems that are important to automation. Automation solutions consist of these and other building-blocks. What must not be forgotten is that it is only the integration and intelligent control of complex assemblies by means of control technology and IT that turns the products into real automation solutions. Nevertheless, the manufacture of individual components must also be designated as belonging to the automation industry.

### 3. VALUE CHAINS IN THE AUTOMATION AREA – A BASIC ANALYSIS

In order to be able to understand and classify the automation industry's value chain/network, the basic structure of a supply chain according to Klaus<sup>4</sup> should first be explained. The basis of the flow concept in value chain management is the so-called "order-to-payment process", which is carried out within every company in order to fulfil customer requirements. Orders on the part of customers need to be generated and then internally processed or fulfilled. These internal processes comprise, amongst other things, materials management (purchase, procurement, etc.), the manufacture of the desired product, the warehousing of raw materials, semi-finished products and finished goods, distribution and, finally, delivery to customers (after-sales services may be added). In addition, administrative processes must also be handled, comprising, for example, invoice raising or the collection of the invoice amount. The following is a simplified representation of the processes described here.

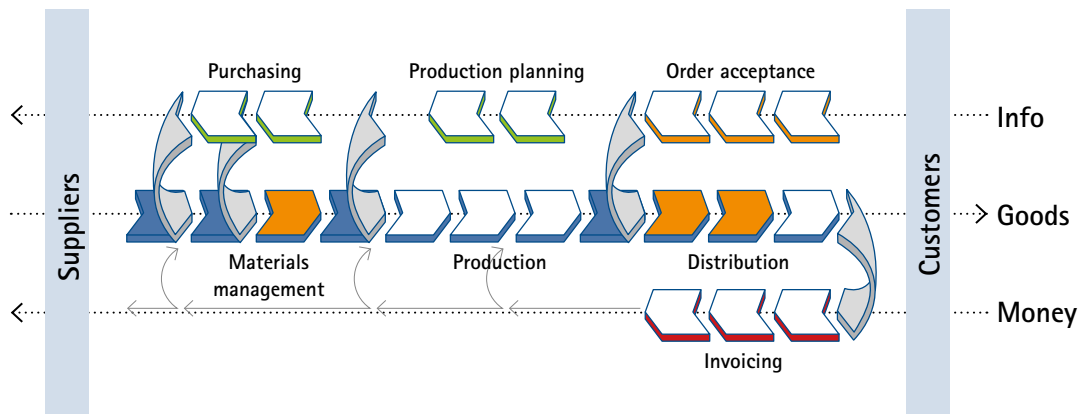


Figure 4: Order-to-payment process within a company

Source: Fraunhofer SCS, based on an Klaus (2003), p. 24.

Figure 4 above shows the different processes performed within a company that acts as a link between suppliers and customers. These activities can be described as "S-curves", each of which represents a part of the information, goods and money flows. Depending on a company's vertical integration/real net output ratio, these "S-curves" may have different characteristics. If finished goods are stored, for example, it is possible to supply the customer directly following order receipt without involving a production process. It is also possible, given maintenance of sufficient stocks, to produce directly, i.e. without having to procure raw materials beforehand.

4 Cf. Klaus 2003, p. 21f.

In order to be able to provide a comprehensive examination and analysis of the automation industry, it is also important to have an extensive understanding of the way in which the companies involved interact. The "order-to-payment process" described above, which is carried out only within an individual company, must be extended to include all companies involved in the value creation of a branch of economic activity. To achieve a value chain that is comprehensively efficient and optimal, each of the processes carried out within a company must be integrated, with the definition of uniform interfaces having a major role to play here. Typically, this means the system interfaces in respect of contract award and execution between the individual companies but, because of the necessary integration of different product components, as uniform an interface as possible is also required at product level in the case of the automation industry. This is the only way to have flexible collaboration between different partners within the value chain.

The automation industry can therefore be depicted as a system of flows of inputs into the sector (from supplier industries), flows within the automation sector and flows out of the sector (to consumer industries). The flows within the automation area can, in turn, be interpreted as a concatenation of several "order-to-payment processes", which are carried out in upstream or downstream companies in each case. The "S-curves" in Figure 5 represent individual companies which alternately act both as customers of an upstream partner and suppliers of a downstream one.

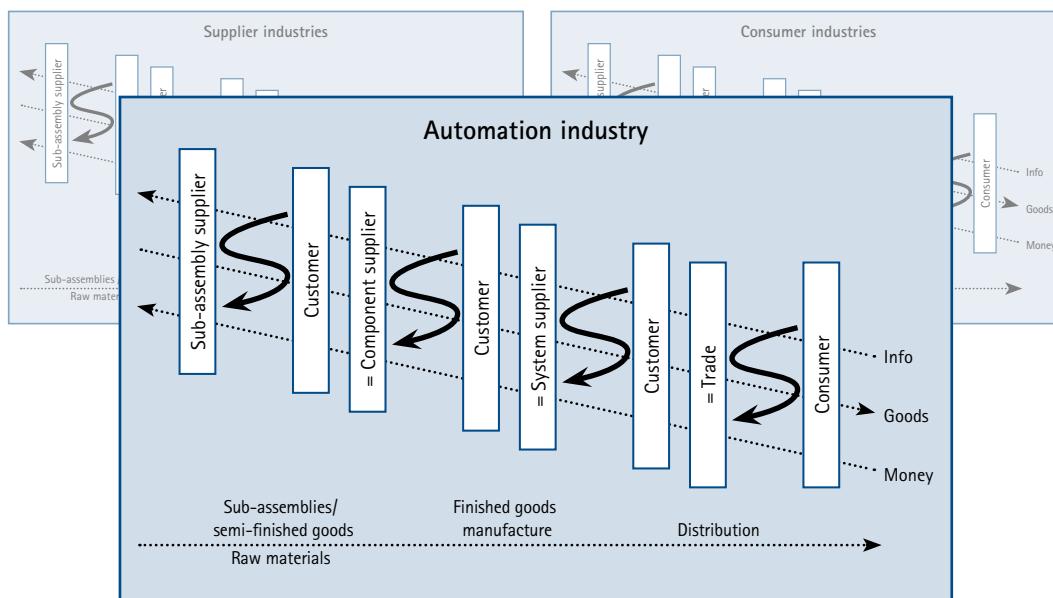


Figure 5: Flow concept based on the example of the automation industry

Source: Fraunhofer SCS, based on Klaus (2003), p. 25.

In line with the representation in Figure 5, the flows within the industry are analyzed from left to right according to the flow direction, from supplies of third-party sectors via the automation industry to the outputs and customers of the industry. In principle, this model can be applied to virtually all branches of economy activity. What is peculiar to the



automation industry, however, is the close link between the companies involved. As already shown in Figure 2 and in Figure 3, the automation industry comprises a very wide variety of merchandise and goods. In the course of the study, it has been shown that the (sub-) products manufactured in the automation value chain do not necessarily pass through the value creation system in the form of a chain, but are intertwined with one another in the form of a network. One and the same company can act both as a supplier and as a consumer of products and solutions. The high complexity of the goods and services in the field of automation technology means that the above-mentioned integration of different products and services between several players is crucially important to being able to act as a comprehensive solution provider in relation to the consumer industries.

### 3.1 Theory vs practice – statistical findings as reflected by the on-site company survey

An analysis of the Federal Statistical Office's national accounts according to the interdependence of automation-related industries for Germany enables the automation sector's rough input and output flows to be represented. Figure 6 outlines the types of goods that flow into the automation industry as input factors (or the sectors from which they flow) and the types of products that are created by the automation industry (or the sectors for which they are created) and ultimately supplied to customer industries / end consumers.

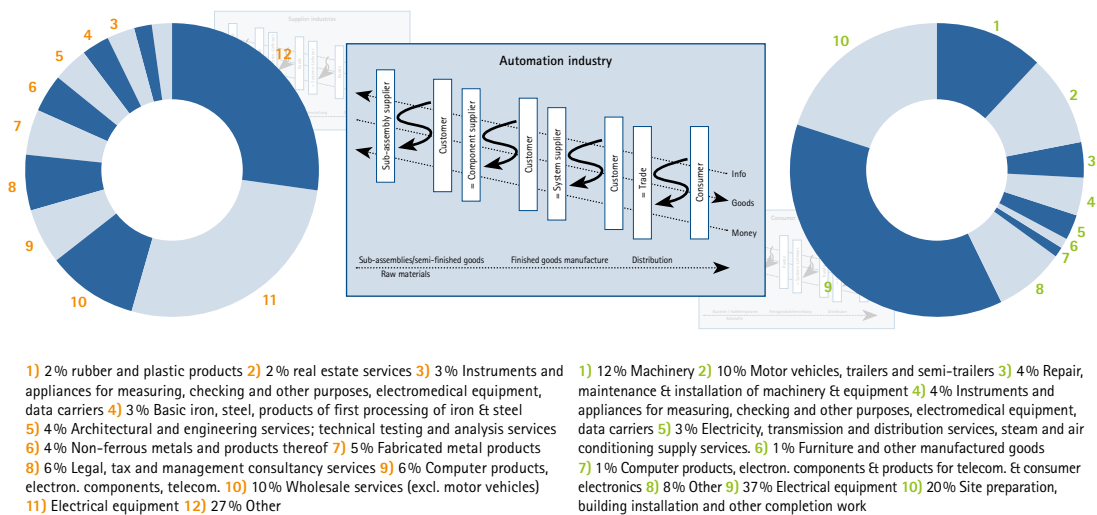


Figure 6: Input and output flows in the automation sector<sup>5</sup>

Source: Destatis 2012, National Accounts; Own Calculations Fraunhofer SCS.

5 Evaluation of national accounts (input-output tables) for the areas "Instruments and appliances for measuring, checking and other purposes, electromed. appliances, data carriers" (EA08: 26.5-26.8) and "Electrical equipment" (EA08: 27). Those areas that account for under 2% of total input (or under 1% of total output) are designated as "Other".

The areas that statistically best capture the automation industry itself are shaded red in the pie charts. On the input side, the industry itself already accounts for around 30 % of inflows (monetary basis). On the output side (consumers or users and customers), this share rises to over 40 %. This already shows the high proportion of value creation interdependence within the industry itself.<sup>6</sup> These extensive interrelationships that the automation industry has with many other branches of economic activity as well as with itself are also confirmed by the peculiarities of the industry described in relation to Figure 5. Many companies in the automation sector depend on inputs from other automation-related companies. On the other hand, many companies in the automation industry also act as a supplier to other customers in the same economic segment.

This necessary interconnectedness between individual players can be commensurately supported and promoted by a network such as Automation Valley Northern Bavaria. Similarly, the existence of functioning supplier and consumer structures is a key success factor for the industry.

**Input side:** Categorization by services, trade and manufacturing industries reveals that inputs are obtained from all areas. Around 12 % is accounted for by various kinds of services, including, in particular, complex activities such as consulting or prototype testing. The wholesale trade, at 10 %, is likewise appreciable and important as a source of supply, as, on the one hand, companies in the automation industry are not necessarily of sufficient size to be able to purchase directly from producers and, on the other, automation solutions are very individual and cannot necessarily be created in great quantities using the same components. In addition to those shown in Figure 6, there are also a wide variety of different sectors that act equally as suppliers to companies in the automation industry. The category of manufacturing industry, which comprises the remaining input groups, can be sub-divided into those input factors that stem directly from the automation industry (measuring and control equipment, electrical equipment) and supplier products from other sectors. These, in turn, include high-tech products (DP devices, electronic components), which already combine a high level of know-how and whose real net output ratio can be estimated as high, as well as raw materials such as basic iron, rubber and plastic goods, which are processed into products with higher real net output ratio only within the automation sector.

Replicating the statistical data with local practitioners confirms and supplements these findings. Automation Valley Northern Bavaria mainly procures components and complete systems and, less frequently, individual parts or semi-finished products. The larger the company, the stronger is the focus on finished systems as inputs for its own value creation. Even the geographical focus of the sourcing strategy differs depending on size of company. The majority of companies interviewed procure the required products in Germany. Small and medium-sized enterprises, in particular, are organized

<sup>6</sup> For an interpretation, see the preceding footnote.

on a regional rather than local basis in this respect. Large companies tend to procure the goods that they need on a global basis.

With regard to the institutionalization of procurement processes, there is a clear focus on long-lasting relationships. Statements like "long-term partnerships are essential in terms of the availability of spare parts for long-lived machinery" or "trust and flexibility only grow with long-term bonds" clearly show that long-standing and trust-based collaboration is viewed as an important factor in business success in the automation industry. Reliability in the sense of adherence to deadlines and deliveries, reasonable costs and consistently high quality is the most important aspect here. Statements such as "the most important factors here are quality, price, extent to which targets are met" or "you do not change something that has proved its worth unless you have a good reason" confirm this. A change in supplier structure therefore usually occurs only if there are quality problems, unreasonable price increases, unreliability or problems with deadlines.

**Output side:** The proportion of service areas that can be classified as users or consumers of automation solutions is statistically around 24% on this side ("Site preparation, building installation and other building completion work"; "Repair, maintenance..." etc.). This shows the major relevance that automation solutions have for the providers of comprehensive service packages, such as facility managers in the real estate sector. The wholesale trade, which, with a share of around 10%, achieves some importance on the input side, is not of major importance in statistical terms on the output side. The calculated proportion for comparison with the "Wholesale trade services" (excluding motor vehicles)" sector that is relevant on the input side comes to under 1% on the output side. This is a further indication that the automation industry as a whole does not tend to be categorized as a producer of high quantities. It is more likely to be classified as a producer of complex high-tech solutions involving a high level of know-how. Owing to the high specialization of the (end) products, it is very rare for volume-based wholesalers to find launching pads for an exclusive business in this sector. Mechanical engineering, in particular, can be cited as a consumer industry in the manufacturing sector (i. e. industry), with the motor vehicle sector ("Motor vehicles, trailers and semi-trailers") being virtually at the same level. Smaller percentages are cited in the sectors of "Electricity generation" and "Furniture or other goods production".

In practice, more than one in two companies interviewed identified the automotive sector as one of the most important consumers. Plant construction and mechanical engineering was also cited as an important sales market for companies in the automation industry. However, in addition to these sectors that are also relevant in statistical terms, other branches of economic activity such as the pharmaceuticals/ medical, energy and packaging industry, wholesale trade, logistics and the electronics industry were also mentioned, with customers from Germany providing a high percentage of sales. Where concrete sales figures were mentioned in the interviews, the

proportion of German customers was between 30 and 40 % on average. In individual sectors of the economy such as energy and environment and wholesale trade, this value increased to as much as 90%. It was not possible to find a particular focus at regional level in the companies interviewed. Similarly, no individual sales market at international level can be explicitly specified; rather, both the classical industrialized nations and the emerging countries are considered and serviced as potential sales markets.

In terms of the self-perception of the companies interviewed, it can also be stated that a large number of the manufacturing companies see themselves as OEMs, with only a fraction wishing to be perceived as a distributor or wholesale trader on the market.

### 3.2 In summary: A model of value chains in the automation area

If the findings of the analyses performed hitherto are summarized, the following picture emerges, which provides a structured representation of the area of manufacturing automation. The representation in Figure 7 is a simplified model of the automation industry and the flows that appear in upstream sectors, within automation and in downstream customer industries.

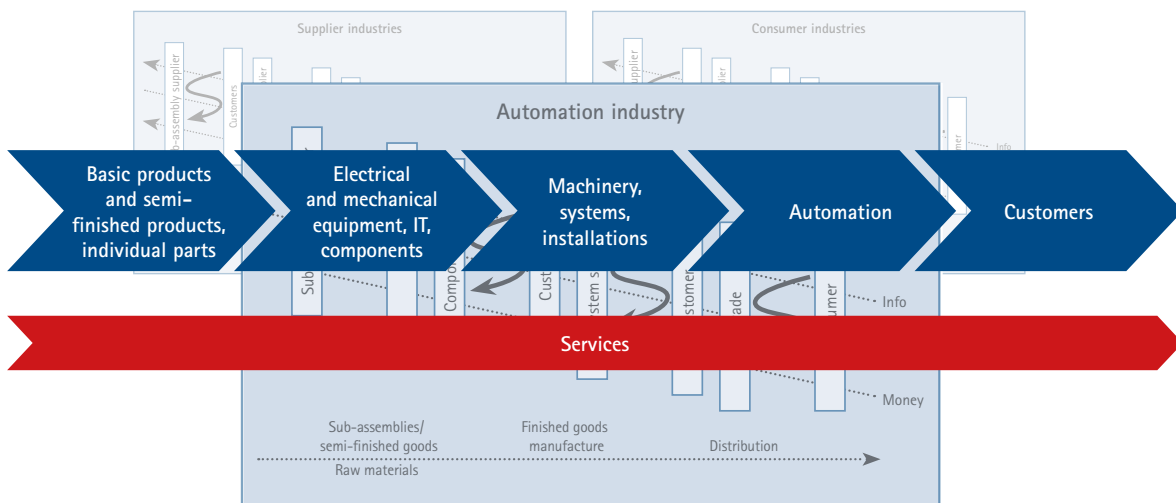


Figure 7: Schematic representation of "automation" – basic model  
Source: Fraunhofer SCS.

Raw materials, basic products, semi-finished products or individual parts flow directly into the automation industry or directly affiliated, upstream branches of economic activity, in raw or already partly processed form. Once the individual components or complete systems have been finalized, companies in the automation industry become active and process these goods further, before they go to the respective end customers and consumer industries for direct use or further processing.

The aim of the two following charts is to summarize the products and services of the automation industry shown in Figure 3 in a clearly structured form. They show the goods and merchandise that flow into automation and how these are further processed into ready-made automation solutions in due course. The core here, in addition to the production of machinery, installations, controls or robots, is the link between product and technology in each case, which makes final deployment of the automated solutions possible. A distinction should be drawn here, by way of example, between the two sub-areas, manufacturing automation (see Figure 8) and building automation (see Figure 9).

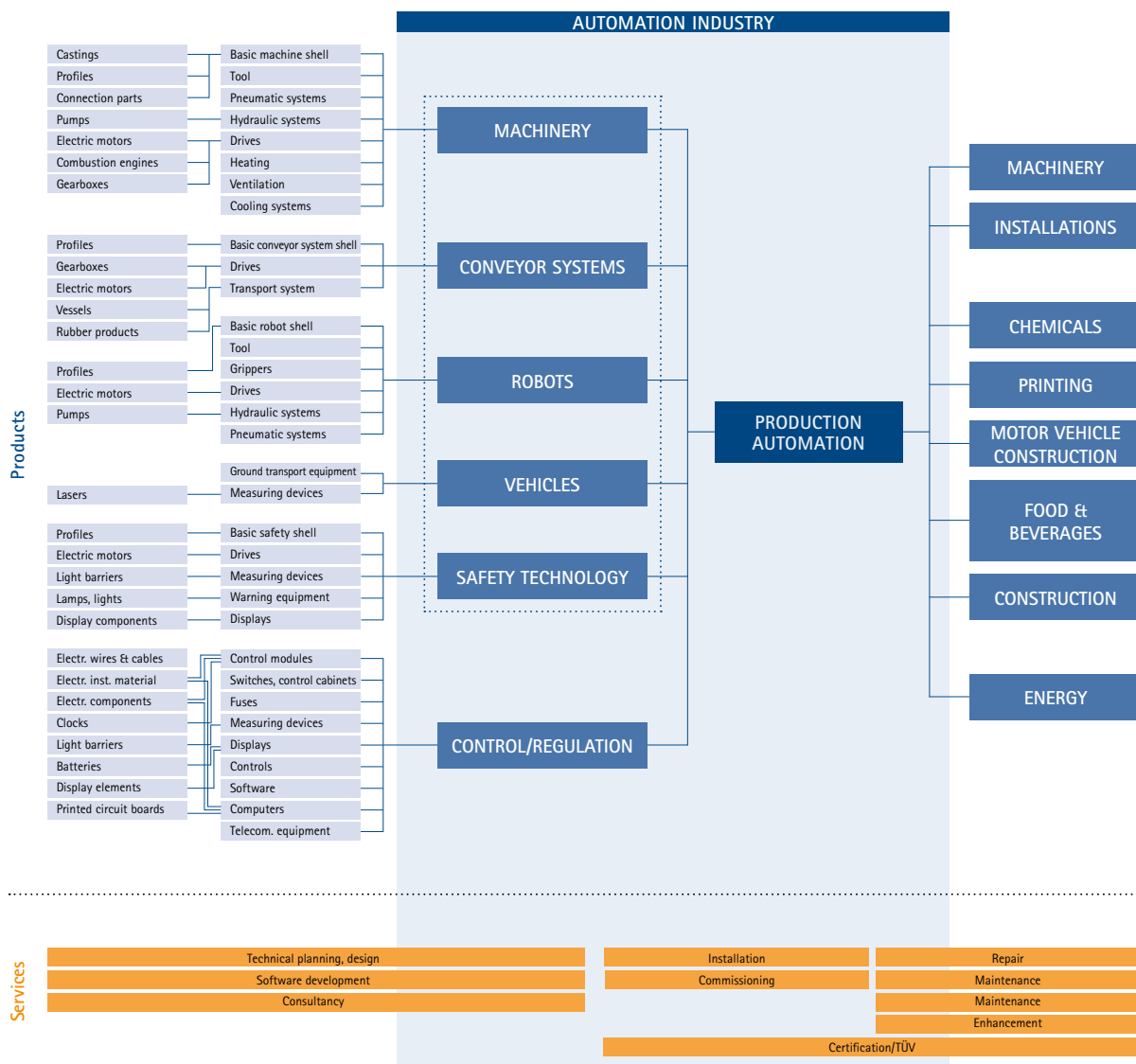


Figure 8: Schematic representation of "manufacturing automation" – complex presentation  
Source: Fraunhofer SCS.

Starting from raw materials such as castings, lamps and lights, wires and cables or even batteries, hydraulic systems or basic shells, for example, are manufactured. The variously integrated companies in the automation industry ultimately create finished automation

solutions and systems, which are then supplied, in turn, to a wide variety of customer industries. Services that support the automation process and are brought to bear at different points in the production process are also important in this context. These involve, for example, planning, design and consultancy services when manufacturing preliminary products. The further course of activity then focuses on on-site installation, commissioning or maintenance of the automation solutions at the location of the customers or the consumer industries. Finished products include machinery, conveyor systems, vehicles or robots, all of which only become ready-made automation solutions with the aid of control systems, controllers or software components. It is then about deploying these solutions in the specified consumer industries. These, of course, include branches of economic activity like mechanical engineering or the automotive industry, but also chemical processing, food production or the manufacture of stimulants (tobacco production).

The following graphic, which is relatively similar to manufacturing automation, but varies in the linking between individual components and in the composition of consumer industries and customers, emerges for the building automation sector. The two sectors of manufacturing and building automation are the two sub-areas that currently play a particularly important role in Automation Valley Northern Bavaria.

Building automation also reveals a close link between the automation industry and many other branches of economic activity. The supporting services are very similar to those of manufacturing automation from Figure 8. As this is a relatively limited area (exclusively building automation), the product portfolios and the consuming industries are also more limited in scope compared with manufacturing automation. Customers in this connection mainly come from the areas of production, logistics, the wholesale trade and facility management.

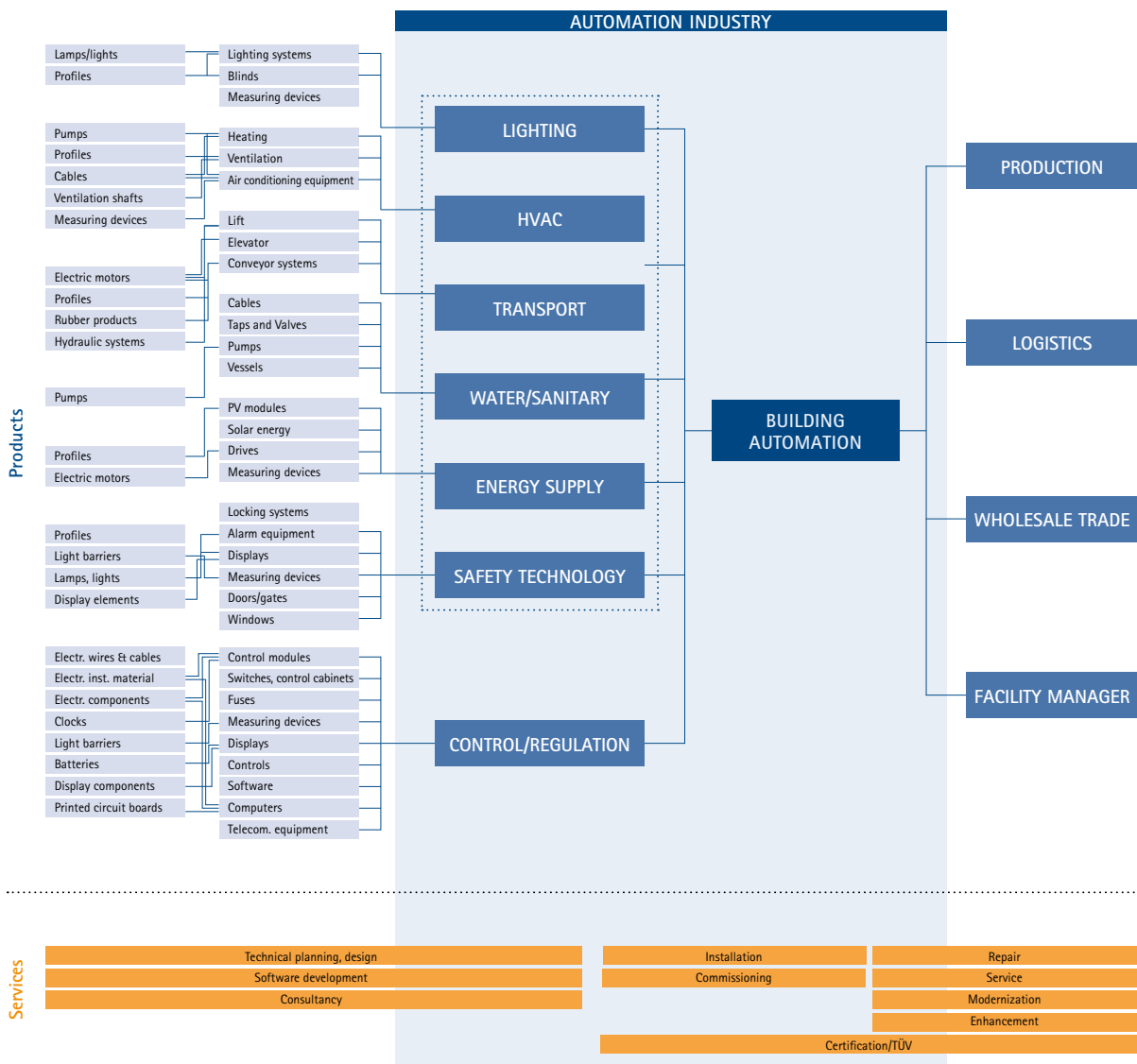


Figure 9: Schematic representation of "building automation" – complex presentation  
Source: Fraunhofer SCS.

By way of an interim conclusion, it can be stated that automation is not a classical branch of economic activity, nor indeed an isolated one; rather, it constitutes a typical interdisciplinary industry. Automation is consequently a superordinate term for a wide variety of tasks and product portfolios. Only by linking products (machinery, control elements, etc.), technologies (robotics, software, etc.) and accompanying services can comprehensive automation solutions be implemented. The interaction of the industry "with itself" and with numerous other segments of the manufacturing industry and the services sector also illustrates the particular importance of the automation industry and its complexity.

### 3.3 Excursus: The role of services in the automation industry

Services are increasingly defining the competitiveness of highly developed economies, already determining over 70% of their gross value creation.<sup>7</sup> In times of globalization, faced by international competition and ever more individual customer requirements, manufacturing companies are attempting to create additional market differentiation from the classical product business by providing services to varying degrees.<sup>8</sup> This development is also bringing about changes in the overall environment for automation industry companies in the Metropolitan Region of Nuremberg, which is why the current role of services in the industry and expected future developments are a central issue in the present study.

#### 3.3.1 Proportion of services in the industry as a whole and importance in the companies

In terms of the industry as a whole, interviewees attach great importance to services. For example, they estimate the proportion of services in the automation industry in the Metropolitan Region of Nuremberg at around 30% on average. However, the findings obtained show a heterogeneous picture of the role performed by services in individual companies, summarized in Figure 10.

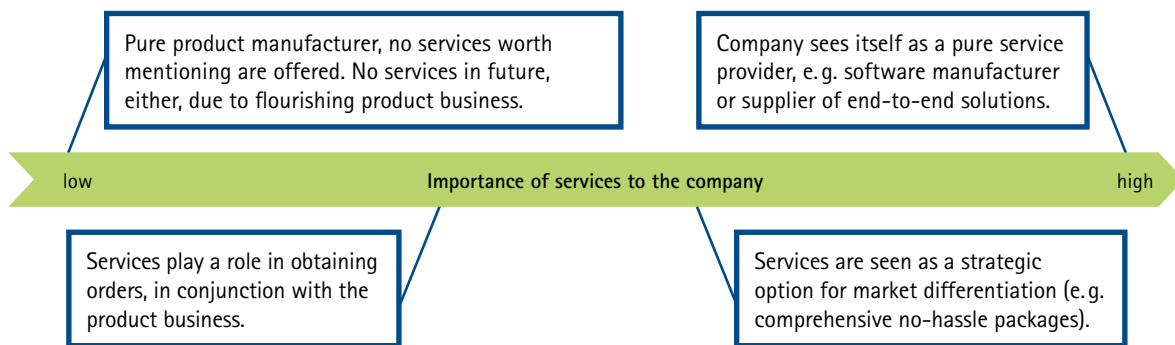


Figure 10: Assessment of the relevance of services in the companies interviewed  
Source: Fraunhofer SCS.

The companies interviewed mostly saw themselves as either pure producers or pure service providers. In the case of the pure product manufacturers, two types prevail: On the one hand, there are companies which, owing to the flourishing nature of their product business, have no future plans to offer services in any appreciable form. On the other hand, some companies have identified an opportunity of being able to service customer requirements better by offering services in future. In these cases, remote monitoring services and end-to-end solutions – i.e. a kind of “comprehensive no-hassle package” for complex customer problems – are mentioned, in particular, as future opportunities. Such end-to-end solutions support the customer at every stage of a product's life cycle, from

7 Cf. Stevens, 2004; Verma, Fitzsimmons, Heineke, & Davis, 2002.

8 Cf. Baines, Lightfoot, Benedettini, & Kay, 2009; Neely, 2007; Vandermerwe & Rada, 1988.



planning and design to the operation of the products right through to maintenance, repair and disposal. They are characterized by a high degree of individualization and customer interaction, which presupposes precise knowledge of the customer's processes and the ability to work together with the customer.<sup>9</sup> End-to-end solutions, however, offer companies the opportunity of long-term customer retention, generate higher margins and provide a possibility of sustained market differentiation.<sup>10</sup> The interviewed companies in this group did not, however, mention any concrete implementation plans for business models based on customer-specific solutions.

What all the companies interviewed have in common is that services are offered in conjunction with a physical product in most cases. These are therefore so-called »product-related services«. Consultancy and design services are of particular importance here, as, in some companies, they are the crucial factor in winning orders. One of the experts estimated that up to 70% of orders would be non-existent if it were not for the associated consultancy and design service. Nor do the participating companies view these services as »additional«, but rather as an integral part of the core provision. The services that are provided additionally to the core provision are also usually directly linked to the product being sold in each case. Maintenance and repair services, as well as typical after-sales services like telephone support, dominate here. In the interviews that were conducted, repair services directly related to the product received most frequent mention in respect of additional services. The second most frequent answer was services in the context of maintenance, followed by after-sales services. Software services, logistical services, commissioning of products and training courses were mentioned less frequently, but at least once. The pure service providers mainly involve software suppliers and intralogistics providers. While the former supply OEMs and providers of automation products with the required software components, intralogistics providers design production cells and production flows through to entire production plants. Value creation in their case is clearly in engineering.

On the whole, it can be stated that, in terms of overall value creation in the automation industry, services play a major role, a role that is also estimated to increase in future.

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9 Cf. Bonnemeier, 2009.

10 Cf. Woisetschläger, Backhaus & Michaelis, 2009.

### 3.3.2 Buying in services

Services are not only important on the »output side« of the automation industry, but are also bought in as "input" into operating activities. In the companies interviewed, it was clear that usually only services outside their own specialism (e.g. strategy consultancy, property management, packaging services, market analyses etc.) are bought in. In this connection, the concept of core expertise is key – services that are attributed to a company's own core expertise in whatever form should not be outsourced, so as to maintain the real net output ratio in that company. Over and above services outside a company's own specialism, engineering and design services, as well as assembly and field sales services, are occasionally bought in.

In terms of the regional distribution of the bought-in services, the local component strongly dominates, which, according to the interviewees, derives more from satisfactory local availability than from operating constraints. No significant gap in the supplier structure of the Metropolitan Region of Nuremberg can thus be identified for services.

The companies use various criteria to select suppliers. It was clear here that the quality of the services is much more important than their price. As already described, average importance is attached to local availability even though, according to most interviewees, a provider in the immediate vicinity would be preferred to one more distant.

In sum, it can also be stated that the development potential for additional services to the automation industry is estimated as being smaller on the input side than on the output side.

### 3.3.2.1 Concluding remarks on the services sector

In conclusion, it can be stated that, in the wake of the burgeoning "Industry 4.0", the blanket advent of information and communications technology and its integration to form an Internet of things, services and data will produce further industrial service innovations. Even traditionally strong sectors in Germany, such as mechanical engineering and plant construction, electrical engineering, and the automotive industry, will not remain unaffected by this development. At the turn of the millennium, for example, product-related services in mechanical engineering in Germany were quoted as accounting for around 10% of sales<sup>11</sup> while, seven years

later, peak values indicating that services are enjoying a more than 30% share of sales are already being recorded for the same sector in the Stuttgart area.<sup>12</sup> Particular potential is opening up here for the automation sector as an interdisciplinary industry, which is why it appears advisable to examine service-driven business models even more intensively in future than has hitherto been the case, based on the statements collected in this study. In order to describe and understand the sector, it should be noted that automation is not conceivable without the services sector and that value creation is accordingly strongly supported by specialism-specific services.

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11 Cf. Vieweg, 2001.

12 Cf. Reichert, 2007.

#### 4. AUTOMATION VALLEY NORTHERN BAVARIA – COMPANY STRUCTURE AND ASSESSMENT OF POTENTIAL FOR FURTHER SETTLEMENTS

Automation Valley Northern Bavaria (AVN), from Roth in the south via Nuremberg and along the Main from Bayreuth via Bamberg, Coburg to Aschaffenburg, is a centre for automation technology that has evolved historically. The region is characterized by a number of global players, numerous small and medium-sized production companies, specialized traders as well as focused research establishments and network partners, which exchange ideas within the network of Automation Valley Northern Bavaria and would like to advance the region's innovativeness together.

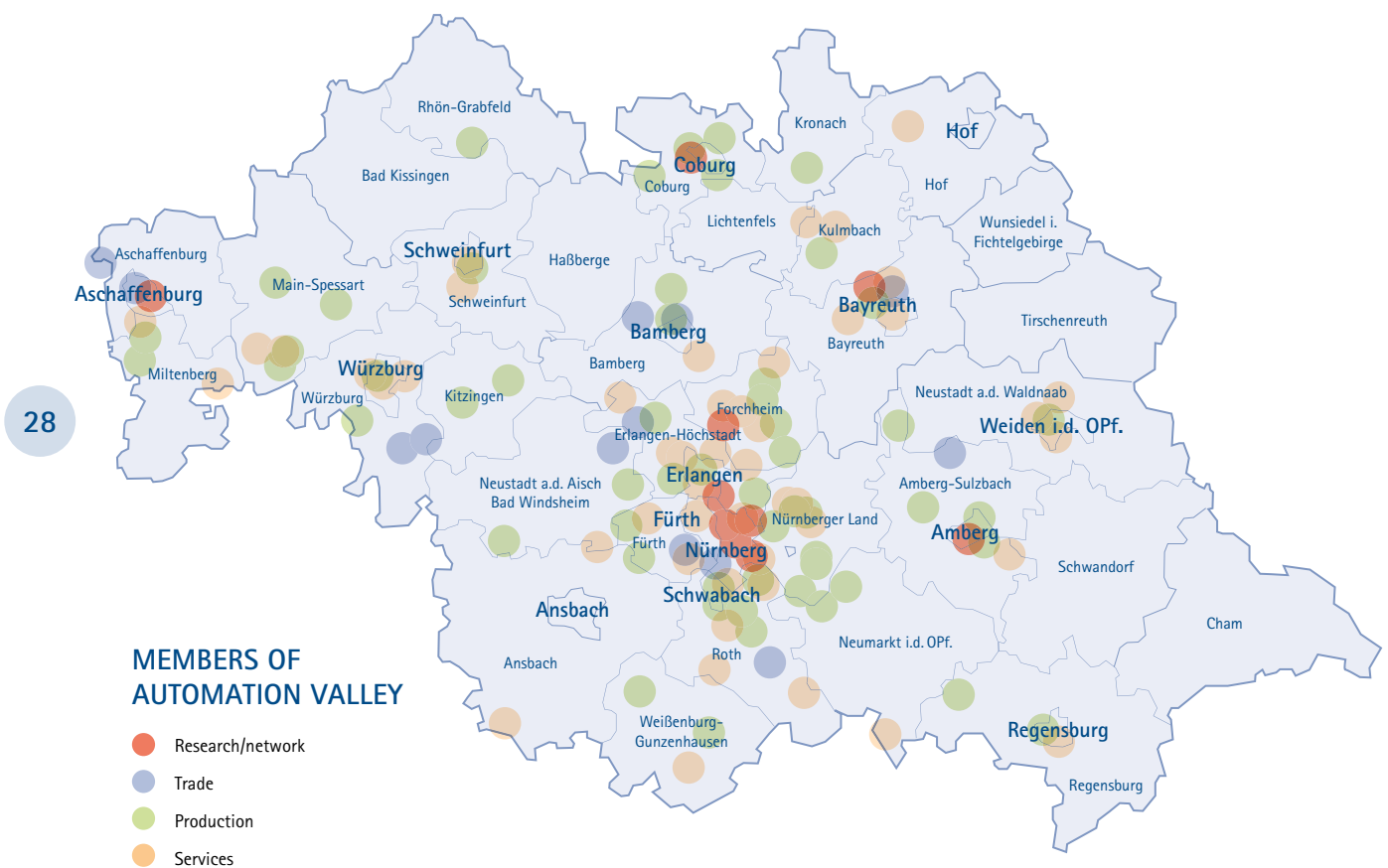


Figure 11: Localization of the member companies in Automation Valley Northern Bavaria  
Source: Fraunhofer SCS.

Pinpointing the current network partners on the map in Figure 11 shows, at first glance, the high concentration of companies in the urban triangle of Nuremberg, Fürth and Erlangen. However, significant groups of companies with relevant expertise in the automation area have developed in Upper Franconia, Lower Franconia and the Upper Palatinate. Apart from large and well-known groups, it is particularly the numerous SMEs that, together, cover a wide area of expertise. The colourful mix of manufacturing companies, traders, service providers and research establishments, which is crucial to successful network activity, is also evident.

Most practitioners interviewed confirmed the network's function as a "contacts forum" and "exchange platform" for the regional providers of expertise in the automation area. Some pointed out, however, that the region's success and international renown was more attributable to the high profile of the global players based here than to any integration through the network. The visibility of the Automation Valley Northern Bavaria "brand" and the associated diversity of expertise are therefore definitely still capable of improvement.

#### 4.1 What already exists? – structural analysis of the local network

Any further growth of Automation Valley Northern Bavaria should, in the view of the interviewed players and the chambers of commerce and industry, focus, in particular, on those areas that are currently not yet covered by local expertise or only inadequately so. What is seen as constructive is less an arbitrary increase in the number of members than a focused selection and settlement of companies that can close these potential "gaps" in the value chain. Industry representatives almost unanimously indicated in the interviews that there were no problematic procurement gaps, as any preliminary products and services that did not exist locally could be bought in at no disadvantage on the national or international market, adding that, rather than new suppliers, large customers from the automotive or mechanical engineering sector would be welcome. In view of the sector's high level of integration with itself, however, this completely comprehensible line of argument also involves possible concern about new potential competitors in the local arena. New members should therefore be sought in complementary areas so as to provide sensible additions to the existing structures. In order to provide the best possible support for such targeted growth of Automation Valley Northern Bavaria, a structural analysis of the local players will be carried out below and completed by an analysis of the most attractive, complementary settlement industries.

While network-forming players like research institutes, universities and chambers of commerce and industry can generally be classified as positive and conducive to innovation for Automation Valley Northern Bavaria, the three areas of trade, production and services will be examined in detail with regard to their current realization. Figure 12 provides a detailed overview of the structure of the companies in Automation Valley Northern Bavaria.



Figure 12: Number of companies in Automation Valley North Bavaria by sector focus – main and ancillary activities

Source: Fraunhofer SCS.

"Production" therefore occupies an important position in Automation Valley Northern Bavaria. Overall, it was possible to identify 119 companies (43%) in Automation Valley whose main or ancillary activity can be assigned to the manufacturing industry.<sup>13</sup> Virtually as many players (42% of all companies, i.e. 117 members of Automation Valley) can be assigned directly or indirectly to the "Services" area. The third area comprises "trade", under which 15% or 43 member companies of Automation Valley can be subsumed.

<sup>13</sup> The analysis of Automation Valley's company structure was performed using the classification of economic activity carried out by the Federal Statistical Office. Each member of Automation Valley was assigned one to three industry codes, depending on main or ancillary economic activity (double entries are therefore possible). The study comprised exclusively industry codes that showed an affinity with the automation area. Companies that could not be assigned a specific industry code were not included in the study.

## 4.2 Where are there "gaps in expertise"? – a methodical identification

In order to determine potential gaps in what is already an extremely diverse provision landscape, an evaluation methodology was initially devised with regard to the attractiveness of a sector and its suitability for the automation area, with the classification of economic activities EA-2008 being assessed completely at the level of 615 classes using the following criteria:

- Products/services serve directly or indirectly to implement automation tasks as an exclusion criterion (automation link)
- Level of sector sales as a measure of the economic relevance of the sector (sector sales)
- Annual change in sales as a measure of a sector's growth potential (sector growth)
- A company's average R&D expenditure as a measure of a sector's innovativeness (R&D expenditure)
- Proportion of the production value that flows into the automation area's core sectors as a measure of the automation intensity of a sector's product portfolio (automation intensity)
- Number of consumer industries as a measure of the sector's wide and highly flexible range of products (number of consumer industries)
- Complexity of the manufactured products as a measure of the sector's substitutability (product complexity)

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The criteria were compared in terms of importance using a pair-wise comparison in the semi-matrix procedure and assigned the weightings shown in Figure 13.

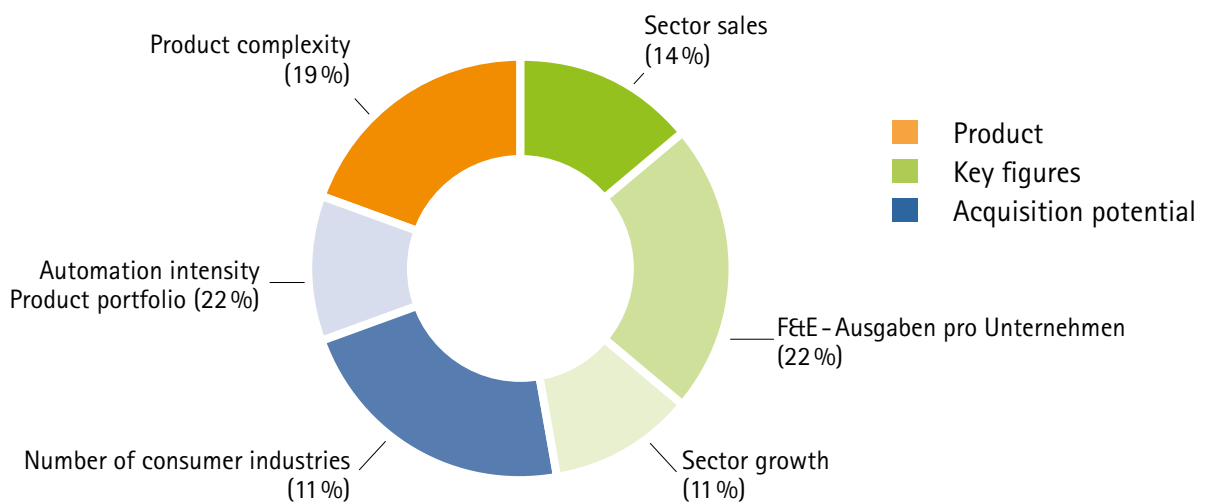


Figure 13: Weighting of the evaluation criteria for the attractiveness of automation industries  
Source: Fraunhofer SCS.

All of the 98 remaining sectors that already have a connection to automation in respect of their product and service portfolio were evaluated in terms of these criteria and a summary "attractiveness index" was identified for the respective sector. This analysis revealed that, in spite of the diversity of the local provision, there are still gaps in expertise, particularly in the manufacturing industry. The service portfolio at the location, however, is very broad and suitably covers all automation-related areas. All areas are also covered in the trade sector, but there is definitely potential regarding the expansion of the specific product portfolio.

The results of the target customer analysis for the three areas of production, service and trade are presented in detail below.

#### 4.2.1 Production – broad coverage, but also a number of gaps

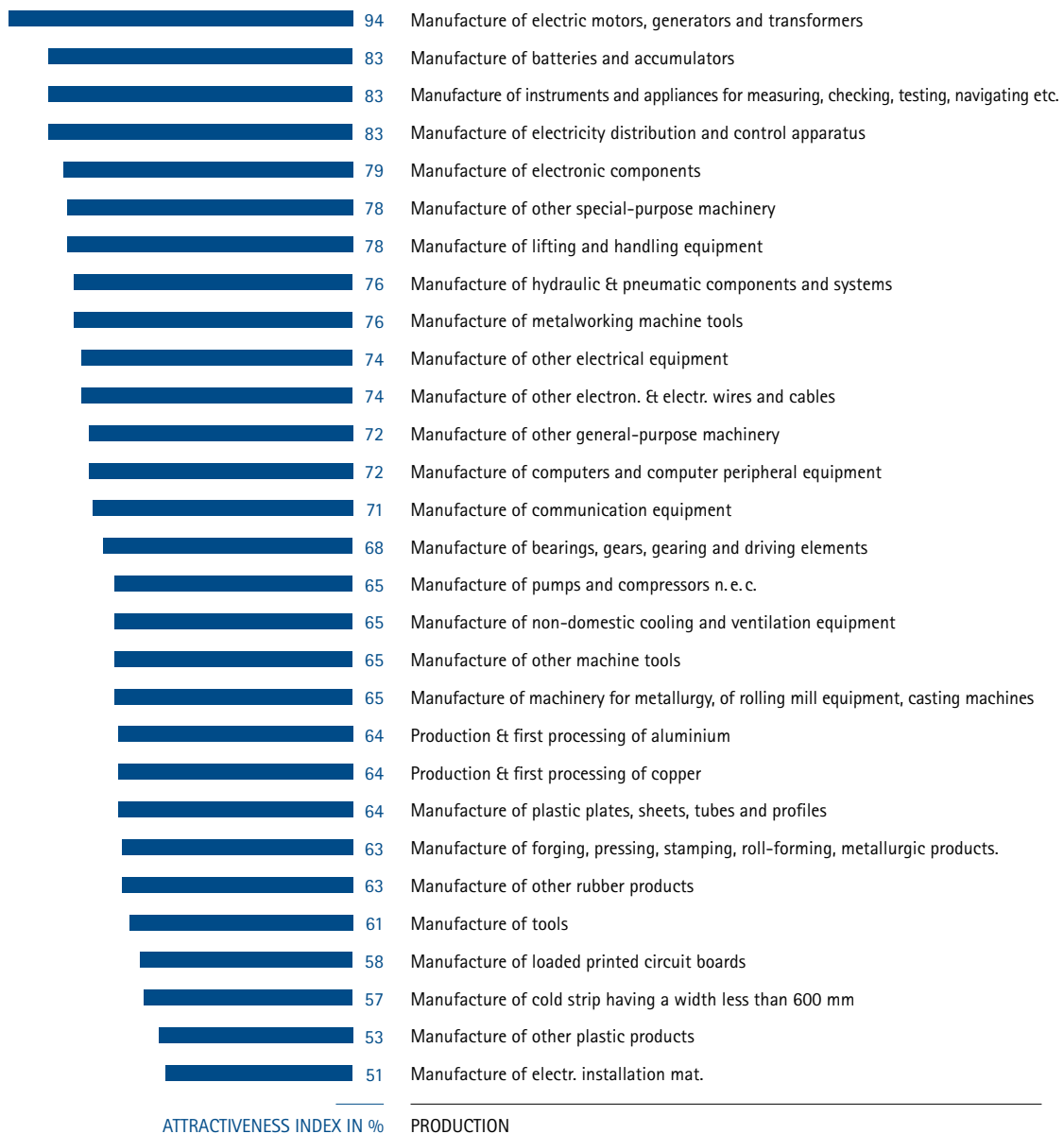


Figure 13: Weighting of the evaluation criteria for the attractiveness of automation industries  
Source: Fraunhofer SCS



The sectors "Manufacture of instruments and appliances for measuring, testing and navigation etc.", "Manufacture of electricity distribution and control apparatus" and "Manufacture of other electrical equipment" are particularly well represented in Automation Valley Northern Bavaria. Around 40% of the entire production companies in Automation Valley can be assigned to these three sectors. The Valley's other core sectors are the manufacture of electronic components, the manufacture of other special-purpose machinery and the manufacture of other general-purpose machinery (e.g. machinery for filling, closing, sealing, capping or labelling).

Although Automation Valley's manufacturing industry has a broad range of sectors, a comparison of the established companies with the sectors that are highly attractive to the automation area reveals a number of branches of economic activity that are not covered.

It is only after an in-depth examination that the relation between the number of companies and the identified attractiveness of a sector can be assigned specific recommendations for action. For example, the number of just 5 players in the highly attractive area "Manufacture of electric motors, generators and transformers" or 2 players in the "Manufacture of electronic and electric wires and cables" seems to be relatively small by comparison, but large and well-known companies with high input and output are based here, which means that there is no "gap" to speak of. Rather, the focus should be on those areas that are scarcely represented, if at all, in Automation Valley; these include, for example:

- The manufacture of batteries and accumulators
- The manufacture of hydraulic and pneumatic components and systems
- The manufacture of telecommunications equipment
- Manufacture of cooling and ventilation equipment, such as fans

The discussions with experts additionally revealed that the manufacture of multi-purpose industrial robots for various special tasks generally represents a very attractive field for automation, as virtually all areas of expertise are concentrated in this field and many automation products are used here. While a number of companies are already active in this field (summarized under EA 2899 in Figure 14), further players would clearly enrich the Valley.

#### 4.2.2 Services – the regional requirements are comprehensively covered

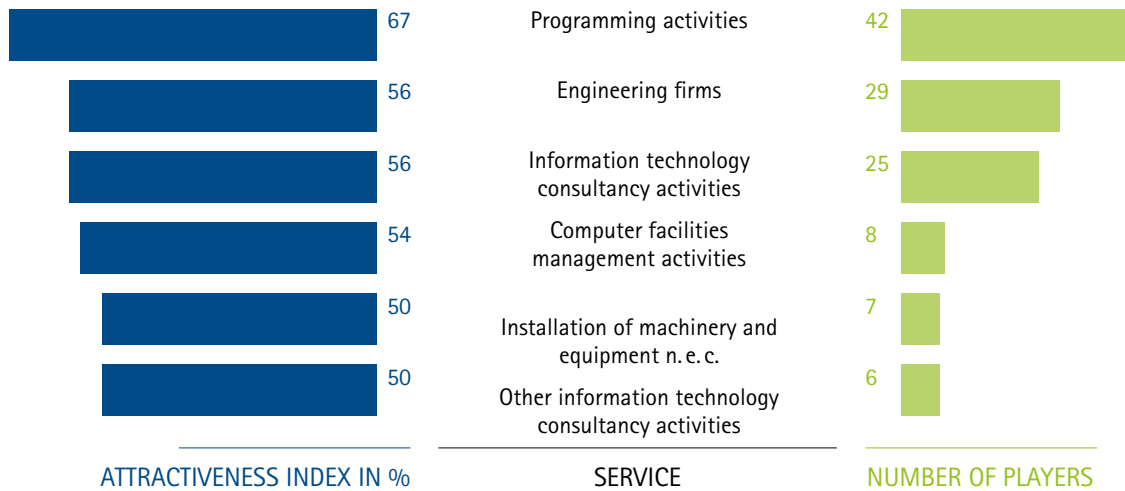


Figure 15: Number of companies in Automation Valley Northern Bavaria by sector focus and evaluation of the attractiveness of sectors in the area of services  
 Source: Fraunhofer SCS.

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The sector focus in the area of services in Automation Valley is on programming activities. This includes, for example, the development of software for the automation industry. In second place, by number of active players, come engineering consultants. This includes, for example, the design of machinery, industrial processes and installations or the design of projects in the areas of electrical engineering and electronics, process engineering, mechanical engineering, manufacturing organization or system development. Close on its heels comes the sector "Information technology consultancy activities"; overall, it was possible to identify 25 companies in Automation Valley whose main or ancillary activity corresponds to classification of economic activities 6202.

In the course of the analysis, it was discovered that the service area is very well covered by member companies in Automation Valley. Those sectors that have a high attractiveness index are already suitably represented at the location. Potential that might arise is in the establishment of companies whose core activities comprise the computer-aided optimization and simulation of processes in the environment of Industry 4.0, the creation of man-machine interfaces and new software solutions in connection with artificial intelligence or the automation of intelligent behaviour.

#### 4.2.3 Trade – numerous specialists exist

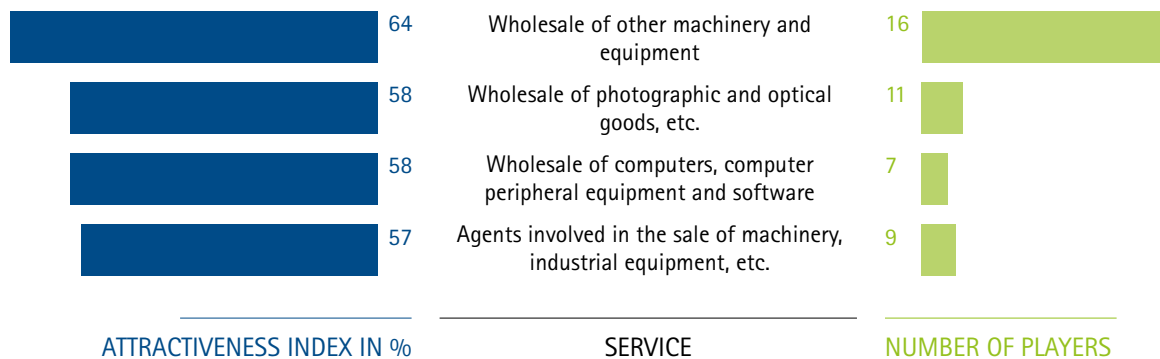


Figure 16: Number of companies in Automation Valley Northern Bavaria by sector focus and evaluation of the attractiveness of sectors in the area of trade

The wholesale trade in Automation Valley Northern Bavaria is well represented at the location, with a total of 43 companies; the company survey also revealed great satisfaction with provision at the location. "Wholesale of other machinery and equipment" is the most important activity here. A total of 15 companies could be assigned to this sector. It is followed by "Wholesale of photographic and optical goods, such as magnifying glasses or microscopes", and by "Agents for the sale of machinery".

"Wholesale of other equipment and supplies for machinery and industrial equipment", in particular, which is subsumed under EA code 4669, is closely related to the automation industry. Relevant sectors here, for example, are "Wholesale of production-line robots", "Wholesale of insulated electrical wires and cables", "Wholesale of other electrical material like electric motors und transformers, accumulators, batteries" and "Wholesale of electrical and electronic measuring, testing, regulating and controlling appliances". Even broader provision in this specific area could cover further requirements through local traders.

To summarize, any attempts to make further additions to Automation Valley Northern Bavaria should focus on companies from the manufacturing industry. Small, highly innovative service providers also constitute a sensible addition to the portfolio of companies, with the driving force behind the automation sector stemming precisely from the combination of production expertise and additional service expertise.

## 5. CORE STATEMENTS AND SUMMARY

A combination of theoretical definitions and concepts, statistical data evaluation and in-depth interviews with experts from the world of practice enabled the present study to show a more transparent picture of the structural peculiarities and interdependence of the regional automation industry. A good summary of the findings of the study can be provided in the form of statements by individual discussion partners:

**"It is scarcely possible to define the sector in one sentence"**

The automation industry is characterized by high complexity and broad sector interdependence. It is not possible to provide a discriminating definition using statistical classifications; nor is this constructive. Rather, "automation" refers to an interdisciplinary industry that facilitates the autonomous function of products and processes and combines a plethora of players from different economic fields.

**"Trust and flexibility grow with long-term bonds"**

The collaboration between individual partners in the automation sector's value network is based on long-standing co-operative ventures. Product quality and reliability are the crucial factors; price, while important, is secondary by comparison.

**"Sales sell the 1st system, service the 2nd"**

Services already constitute an important component of the automation industry. This component is expected to continue to grow, and the willingness to pay for services will increase. Against the background of the mega trend of Industry 4.0, deeper integration of services with products can be expected, which will act as a catalyst for the automation industry.

**"The Valley acts as a contacts forum, a facilitator and a generator of ideas"**

The network function of Automation Valley Northern Bavaria is perceived and appreciated by the member companies; the colourful mix of companies with widely different orientations and sizes is particularly welcomed.

**"Although Automation Valley has external appeal, it does not have a clear image"**

The contacts persons find it difficult to draw a distinction between Automation Valley and the "Mechatronics and Automation Cluster". Strengthening the profile/ image can ensure better recognition value. Up to now, it has not been Automation Valley's international recognition value, but mainly the names of large companies that attract customers to the region.

### **"We actually have everything we need"**

The companies interviewed do not see any acute "gaps" in the value chain, either in terms of suppliers or special know-how. It was possible, however, to methodically identify a number of sectors that, owing to their high similarity with automation and their expertise that does not as yet exist in the network, could make sensible additions to Automation Valley Northern Bavaria. These include, in particular, companies from the areas "Manufacture of batteries and accumulators", "Manufacture of hydraulic and pneumatic components and systems", "Manufacture of telecommunications equipment" as well as "Manufacture of cooling and ventilation equipment". On the service side, particularly innovative players from the areas of artificial intelligence and man-machine interfaces represent a sensible addition.

### **"Promotion of new talent can be expanded"**

The acquisition of new skilled labour is identified as a potential obstacle in the way of further expansion of the automation area. SMEs, in particular, which support a large part of Automation Valley, fear a visibility problem in relation to the established global players in the region. Closer collaboration with schools and universities as well as greater awareness of the automation area should be promoted so as to continue to be able to act successfully in this market environment.

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Tel. +49 (0) 911 / 13 35-335  
Fax: +49 (0) 911 / 13 35-15 03 35  
E-Mail: [info@nuernberg.ihk.de](mailto:info@nuernberg.ihk.de)  
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