

# MANUFACTURING THE FUTURE WORKFORCE

VISIT REPORT: GERMANY 



In partnership with

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## INTRODUCTION

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### STRUCTURE OF REPORT

Each meeting report summarises general discussions, additional observations and further background information provided by the hosts about their organisation and its involvement with wider vocational and professional education and training systems and Centres of Innovation.

Individual meeting reports also ‘highlight’ good practice and useful counsel captured during discussions then subsequently explored in delegate group de-briefs. These highlights are brought together using headings common with other visits in the closing section of this report to support further analysis and leading to recommended actions.

This document and its references are an appendix to the overall *Manufacturing the Future Workforce* report.

The full report is available to download at: [hvm.catapult.org.uk/mtfw](http://hvm.catapult.org.uk/mtfw)

### VISIT ITINERARY 13<sup>TH</sup> TO 14<sup>TH</sup> DECEMBER 2018

1. **IG Metall** Manufacturing Union, Berlin
2. **BIBB** Federal Institute for Vocational Education and Training, Bonn
3. **DigitalHub** Local Cooperative to promote Start-ups, Bonn

#### Delegates

Chris Beck – TWI

Ian Collier – HVM Catapult

Daniel Sandford Smith – Gatsby Foundation

Paul Shakspeare – HVM Catapult

Jack Stallworthy – Education, Health, Labour & Social Affairs Attaché, UK Embassy Berlin (IG Metall visit only)

### VISIT ITINERARY 30<sup>TH</sup> JANUARY TO 1<sup>ST</sup> FEBRUARY 2019

4. **Bavarian Ministry of Economic Affairs, Regional Development & Energy**, Munich
5. **Fraunhofer Academy**, Munich
6. **MittelstandsCampus**, Bayern
7. **JOSEPHS Living Laboratory, Fraunhofer SCS and FAU**, Nuremberg
8. **Fraunhofer IPA/Produktionsakademie**, Stuttgart

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9. Gewerbliche Schule, Göppingen

10. Festo Didactic, Stuttgart

### Delegates

Chris Beck – TWI

Ian Collier – HVM Catapult

Graeme Henderson – Department for Education, UK (30th)

Jonathan Mitchell – Institute for Apprenticeships (now IFATE) (30th)

Neil Rawlinson – Manufacturing Technology Centre (MTC; part of HVM Catapult)

Daniel Sandford Smith – Gatsby Foundation

Paul Shakspeare – HVM Catapult

Dr. Daniela Reimer – UK Science and Innovation Network, British Consulate Germany

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## MEETING REPORTS

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### IG METALL AND I4.0 NATIONAL WORKGROUP ON WORK, EDUCATION AND TRAINING

Thursday 13<sup>th</sup> December 2018, 13:00 to 16:00

Alte Jakobstr. 149, 10969 Berlin

<https://www.igmetall.de>

<https://www.plattform-i40.de/I40/Navigation/EN/Home/home>

#### Host

Martin Kamp, Department of General Policy and Socio-political Issues

#### Background

Martin leads Working Group 5 (Work, Education and Training) for the national Platform Industry 4.0 (I4.0) on behalf of the social partnership. The group meets quarterly with several sub-groups (e.g. AI, Agility, Education) to look at technological and organizational changes that are associated with moving to I4.0 and seeking to influence policy to ensure best opportunities for all – society, industry and individuals.

(The other Platform Working Groups are: Reference Architectures, Standards and Norms; Technology and Application Scenarios; Security of Networked Systems; Legal Framework; Digital Business Models in Industry 4.0.)

The German education system has successfully managed structural change over a long period – which encourages support for the outcome of continuing developments, including lifelong learning. The social partnership model (the Stinnes-Legien agreement) is 100 years old as of 2018

There are now increasing social pressures resulting in trends towards university entry away from the Dual System, leading to current responses such as reviews of apprentice wages and the introduction of greater recognition of vocational achievement.

Unions are not resisting digitalization and anticipate reductions in current occupations and jobs whilst expecting gains in others (many new) as a consequence of technology change and continued economic success. (Shaping the Digital Transformation report). There is concern about loss of power from the established Unions within the social partnership to new organisations like BitKom (Germany's digital association, representing 2,600 companies) which is not a traditional social partner.



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## IG Metall Discussion

### *Changes to Training Standards*

Recent development of changes to standards (e.g. mechatronics) reflect I4.0 requirements of future curricula in the dual system for apprentices by adding small, top-up 'qualification' modules, e.g. process integration. This means that the underlying standards remain relatively stable with periodic major review at varying timescales which may then incorporate the additional content. These top-ups appear to be mainly addressed at young people – it was not clear if they were intended for upskilling of older workers.

### *Labour Market Information*

IG Metall is working with BiBB on a 'Transformational Atlas' to capture what is happening as a result of changes due to technology, digitalisation and de-carbonisation – with a stocktake of current skills and changing scenarios.

### *Upskilling for I4.0 – Skills/Future of Work: the new 'Qualification Opportunities' Act*

This law is designed to prepare the workforce for structural changes in labour market. Under the new law, the Federal Agency for Labour (job centres) will offer advice to those already in work about the sort of training they could undertake to improve their skills and adapt to the changing world of work. The job centre would pay half the cost for training, with employers picking up the other half. The content of the training has to be focused on possible future tasks and not on skills currently required for employees' roles. Those who have completed a VET qualification within the last four years would not be eligible, as they are considered to be up to speed.

'Learning Factories' should broaden opportunities within the college system to introduce education specifically aligned to I4.0 (as is happening in Baden-Württemberg). There is strong resistance to digital change in the overall school education system, however Technical Colleges are more open to innovation.

### *Revised 'Vocational and Educational Training Act'*

Revisions are in hand in early 2019 to revise the National Further Education Strategy (in the sense of Lifelong Learning). The law is expected to introduce new titles for vocational qualifications that build on the Dual System and are undertaken after an initial apprenticeship. The over two hundred titles for post-apprenticeship vocations will be replaced by three stages for additional qualifications in the VET space:

1. Berufsspezialist (specialist in a vocation)

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2. Berufsbachelor (bachelor in a vocation) and as well as a 'strengthened' Meister (master craftsman/tradesman)
  3. Berufsmaster (master of a vocation).

In addition, for the first time there will be a minimum training allowance that firms pay to apprentices, access to part-time VET will be improved and volunteering to examine apprentices will be made more flexible (more volunteers can be involved in the examination of the same apprentices).

### *Individuals' Motivation to Study*

Individual motivation is an important component and there has been much previous discussion about lifelong learning but with little progress. German employers already spend €30bn on workforce training which does not lead to formal recognition. German Unions have collective agreements with employers (at company level and for special programmes in different parts of the workforce) to cover allowances for part time education.

A 'Life Long Learning 4.0' group has been formed to influence companies and works councils (in parallel with several groups already working on many aspects) to look at the twin problems of how to implement change in companies and how to work with providers to meet the different needs of adult learners.

### *Vocational Recognition*

Some 20,000 people study annually for Government funded 'Meister' qualification. Meister is esteemed in its own right as well as being a recognised route from the Dual System into higher education, however at relatively low levels of success.

The Unions have lobbied for means to accumulate recognition to incentivise lifelong learning which has resulted in proposals in the current legislation review. It is not clear yet about parity and relative status with academic awards.

Chambers (which represent typically 1/3 employees, 2/3 employers and carry out Occupational Licensing) are also seeking modular recognition for lifelong learning to enable changes to their role in workbased learning and examination.

## **IG Metall Highlights**

- The Social Compact supports the stability of Dual System leading to reliable outcomes for individuals and industry. It also provides confidence that changes to the System will build on the current model and be effective.

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- The use of 'top-up' qualifications to bring new digital subjects to learners prior to standards review reflects urgency.
  - Legislation and funding is moving to provide upskilling for those in work at all levels to pre-empt future job losses resulting from digitalisation and re-direct skills across the workforce.
  - Further lifelong learning and education policy and funding is now in process to address longer term changes and the future role of training providers.
  - The Industry 4.0 'Platform' is far reaching and connects issues across the elements of the Social Compact.
  - The Baden-Württemberg Learning Factories Initiative is thought by IG Metall to be good practice.
  - Need to provide forms of transferrable recognition for employer-based learning. Current proposals for vocational awards to sit in parallel with academic and Meister recognition.
  - A 'Transformational Atlas' will assist understanding and forecasting change and churn in jobs, roles and skills brought about by technology, digitalisation and de-carbonisation.
  - Unions embrace digital change but are concerned about new, digitally enabled entrants changing social partnerships.
  - Chambers, as employer representatives are interested in a more modular learning and recognition approach to cope with pace of change.

## IG Metall – Information and References

### Shaping Digital Transformation

<https://www.plattform-i40.de/I40/Redaktion/EN/Downloads/Publikation/digital-transformation-training>



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## BIBB – FEDERAL INSTITUTE FOR VOCATIONAL EDUCATION AND TRAINING

Friday 14<sup>th</sup> December 2018, 10:00 to 12:00

Robert-Schuman-Platz 3, 53175 Bonn

<https://www.bibb.de/en/>

### Hosts

Dr. Ralf Hermann, Head of GOVET, German Office for International Cooperation in VET

Airi Schmidtpott, BiBB, Press and Public Relations

Dr. Gert Zinke, BiBB, Electrical, IT- and Scientific Occupations

Dr. Hannelore Kress, BiBB International / GOVET

Bettina Nelles, BiBB Inter-company Vocational Training Centres Division

### Background

BiBB is the Federal Institute for Vocational Education and Training. GOVET is the German Office for International Cooperation in Vocational Education and Training and is one of 4 operational departments in BiBB which has a total of 630 staff (64% female). Centred on the cooperation of public sector, business and social partners, the German VET Dual System relies on continuing research about VET needs, developing and maintaining national standards, training and qualifying teaching personnel and promoting work-based learning.

*From website:*

*“BiBB has been shaping vocational training in The Dual System for more than 45 years, and in doing so, ensures both the ability of people to participate as well as the competitiveness of the German economy.”*

*“The communication of research, policy and practice in vocational education and training is a core task of the BiBB”*

*“Our research and consultancy are always at the forefront of change with the result that our expertise is sought after not only in Germany but also globally.”*

- 520,000 new training contracts each year
- 326 recognised training occupations
- 800,000 participants in career orientation programmes
- 50% of employees in occupation-related continuing education and training

*“The relationship between university and vocational education and training is in a state of flux’ The BiBB investigates the opportunities which might arise from improved permeability between these two education and training sectors and how flexibly education and training careers can be supported.”*

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75% of Dual System training is carried out in-company, monitored and examined by the Chambers to federal requirements, 25% is undertaken in VET schools under state authority. The number of professions regulated in 1950 was 900, this is now reduced to 327 and unlikely to increase.

This Study visit followed BiBB meetings with the UK Secretary of State in October 2018. The meeting was specifically structured to look at VET in the light of disruptive effects of digitisation, the capacity of educators and the appropriateness of current pedagogy as well as lifelong learners on ever shorter cycles of change.

GOVET exists to provide a single access point for international VET relations with Germany, examples were given of strong relations with Russia and China – necessary because of globalisation of technologies and markets and the changes to labour structures brought about by digitalisation. International VET relationships do not exist to promote the German system as a whole but operate at the level of close cooperation between governments and businesses, sharing learning standards, training and qualification of training personnel and research and advice.

## BiBB Discussion

### *Confidence that VET pathways open career opportunities*

A key success factor is that VET provides permeability for an individual's own future development as well as promoting employability within a profession. Quality assurance of delivery is reflected by the supply of training placements that matches the demand from young people.

### *Updating Standards*

Ordinances (Standards) are usually reviewed at a rate of 10 a year (this rose to 25 in 2017). Priorities are led by politics and industry leading a partnership of federal and state bodies, social partners (Union / Work Council) and competent bodies (Chambers). Revisions include updates to minimum pedagogical standard for trainers in companies. By example, a new electromobility element was introduced to car mechatronics in 2014, with first graduates in 2017.

### *Matching Demand and Supply of Skills*

Despite high levels of stability built into the VET systems, the pace and potential scale of change requires more rapid and detailed insight into future needs founded on understanding the impact of parallel mega-trends in technologies, markets, business and social structures.

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As a superficial trend, there will be a significant transition to higher level qualifications within a generation. However, it is the detail behind these broad-brush numbers that enable planning for the necessary actions within the complexities of the Dual System and require forecasting of both demand and supply with a collective responsibility for action.

The underlying figures represent changes to the occupations of individuals already in work if demand is to be met and unemployment avoided. There were said to be some 1,000 continuing education training programmes, many commercial and with limited public funding.

A figure of 600,000 vacancies was quoted with 300,000 people in job transition at any one time, hence there is very little slack in the labour market.

### *Changing Standards – Digitalization in the economy and the response of the German VET*

Introduced with the example of modern agricultural machinery now requiring mobile, independent fitters with diagnostic laptops – as well as the ability to fix mechanical systems with traditional heavy tools.

The regulations are currently written with ‘open phrases’ that allow detail and interpretation to meet local needs whilst remaining within requirements agreed by all partners. However, such detail is likely to need to increase in future to proactively respond to the pace of change using short additional modules (qualifications).

Working groups for related groups of standards (similar to IFATE route panels) are drawn from the social partners to screen occupations, define the competence of trainers, undertake skills forecasting, and define the equipment and facilities necessary for training. Labour Market Intelligence (LMI) forecasts drive need for change, some occupations will reduce (as well as change), whilst others grow.

Technical and Industry input from both ‘pacemakers’ (i.e. those at the forefront of technology adoption) and ‘latecomers’ (i.e. those continuing to employ well-established processes) is fundamental to align outcomes with incremental needs. Fraunhofer literature is used as a data input for panel consideration.

A short-term approach adds additional small qualifications onto standards which remain optional and for upskilling (taught by industry and examined by Chambers, not Colleges). These are then added (or deleted) from standards on periodic review. Common training modules meeting the additional needs of multiple standards are being discussed, however differing review timings make this difficult as does the need to work with local players for examinations (Chambers derive income and power from local examinations.)

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### *Digitalisation demands of future skills*

1. Digitalisation is an uneven process that is accelerating and intensifying. Artificial intelligence is now seen as a second wave of digitisation.
2. In the short term, additional qualifications are the most effective means for many of the professions examined to gain new skills. In the medium term, a fundamental redefinition of occupation descriptions, profiles and details should be examined.
3. Changed occupational and cross-occupational core competencies have to be recognised and included in standards:
4. The continuing ability to learn
5. Profession-specific skills and knowledge
6. Process and system understanding
7. Digital skills
8. Flexibility/Spontaneity
9. Research results continue to confirm that digitalisation will systemically change vocational education and training approaches:

#### *Professionalism*

- Profile building and demarcation
- Cross-professional competencies
- Core competencies (basic education) and specializations
- Permeability and ascent
- Regimes of regulatory work

#### *Flexibility*

- Open training regulations
- Training solutions design as work-based learning locations as opportunities emerge
- Changed roles and views of those involved in training and securing the necessary framework conditions (e.g. Management staff in schools and training companies, but also in Chambers of industry and commerce)

#### *Realisation of training and further education*

- Didactic-methodical tools
- Forms of learning
- Learning progress controls

### *Inter-Company Vocational Training Centres (ICVTC)*

The Dual System comprises in principle two learning venues: Vocational School for the theoretical part and the Training Company (employer) for the practical part. There is an

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important third venue, the ICVTC which complements and enlarges in-company training options for smaller companies only and are regulated under the same German Vocational Training Act.

There are two strands of ICVTCs – conventional advanced skills and the more recent separately considered programme to cover digitalisation.

Conventional ICVTCs are the joint responsibility of Federal government, the State and the ICVTC itself. Funding varies according to type, location and social needs. Annual federal funding of some €40m covers equipment, buildings and limited resources to about 50% of the total cost. These Competence Centres are modern and customer oriented delivering education service contracts and seen as beacons to increase quality and meet socio-economic requirements to adjust to advanced technologies.

Digitalisation ICVTCs are a partnership between Federal government and the ICVTC with 90% of funding from government but building costs are not eligible. Annual funding at around €30m. There are 8 Digitalisation ICVTCs across Germany, each with a distinct occupational focus working within a network to share practice and pedagogy.

### *Innovation transfer players in Germany*

Beyond some representation on working groups, provision of expert technology views through research outputs, little formal role in the development and maintenance of training standards was seen.

## **BiBB Highlights**

- Consistently high demand by employers for apprentices is seen as a mark of achieving good quality outcomes.
- Future skills needs are built on today's practise, hence although changes are inevitable, they are evolutionary and not simply wholesale replacement of current standards and provision.
- Research to provide LMI and determine skills needs is an essential driver for change processes and management of standards
- There are significant numbers of learners in programmes supporting transition and continuing education.
- Concern about growing demand for University education, both in place of vocational training and as follow-on.
- Global trade opportunities are linked to provision of VET services.
- Transparency, Permeability, Reliability of the Dual System and outcomes are all essential values, hence quality assurance is central.



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- Revisions to Standards include changes to pedagogical requirements for trainers in companies as well as colleges.
  - Detailed analysis to understand future demand and supply of skills is used as a prompt for collective action.
  - Current training regulations are deliberately loosely worded to provide scope for some customisation in their application. Greater definition of digitalisation driven changes may be necessary to react to required pace of change.
  - A 'modular' approach is preferred to gain greater commonality across standards; however their varying review timescales complicate this operationally.
  - Short terms changes to regulated standards using 'top-up' qualifications are preferred.
  - The nature of Industry 4.0 progress is inconsistent and unpredictable but accelerating.
  - Examinations of work-based learning are carried out by the Chambers, providing income and authority.
  - Consistently high levels of federal and state funding of Inter-company Vocational Training Centres (advanced technologies and digitalisation) in nationwide specialised networks. Used as beacons.

## BiBB – Information and References

Training Regulations and how they come about

<https://www.bibb.de/veroeffentlichungen/en/publication/show/8277>

Quality Assurance of company-based training in the Dual System

<https://www.bibb.de/veroeffentlichungen/en/publication/show/8548>

German - English Taxonomy

<https://www.bibb.de/veroeffentlichungen/en/publication/show/8376>

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## BONN DIGITALHUB

Friday 14<sup>th</sup> December 2018, 14:30 to 15:30

Rheinwerkallee 6, 53227 Bonn

<https://www.digitalhub.de/en/>

### Host

Dennis Mita, Marketing and Business Development/Project Management

## Background and Discussion

One of 6 hubs in a network in North Rhine-Westphalia to promote digital start-ups. With different constitutions, the Bonn one is part funded through member shareholding allowing scope to invest small sums as a VC in early stage, small start-ups. 50% State funding with banks and universities as stakeholders, the Chamber is an important partner.

Mainly ex-students, with some 40 start-ups on the books.

Match making with local SMEs provides alternative route to talent and growth compared with recruitment. Digital Hub as broker for 'Innovation-Active SMEs'.

The concept exposes the lack of agility and entrepreneurship in the Dual System, BiBB reports reduction of interest in early stage selection of 'Beruf' which seems likely to continue.

University may be seen as a positive choice to defer career decisions and hence the importance of entrepreneurship to bring talent to industrial supply chains locally.

## DigitalHub Highlights

- Growing importance of entrepreneurial skills aligned with digitalisation is growing in parallel to Dual System.
- Start-ups and small companies present an alternative route to skills for established businesses and supply chains through commercial, investment and acquisition.

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## BAVARIAN MINISTRY FOR ECONOMIC AFFAIRS, REGIONAL DEVELOPMENT AND ENERGY

Wednesday 30<sup>th</sup> January 2019, 09:00 to 10:00

Prinzregentenstrasse 28, 80538 Munich

[www.stmwi.bayern.de/en/](http://www.stmwi.bayern.de/en/)

### Hosts

Martin Grossmann, International Affairs, Head of Division Foreign Economic Relations, Europe, Trade Fairs

Andreas Reuchlein, Department Internationalization, Deputy Head of Division Europe, Trade Fairs

### Background

Bavaria has economic significance as a State with a population of 12.8m and budget of €600bn, GDP growth over the 20 years to 2017 was 50%.

The agenda covered Cluster Policy, I4.0 Digital Strategy, Addressing Skilled Labour Shortages and Digital Start-ups. This was not the Ministry of Labour Affairs and hence discussion was about industry in general.

### Bavarian Ministry Discussion

#### *Clusters*

Bavaria introduced Cluster Policy to Germany starting some 15 years ago and now has 17 cluster platforms in the domains of Digitalisation, Energy, Health, Materials and Mobility, some technology, some sector based. Limited initial public funding supports cluster administration to enable collaboration to jointly overcome translation gaps for technology into industry.

Clusters have an academic push focus in contrast to Chambers which work with employers in more of a steady state mode. Clustering of clusters is now apparent. Academic workforce shortage is itself a cluster challenge. The Cluster initiative has become a federal model.

Major infrastructure investments of €5bn (€1.5bn in 5G) are in hand for the Bavarian Digitalisation Strategy (Bayern Digital) for the years 2015-2021, including the set-up of the new Ministry and investments in the strategy to progress the following:

- Infrastructure for the gigabit-society
- Enabling lifelong learning for all

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- Security in the digital world
  - Digital skills for SMEs and start-ups
  - R&D and investment in future technologies
  - Digital transformation: serving the people

Start-ups are an important aspect of strategy.

### *Zentrum Digitalisation Bayern – ZD.B*

Since 2014 Industry 4.0 status in Germany has moved from a situation where 70+% of businesses had not reviewed or made plans, to where individual projects are now pursued by 40+% in 2018, although less than 10% are extensively implementing integrated I4.0 systems. This highlights a potential future weakness in the provision of digital services delivered by changed digital business models.

ZD.B was established in 2015 as a €200m state wide network under the Bayern Digital Strategy with a view to digital transformation of Bavarian companies, universities and non-university research:

- 20 new professors. 10 each at the state universities and colleges of applied sciences. Research and teaching in the field of digital topics will be expanded and intensified.
- 10 innovation labs at various university locations to be integrated into student education.
- 11 cross institution thematic platforms to enable knowledge transfer.
- Doctoral studies.
- Up to 10 junior research groups to build research and teaching capability.
- Expansion of Entrepreneurship Education at Higher Education Institutions with focus on digitisation.

### *Skilled Labour Shortages*

Labour market failure has been sheltered by immigration policy and associated training budgets. A net shortage of skilled people, partly due to growing preference for academic routes, is anticipated which is leading a shift in schools towards MINT (cf. STEM – Maths, ‘Engineering’, Natural Sciences and Technology). This is accompanied by efforts to raise prestige and esteem, including marketing campaigns aimed at ‘Proud Parents’.

Five pillar strategy to:

1. Better exploit education opportunities
2. Strengthen vocational training (fund infrastructure and facilities and teachers)
3. Support SME HR strategies and promote better succession planning

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4. Reduce workforce imbalance (gender, disability), increase the return to work employment
  5. Allow the migration of highly qualified workforces

The last 2 points are the subject of legislation.

## Bavarian Ministry Highlights

- 'Proud Parents' programme to address societal esteem for vocational routes and jobs.
- Difficulty in influencing schools to adopt and deliver digital technologies and subjects.
- SME HR strategy and succession planning assistance to secure Mittelstand companies.
- Role of clusters as intermediaries for other innovation agencies to provide a more effective interface with smaller businesses, eventually self-funding through membership arrangements.
- Importance of Start-ups to respond to digital opportunities in flexible and innovative ways.

## Bavarian Ministry – Information and References

### Bavarian Cluster Initiative

[https://www.cluster-bayern.de/fileadmin/user\\_upload/stmwi/Publikationen/2019/2019-01-30\\_Cluster-Initiative\\_Bavaria\\_2018.pdf](https://www.cluster-bayern.de/fileadmin/user_upload/stmwi/Publikationen/2019/2019-01-30_Cluster-Initiative_Bavaria_2018.pdf)

### ZD.B Initiative

<https://zentrum-digitalisierung.bayern>



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## FRAUNHOFER ACADEMY

Wednesday 30<sup>th</sup> January 2019, 11:00 to 13:00

Fraunhofer Headquarter, Hansastr. 27c, 80686 Munich Room EG, 14

<https://www.academy.fraunhofer.de/en.html>

### Hosts

Dr. Roman Götter, Head of Fraunhofer Academy

Dr. Stephanie Jung, European & International Business Development

### Background

'Fraunhofer' is the biggest RTO world-wide. Focussing on Europe with 72 centres, 26,000 staff and €2.6bn revenue. Growth has been organic and in step with industry absorption capacity. Fraunhofers operate on the 'Thirds' financial model, with 90% Federal funding of core costs linked to limited KPIs allowing a high degree of self-determination (i.e. limited influence by larger companies on decision making) which is seen as positive. 25% of research income is from EU funds.

There is a UK Fraunhofer Institute at Strathclyde University covering photonics with 40+ staff.

The promotion of innovation and the movement of knowledge into industry occurs in 4 channels:

1. Contract Research
2. Formation of Companies
3. Transfer of People ('by minds')
4. Professional Training

Typically, Fraunhofer Institutes will lose 10% of their staff (70% to industry, 25% to academia) annually. Gains have been typically 12%.

The Fraunhofer Academy was initiated 17 years ago by RG, in part to support aims to increase R&D spend to 3% (caution about comparison with UK target). There is now a team of 15 people with a revenue of more than €6m. There is a small contribution for the Fraunhofer Institutes that partner with the academy of €35k to cover overhead costs

There were some 4,000 students in 2018, mostly part time. The Academy worked with 35 of the Institutes to offer 40 programmes in the areas of:

- Energy and Sustainability
- Manufacturing and Testing Technology

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- Technology and Innovation
  - Logistics and Production
  - Information and Communication

Part time offers include Masters programmes, certified short courses and seminars. Courses incorporate up to date research knowledge and are practically oriented to increase relevance and implementation on current jobs. This can lead to follow through from course participation to future innovation projects.

## Fraunhofer Academy Discussion

### *Programme Structure*

Training is carried out by University partners (through the Fraunhofer connections), many of these have an emphasis on technical education as well as research. Building these relationships has taken time and effort to develop programmes and business models that work for both learners and academics.

Programmes are becoming more open and modular with greater blended learning to reduce barriers for continuing education and are seeking a lego-approach using material that can be 'interoperable' whilst related to context and discipline. There is also a Fraunhofer iAcademy to host and develop mobile device apps and courses.

I4.0 is seen to create both the need and an opportunity for Fraunhofer intervention in skills development. There is some work with VDMA – the organisation of manufacturing companies to contribute to industry standards.

### *Roberta Teacher Training (Robotics for girls)*

The aim of the Roberta trainings is to provide teachers from elementary to secondary level II with knowledge and skills in dealing with digital and innovative learning materials. Based on the successful Roberta concept, the focus is not only on gender-appropriate teaching content, but also on programming and designing robots. The participants of the training courses gain a comprehensive insight into the Roberta concept of the Fraunhofer Institute for Intelligent Analysis and Information Systems IAIS.

### *Cyber Security Training*

The Academy is running a Federal Cyber Security Learning Labs project across 7 centres, each sharing the same training content, trainer support and using similar facilities with €6m annual funding for 40 different programs of 2-3 Days

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7 Institutes co-operated in building the content following government request to involve University of Applied Science with 7 New Professorships. A similar 'learning labs' approach was taken some time ago to implement windscreen installation training and certification given the critical nature of the job.

## Fraunhofer Academy Highlights

- At least 10% churn of staff is a major knowledge transfer mechanism to and from Fraunhofer Institutions.
- The academy was the first commercial business unit run from Fraunhofer Headquarters reflecting an opportunity to provide a different approach to conventional, university channels.
- 'Roberta' teacher education with focus on girls and technology.
- Developed and operating Learning Labs for cyber-security training using common delivery model in duplicated facilities.
- Recognition of the need for a modular, interoperable, 'lego' approach to programmes to increase responsiveness.
- Anticipate continuing organic growth and leadership for emerging technology related training from the smaller Fraunhofer Institutes.
- Limited direct involvement in the generation and update of VET regulations.

## Fraunhofer Academy – Information and References

Fraunhofer Academy Prospectus

<https://www.academy.fraunhofer.de/en/continuing-education.html>

Fraunhofer Roberta Teacher Training

<https://www.academy.fraunhofer.de/de/weiterbildung/information-kommunikation/roberta.html>

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## MITTELSTANDSCAMPUS BAYERN, NEAR MUNICH

Wednesday 30<sup>th</sup> January 2019, 15:30 to 17:30

Robert-Bosch-Str. 14. 82054 Sauerlach

<https://mittelstandscampus.de>

### Hosts

Norman Weiss, CEO, MittelstandsCampus MD

Dr. Thomas Kinkeldei, Division Industry 4.0, Training of Workforce

## Background

The MittelstandsCampus is a privately established and commercially operated centre which was set up to meet the needs of manufacturing SMES to access and adopt digital technologies and develop new culture, partnerships, business models, products and processes appropriate to future technologies.

Thomas Kinkeldei previously worked for VDMA on the ZD.B I4.0 programme for Mittelstands companies which was described by the Bavarian Ministry. (VDMA - the Mechanical Engineering Industry Association - represents more than 3,200 member companies in the SME-dominated mechanical and systems engineering industry in Germany and Europe.)

Bavarian mechanical engineering business profile shows 75% of companies have less than 100 employees, with 66% of revenue from companies with less than 1,000 employees. Most companies remain under traditional family ownership with many 'Hidden Champions' of global significance in terms of specialism and market share.

Within this broad categorisation, the 'Mid-Caps' (i.e. 250 to 3,000) employees show twice the growth of smaller and larger businesses – some 50% since 2003 for those with 1,000 to 2,000 employees. This results from their sufficient size to act globally whilst remaining small enough to be agile, they are rarely shareholder driven due to persisting family ownership.

## National and State I4.0 Initiatives Discussion

(See 'ZD.B' Section under Bavarian Ministry)

### *Mittelstand Digital*

The Mittelstand-Digital Federal programme informs small and medium-sized enterprises about the opportunities and challenges of digitization. Mittelstand 4.0 competence centres throughout Germany help with expert knowledge, demonstration, networks for the exchange

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of experience, events and practical examples. The Federal Ministry for Economic Affairs and Energy funds the free use of all offers from Mittelstand-Digital.

25 SME 4.0 Competence Centres have already been set up since 2015 at existing institutes (e.g. Fraunhofer at Augsburg), informing and providing concrete support to entrepreneurs. Resources include a number of Industry 4.0 trucks with demonstration and awareness raising equipment (fully booked). Examples of model factories producing cars to raise awareness and helping reach 'activation energy' for SMEs ahead of receiving clear advice by working through existing associations.

### *Labs Network 4.0*

Network of test centres equipped for practical testing and validating standards. Up to 40% government funding and including R&D or Fraunhofer partner.

### *VDMA Experience and Feedback on I4.0 Initiatives*

Lighthouses drive interest, competence centres offer consultancy, peer group advice secures change – reflecting that for SMEs the most important aspect is trust in the message and messenger, not consultant reports. Case studies and respected recommendations are essential.

Best events are where you can show something practical - best practice visits - but needs to be at the right level and stage for the audience of SMEs who benefit from relevant examples. 'Eye level knowledge' shared by bottom-up, local working groups to spread learning ('Stammtisch' = 'sitting at a table').

Emerging need for SMEs to learn methods for business model innovation as well as for new technology integration. Many business leaders do not have this capability whilst younger members of staff and start-ups may be more flexible.

This approach leads to the need for co-creation processes where companies and students work jointly on new ideas (Problem based learning). Mixed age groups give the best results. There is a continuing need the 'Caretaker' role to support the success of change projects and to de-risk implementation following initial support.

Three critical elements from all of the I4.0 buzzwords and initiatives:

- Work on specialised topics relevant to the business, not generic I4.0 principles
- Organisational change management is more of a challenge than changes to technology (example of 70 person company changing 40% of its workforce)
- IT security and awareness and skills are essential given that I4.0 increases the importance of software in manufacturing



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Clear role for talent to drive change but requires an overall system that secures individual and business advantage – Continuity and Trust are foundations of Common Purpose.

## MittelstandsCampus Discussion

The business mission appears to be the development of new collaborative and business models to deliver opportunities founded on digital technologies – Robotics, AR/VR, Additive Manufacture, AI, etc. 'Explore, Explain, Execute'. Income is from hire of facilities and return on investment in new ventures (and charging for visits).

Clients achieve value from access and awareness; new digital business models and finance; the digital eco-system and brokerage. The effect of this seems to be a re-configuration of supply chains to incorporate I4.0 elements at minimum risk to traditional businesses.

Companies that can benefit from this environment are those where the CEO takes a strategic, not day-to-day role in the business. This is not necessarily company size related.

## MittelstandsCampus Highlights

- MC provides a concept of the 'last kilometre' for innovation to get to market benefitting from new business models enabled by digitisation and investment partners.
- Importance of Mid-caps (250 to 3,000 people) to economic success – big enough to matter, small enough to change, family ownership.
- Most German manufacturing companies are now actively preparing or pursuing digital opportunities (reverse in the UK).
- Mobile resources (a truck) to deliver awareness and early stage digital training to Mittelstand companies.
- Bottom-up and peer group learning are most effective mechanisms 'Stammtisch'. Businesses need 'eye-level' information related to their current situation and offering short term value.
- Changing business models as well as technology for smaller businesses, 'co-creation' of learning and business change opportunities for young people.
- Essential role of continuing 'Caretaker' to advise on change processes.
- Growing awareness of three themes as essential to I4.0 transition being: specialised skills, organisational development and cyber-security.

## MittelstandsCampus – Information and References

Labs Network 4.0

[http://files.messe.de/abstracts/77174\\_CeBIT\\_20\\_03\\_1540\\_Labs\\_Network\\_Industrie\\_.pdf](http://files.messe.de/abstracts/77174_CeBIT_20_03_1540_Labs_Network_Industrie_.pdf)

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## JOSEPHS LIVING LAB, FRAUNHOFER SCS AND FAU (UNIVERSITY), NUREMBERG

Thursday 31<sup>st</sup> January 2019, 10:00 to 12:00

JOSEPHS – The Open Innovation Lab, Karl-Grillenberger-Str.

3/Hintere Ledergasse 44, 90402 Nuremberg

<http://www.josephs-service-manufaktur.de/en/>

<https://www.scs.fraunhofer.de/en.html>

### Hosts

Nadja Hosbach, Fraunhofer IIS – Centre for Applied Research on Supply Chain Services  
SCS, Groupleader Business Transformation

Simon Klose, Fraunhofer IIS – Centre for Applied Research on Supply Chain Services SCS

Angela Roth, Scientific Support JOSEPHS

Prof. Kathrin Moeslein (10:45-11:00h), Chair for Information Systems, Innovation & Value  
Creation at FAU

### Background

Named after Joseph Fraunhofer, JOSEPHS is a ‘store’ located in the city centre of Nuremberg where visitors can test and co-create new concepts, prototypes and ideas directly with larger and smaller businesses. It is run by the Fraunhofer Centre for Applied Research for Supply Chain Services (SCS) in cooperation with the Chair of Information Systems at Friedrich-Alexander-University Erlangen-Nuremberg and funded by the Bavarian Ministry for Economic Affairs and Media, Energy and Technology.

### JOSEPHS Discussion

Following earlier work to research customer behaviour in retail environments, the shop is now split into zones which are hired by businesses during late stages of consumer product / service development. ‘Real’ customers (> 1,000 per month) visit the shop to experience and contribute to latest technologies organised under periodic themes promoted to maintain attraction and variety. There are also regular school visits and a fully booked ‘think-tank’ room.

The process was described as co creation, not market testing with the academic team providing support and access to further expertise. After 5 years of public funding, plans are under development to create a spin off company from the university to continue operations.

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Academic and Fraunhofer partners plan to create a further Living Laboratory near to Munich Airport with a business to business purpose and to provide greater access for learners from elsewhere.

JOSEPHS has varied relationships with Chambers – the Innovation Chamber wishes to rent permanent space in the shop, others are challenged by changing organisational models and business practice (moving from command and control to networks and from collective to individual relationships)

A 10 week 'Sprint' learning programme is being introduced to cover Business Model Design and will be delivered in a combination of theory and workshops. This should make projects using the Living Lab more effective.

## JOSEPHS Highlights

- Co-creation of consumer-oriented products and services (in this case) requires understanding of changed business models.
- Challenges to established Chamber thinking because of direct access to companies and public.

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## FRAUNHOFER IPA/PRODUKTIONSAKADEMIE, STUTTGART

Friday 1<sup>st</sup> February 2019, 09:00 to 10:00

Nobelstr. 12, 70569 Stuttgart, Meeting Room E4.03

<http://www.stuttgarter-produktionsakademie.de>

### Hosts

Prof Engelbert Westkämper, Ex-Head of IPA, Stuttgart University, Head of S-Tec

Anja Demont, Head of Business Development, IPA

Simon Schumacher, Research Associate, IPA

Michael Trierweiler, Research Associate, IPA

### Background

The Fraunhofer Institute for Manufacturing Engineering and Automation (IPA) is the second largest in the Fraunhofer network, covering applied production research with other partner institutes from the University of Stuttgart. Established in 1959, there are now more than 1,000 employees with a total operating budget of €63m including €24m industrial income over more than 1,000 projects annually. The IPA also works outside of Germany on 20% of projects.

Networked and collocated with Fraunhofer IPA (and IFF, ISW and IfW), the Stuttgarter Produktionsakademie integrates research outcomes into technical and managerial seminars and courses for Industry 4.0, Robotics, Materials, Coating, Electroplating, Organic Production, Machine Tools and Control Engineering.

Stuttgart Technology Engineering on Campus - 'S-TEC', working with the Graduate School of Excellence for Advanced Manufacturing Engineering – GsaME and the Produktionsakademie, is run as a separate Foundation to enhance knowledge transfer to industry.

The Application Centre supports SMEs to establish I4.0 through demonstration projects and training. The Future Worklab aims to provide a single point of contact for digitisation of manufacturing in the context of worker interactions with automation and machinery.

Baden-Württemberg is a global of manufacturing industry powerhouse and combines industry that 'makes the making equipment' and industry 'using the equipment'. With many disciplines and expertise needed across industrial sectors – capital and consumer goods, materials and services and exporting some 80%.

Swabian culture was given as a factor in continuing regional success post 2008, embodied in the approach of Mittelstand companies with limited reliance on banking and financial markets

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for their success. Some of the large corporations are now structuring their organisations to reflect the qualities and size of a typical Mittelstand business.

## Fraunhofer IPA Discussion

### *Dual System Diplomas*

There was regret about the demise of Diplomas with their greater emphasis on creative problem solving and their replacement by academically structured qualifications. The role of Applied Technical Universities (cf. Polytechnics) was described in the context of the 'Dual System' with time spent both in academia and the employer.

### *Stuttgart Technology Engineering on Campus - 'S-TEC'*

Set up as a Foundation and led by Prof Westkamper, S-Tec connects academia and industry to strengthen industrial research, promote interdisciplinary cooperation and teaching (Technology Academy) and develop start-ups (Innovation Services) at the post-university stage of implementation, optimisation and usage.

The S-Tec Foundations does not receive public funding to bring together a network of other funded partners. Industry has historically supported modest operating costs of around €0.5m. There may be some intent to generate future funds from venture capital participation in start-ups.

### *Graduate School of Excellence for Advanced Manufacturing Engineering*

Stated to run on a 'Dual System' combining University basic research, Fraunhofer applied research and industry application using the infrastructure of digital and Learning Factories as well as partners' technology laboratories.

There are currently more than 100 doctoral students working to individual programmes related to their interest. Graduating with Dr. of Engineering or Economics (relates to EngD), students develop skills for Advanced Manufacturing Engineering technologies and methods for factories of the future.

### *Stuttgarter Produktionsakademie*

S-TEC Foundation is the Shareholder of the Technology Academy which delivers some 80 seminars to 2,000 participants (shop floor to management), MOOCs support I4.0 and webinars. Typical daily charges are from €200 to €500 for technology and managerial subjects (about 50:50).



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It is important to use the right training resource for the course – manufacturing analogy of low volume, high precision – high cost compared with high volume, low precision, less cost processes.

Resources include a Learning Factory (from Festo Didactic) which was originally set up to support research projects, but which is now used to enable practical learning at different academic levels in a totally reconfigurable environment.

There is little connection with the Fraunhofer Academy (which was described as being mainly for the smaller Institutes). The Produktionsakademie sets out to integrate local services that meet local needs.

### *Future S-TEC Direction – Wider Than Manufacturing*

Interest is growing to include the whole life-cycle, bringing in user issues ('B2U') to add to 'B2B' and 'B2C'. This adds services to the mix with the need to consider changing business models and skills.

### *Future Work Lab*

Funded by the Ministry of Economic Affairs, Labour and Housing (€5.5m first stage) to research, develop and demonstrate cyber-physical production systems, real-time manufacturing control and generative production: 'The digitization of the value-adding system as a basis for efficient integration of humans into cost-efficient manufacturing of multi-variant products up to personalized products'.

Scope includes personalised products and 'Humans as Conductors'. The Future Work Lab collaborates with Academia, Industry, Unions and the Chambers in three areas:

- Demonstration World - 30-50 Demonstrators
- Learning World - researching competence profiles, pedagogy and use of education technology
- Idea World - Think-tank (e.g. Industrial Worker at the centre of the system)

The Lab is used by students and industry to develop and experience the future world of work with the industrial worker at the centre of the issues and an important part of the co-creation of new approaches.

### *Application Centre Industry 4.0*

This is a large reconfigurable space run to showcase and demonstrate I4.0 principles and technologies, now moving into S-TEC and working on parallel areas of interest as the Future work Lab. Examples of projecting information onto the floor and low-cost AR approaches.

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## FRAUNHOFER IPA Highlights

- Produktionsakademie is a knowledge transfer organisation, integrating research outcomes to offer seminars to qualifications.
- Regret about lost 'Dual System' Diplomas with flexible world-based projects, now replaced by more formalised academic degrees.
- S-TEC Foundation – as single point of engagement for various innovation and education services: University, Fraunhofer, Academy. Integration of local services to meet local needs.
- Significant practical doctoral education programme.
- Future of Work Lab includes competence and pedagogy specialisms and supports Unions and Chambers.
- Learners from all levels attend appropriate courses. Lots of knowledge transfer seminars and courses but no talk of modular credit.
- Emerging low-cost AR and VR tools and approaches.

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## **BADEN-WÜRTTEMBERG MINISTRY, STUTTGART, GEWERBLICHE SCHULE, GÖPPINGEN**

Friday 1<sup>st</sup> February 2019, 11:00 to 13:30

Gewerbliche Schule, Christian-Grüniger-Str.12, 73035 Göppingen

### **Hosts**

Tobias Barthruff, Ministerium für Kultus, Jugend und Sport

Thomas Dorner, Regional Council Stuttgart

Franz Thaler, Gewerbliche Schule Göppingen

### **Background**

This was a combined visit to the Gewerbliche Schule and its learning factory and the ministry responsible for State-wide deployment of learning factories to vocational schools.

### *Gewerbliche Schule*

This vocational school for Trade and Industry has 1,400 part time and 600 full-time students studying mechanical, automotive and electrical engineering with 80 staff (25% female). It is one of three schools of similar size on the same site taking pupils from the age of 17. The college offers:

- Vocational preparatory year and the pre-qualifying year (Small Employers)
- Full-time vocational school (1 year): mechanical engineering, electrical engineering, automotive
- Dual System: part-time vocational school + in-company training (Level 4)
- Upper secondary school (3 years, Level 4)
- Senior vocational schools (Level 6 Diploma – full or part time with final year industry project)
- Engineering (Technical Engineers)
- Master craftsmen

There are some 100 vocational engineering schools in the State of B-W, of which 30 run diploma courses. Students leave after Level 4 (A level equivalent) and can return for a Diploma course after at least 2 years of experience in a relevant job.

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## *Bader-Württemberg Ministry – Smart Factory Initiative*

### *'Implementing Industry 4.0 in vocational schools'*

By 2019 there will be 20 smart factories in 30 vocational schools in the State. This is planned to grow to 41 different smart factories to reflect local needs from a total of 72 vocational schools by 2020 and will bring total State spend to €20m which will have been matched 50% by local funds. (Teachers are paid for by the individual federal state i.e. Baden-Württemberg, buildings are maintained by the local authority). Although each smart factory is tailored to meet local needs with input from local companies, it must comply with a number of standardised common learning requirements if it is to receive funding:

- Flexible production system
- Lot size of one
- ERP and MES systems
- Cyber / physical modules and factory
- Intelligent sensors and Big Data

This school was a pathfinder in the use of Learning Factories (working with Festo Didactic), progressing from facilities and staff that taught 'I3.0' to the fully intelligent I4.0 systems now operational. In hindsight it has been a 10-year process to develop the full teaching capability.

Note. Thomas Dörner travels to Singapore ITE to conduct end of course examinations for those students undertaking the German provided automotive courses that were discussed during the study visit.

## **Smart Factory Discussion**

### *Industry 4.0 Training Scenarios*

In 2004 Baden-Württemberg's vocational education in Mechanical, Electrical and Informatics (Engineering) moved to '6 scenarios' - Digitalisation of Work Life and Digital Security:

1. Product Development / Production Planning
2. Flexible Production
3. Manufacturing Execution System
4. Maintenance / Condition Monitoring
5. Energy Management
6. Network / Data Security

Industry and state worked together to generate curriculum and the exams within this structure to meet federal syllabus requirements. The benefit of scenarios is that Teacher Training support is available on line and that the subjects taught by individual schools can be

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adjusted via the Chambers to reflect local industry needs. There is a State cascade of the Teacher Training where teachers in turn train others in the schools.

### *Changing Curriculum and Content*

Large companies demand change to programmes more often than small. The Ministry brings in consultants to advise on particular topics (some from Fraunhofer). Little has changed for the basics, even though companies demand young people with 'smart technologies' – who may end up doing basic calculations. There is concern about hype and about what should be removed from curriculum.

New technologies are increasing demand for diploma level studies.

### *Adult Training, Upskilling*

Learning Factory contracts required that company training and upskilling was included. However, this has yet to become significant at a relatively early stage and before many students have completed studies.

Many Craft Schools will have an 'Association' - e.g. a community owned training business connected to the school using school equipment and staff to deliver short courses (outside of State qualifications), including manufacturers' training and certification of competence (welding). Numbers are relatively significant – 60 to 80 a year on robotics courses, 300 a year on awareness programmes.

### *Teaching Challenges*

As well as determining what skills need to be trained and with what equipment, it is also necessary to understand what skills and competences teachers need. Some guiding principles have been developed to structure change:

- Focus on complete vocational action
- Approach to industrial application
- Combine key technologies
- Create a platform for future industry (Industry 4.0)
- Cope with complexity

This requires new skills sets for teaching staff working with the new technologies including professional expertise in new domains, trouble shooting and problem-solving competence, confidence to deal with complex equipment and systems and the ability to work autonomously.

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Success factors are:

- Teachers with relevant professional Expertise
- Team structures, cooperation in-house
- Continued in service training for staff
- Teachers taking care of and maintaining laboratory equipment
- Partners in industry to get support and to ensure transfer of knowledge and technology

## Baden-Württemberg Ministry and Gewerbliche Schule Highlights

- Baden-Württemberg Smart Factory programme requires significant local investment to match state funding. There will be more than 40 Smart / Learning Factories in Technical Schools by 2020 with an overall investment of at least €40m.
- Common training scenarios across disciplines and colleges are used to standardise teacher training and assist collaboration in the development of syllabus.
- Each Smart Factory installation reacts to standardised requirements but reflects local industry context, sharing common training scenarios and syllabus.
- Use of 'Cyber-Physical' approach to increase capacity and improve learning outcomes.
- Growing need for high level skills as a consequence of digitalisation.
- Trainees need skills appropriate to their future jobs as well as learning that equips them in preparation for future opportunities in what may be a 10-year process of change.
- Learning Factories are not yet used for adult upskilling – little demand until further change is apparent (as previous comment). Their current deployment is mostly to deliver the underpinning education about I4.0, not to cover specific application.
- Technical education is leading industry in the take-up of I4.0.
- I4.0 places significant demands on teaching staff who receive additional training and support from the State education system and industry to develop new skills and knowledge.
- Use of School facilities and staff to deliver training out of hours through the 'Association'. This includes competence compliance as well as broader education.

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## FESTO DIDACTIC, STUTTGART

Friday 1<sup>st</sup> February 2019. 14:30 to 15:30

Rechbergstr. 3, 73770 Denkendorf

<https://www.festo-didactic.com/int-en/>

### Hosts

Dr. Reinhard Pittschellis, Division DC-ER, Head of Global Research and Development

Jose Antonio Gonzalez, Business Development

Babak Jahanbani, UK Sales and Distribution

### Background

Festo Didactic provide education technology tools, systems and courses to support industry's training needs, including education equipment and curriculum for I4.0. The 25-year-old business is a subsidiary of Festo which itself is a €3bn + automation company and remains in family ownership (as a Mittelstand company). Festo Didactic has 800 employees operating in 61 countries with 42,000 training participants annually.

There is an obvious but indirect link between the impact of improving understanding and skills and the absorption capacity of automation equipment and systems customers – 'who don't buy things that they don't need'. Offers are:

- Managed Services – development of training centres
- Curricula, programmes and certification – development
- Turnkey equipment – design and equipment of laboratories, schools, universities and training centres
- Training and Consulting – services for people, technology and organizational development

Training systems are modelled on industrial equipment ('no toys') at a lab-scale and are not designed to teach specific processes (i.e. welding, milling). The modular approach was initially developed with universities (Fraunhofer IPA was first) and has now been developed to a highly configurable system to simulate manufacturing environments using processes of assembly ('no glue'). This is based on building a learning environment from physical modules, machines and cyber/ physical systems which then operate and can be readily reconfigured.

Therefore learning outcomes are generically educational and practical but not specific skills training. Cyber/physical approaches are used to increase the efficiency of training delivery which can become cloud based and linked to other partners.



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## Festo Didactic Discussion

### *Strategic Approach*

Didactic developments follow technology progress, 'foresighted' by the parent company as well as in-house analysis. Digital content and blended learning is growing (flipping') which in turn raises the importance of effective hands on learning environments to support cyber teaching.

The Fraunhofers are seen as research institutes, separated from teaching and therefore with a limited didactic contribution.

Festo Didactic supports certification by others using their courses but does not do so themselves.

### *Baden Württemberg Industry 4.0 in Vocational Training*

The Göppingen Vocational School was the pathfinder for the State project (senior Festo person had family at the college), their early Smart Factory Demonstrator led to the broader call. 13 of 15 schools who applied for funding were supported in their application by Festo. The initial level of total funding was €6m which had to be matched in applications at 60% by the school authority and 10% contribution from industry. This included funding of the 'didactical concept' and training of the teachers up to €100k per school.

There has been common development of courses, led by 'Master Trainers' who also develop teacher training material for courses carried out in the State Institute for Education Development. These courses and accreditation to teach are based on the standard 6 manufacturing scenarios

### *Pace of Change and Leadership*

Festo's understanding (from work with lots of Universities and Schools as well as the 'mother company') is that in many ways education is I4.0 is leading industry take up and hence education, not industry is challenging them to develop new approaches. Previously teaching followed, not led companies' needs - with I4.0 it appears to be the other way around. The B-W I4.0 strategy makes positive use of newly educated young people to carry the I4.0 message into smaller companies (similar to the approach seen in Singapore). The formal qualification review systems will need to react with curriculum updates, including changes to examination content and processes ('hidden curriculum'), including more project / performance-based assessment.

I4.0 manufacturing is likely to integrate training in the factory design and will support adult learning in the work context and reducing formal up-skilling, off-the-job programmes, although Chambers offer awareness and basic understanding courses.

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### *Festo Didactic activities in the UK*

Festo have a small installed base in the UK, mostly in universities, some in colleges and only recently for I4.0 (Shrewsbury, Derby). Typical investments are up to £250k and include curriculum and trainer support. Sales have also been made to the defence sector (Royal Navy)

Festo Didactic are co-writing a module with Siemens using 'Mindsphere' with Newcastle and Sheffield Universities to support UK Made Smarter Review. They have also supplied proposals for 2 of the UK's IOT submissions

### *UK Challenge*

There are concerns about white elephants in UK Colleges because they can't find people who can teach and, if they do, they inevitably are attracted to work in industry with their newly acquired and valuable skills. This reflects the relative ease of funding buildings and capital equipment compared with the operational costs of building capability and developing programmes. It also highlights poor cooperation between education institutions and their industry partners to co-develop solutions to this need.

### *Master Trainers and the role of Centres of Innovation*

This was discussed as a possible response to the challenge of developing and retaining training staff and to increase collaboration.

## **Festo Didactic Highlights**

- Festo Didactic offer complete packages – advice, equipment, content.
- FD supplied the majority of the B-W Smart Factories.
- Limited UK take-up compared with Germany – training and retention of trainers a major issue. 2 Institute of Technology bids have included FD elements.
- Master Trainer approach has been important to support role out. This seems an obvious role for Centres of Innovation to fulfil.
- Previously teaching followed, not led companies' needs - with I4.0 it appears to be the other way around - education, not training being the key to future capabilities.

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## GOOD PRACTICE – CORRELATED HIGHLIGHTS AND COMMENTARY

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### RELATED TO VISIT REFERENCE (N)

#### POLICY AND STRATEGY

##### Dual System Success (1, 2, 3, 4)

- Transparency, Permeability and Reliability of the Dual System are all essential values to deliver learning outcomes, hence robust quality assurance of all aspects of the system is central for all partners.
- There is concern about growing demand for University education, both in place of vocational training and as an accepted follow-on. Example of Bavarian ‘Proud Parents’ programme to address societal esteem for vocational routes and jobs.
- Significant difficulty in influencing schools to adopt and deliver digital technologies and subjects up to secondary level.
- Examinations of work-based learning are carried out by the Chambers, providing income and authority from meeting local needs (cf UK Awarding Bodies).
- Global trade opportunities are linked to provision of respected VET services.

##### Impacts of Digitalisation on Training and Education (1, 2, 3, 6, 7, 9, 10)

- The national Industry 4.0 ‘Platform’ is far reaching and connects issues across the elements of the Social Compact concerning digitalisation. Unions embrace digital change but are concerned about new, digitally enabled entrant organisations changing underlying social partnerships and common purpose.
- The majority of German manufacturing companies are now actively preparing for or pursuing digital opportunities (reverse of the UK). There is growing awareness of three themes essential to I4.0 transition: specialised skills, change management and organisational development and cyber-security.
- A ‘Transformational Atlas’ will assist understanding and forecasting change and churn in jobs, roles and skills brought about by technology, digitalisation and de-carbonisation. The nature of Industry 4.0 progress is inconsistent and unpredictable but accelerating.
- BiBB labour market research provides granularity of changing supply and demand – both growth and decline – within professional categories.
- Current training regulations are deliberately loosely worded to provide scope for customisation in their application in pursuit of consistent overall learning outcomes. Future closer definition of digitalisation driven changes may be necessary to react to and anticipate the required pace of change.

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- Trainees need skills appropriate to their future jobs as well as learning that equips them in preparation for future opportunities in what may be a 10-year process of change. In general, higher level skills are likely to be a consequence of digitalisation.
  - Previously teaching followed companies' needs - with I4.0 it appears to be the other way around where technical education is leading industry in the subject matter of I4.0.

## Changing Business Models (3, 4, 6)

- Recognition of the importance of Mid-caps (250 to 3,000 people) to economic success (big enough to matter, small enough to change, generally under family ownership). However, they now require support with HR strategy and succession planning to secure Mittelstand companies faced with aging current owners.
- Start-ups and small companies represent a currently small but growing alternative source for skills acquisition by established businesses and supply chains through commercial, investment and acquisition arrangements.
- Co-creation of consumer-oriented products and services as well as in business to business markets is leading to new business models as well as technology change for smaller businesses and requires approaches to learning for new entrants and current staff that integrates all aspects.
- Essential role of a continuing 'Caretaker' to advise on change processes.

## EDUCATION AND TRAINING PROVISION

### Updating of Dual System Standards (1, 2, 8)

- Research of needs as well as management of standards is a major role for BiBB who have conducted detailed analysis of employers and markets to determine future demand and supply of skills to use as a prompt for collective action.
- Although changes to skills are inevitable, future skills needs are built on today's practise, and must be evolutionary, not wholesale replacement of current standards and provision.
- Revisions to Standards include changes to pedagogical requirements for trainers in companies as well as colleges.
- Fraunhofer IPA's Future of Work Lab includes competence and pedagogy specialisms and supports Unions and Chambers.
- Regret about lost 'Dual System' Diplomas with flexible work-based projects, now replaced by more formalised academic degrees.

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## Modular Approach to meet changed needs (1, 2, 5)

- Short term changes to regulated standards using modular ‘top-up’ qualifications are preferred to rapidly bring new digital subjects to learners prior to longer term standards review. This reflects perceived urgency of changing skills needs.
- Recognition of the need for a modular, interoperable, ‘lego’ approach to programmes to increase responsiveness in response to ‘top-up’ qualifications approach.
- Chambers, as employer representatives are interested in a more modular learning and recognition approach to cope with pace of change however varying review timescales complicate this operationally for review and update of Standards.

## Lifelong Learning, Re-Training, Upskilling (1, 2, 6, 8, 9)

- Recent legislation and funding changes provide upskilling for those in work at all levels to pre-empt future job losses resulting from digitalisation and re-direct skills across the workforce. Further Lifelong Learning and Education policy and funding is now in process to address longer term changes and the future role of training providers.
- The requirement for forms of transferrable recognition of employer based learning and accumulation of ‘credits’ are reflected by current proposals for vocational awards in parallel with academic and Meister recognition.
- Use of School facilities and staff to deliver training out of hours through an ‘Association’ that is related to the school but operated in parallel. Courses include competence compliance as well as broader educational topics.
- Bottom-up and peer group learning are most effective mechanisms for smaller businesses (‘Stammtisch’ – table discussions). Businesses need ‘eye-level’ information related to their current situation and offering short term value.
- Teacher and Trainer Development (5, 9, 10)
- The established use of common training scenarios across disciplines and colleges helps to standardise teacher training and assist collaboration for the development of syllabus.
- I4.0 education places significant demands on teaching staff who receive additional training and support from the State education system and industry to develop new skills and knowledge. The Master Trainer approach has been important to support role out of digital subjects. (This seems an obvious role for Centres of Innovation to fulfil.)
- ‘Roberta’ teacher education with focus on girls and technology.

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## Planning and Investment in Learning Factories (1, 5, 9, 10)

- This Baden-Württemberg ‘Smart Factory’ programme required significant local investment to match state funding, however there will be more than 40 Smart / Learning Factories in Technical Schools across the State with an overall investment of at least €40m by 2020.
- Each Smart Factory installation meets standardised requirements and will deliver education built on shared training scenarios and common syllabus whilst reflecting local industry context.
- The B-W Smart Factories use a ‘Cyber-Physical’ approach to increase capacity and improve learning outcomes. (Festo Didactic supplied the majority.)
- Festo Didactic offer complete Learning Factory packages – advice, equipment, content. There has been limited UK take-up compared with Germany – training and retention of trainers being a major issue. (Two Institute of Technology bids were indicated to have independently included FD elements.
- The Fraunhofer Academy developed and operates Learning Labs for cyber-security training using a common delivery model in a federally funded network.
- BW Learning Factories are yet used for adult upskilling since at this relatively early stage of widespread I4.0 adoption, there is little demand until changes in the workplace are more apparent. Their current deployment is mostly to deliver the underpinning education about I4.0, not to cover specific application.

## Educational Technology and Facilities (2, 6, 8)

- There is very considerable national, state and local funding of Inter-company Vocational Training Centres (advanced technologies and digitalisation) used as beacons in specialised nationwide networks. (In addition to the B-W investment in Smart Factories)
- The Federal Mittlestand Digital initiative includes fully equipped mobile facilities (trucks) for awareness raising and initial training.
- Emerging low-cost AR and VR tools and approaches will support blended learning.

## CENTRES OF INNOVATION

### Knowledge Capture / Transfer (4, 5, 8)

- Fraunhofers have limited direct involvement in the generation and update of VET regulations, however their research publications are used by BiBB researchers.
- Fraunhofers in general experience at least 10% churn of staff which constitutes a major knowledge transfer mechanism to industry and academia.

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- The Fraunhofer Academy was the first commercial business unit run from Fraunhofer Headquarters and was an opportunity to provide a different approach to conventional, university channels for knowledge transfer. It is anticipated to continue organic growth and leadership for emerging technology training from the smaller Fraunhofer Institutes.
  - The S-TEC Foundation is a single point of engagement for various innovation and education services: University, Fraunhofer, Academy, integrating local services to meet local needs. The Produktionsakademie is a knowledge transfer organisation, taking research outcomes to offer seminars, short courses and qualifications. There are also significant practical doctoral education programmes in S-TEC (cf. WMG).
  - Bavarian Clusters acts as intermediaries for other innovation agencies to provide a more effective knowledge transfer interface with smaller businesses and are eventually self-funding through membership arrangements.





## ABOUT THE HIGH VALUE MANUFACTURING CATAPULT

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The High Value Manufacturing Catapult creates the conditions for economic growth by enabling UK manufacturers to achieve significant improvements in their performance and productivity. We do this by providing open access to world-class innovation capability and technical expertise, enabling companies to embrace different ways of working, adopt new technologies and achieve step-change in their performance.

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## ABOUT THE GATSBY FOUNDATION

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Gatsby is a foundation set up by David Sainsbury to realise his charitable objectives. We focus our support on a limited number of areas: plant science research; neuroscience research; science and engineering education; economic development in Africa; public policy research and advice; the Arts.

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