



Industry 4.0 for the future
of **manufacturing** in the EU

COUNTRY REPORT

GERMANY

provided by nordbildung gGmbH



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Further information is available at <http://www.adapt.it/industry4EU/>

Industry 4EU – Industry 4.0 for the future of manufacturing in the EU
Country Report: Germany

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1. Introduction

The EU manufacturing output stands for 15% of the overall member states' GDP and EU has declared that the goal is to increase this level by 20% by the year 2020. However, since 2008 over 3.4 million jobs have been lost in the metal industry. This data proves that a new phase of EU economic growth cannot come without the involvement of metal and mechanical industry. Industry 4.0 is a new production system resulting from the application of new technologies to manufacturing. Industry 4.0 represent a game changer affecting all the activities linked to manufacturing, from planning to processes, from products to work organisation. While the robotic evolution of production represents an opportunity for the EU economy, as it implies the demand for new professional figures, the process will involve several challenges for the EU labour market, including a loss of low qualified jobs and a lack of high-skilled workers (F. McCrory, Y. Alhammadi, G. Westerman, E. Brynjolfsson, Racing With and Against the Machine: Changes in Occupational Skill Composition in an Era of Rapid Technological Advance, 2014).

This report is part of INDUSTRY 4EU (Industry 4.0 for the future of manufacturing in the EU), a project aimed at bringing together social partners and institutions from Italy (ADAPT; FEDERMECCANICA), Germany (NORDBILDUNG), Slovenia (Chamber of Commerce and Industry of Slovenia) and at the European level (CEEMET) in an effort to identify concrete actions to cope with challenges and opportunities of Industry 4.0. Particularly, INDUSTRY 4EU is intended to identify good practices and possibilities for employers to successfully support the implementation of Industry 4.0, especially by the means of social dialogue at all levels, from firm to the European Union.

According to the European Commission, one of the goals of the Europe 2020 strategy is “to promote the restructuring of sectors in difficulty towards future oriented activities, including through quick redeployment of skills to emerging high growth sectors and markets” (European Commission, Europe 2020. European strategy for smart, sustainable and inclusive growth, 2010), thus fostering the Renaissance of industry in Europe. Even though Industry 4.0 has still not been tackled by a joint action within the framework of the European social dialogue, EU social partners are currently demonstrating an increasing interest in this topic. INDUSTRY4EU (Industry 4.0 for the future of manufacturing in the EU) wants to be a stepping stone to put Industry 4.0 on the top of the EU social dialogue agenda. The project is aimed at bringing together social partners and institutions in an effort to identify concrete actions to turn Industry 4.0 challenges into opportunities. The main objective is to improve dialogue between employers' associations in order to create conditions for the spread of Industry 4.0 in the European countries, thus contributing to reconverting present factories and helping them to be more competitive.

This national report is one of the outputs of the project, aimed to explore the current landscape of Industry 4.0 in Germany based on the results of a map of past and existing unilateral programmes, as well as social dialogue initiatives to deal with the skills mismatch arising from the digitalisation of production methods and developing the technical skills necessary for the implementation of Industry 4.0, a mapping exercise conducted by nordbildung gGmbH and semi-structured interviews conducted by ADAPT.

2. Objectives and methods of analysis

The aim of this report is to provide the partners of the Industry 4EU project with an overview of the current approach taken by the metal and electrical industry in northern Germany to the issues relating to digitalisation, Industry 4.0 and Work 4.0, and a summary of the initiatives that have been launched

- a) to collect information,
- b) to identify and analyse areas of activity and
- c) develop appropriate measures.

Besides technological aspects, which play an important role particularly in the metal and electrical industry in the light of increasing digitalisation, this report also deals with sociological determinants, or “soft” factors, which describe the integration of human labour in technological processes. These face major challenges in terms of adapting to the wide-ranging change processes arising from Industry 4.0. In Germany, these aspects and their general conditions (e.g. employment law, workplace design, working time models, management culture, communication) are summarised under the heading ‘Work 4.0’ in the context of digitalisation.

The results of the report are based on research carried out by nordbildung gGmbH, the education network of the metal and electrical industry. This network is managed and organised by

- NORDMETALL, the Federation of the Metal and Electrical Industry,
- AGV NORD, the Employers’ Association in Northern Germany
- and seven educational institutes for industry and commerce in northern Germany.

A large part of the collected and analysed data comes from the associations’ day-to-day activities in Hamburg, Bremen, Schleswig-Holstein, Mecklenburg-Western Pomerania and northwest Lower Saxony. This information is supplemented by the work results of the national umbrella organisations GESAMTMETALL and BDA (the Confederation of German Employers’ Associations) and by reports of the Federal Ministry of Labour and Social Affairs.

The following methods for data collection and analysis were used in the preparation of the report:

- The organisation of specialist and interdisciplinary working groups of the associations NORDMETALL and AGV NORD and their member companies.
- The organisation and analysis of panel discussions and information events of the associations NORDMETALL, AGV NORD, GESAMTMETALL and BDA, including member companies and third parties (external experts).
- The study and application of publications by the relevant stakeholders in the M+E industry.
- The inclusion of information and interim results from the social partnership agreement that is currently being drafted.

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- The organisation and analysis of online member surveys carried during the Industry 4EU project.
- Bilateral discussions with selected decision-makers from the member companies of NORDMETALL and AGV NORD.

The report provides a structured summary of the association activities of NORDMETALL, AGV NORD and nordbildung in the context of Industry 4.0 and Work 4.0 in order to support the achievement of the project objectives.

3. Stakeholders' involvement

In the context of this report, the term stakeholders refers to the partners of the employers' associations NORDMETALL, AGV NORD and nordbildung who play an active role in Industry 4.0. Apart from the member companies of the associations, the stakeholders also include partner associations, social partners, education partners and other experts on specific practical issues.

The stakeholders mentioned below were directly or indirectly involved in the preparation of the report – largely through their day-to-day activities or through regular discussions in connection with Industry 4.0 and beyond. In addition, selected representatives of the stakeholders also took part in interviews conducted during Industry 4EU project.

3.1. Member companies

The member companies of AGV NORD and NORDMETALL are the main sources of information relevant to this report. Their day-to-day activities are behind the growth of the metal and electrical industry and its significance to the German and the global economy. They also provide the necessary information about the latest developments in the sector with regard to Industry 4.0.

Member companies in figures (total):

NORDMETALL:	233 companies
AGV NORD:	417 companies

3.2. Partner associations

AGV NORD and NORDMETALL represent the M+E industry in a large number of projects, networks, bodies and (education) policy committees either through a direct mandate or via regional or national umbrella organisations. The umbrella organisations and partner associations involved in this report are:

3.2.1. GESAMTMETALL (www.gesamtmetall.de)

The employers' association GESAMTMETALL is the umbrella organisation of the regional employers' associations in the metal and electrical industry in Germany. The umbrella organisation represents the common and general interests of M+E companies at national level. Gesamtmetall is a member of the Confederation of German Employers' Associations (BDA) in Berlin.

The responsibilities of an employers' association mainly revolve around wage, social and education policy. Together with the regional employers' associations, GESAMTMETALL plans and coordinates measures at national level and ensures that the metal and electrical industry speaks with one voice on the important common interests of the companies. The association lists as its members 13 collective bargaining associations and 8 associations not covered by collective bargaining.

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3.2.2. BDA (www.arbeitgeber.de)

The Confederation of German Employers' Associations (BDA) is the umbrella organisation dealing with employment and social policy on behalf of German business as a whole at its headquarters in Berlin (in Cologne from 1951 to 1999). The BDA unites the German employers' associations under one roof. Its members include 14 multidisciplinary state associations (joint associations for Berlin and Brandenburg and for Hamburg and Schleswig-Holstein), each including multidisciplinary regional associations, and 52 national umbrella trade associations, each including state and regional trade associations from the fields of industry, services, finance, trade, traffic, crafts and agriculture. Overall, some one million companies are direct members of the BDA. These companies employ about 70 per cent of all employees.

At European level, there is *BusinessEurope* (formerly *Union des Confédérations de l'Industrie et des Employeurs d'Europe*), and internationally, the BDA is also represented in the *International Organisation of Employers*.

3.2.3. UV NORD (www.uvnord.de)

The Federation of Business Associations in Hamburg and Schleswig-Holstein (UV Nord) is the umbrella organisation dealing with economic and social policy on behalf of north German business. The organisation represents cross-sector business interests in Schleswig-Holstein and Hamburg to the government and the community and is a social partner representing the employers' interests in negotiations with the umbrella organisations of the trade unions. UV Nord comprises 71 business and employer associations in Hamburg and Schleswig-Holstein. Apart from multidisciplinary regional associations, the federation also includes associations from the fields of industry, trade, banking, services and crafts. UV NORD represents the interests of about 34,000 companies with 1.4 million employees.

3.3. Social partners

In Germany, the term 'social partner' is used to refer to the parties to collective agreements, that is, trade unions on the one side and employers' associations on the other. A 'social partnership' describes the cooperation between them with regard to formulating joint rules on wage and working conditions in collective agreements.

This report looks at the social partnership in the metal and electrical industry at two levels: at national level, where the term 'social partner' refers to IG Metall (www.igmetall.de) and the employers' association GESAMTMETALL, and at regional level, where the social partnership is shaped by IG Metall Küste (www.igmetall-kueste.de) and NORDMETALL.

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In the context of the Industry 4EU project, the fact that IG METALL and GESAMTMETALL entered into a **social partnership agreement** in April 2016 in cooperation with the associations VDMA¹ and ZVEI² deserves particular attention. The partners agreed to carry out a joint review of the training occupations relevant to Industry 4.0 and the associated further training in the metal and electrical industry with regard to changing requirements and new career prospects. The partners also plan to develop recommendations for action on jobs in the metal and electrical industry. This includes guidelines for on-the-job training and school education, changes to the curriculum or new job/further training profiles and specific information on interdisciplinary qualification profiles.³ Some of the core elements of this social partnership agreement are presented further below. The agreement is still being drafted and the final version is expected to be published in summer 2017.

3.4. Education partners

Together with the seven educational institutes for industry and commerce in northern Germany, AGV NORD and NORDMETALL offer their member companies an extensive range of seminars and qualifications via the training association nordbildung gGmbH (www.nordbildung.de), an organisational alliance that provides a comprehensive service of consistent quality for the member companies in Schleswig-Holstein, Mecklenburg-Western Pomerania, Hamburg, Bremen and northwest Lower Saxony. The seven educational institutes for industry and commerce in northern Germany are:

- Bildungswerk der Wirtschaft Hamburg e.V. (www.bwh-hamburg.de)
- Bildungswerk der Wirtschaft Mecklenburg-Vorpommern gGmbH (www.bildungswerk-wirtschaft.de)
- Technische Akademie Nord (www.t-a-nord.de)
- Bildungszentrum der Wirtschaft im Unterwesergebiet e.V. (www.bwu-bremen.net)
- Bildungswerk der Niedersächsischen Wirtschaft gGmbH (www.bnw.de)
- Bildungs- und Tagungszentrum Tannenfelde e.V. (www.tannenfelde.de)
- AFZ Aus- und Fortbildungszentrum Rostock GmbH (www.afz-rostock.de)

Alongside an extensive range of seminars, nordbildung also organises regular networking events for the member companies of the associations and for the stakeholders of the education partners. The key issues dealt with at these networking events reflect the requirements of the seminar customers that are identified through personal discussions and specific surveys.

¹ https://de.wikipedia.org/wiki/Verband_Deutscher_Maschinen-_und_Anlagenbau: the Mechanical Engineering Industry Association (VDMA) is based in Frankfurt am Main and has around 3,200 members, making it Europe's largest industry association. It represents the interests of the mostly medium-sized capital goods industry to political and social institutions, business, science, public authorities and the media.

² https://de.wikipedia.org/wiki/Zentralverband_Elektrotechnik-_und_Elektronikindustrie: the German Electrical and Electronic Manufacturers' Association (ZVEI) represents the economic, technological and environmental interests of the mostly medium-sized German [electrical industry](#). According to its own information, ZVEI has 1,600 members. With 840,000 employees nationwide (at the end of 2012) and a total turnover of €175bn (at the end of 2012), the electrical industry is the third-largest industrial sector after mechanical engineering and IT.

³ <https://www.gesamtmittel.de/aktuell/pressemitteilungen/me-sozialpartner-analysieren-qualifizierungsbedarf-und-berufsbilder-fuer>

4. Mapping exercise

NORDMETALL and AGV NORD have been dealing explicitly with issues relating to Industry 4.0 and Work 4.0 since 2015. The main focus of their activities to date has been

- a) to inform their own member companies about the basics, developments and trends
- b) and to forge links between the member companies and with third parties (e.g. with experts on specific issues).

Since the member companies vary greatly in terms of structures, processes, size, strategy and objectives, the work of the associations with regard to supporting the companies is intentionally based on the principle of ‘helping others to help themselves’. This means that the associations provide the companies with a financial and organisational framework to establish contacts with experts, build cross-business networks and generate new momentum from “outside”. The core objective is to ensure that the companies find individual solutions to their specific questions and problems. The associations act as a learning and development guide.

The following pages describe the associations’ activities that contribute to achieving the aforementioned objectives in the context of Industry 4.0 and Work 4.0. They focus primarily on in-house working groups, networks and events, which are summarised under the heading ‘**unilateral programmes**’ in the project report for Industry 4EU. These unilateral programmes are partially organised by nordbildung gmbH, which implements its own event formats that also contribute to achieving the objectives of the associations.

The description of the ‘**social dialogue**’ particularly refers to the aforementioned social partnership agreement, whose aim is to define the future qualification requirements for training (and personnel development) in the context of Industry 4.0. This specific focus is simply due to the fact that the resulting actions recommended by the social partners will be an important indicator for the M+E industry when it comes to effective qualification concepts that take account of increasing digitalisation.

The practical implementations during the Industry 4EU project (online survey and stakeholder interviews) and their results are included in the associations’ action portfolio. The key results of the online survey are summarised in section 4.3. The content of the **stakeholder interviews** is presented as bullet points in this report, however, full details will be available in a separate paper to be published by the project partner ADAPT.

NORDMETALL and AGV NORD are currently considering the formation of a steering committee, which would review and group together all association activities relating to Industry 4.0 and Work 4.0 along strategic lines and route them to the appropriate implementation and communication channels. The makeup of this committee has not been finalised, however, due to its potential significance it is described in a separate section below. The working title of the committee is ‘**Industrieclub Arbeit 4.0**’.

4.1. Unilateral programmes of NORDMETALL and AGV NORD

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As mentioned briefly in the introduction to this section, unilateral programmes of the associations and of nordbildung refer to all activities intended to inform the member companies about Industry 4.0 and Work 4.0 and forge links between them and with third parties. Particular attention is given to events, networking and working groups because the content of these exchanges is centrally organised by the associations.

4.1.1. Community of Training Practice

The Community of Training Practice (CoTP) is a networking service for all NORDMETALL and AGV NORD member companies. The community brings together specialists and managers responsible for the organisation of product-related and process-related training content, formats and media. The training programmes are targeted at in-house after-sales staff and at employees of the end customers who are familiar with the use of the product.

In the context of a traditional best-practice exchange, the main question is how learning content should be prepared and conveyed effectively to ensure it has a long-term effect and a high ROI.

The CoTP takes place three times a year over a long afternoon. It is held on a rotational basis at one of the member companies that participate in the community. As a result, one of the collateral benefits of the exchange is that the companies are able to meet “live” at the event and discuss specific practical implementation issues.

The associations chose ‘Industry 4.0’ as the heading for the next three events. The host companies can choose their own topics within the confines of this heading. The following CoTP meetings will be held in 2017:

- Host 1: HellermannTyton, 7 March 2017
- Host 2: AIRBUS, 13 June 2017
- Host 3: WEINMANN Emergency Medical Technology, 14 November 2017

4.1.2. Personnel Development Working Group

The Personnel Development Working Group (PEAK) is a networking service for all NORDMETALL and AGV NORD member companies. PEAK invites HR experts for specialist discussions across corporate boundaries on current incentives and best-practice processes in personnel development. The subjects at the centre of the discussions include evaluation exercises, such as the implementation of integrated personnel development concepts, or the support and anchoring of HR projects on specific issues.

Like CoTP, PEAK also takes place up to three times a year on a rotational basis with meetings being held at one the member companies involved. The host company is largely responsible for the choice and structure of the content.

Industry 4.0, as an area of activity, was chosen as the heading for two PEAK meetings in 2016. The meetings were hosted by STILL GmbH and NIT (Northern Institute of Technology Management). The companies involved explicitly requested the

development of a set of questions to review their own specific structures and processes.⁴ The work results of PEAK (key questions) generated in the context of Industry 4.0 are listed in Annex 1 to this report.

4.1.3. HR Networks

AGV NORD and NORDMETALL have for many years been inviting the HR managers (managing directors, personnel managers) of the member companies at least three times a year to exchange HR-specific experience. The exchanges are based on a presentation on HR issues, the latest information about employment and social security law and current developments in wage policies.

In order to give the HR managers more time and space to share ideas among colleagues, the associations have adapted the format of the meetings as of 2017 and included more interactive elements. The next meeting, for instance, will open with a joint breakfast accompanied by a keynote speech.

4.1.4. Training Networks

The Training Networks in the M+E industry organised by NORDMETALL and AGV NORD are targeted at training managers or those responsible for training in the member companies. The networks focus on sharing experience and information relating to training issues and are brought to life by the experience and the expectations of the participants.

The issues dealt with at the networks are either suggested by a participant or by an external speaker and discussed at network meetings. This allows the participants to network and learn from each other. The specific key issue is always accompanied by an open exchange of experience covering recent successes and challenges in training.

The network meetings take place at regional level in four areas: Bremen/northwest Lower Saxony, Hamburg, Mecklenburg-Western Pomerania and Schleswig-Holstein. They are usually held twice a year in each region and take the form of a half-day event with one member company acting as host.

The issues surrounding Training 4.0 are currently not explicitly on the agenda of the Training Networks, partly because of their local structure. However, many issues, such as the use and integration of digital media in training, are covered automatically. Major recurring themes that are relevant to the entire training programme in the M+E industry are deferred to the annual Training Managers Conference (cf. section 4.1.5.).

⁴ Note: the principle of helping others to help themselves usually also applies to the working groups of AGV NORD and NORDMETALL. Therefore, the content of the discussions often consists of questions, which each company can reflect in its own structures and processes after the discussions.

4.1.5. Training Managers Conference

The Training Managers Conference usually takes place once a year to discuss an issue that is relevant to all four regional training networks. The conference is therefore set up at supra-regional level.

In 2016 the subject of the conference was *'Training 4.0: Pipedream or Reality?'* and delegates examined how digitalisation as a driving force behind technological development affected commercial and technical training in the M+E industry. Speakers included scientific, economic and political experts who provided plenty of background information and the opportunity to discuss practical implementation. The presentations were followed by workshops to answer individual questions raised by the participants.

4.1.6. Treffpunkt nordbildung

The networking format *'Treffpunkt nordbildung'* is a joint project of the education network nordbildung and the employers' associations NORDMETALL and AGV NORD with two events in each year targeted at employers, managing directors, training managers and HR managers. Under the banner of *'Sharing Knowledge – Cultivating Contacts'* the aim is to hold cross-functional discussions, share experience and incorporate new ideas into operational practice.

The issues discussed at Treffpunkt nordbildung originate from the pool of subjects developed by nordbildung or its partners (cf. section 3.4 Education partners). In other words, the education institutions and associations decide which areas of activity should be given more emphasis on the basis of their customers' current requirements. The organisation and structure of a Treffpunkt nordbildung is guided by the given subject. For example, a networking afternoon under the heading *'Utilising In-house Knowledge across Generations'* was held in the form of an open bar camp, and an event on *'Intercultural Competence from A-Z'* was set up as a subject-specific workshop.

The first Treffpunkt nordbildung in 2017 will take place in Hamburg on 6 April under the heading *'Learning and Communicating in Work 4.0 – a Networking Afternoon by Practitioners for Practitioners'*. As the heading implies, the core idea is to introduce participants to best-practice experience gained from corporate practice. The meeting focuses on proven digital learning content and learning techniques in terms of a continuous improvement process (personnel development/organisational development). Experts and managers from the member companies and external experts from the learning environment provide inspiration derived from practical applications.⁵

4.1.7. Production Forum

The associations organise an annual Production Forum to provide managing directors, plant managers and production managers of the member companies with comprehensive and practical information about current issues and the latest

⁵ Inspiration at Treffpunkt nordbildung on 6 April 2017 will be provided by Prof. Peter Dehnbostel (DUW Institute for Professional Studies), Dietrich Weidmann (Siemens Germany, Process Industries and Drives Service Operation), Josef Buschbacher (Corporate Learning & Change GmbH), Daniela Peeters-Bendix (Beiersdorf AG).

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developments in the metal and electrical industry. This is supported by renowned speakers with a scientific and practical background who report on the relevant key issue.

In 2016, the Production Forum devoted itself entirely to the subject of Industry 4.0. The meeting focused on the umbrella theme of 'Change Management and Leadership' and dealt with the following subthemes:

- 'Increasing Corporate Success through Transformational Leadership'
- 'SMEs Successfully Forging ahead towards Excellence'
- 'Mastering Organisational Development successfully – a Challenge for a Medium-sized Company'
- 'Shaping and Securing Change Processes in a Sustainable Manner'
- 'Involving Employees Successfully on the Road to Change'
- 'Increasing Agility in Organisations'

The following presentations rounded off the event:

- 'Work in the Digitalised World – the Industry 4.0 Challenge to a Medium-sized Company and its Organisation'
- 'Changes in a Small Trade Business – What do We Need to Continue Operating Successfully in 2025?'
- 'Changes in Production: Work 4.0 – How Does This Concern Me?'
- 'The Significance of Transformational Leadership for Corporate Success, Particularly in Rapidly Changing Environments'
- 'Collaborative Productivity, Opportunities for a Global Network'

4.1.8. Production Manager Meeting

As part of the Production Manager Working Group, which deals with various practical issues, NORDMETALL and AGV NORD organise a Production Manager Meeting once a year. In order to ensure a high degree of practical relevance, the meeting is held at one of the participating companies, which can choose to give a practical illustration of the specific issue.

In 2016, the Production Manager Meeting took place under the motto 'Industry 4.0 – More Than a Buzzword?'. The purpose of the event was to explain the important facts relating to Industry 4.0 to the participants and let them develop ideas for their own companies. The introductory talk and the subsequent workshop looked at the following issues:

- 'Industry 4.0 – Classification of the Various Terms'
- 'Industry 4.0 – Results of Current Research Projects'
- 'Industry 4.0 – Opportunities and Challenges for Operational Practice'

The company organising the event then demonstrated how the automation of production was implemented in the context of Industry 4.0 at its plant. Participants were able to ask questions about technical aspects and about the challenges during the planning and implementation of the solution presented.

4.1.9. Participation in regional, supra-regional and international projects

NORDMETALL and AGV NORD participate, in part directly and in part via nordbildung gGmbH, in a wide range of regional, national and international projects to actively support the developments of Industry 4.0 and Work 4.0 and to help shape them in accordance with the objectives of the M+E industry in northern Germany.

Two examples of **regional projects** worth mentioning at this point are the ‘Airbus Factory for the Future – HR 4.0’ and the ‘DigiNet – Air’ application. Both projects deal with the design of sustainable processes and structures within the aviation cluster in Hamburg in the context of Industry 4.0 and Work 4.0. Apart from the two companies from the aviation industry in Hamburg (Airbus and Lufthansa Technik), the project partners also include universities, vocational schools, ministries, research institutes, trade unions and associations.⁶ With regard to both projects, NORDMETALL and AGV NORD consider it their responsibility to disseminate information and shape networks in order to identify best practice on the basis of the projects and apply it company-wide. This is mostly for the benefit of the affected supply chains of the above-mentioned companies since they generally have fewer resources to fully develop concepts such as Industry 4.0. In addition, NORDMETALL and AGV NORD also see themselves as main contacts responsible for initiating the social dialogue from the employers’ perspective in both cases.⁷

The EU initiative ‘Industry 4EU’ is an example of the associations’ **international project activities** that deserves attention at this point. The relevant contents and work results will be described in more detail below.

nordbildung gGmbH and its partners support many, albeit not all, regional and supra-regional projects as education and qualification experts for the member companies of the associations. They make extensive use of the opportunities offered by a comprehensive service of consistent quality in Hamburg, Mecklenburg-Western Pomerania, Schleswig-Holstein, Bremen and northwest Lower Saxony.

4.1.10. Evaluation of current research projects

There are research institutes that present practical implementation measures under laboratory conditions in several regions of Germany. Staff from the work organisation division of NORDMETALL and AGV NORD have been visiting the main research institutes since 2015. This largely work science-based focus is aimed at informing the member companies about current technical research results and the latest developments relating to Industry 4.0 and defining key issues for future events on the basis of this. During these events, the associations work together with the member companies to examine the question as to what impact the new developments are going to have on the future structure of employment.

⁶ Here specifically: HAW (Hamburg University of Applied Sciences), TUHH (Hamburg University of Technology), Gewerbeschule Fertigungs- und Flugzeugtechnik (G15), Hamburg Authority for Economy, Transport and Innovation, acatech – National Academy of Science and Engineering, IG-Metall and IG-Metall-Küste

⁷ For reasons of data protection no detailed information on the regional projects mentioned may be published in this report. If you have any queries, please contact nordbildung gGmbH.

4.1.11 Evaluation of best practice examples from practical applications

NORDMETALL and AGV NORD share the prevailing view of the research community that people are at the centre of Industry 4.0 and that Industry 4.0 should be regarded as an open socio-technical system.

In order to gain an insight into the associated opportunities and risks for the companies, the associations are currently visiting businesses that have already gathered practical experience of the development and implementation of the issues relating to Industry 4.0. The focus is on the challenges inherent in the development and implementation of Industry 4.0 together with the employees and, in particular, on the requirement for occupational competence. The associations also asked the companies which solution strategies turned out to be useful when dealing with the (new) requirements.

The following similarities between the companies have already been identified on the basis of the current findings from the surveys (extract):

From the employees' perspective

- Essentially, there is an increasing need for interdisciplinary skills. This particularly applies to IT skills.
- There is a significant lack of skills among employees.
- The qualification of key skills should begin at an early stage.

From the organisation's perspective

- There is a high degree of acceptance of Industry 4.0 among staff at all levels in companies that have previously dealt with lean management methods.
- High practical relevance, joint experimenting and the creation of small successes increase the acceptance of further experiments.
- Flat hierarchies and a management culture based on trust and anticipation are regarded as prerequisites for the implementation of Industry 4.0.
- Showing how Industry 4.0 works at normative level and granting relevant freedoms is regarded as another prerequisite.

On the basis of best-practice examples and the findings from science and research, NORDMETALL and AGV NORD develop recommended actions for the implementation of Industry 4.0 from a socio-technical perspective. In collaboration with interested companies, the practical implementation of specific applications, for instance, as part of Industrieclub Arbeit 4.0 (cf. section 4.4), is scheduled to start in 2017.

4.2. Social partner dialogue

A continuous social dialogue takes place between employer and employee representatives in the M+E industry in Germany. This dialogue covers all business-related questions on the

(further) development of the industry and the safeguarding of its future. During this process, an innovative structural model and modern careers were developed for the M+E industry and for the IT sector. These process-oriented, flexible job profiles also satisfy the requirements of the system orientation of Industry 4.0 across the sector and the associated value creation and networks.

This is also the basis for a new initiative by the German social partners of the M+E industry, which led to the conclusion of a **joint social partnership agreement** that defines agile methods (cf. Annex 2). GESAMTMETALL, VDMA, ZVEI and IG Metall reviewed the Industry 4.0-related training occupations and the associated further training in the M+E sector with regard to changing requirements and new career prospects. The review included the expertise of company and education experts and researchers.

As a result, the parties to the agreement swiftly developed recommended actions for initial, advanced and further training in the M+E industry with specific proposals for further measures and initiatives. This forms the basis for future negotiations with the process participants affected by the recommended actions.

Since the wording of this social partnership agreement is still being drafted it cannot be published in this report. The document is to be finalised by summer/autumn 2017. It will be available from nordbildung gGmbH on request in due time.

4.3. Industry 4EU – online survey and stakeholder interviews

The following briefly summarises the results of the **online survey**, which was carried out as part of the Industry 4EU project. The overall results are attached to this report in Annex 3.

The project-related **stakeholder interviews** and their evaluations – both conducted and supported by ADAPT – were not available at the time the country reports were being prepared. They will be made available by ADAPT after they have been finalised and added to the country reports as a separate annex.

4.3.1. Online survey – key results⁸

A total of 54 companies took part in the online survey on the Industry 4EU project between 20 July 2016 and 11 August 2016 (inclusive).

Asked about **their own assessment of the level of digitalisation** in their own company, the participants showed great uncertainty: one third of all companies felt unsure or unable to assess their own level of digitalisation. Among the remaining participants, 13 per cent regarded their own level of digitalisation as low and almost half of those surveyed rated it as 'medium'. Only a small minority of 6 per cent of all survey participants rated the level of digitalisation in their company as 'high'. Smaller companies tended to rank their level of digitalisation much lower than larger companies.

⁸ Management Summary of the "Industry 4EU Study Report on the Online Survey conducted for NORDBILDUNG gGmbH", cf. pages 5-7; conducted by IW Consult GmbH, Konrad-Adenauer-Ufer 21, 50668 Cologne, Author: Dr Thomas Schleiermacher

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Mechatronics was by far the **most widely known technology**. Robotics followed in second place. Cloud computing and cyber security took third and fourth place. Virtual reality (VR), nanotechnology and big data/data mining were in the mid-range in terms of familiarity. Near the bottom of the list was the internet of things, with only just over half of the companies stating that they were aware of this technology. Rapid prototyping, as used in 3D printing, took last but one place. And finally, in last place were smart materials, which not even half of the companies were familiar with.

The surveyed companies in the metal and electrical industry were the greatest users of mechatronics. Cyber security was in second place. The internet of things was already being used by exactly half of the companies. Cloud computing, big data analysis or data mining and robotics ranked in the mid-range of applied technologies. Rapid prototyping, virtual reality, smart materials and nanotechnology brought up the rear.

Mechatronics took first place among the technologies in which the surveyed companies planned to invest in the short, medium and long term. Cyber security, cloud computing and robotics followed in second to fourth place. By contrast, a relatively small number of the surveyed companies intended to invest in big data/data mining, the internet of things, rapid prototyping and virtual reality in future. Only a minority of companies would consider potentially investing in nanotechnology and smart materials.

With regard to the **benefits the application of new technologies would create for the companies**, most of the businesses surveyed expected increased productivity within their own company. Greater flexibility with more customer-orientated products and services and the opportunity to optimise costs followed in second and third place. Relatively few companies associated the use of new technologies with an opportunity to reutilise or further utilise existing products and services and create interfaces between real and virtual systems.

On average the employees of the companies surveyed spent about **25 days per year on further training**. With 29 days, employees of SMEs spent more of their time on further and advanced training than those in companies employing more than 250 people (24 days). Companies that rated their own level of digitalisation as high trained their employees on only 15 days per year. In companies with a medium level of digitalisation, the figure was 29 days and rose to a far above average 44 days in companies with a low level of digitalisation. Companies that had already established research partnerships with universities and external institutions spent 22 days per employee on further training, however, companies without such partnerships spent 28 days a year per employee.

With regard to the **changing significance of specific soft skills** following the introduction of new technologies, the greatest changes relate to digital communication or the handling of digital media. The survey participants expected the smallest changes to be in the area of interpersonal relationships or empathy.

Asked about which **know-how components** had already been established in the company, the majority of the companies surveyed mentioned knowledge relating to IT

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infrastructure management. Data analysis followed in second place and general programming skills ranked in third place. Prototype development, automation management, process control using machines and the simulation of production processes brought up the rear.

When the companies were asked how strong the **effects of the new technologies on the implementation of new working-time and workplace models** (smart working) are, a not very dynamic picture emerged. Only two per cent of the survey participants reported strong effects, while two thirds of the companies did not expect any, or only minor, effects as a result of the new technologies. The picture changed when the companies were asked to assess the impact of the new technologies on the networking and sharing of knowledge. In this case, almost one third of the survey participants expected strong or very strong effects.

During the survey, the companies were given **different statements** for evaluation. The statement that 'Industry 4.0 allowed customer-specific production that would increase competitiveness' received the highest level of agreement. The companies surveyed seemed to be quite capable of assessing their own position on the road to Industry 4.0 in a self-critical manner ('Industry 4.0 is very important but requires know-how that we haven't acquired yet' – in third place) and did not expect to be able to implement the necessary adjustment process at zero cost ('Industry 4.0 requires major investment' – in fourth place). The statements in the bottom three places – 'the preparations for Industry 4.0 require little investment', 'Industry 4.0 offers no new opportunities for small companies in particular' and 'the discussion about Industry 4.0 is just a buzzword without any real content or relevant economic effect' – were met with very little agreement. The above average rejection of the last statement, which referred to the presumed irrelevance of Industry 4.0 for the German economy, confirmed that the M+E industry in Germany was aware of the forthcoming changes and would, and had to, actively take on the associated challenges.

Asked about the measures that their own company should take for the **successful implementation of Industry 4.0**, the survey participants ranked the promotion of lifelong learning among employees at the top of the list. The adjustment of the management culture to meet the requirements of Industry 4.0 took second place in terms of the most important measures. Synergy improvements in business processes to optimise regional networking and the reorganisation of the company to increase innovation activities followed in third and fourth place.

The **support measure most frequently requested of nordbildung gGmbH by the companies** was an 'assessment and support of regional or local initiatives relating to Industry 4.0'. The development of a communication campaign or networks to identify and present best practice approaches and the compilation and preparation of information on national and European subsidies for Industry 4.0 followed in second and third place. Relatively few companies expected nordbildung gGmbH to emphasise the significance of entrepreneurship more strongly than before.

4.3.2. Stakeholder interviews

The stakeholder interviews planned as part of the Industry 4EU project were organised and conducted by the project partner ADAPT. The same applies to the evaluation and summary of the results of the interviews. As soon as all the data has been submitted it will be made separately available by ADAPT.

4.4. Industrieclub Arbeit 4.0

AGV NORD and NORDMETALL developed 'Industrieclub Arbeit 4.0' as a proposal for the establishment of a central steering committee that would deal with all the activities of the associations relating to Industry 4.0 and Work 4.0 and route them to suitable communication and implementation channels. In addition, Industrieclub Arbeit 4.0 could draft and develop central themes for the member companies. This option is regarded as beneficial particularly if areas of activity arise from the day-to-day work of the associations (e.g. as part of projects and working groups) that should be applied to the wider business context.

In summary, the Industrieclub Arbeit 4.0 is meant to play a strategic function. The appointments to such a committee should, on the one hand, be of an interdisciplinary nature (i.e. across all departments of the association) and, on the other hand, include strategically important representatives from the member companies. At present, it would also be conceivable to appoint experts from the wider stakeholder group.

The Industrieclub Arbeit 4.0 is expected to commence its work in 2017.

5. Outcomes

As mentioned at the beginning of this report, the associations NORDMETALL and AGV NORD and the education network nordbildung have been addressing the issues surrounding Industry 4.0 and Work 4.0 since 2015. The organisation of information and networking events, the management of specialist and interdisciplinary working groups and the conduct of face-to-face interviews are the **most important sources of information from the member companies** and other stakeholders in this context.

With the exception of specific individual cases, both the associations and nordbildung have so far reached the conclusion that the above-mentioned **topics have to be considered and processed under various aspects**. This conclusion is mainly based on the fact that the initial situations of the companies in the M+E industry vary greatly in the context of Industry 4.0, particularly with regard to the following points:

- The concept of the significance of the term 'Industry 4.0' and the associated formulation of expectations and consequences for their business activities
- Experience of the implementation of digitalisation and digital media in corporate structures and processes
- Thematic awareness among experts and managers to determine their company's position and set objectives derived from it
- The development and implementation of a substantive and organisational strategy for dealing with Industry 4.0
- The maturity of the company's management and communication culture
- The provision of time, budget and personnel resources to develop and explore the issues relating to Industry 4.0 and Work 4.0
- The size and role of the company in the value chain

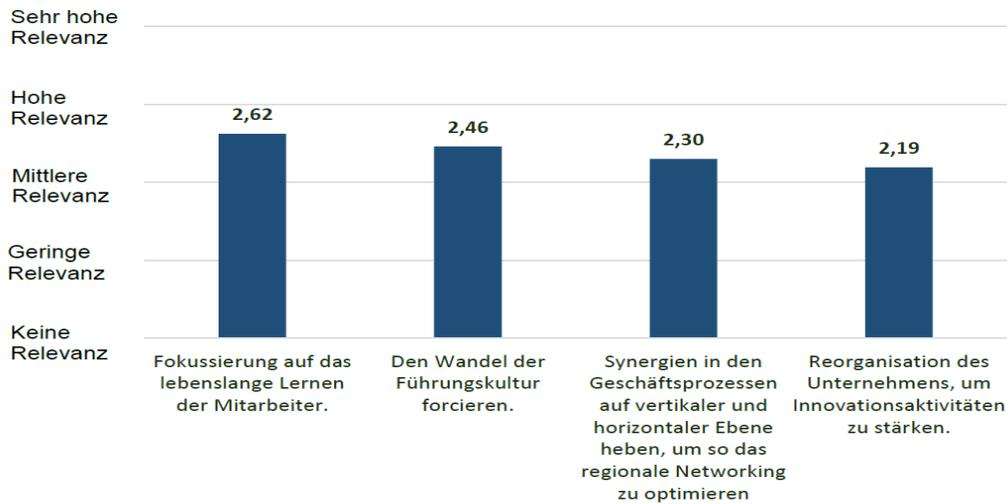
The results of the online survey provided NORDMETALL, AGV NORD and nordbildung with a good summary of the companies' self-assessment with regard to Industry 4.0.

The future areas of activity and the expectations of the members vis-à-vis the association also became clear:

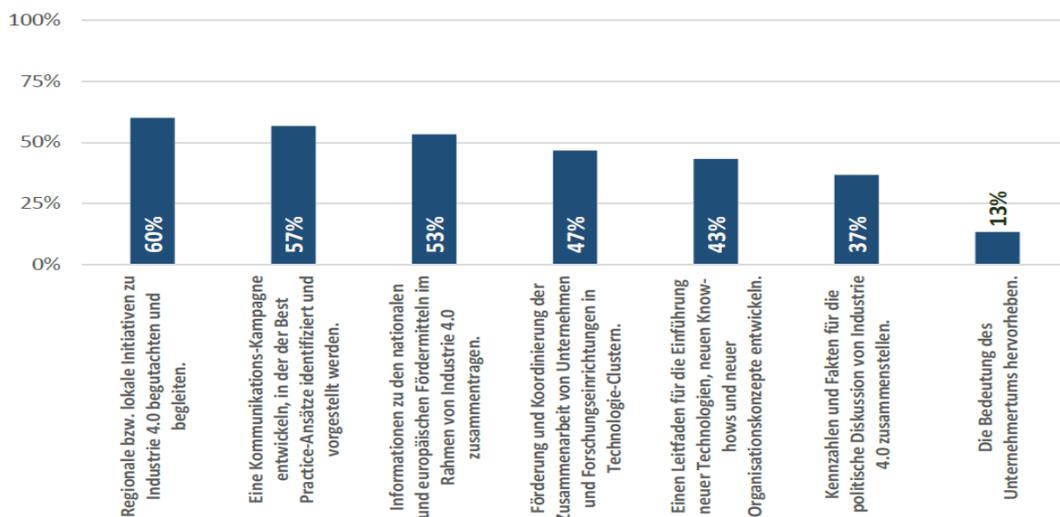
- 1) *Measures that from the companies' perspective have to be taken to successfully shape the changeover to Industry 4.0:*⁹

⁹ Online-Survey " Industry 4EU Study Report conducted for NORDBILDUNG gGmbH", cf. page 40; conducted by IW Consult GmbH, Konrad-Adenauer-Ufer 21, 50668 Cologne, Author: Dr Thomas Schleiermacher

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2) Activities with which nordbildung and the associations can support the objectives of member companies in future:



In this respect, the project results support NORDMETALL and AGV NORD in the process of defining future actions and objectives in the context of Industry 4.0.

The stakeholders put forward many new ideas in terms of content and structure, which the associations and nordbildung will take up and use in future. In this context, priority will be given to integrating the project content in day-to-day activities and using it in future agenda setting within the working groups, networks and other events. The planned Industrieclub Arbeit 4.0 is likely to play a role in this (cf. page 16 of this report).

6. Problems emerging within the mapping exercise

During the mapping exercise carried out in the course of the Industry 4EU project, no structural or procedural problems emerged among the German partners. The project-based surveys among the member companies of AGV NORD and NORDMETALL were carried out as planned. The same applies to the planning and conduct of the discussions and networking events with the member companies and other stakeholders.

However, a look at the content of the Industry 4EU project or of the content relating to Industry 4.0 and Work 4.0 reveals that it was, and is, very difficult to identify and formulate a uniform starting point for the M+E industry.

On the one hand, the companies differ too much in their structures, processes and level of digitalisation (cf. section 5) and on the other, the 4.0 issue is too complex horizontally and vertically for it to be readily broken down into brief, general key messages that focus on a single industry. This conclusion is also confirmed at operative level by the fact that current issues relating to Industry 4.0 cannot be easily transferred to a wider business context in a uniform format.

Specifically, this means:

Companies that have taken a deliberate in-depth approach to the issues surrounding digitalisation justifiably demand that they are supported by the activities of the associations with practicable, operative and strategic input (ideas for topics, contacts with experts, best practice in the application of models, formats and materials). This means that AGV NORD and NORDMETALL have to work in a specialist and detailed manner to satisfy this demand. Companies that have no or little prior knowledge of Industry 4.0 are asking for a general overview to enable them to orient themselves and establish basic networks. The companies generally regard too much detail as information overload and as ‘too far removed’.

These diverging expectations also became clear at the German Round Table meeting in Hamburg on 17 January 2017 and during the conduct and evaluation of the online survey.

An extract from the feedback query, which the associations sent out after a Treffpunkt nordbildung in 2016, illustrates this point perfectly:¹⁰

Asked about what expectations the companies had of the event and if these had been met, the companies provided the following qualitative feedback (extract):

- (+) *‘I wanted to get an overview of the subject. The amount of information was just right.’*
- (-) *‘There was not enough time to get to grips with the expert opinions in the working groups.’*

¹⁰ Feedback query as part of Treffpunkt nordbildung on ‘Intercultural competence as an opportunity for personnel and organisation development’ on 30 March 2016, in-house evaluation by nordbildung by means of a participant questionnaire.

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- (-) *'Specific, including legal, contributions would have been helpful.'*
- (+) *'A comprehensive insight into intercultural partnership projects – excellent!'*
- (+) *'There was an interesting exchange of ideas during the coffee breaks.'*
- (-) *'Some of the content was too superficial and the sessions were too short.'*

This feedback could give the impression that the participants visited different events.

To sum up, it can be said that the problems emerging during the mapping exercise are identical to the challenges that the associations have to face in their day-to-day activities. The associations have the duty to precisely define and organise the target groups within the member companies and the specific choice of subjects and methods for the exchange and information formats.

7. Perspectives of analysis

nordbildung states that the project objectives at the level of Industry 4EU have been met in addition to the contents described above.

The country representative involved in the project shared its contents on a continuous basis, mainly during round tables meetings and minute calls organised as part of the project. The interviews and network talks with national stakeholders also provided highly interesting practical insights into the current situations in other countries.

It remains to be seen whether the contacts made between countries during the project will be maintained after its completion, however, this would certainly be desirable, particularly in view of the fact that Industry 4.0 will continue to be relevant for the next few years or even decades. The cross-border sharing of best practice is going to be a particularly important element of the continuous improvement process within the EU structures.

AGV NORD and NORDMETALL together with nordbildung will process and organise the information acquired as part of the Industry 4EU project for the member companies and the extended stakeholder group. Initial talks have already taken place in existing project and network structures, e.g. in the core project team of AIRBUS – Factory for the Future or in the Community of Training Practice. The development of new communication and event formats that explicitly and successively deal with Industry 4.0 and Work 4.0 over a long period is also being considered.

The further application of the project information of Industry 4EU will primarily be based on the expectations of the member companies in terms of content (cf. section 4 Outcomes). The associations are going to focus on an interdisciplinary approach, which could be supported by the establishment of a cross-sectoral working group.

8. Final conclusions

Failure to shape the digital transformation for the benefit of Europe will lead to potential losses adding up to €605bn (EU-17) by 2025, which corresponds to a loss far in excess of 10% of the industrial base. The declared EU aim of increasing the share of industry to 20% in Europe by 2020 would become unachievable because without digitalisation there is going to be no reindustrialisation. In the best-case scenario, there would be an additional value creation potential of €425bn in Germany alone and of €1.25tn in the industrial sector in Europe over the next ten years.

Against this background, the following recommended actions were developed:

1. Digital maturity

Top priority is given to creating greater awareness and initiating processes in companies because many of them regard digitalisation primarily as a means to improve efficiency. However, the digital economy not only forces companies to optimise existing business models but also promises new, previously untapped value creation potential. Companies have to raise their level of digital maturity to identify and implement these opportunities. This involves greater penetration of digital trends and opportunities, a deep understanding of how the rules of competition change in the digital space to optimise existing and develop new business models and, lastly, the capacity to establish and expand the resources required to harness new opportunities.

2. Safeguarding Europe's interests during standardisation

The Industrial Internet Consortium (IIC) in the US has taken a pragmatic approach to promoting the setting of industrial standards. South Korea has a dedicated department for digital matters in the form of the Ministry of Science, ICT and Future Planning, and the Korea Industrial Technology Association (KOITA) represents the standardisation interests of the country's industry. The Chinese government is investing the equivalent of approximately €700m in the roll-out of the internet of things. Industry regulations will play a key role in translating industrial expertise into competitive advantages in future. German and European companies must not fall behind and therefore have to create appropriate platforms for sharing ideas, knowledge and experience.

3. Stimulating investment in the digital future

Investments in the digital future in Europe have so far been woefully inadequate. The US invests around €17.5bn in venture capital every year while the figure for Europe as a whole is only €3.5bn. Europe has to create the general conditions to make private investments in infrastructure and start-ups worthwhile. The public sector also has to take action to break through the existing investment backlog. Investment programmes, such as the "Juncker Plan", must be rigorously oriented towards promoting the digital transformation. This could be a driver for comprehensive broadband expansion in Europe, the funding of digital start-ups and the development of new tools to mobilise private investment. Changes to the

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educational programmes for pupils, students and further staff training with the aim of acquiring, expanding and updating key skills for the digital future must also be given greater priority in future.

4. European-wide coordination

Success in the digital economy requires joint action. Clusters, partnerships and associations must be promoted by a European economic alliance and the skills scattered across Europe must be brought together in a virtual “Digital Valley” as part of a coordinated EU-wide approach. This European counterpart to Silicon Valley would connect the developers and providers of digital solutions to each other, from start-ups to global players and from garages to high-tech laboratories, and so create the necessary density to encourage new developments and innovative business models.¹¹

¹¹ ‘The digital Transformation of Industry’; a European study by Roland Berger Strategy Consultants on behalf of the Federation of German Industries (BDI), Breite Straße 29, 10178 Berlin

9. Annexes

ANNEX 1) Work results of PEAK

First set of questions – fundamental issues

- ‘Who is going to produce which products in future (here: Google car)?’
- ‘Which new demand options are going to result from Industry 4.0 for different customer groups with regard to the determinants time, investment and supplier diversity?’
- ‘How are customers’ demand profiles going to change?’
- ‘Which distribution channels and what types of customer approach will or must result from this?’
- ‘What key skills and what knowledge are actually going to be required at existing production plants in future?’

Second set of questions – support of corporate change processes at social level through personnel development

- ‘Is it possible to predict the social impact, and if so how?’
- ‘What type of support is required to infer and implement personnel development measures?’
- ‘What skills does the overall organisation require to adjust to new systems?’
- ‘How can we persuade a capable workforce to make sure that the “core processor” of the company is running?’
- ‘What is going to distinguish a capable workforce with regard to personal, methodical, technical and social skills in future?’
- ‘How can we develop ideas from a personnel development perspective to encourage managers to question their existing thought patterns and direct them towards a completely new system?’
- ‘And how can personnel development encourage managers to learn things that they will not need to know until later?’

Third set of questions – networking

- ‘How can we implement and encourage a corporate networking culture that ensures that the necessary knowledge is passed on to the appropriate employee at the right time?’
- ‘How can we motivate employees to participate in the culture and share their knowledge? Perhaps through incentive schemes?’
- ‘What general infrastructure conditions have to be created to ensure that knowledge is and can be passed on as necessary? (Catchphrase: from the suggestion box to the tablet).’
- ‘How can personnel development support and analyse these exchange and networking processes and assess their effectiveness and efficiency?’
- ‘How can personnel development monitor this large number of, in some cases highly complex, communication processes and draw suitable, that is, commercially target-oriented conclusions?’

Fourth set of questions – changes at the level of work organisation and human resource allocation

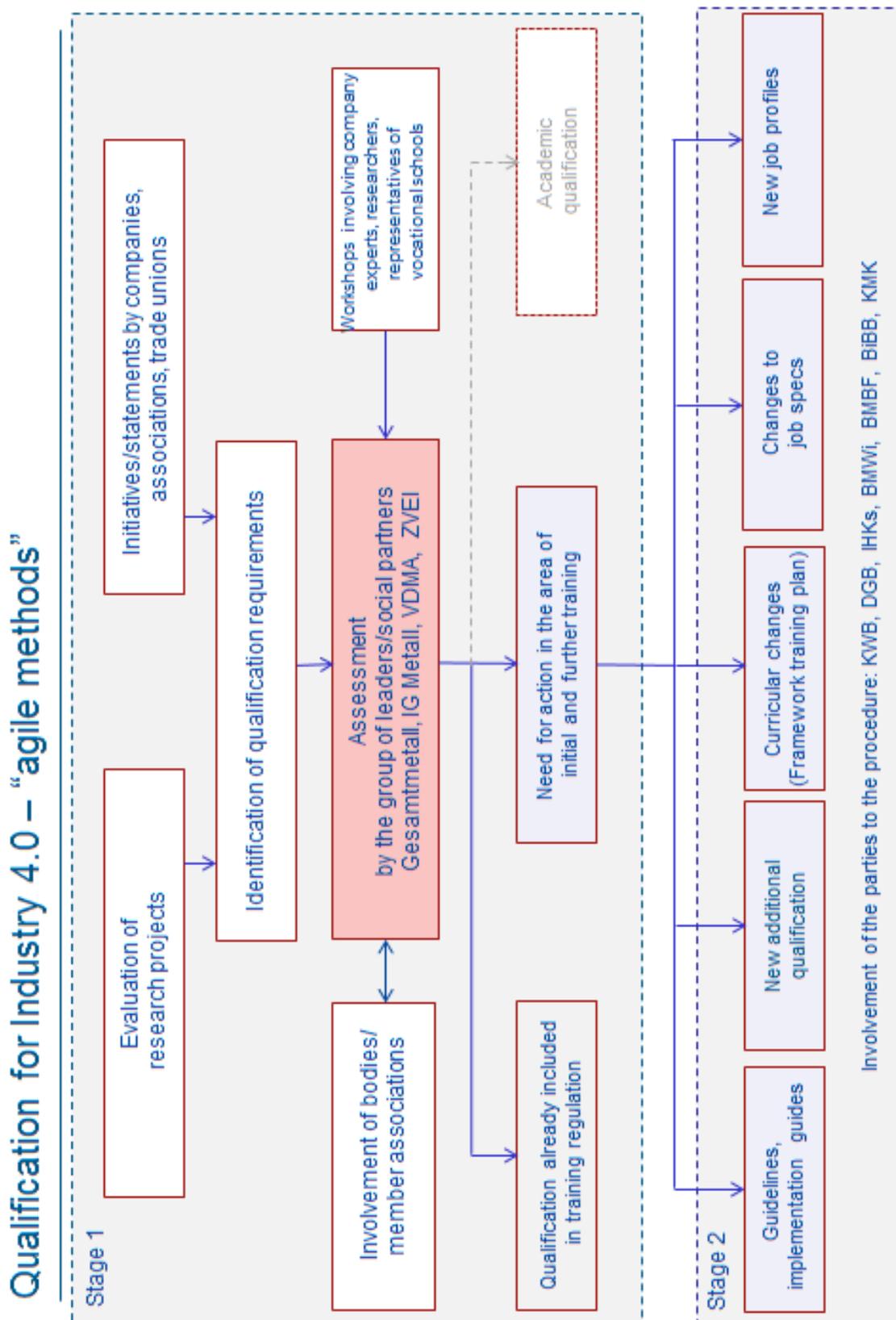
- ‘How is production going to take place in our company in future?’
- ‘Which jobs will be affected by a new production structure?’
- ‘What impact is this going to have on the current and future employee qualification profiles?’
- ‘What do these substantial changes mean in terms of research and development, that is, what and how are we going to carry out developments in future?’
- ‘To what extent are the current working-time models going to survive in future? Will they still be useful in their current format or will they have to be completely reassessed?’
- ‘Are the changes also going to affect the existing communication structures with the works council? How quickly and flexibly must it be possible to reach agreements in future in order not to lose competitiveness due to long coordination channels?’

Fifth set of questions – learning and acquisition of knowledge

- ‘What could modern offices look like?’
- ‘How could cyber-physical systems be embedded in production and logistics and how could the internet of services be integrated into industrial processes?’
- ‘To what extent are the methods of knowledge transfer going to change in initial and further training?’ The trend is moving toward “fast vehicles” (technical training lasting 3 to 4 days) and “continuous horizontals” (skills-based learning).
- ‘What consequences should we expect if the places of skills-based learning are going to be increasingly relocated to specially designed training factories in future?’
- ‘Is there going to be more classroom training and will this completely replace traditional forms of training?’ => Question based on the McKinsey Capability Centre MCC
- ‘How do companies, and hence personnel development, deal with the fact that knowledge transfer in companies is becoming increasingly individualised? How can it be integrated into the current exchange platforms and proactively take advantage of them?’ (cMOOCs, databases, LoD, ActiveMath, etc.)
- ‘How can personnel development encourage the creation of agile decision-making structures in companies and how will the social systems have to be advanced to sustainably support an agile network?’

Future dates for PEAK are still being planned and will be transferred to the HR network, as necessary (cf. 4.1.3.).

ANNEX 2) Figure showing the agile methods agreed between the social partners¹²



¹² Internal working paper (not for publication): Training and Qualification for Industry 4.0 – Successfully Shaping Change –Recommended Actions for Agile Methods, 30 November 2016

ANNEX 3) German online survey as part of Industry 4EU