



Future of manufacturing
**Knowledge centres for robot
technology and automation –
Denmark**

***Company initiatives to align apprenticeships
to advanced manufacturing***

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Contents

Introduction	1
1 Context factors	3
2 General information on the case.....	5
3 Design and implementation.....	8
4 Outcomes, impact and lessons learned.....	13
5 Commentary and conclusions	15
References	17
Annex	18

Introduction

Scope of the research

This case study will focus on the establishment of the two knowledge centres of ‘robot technology and automation’. The centres were appointed in September 2017 after a tendering procedure among vocational schools, and are currently in a set-up phase prior to commencing operations. There is thus as of yet not any practical experience of running these centres (even though some of the vocational schools involved in the consortia building the two centres are currently carrying out activities that will in time be coordinated by the consortium), and the study consequently focuses on the set-up process and the planned activities. On the other hand, the initiative is very significant in a Danish context as it constitutes a new way of developing apprenticeship training in the light of the technological developments and their impact on the Danish advanced manufacturing industry.

The study should thus be seen as an ex-ante evaluation based on existing documentation (mainly from the tendering procedure and the detailed planning made by the centres) and on 5 interviews carried out with key actors and stakeholders¹. The empirical phase of the study was carried out in November/December 2017.

This case study is linked to the first case study on apprenticeship (‘Talent Tracks’) as well as the general report on apprenticeship and the advanced manufacturing in Denmark, and frequent references will be made to these in the text (Eurofound 2018a, 2018b).

The case at a glance

Technological progress in the field of manufacturing is accelerating and proceeds at a relentless pace. To remain competitive, enterprises are forced to follow this development; especially in the case of enterprises in high-wage countries like Denmark, which must at all times be equipped with the latest technology in order to stay abreast of the competition from countries with lower wage-costs, if production is to be retained in the home country.

Vocational schools are in their turn also forced keep abreast of this, and must regularly renew curricula, teaching practices and equipment if they are to live up to the requirement of continuously resupplying enterprises with a workforce that is fully updated in terms of knowledge, skills and competences. For the individual vocational school in a VET-system exposed to market mechanisms like the Danish, this need for constant investment in equipment as well as upskilling of staff can be an onerous burden in times of strained budgets. A failure to do this, however, may result in lower quality training and, in the long term-perspective, skills deficits that may affect the competitiveness of Danish industry.

As part of the 2014 reform of VET, the Government and a broad coalition of parties in the Danish Parliament decided to address this problem by appropriating additional funds to strengthen Danish VET in the light of the accelerating technological development. A significant part of these funds is earmarked to the establishment and running costs of nine so called *knowledge centres*, that have been set up in selected vocational schools to act as a spearhead for the technological innovation of VET. These knowledge centres will receive additional funds for the purchase of advanced equipment and to cover other activities aimed at developing the quality of VET in

¹ The persons interviewed for this case study come from employers (1), trade unions (2) and vocational schools (3). For details see the list in the annex.

relation to the technological development (notably curriculum development and continuing training of teaching staff). The knowledge centres will be operational as of November 2017, and the appropriation runs until 2020. After this period, the centres are assumed to be self-supporting.

Due to a number of factors, primarily the composition of the Danish economy with its strong focus on the advanced manufacturing industry, it was decided to establish two centres in the field of ‘robot technology and automation’. These centres will support a number of IVET-programmes directly linked to the (advanced) manufacturing industry. There is moreover a significant overlap with a third centre focusing on ‘Process technology’ and a number of IVET-programmes that are also relevant in a context on advanced manufacturing. Of the nine centres, three are therefore more or less directly associated with the advanced manufacturing industry².

Assessment of the case study against selection criteria

As regards the four different forms of adaptation of apprenticeship that are addressed by the research³, the case concerns the type a) modernisation of a specific occupation, even though it covers not one, but a range of occupations of relevance to the advanced manufacturing industry.

Structure of the report

The report basically falls in three parts: a general part with background information (including context factors); a descriptive part which outlines the set-up and implementation process; and an evaluative part which deals with outcomes and impact. In a final section, the initiative is viewed in a broader perspective and in relation to the continued development of apprenticeships in the advanced manufacturing sector, and relevant conclusions are drawn – also in the light of subsequent developments.

² Information on the knowledge centres and all available documentation can be accessed from the Ministry of Education’s website: <https://uvm.dk/erhvervsuddannelser/skoleudvikling/videnscentre>

³ These are: (a) modernisation of a specific occupation; (b) creation of new occupations/emerging occupations; (c) creation of a company apprenticeship / training programme; and (d) organisation of apprenticeships/training in (regional) clusters.

1 Context factors

The creation of knowledge centres in VET was to a large extent inspired by the experiences of the ‘Centres of Excellence’-project, which was initiated by the Confederation of Danish Industry and ran in the years 2010-2015⁴.

The knowledge centres were appointed in late September 2017 after a tendering procedure that was commenced in the spring of 2017. For the two knowledge centres in the field of robot technology and automation, the Ministry of Education received four bids from consortia of vocational schools, underlining the competitive nature of Danish VET-provision.

The establishment of the knowledge centres in some ways represents a new departure in Danish VET-policy. Whereas all vocational schools in principle are self-owning institutions with their own budgets built on performance-based payments (the ‘taximeter-principle’, see Eurofound 2018a) and in a competitive relationship with one another, the appointment of knowledge centres among schools with a role as spearheads for the introduction of new technology and the concomitant budget for the purchase of new equipment may be said to give certain vocational schools an edge over others. The decision to appoint two centres for this strategically important sector – with the problems that this may entail in terms of coordination and the risk of overlap – may (as well as reflecting the importance of the sector to the Danish economy) *also* be construed as an attempt to retain an element of competition among schools here.

1.1 Regional/sectoral and/or company specific set-up

For most of the other fields for which knowledge centres have been appointed, there is one knowledge centre covering the entire country. However, it was – as stated above – decided to establish two centres for robot technology and automation. These two centres are in principle nationwide in their coverage, and any geographical partition is not foreseen. In reality, however, they are run by two consortia that between them represent some sort of a geographical coverage of Denmark:

Consortium no. 1 consists of 3 vocational schools covering the southern part of Jutland and Funen + surrounding islands (*EUC Syd, SDE and Herningsholm*).

Consortium no. 2 consists of 5 vocational schools covering the middle and northern parts of Jutland as well as Zealand (*Aalborg Tech, EUC Nordvest, Mercantec, TEC and Next*).

It is at the present stage not quite clear how the centres will coordinate their activities and ensure that there is no overlap, both in terms of geographical coverage and in relation to the activities. There is no overarching, common steering group foreseen, and the Ministry is only to a very limited extent capable of assuming a coordinating role. The MoE will, however, undertake an ongoing ex-post evaluation of the activities of the centres, and a joint website (portal) for all 9 knowledge centres will be set up, so that it is possible to follow their activities over time.

1.2 Relevance of dual apprenticeship

The knowledge centres are focused around apprenticeships, as this is the dominant (only) mode of delivery of initial vocational education and training (IVET) in Denmark (see Eurofound, 2018a).

⁴ <https://foreninger.di.dk/CoE/Pages/forside.aspx>

1.3 Needs and challenges related to manufacturing and advanced manufacturing

The Danish manufacturing industry is highly developed, but under pressure from competitors in countries with lower wage costs. After a first wave of outsourcing, enterprises have become aware of the need to keep production on Danish soil, and Danish enterprises therefore generally have a very high degree of automation, and have been among the first to embrace robot technologies⁵. This requires a constant supply of highly skilled workforce, however, but Danish VET has been challenged by dwindling enrolment and low prestige, which is perceived as deterring the best learners from entering VET (see Eurofound, 2018a). This situation is exacerbated by the fact that large amounts of skilled workers are due to leave the labour market in the coming years due to age (retirement).

In response to this, enterprises have been very active in ensuring that VET-provision is being constantly developed both in terms of quality (higher level and more specialized skills) and quantity (numbers of learners enrolled). Within the framework of the Confederation of Danish Industry, a number of pilot projects have been instigated and funded in order to address these problems. In particular for the advanced manufacturing industry, the project ‘Centres of Excellence’⁶ harvested important experience that has since been implemented at national level as part of the IVET-reform of 2014.

⁵ See Eurofound, 2018a

⁶ See Eurofound, 2018b

2 General information on the case

In all, 4 applications were submitted by consortia of vocational schools that wished to become knowledge centres for robot technology and automation. This demonstrates the importance vocational schools attach to this role and the benefits that accrue from it, but also the competitive nature of Danish VET.

The knowledge centres are currently in an establishment phase, and have as yet not begun operations on any significant scale. Moreover, one of the two consortia (Consortium no. 2) has already encountered delays due to a prolonged contractualisation phase. Many details have therefore as yet not been fully worked out.

2.1 Background and reasons for initiating the practice

The knowledge centres constitute a response to the rapid technological development, which threatens to make elements of VET-provision obsolete, as individual vocational schools find it difficult to contain necessary investments in new technology within their budgets.

2.2 General and detailed objectives and expected results

The general aim of the knowledge centres is to ensure that enterprises are constantly able to renew and supplement their workforce with new recruits that are trained to the highest standards, and that individual learners are given the opportunity to develop their skills to the highest of their potential. The knowledge centres achieve these general aims by investing in advanced equipment and attracting cutting-edge expertise by making strategic alliances with higher education institutions and technological institutes. The knowledge centres are expected not only to benefit the involved schools, but to stimulate the quality of training in the involved fields across the country by offering courses and other competence-development activities for learners and staff for all relevant vocational schools. In particular, the Knowledge centres are expected to support the schools that offer the so-called Talent Tracks for gifted learners⁷.

As for the detailed objectives, the Ministry of Education stipulates the following duties and activities:

- Ensure that the entire capacity of the Knowledge Centre concerning new technology and digitalization is benefitting all learners in the programmes covered by the Centre. This also means that learners from vocational schools across the country will be invited to participate in the activities organized by the Centre: Talent Tracks, Training Camps, special courses etc.
- Develop and disseminate new learning and teaching material within the technologies covered by the Centre. These could be digital, and will be available to all vocational schools in Denmark
- Integrate new technology in teaching at vocational schools
- Establish networks of vocational teachers within the range of activities of the Knowledge Centre. The Knowledge centre will support the teachers in acquiring the didactical competences and skills that are necessary in order to secure that the use of technology and digitalization will enhance learning processes.
- The Centre will build up a knowledge base on new technology and mediate this to vocational teachers through short courses that can bring their knowledge up to date.
- Carry out Talent Tracks and other high-level subjects for learners.

⁷ Ibid.

- Develop and test new forms of cooperation on new technology and gifted learners (talents) between vocational schools, enterprises, regional authorities and consortia, existing technological institutes, higher education and other educational institutions, including primary and lower secondary general education.
- Offer training camps in preparation of participation in e.g. World Skills competitions. These will be open to all learners.
- Participate in collaborative projects with relevant higher education establishments concerning work with talents and placements, as well as courses, continuing training and networks across educational sectors.
- Contribute to capacity building between all Knowledge Centres by sharing relevant knowledge and resources, and collaborate on developing pedagogical/didactical material and networks with a view to increasing effectiveness and securing a firm foundation for the efforts made to digitalise VET.
- Purchase and maintenance of highly specialized equipment, which is outside the financial range of individual vocational schools.

2.3 Linkages to national programmes and initiatives

The regional knowledge centres are closely linked to the initiative ‘Talent Tracks’ (see Eurofound 2018b). With their more advanced equipment and expertise, the knowledge centres can offer high-level learning activities that cannot be carried out at other schools due to lack of equipment and/or expertise, and these can send their learners to the knowledge centres to train here. Also, the knowledge centres have an important task to develop and test new high-level subjects, which other schools subsequently can adopt and offer in their own context.

2.4 Scope of the programme/initiative

The knowledge centres cover, in principle, all IVET-programmes that include (elements of) automation and robot technology. In the information material elaborated by the Ministry of Education for the bidding procedure, the following programmes were enumerated as being in focus of the activities of the centres:

- Industrial technician
- Automation and process technician
- Tool and die maker
- CNC-technician
- Metalworker
- Electrician
- Electronics technician
- Industrial operator
- Data- and communication technician
- Woodcutting machinist
- Wind turbine operator
- Maritime service engineer
- Plastics processing operator

Geographically, the two centres each cover one part of the country, but vocational schools across the country have access to the activities and services offered by both centres, and are not restrained by their physical location.

The present case study is based on the two centres covering automation and robot technology, but there are overlaps between these and the third knowledge centre covering ‘process technology’. This overlap is evident in the list of programmes that are in focus by this centre:

- Automation and process technician
- Process operator
- Industrial operator
- Electronics technician
- Metal worker
- Electrician

It is, of course, an important point that much of the technology (e.g. robotics) transgresses traditional vocational lines of demarcation, so there is bound to be an element of convergence between the centres for robot technology and automation on the one side, and the knowledge centre for process technology on the other. The main difference at this stage is that the knowledge centre for process technology generally has a focus on food production and is mainly targeting the programmes of process and plant operators.

3 Design and implementation

At the time that this case study was undertaken, design and planning had still not been worked out in all details, and implementation proper only begins in early 2018. However, many of the activities that the centre will carry out are already being implemented in a smaller scale at institutional level.

3.1 Needs assessment and type of change implemented

The needs assessment for the initiative is based on several elements, including:

- The need of industry for qualified labour trained by the highest standards and with the latest technology;
- The difficulties of vocational schools to purchase up-to-date technological equipment within existing budgets;
- The requirement to give high-performing learners the possibility to train to the maximum of their abilities, both to attract a different kind of learners to IVET and to heighten the general esteem of VET among young people and their parents.

As mentioned above, the notion of selecting certain schools to form consortia and set up knowledge centres within specific fields is innovative in the Danish VET-system. As vocational schools are independent operators with their own budgets, based on performance-linked payments from the state, the policy so far has been to let individual vocational schools decide on the range and level of programmes offered, and to allow learners to choose freely between vocational schools. This is predicated on a conviction that free and open competition will ultimately result in better quality and relevance of VET-provision. However, with the knowledge centres, certain schools (consortia) will receive substantial extra funds for the purchase of sophisticated machinery and the competence-development of staff. Even though the centres are expected to operate as spearheads of innovation on behalf of all relevant vocational schools, schools involved in the knowledge centre-consortia can nevertheless be expected to gain a competitive edge vis-à-vis other schools. In time, this may lead to a situation where certain programmes (or varieties of programmes like the ‘Talent Tracks’) are concentrated in special schools, as only these are in a position to offer learners training of high quality.

By 2020, the public grant will cease, and the consortia are expected to finance the activities from their own budget and/or income-generating activities.

3.2 Involvement of different actors

The establishment of the centres and the activities in the initial period from 2017-2020 is regulated by a contract with the Ministry of Education, based on the contents of the proposal made in response to the tendering procedure. The Ministry is thus not involved in the day-to-day running of the centres. Physically, the knowledge centres are placed in consortia of vocational schools and run by these on an everyday basis, but in terms of decision-making both in relation to overall strategy pursued as well as on individual activities, the social partners are directly involved due to the nature of the Danish VET-system. This involvement manifests itself at two levels:

- All Danish vocational schools are self-owning institutions with their own boards of directors, the composition of which is dominated by the social partners. The board of directors is involved in all decision-making at strategic level, including those linked to the management of the knowledge centres;
- To all IVET-programmes offered at a school is attached a local trade committee consisting of representatives of the social partners, who will – within the framework of the flexibility laid

down in the Ministerial Order for the programme in question – take all decisions on the range and the level of subjects offered by the school, including those linked to the centre.

The involvement and the decisive influence of the social partners ensure that the activities reflect the need of the labour market at all times.

Besides the social partners, also other actors are involved, albeit not in a decision-making role:

- Both consortia have made strategic alliances with technological institutes and institutes of higher education in relevant fields in order to have access to higher level expertise in relevant fields;
- Both consortia operate with support-teams of enterprises working with automation and robot technology with regular dialogue meetings.

3.3 Financing

A total of DKK 213 million from Government funds (app EUR 29 million) have been earmarked for the whole process for the period 2017-2020, covering the costs for establishing and running the 9 centres (EUR 18 mill.) and the purchase of equipment (app. EUR 11 million). The amount earmarked for the purchase of equipment only covers 7 centres, as the two centres in the field of trade and commerce have separate budgets.

It should be noted, however, that this amount is part of a total budget of DKK 497 million (app. EUR 68 million) that has been set aside to strengthen the quality of Danish (I)VET, and some of the remaining funds may directly or indirectly benefit the activities of the knowledge centres at a later stage.

To supplement Government funds, the vocational schools in the appointed consortia are expected to contribute to the operations with own funds. The level of co-financing required by the Ministry of Education is 25%. After 2020, the current grant scheme expires, and the knowledge will receive no further earmarked support, but are expected to continue their work on the basis of the schools' own funds and revenue-generating activities.

3.4 Other forms of local, regional and/or national support and expertise

Both knowledge centres have established networks with partners that can assist them in developing the activities of the centre, primarily with technological institutes and universities. Just to give an impression of the nature of these networks, Consortium no. 1 (consisting of the vocational schools EUC Syd, SDE and Herningsholm) currently has a network that contains the following members:

The University of South Denmark has a strong focus on robot technology and automation with the internationally renowned SDU Robotics and RoboLab centres, as well as the Mads Clausen Institute for Automation. The university offers a Master of Science degree in robot systems with specializations in either advanced robot technology or drone technology, and (as of 2017) it also offers a BSc in this⁸.

Odense Robotics is an umbrella organization of more than 100 enterprises from the island of Funen employing robot technology. The organization has so far been operating mainly at higher education level, but member enterprises can contribute to the competence-development activities for both learners (apprentices) and teachers, and can be used as cases in teaching material⁹.

⁸ <https://www.sdu.dk/en/uddannelse/kandidat/robotteknologi>

⁹ <https://www.odenserobotics.dk/>

The *Danish Advanced Manufacturing Research Centre (DAMRC)*¹⁰ is a research and development centre for advanced manufacturing technologies in Jutland, set up by a partnership of enterprises, educational institutions and regional authorities. Some vocational schools are already involved in this network, and have used the courses offered by DAMRC to train teachers.

The *Danish Technological Institute (Teknologisk Institut)*¹¹ has for over 100 years assisted Danish enterprises in the introduction and implementation of new technology. The partner in the project is the Institute's Centre for Robot and Welfare Technology in Odense (on the island of Funen), which is supporting the robot industry of Funen.

The *Lillebælt Academy - University of Applied Science (Erhvervsakademi Lillebælt)*¹² participates with its department of automation, which offers the short cycle (2-year) degree of automation technologist. This programme is used by many learners with relevant qualifications from IVET who wish to further specialize in this field.

Also, to cater for the niche of the robot industry that works with drones, the network also includes *UAS Denmark*¹³, an international test centre and drone industry cluster, based in Odense.

In addition to this network, both consortia are planning to set up a support team consisting of enterprises with a focus on robot technology and automation.

3.5 Implementing the initiative

The decision about the location of the knowledge centres for automation and robot technology was a competitive one with 4 consortia bidding to become one of the two knowledge centres. The final decision was taken in late September 2017, but due to adjustments in the set-up and economy of the centres, these could not start operations before November the 6. It is therefore still (very) early days, and as no payments have been released for the centres yet, activities have only commenced on a very modest scale.

3.6 Quality assurance measures

Quality assurance is, so to speak, weaved into the very fabric of the project, due to the nature of the activities and the characteristics of the Danish VET-system.

As for any developments of the curriculum (new high-level subjects), these have to be approved by the relevant national-level Trade Committee, which consists of representatives of employers and trade unions. The Trade Committee thus acts in an external evaluation function vis-à-vis the curriculum development activities. As for concrete training initiatives (courses for learners/apprentices and vocational teachers, either in a physical form or as on-line courses), the relevance of these is judged by the extent to which they are taken up/frequented by learners and staff from other vocational schools than the ones represented in the consortium.

3.7 Skills of involved training and mentoring personnel

The skills and competences of teachers and mentoring personnel is a vital component in the efforts to integrate new technology linked to robotisation and automation in Danish VET. Consequently, two items on the MoE-list of objectives to be achieved by the knowledge centres

¹⁰ <http://www.damrc.dk/>

¹¹ <https://www.teknologisk.dk/ydelser/robotteknologi/22786>

¹² <https://www.eal.dk/uddannelser/automationsteknolog/>

¹³ <https://www.uasdenmark.dk/uas-denmark-international-test-center-and-drone-cluster>

(items four and five) are focused around the continuing training and competence development of teachers and trainers in VET.

3.8 Difficulties and challenges during implementation

The implementation phase has only just started and is slowly gathering momentum, so there is very little experience to base a proper analysis on. However, already at this stage actors and stakeholders are anticipating a number of challenges due to factors inherent in the construction of the consortia and/or in the basic fabric of the Danish VET-system.

The challenges are linked to the fact that the appointment of knowledge centres (and not least the budget allocation for the purchase of equipment) to some extent goes against some of the fundamental principles on which Danish VET is built. They may relate to extrinsic and intrinsic factors.

The intrinsic factors are:

- Consortia are unable to maintain internal cohesion;
- The two centres fail to coordinate their activities; and
- The activities will be compartmentalised and focused around individual programmes, not taking into account the cross-cutting nature of many technologies

The extrinsic factors are:

- The vocational schools outside of the consortia not using the activities developed by these; and
- The consortia using the assets developed or purchased by the centre to attract learners from other schools (or their catchment area).

Ad 1: Intrinsic factors

The two consortia are structured around one leading school and two (respectively four) partner schools. The partnership is regulated by a collaboration agreement which sets out the rights and obligations of each member of the consortium and prescribes methods of arbitration and decision-making in the event of disagreements. Yet the formation of partnerships – especially for one of the two consortia – was not a smooth process, and especially the location of equipment proved contentious. As much of this is heavy machinery that cannot be moved around on any regular basis, the purchased equipment will have to remain in one location, and this may give one school a marked advantage over others, which may in turn weaken the cohesion of the partnership. This may mean that the partnership structure falls apart when the period of financing (2017-2020) is over, thus potentially nullifying many of the intended effects.

The two centres have struck some kind of geographical balance between them, with Consortium no. 1 covering the southern part of Jutland, the island of Funen and the islands off Zealand, while Consortium no. 2 covers the rest of Denmark (the middle and the northern part of Jutland and Zealand). In principle, however, the activities of both centres are available to – and open for – schools, learners and enterprises on a nationwide basis, and some kind of coordination is therefore necessary to avoid that the wheel is reinvented too many times over. Some coordination – for the development of the curriculum of relevant programmes – will happen through the Trade Committees, which are ultimately responsible for these matters, but in other fields (courses, activities), there is a risk of a duplication of efforts – not only in the two centres for robot technology and automation, but also with regard to the centre for process technology.

All of the 13 programmes that are targeted by these two knowledge centres will to some extent be using the same technologies (hard- and software), and it therefore makes sense to develop

activities that cut across vocational boundaries. Therefore, it is the technology that must constitute the fulcrum, and not individual programmes. However, if the centres develop into a direction where each school in a consortium will focus on individual programmes and develop products and activities within the framework of this, much valuable potential for synergy will be lost.

Ad 2: Extrinsic factors

Danish VET-schools are financed according to performance-based criteria, notably the number of learners enrolled and the duration they spend at the institution. Schools sending learners to another school for even short periods are deducted for these in the payments they receive from the state, and this may lead them to try and retain their learners. In the ‘Centres of Excellence’-project (2010-15), where selected vocational schools developed activities that were open to learners also from other schools, it was very difficult to attract these, as other schools were not willing to send learners away and thus lose money. As one enterprise representative stated: ‘It’s partly about local patriotism, and partly about thinking in terms of the bottom-line, where schools are very reluctant to send learners – and the attached taximeter-grants – to what they perceive as competing institutions’¹⁴.

As there is a free choice of vocational schools in Denmark, it is possible for the vocational schools in the consortia to use the additional funds to make themselves more attractive to learners and especially to enterprises, and thus erode the economic basis of other schools and ultimately force them to discontinue offering specific programmes. Even though learners often are reluctant to relocate for training and enterprises have an interest in sending their apprentices to a vocational school in the vicinity, concerns about quality may overrule these reservations. As enterprises also prefer to have their apprentices in one or a few vocational schools to facilitate the dialogue, any migratory movement of learners may have a self-reinforcing effect.

¹⁴ Dansk Industri 2014a, p. 34

4 Outcomes, impact and lessons learned

Given the very recent establishment of the initiative and the fact that hardly any concrete activities have been carried out as yet, it is only to a limited extent feasible to talk about outcomes, impacts and lessons learned beyond the set-up phase. This section will therefore mainly focus on the process leading up to the establishment of the centres, and the teething problems and beneficial effects that have occurred in this phase.

4.1 Major outcomes and impacts on company and region

Without even having started operations, the centres can in one way be said already to have notched up one major result – namely in the sense that the very establishment marks a paradigm shift in Danish VET-policy; from a scenario of free-for-all competition towards a scenario where specific vocational schools are given extra benefits to allow them to take the lead in relation to specific programmes. This specialisation of VET is by some actors and stakeholders necessary in order to allow for apprenticeship keep abreast of the developments in technology, based on the realisation that it is simply not feasible for all schools to be equally updated in terms of equipment and competences of teaching staff. This development was initiated by the manufacturing enterprises themselves, when the Confederation of Danish Industry in the years 2010-2015 carried out the project ‘Centres of Excellence’, which singled out 4 vocational schools to receive extra funding earmarked to develop apprenticeships in particularly the field of advanced manufacturing. All of these schools (Herningsholm, Next, Mercantec and TEC) are involved in the new knowledge centres for automation and robot technology, which gives them the possibility to further develop their programmes and make these even more attractive to learners and enterprises.

The official rhetoric surrounding the knowledge centres does not underpin this interpretation, but speaks of creating ‘light towers’ which will develop products and activities that will benefit all vocational schools offering the apprenticeship programmes covered by the knowledge centre. However, a vocational school, which is part of a knowledge centre, will have additional, earmarked funds to purchase equipment and to develop products, and this will over time add to their attractiveness for enterprises and learners and give them an advantage over other schools offering the same programmes. With learners and enterprises having a free choice of vocational schools, it may over time lead to a reduction in the numbers of schools offering these programmes. Whilst this may be a desirable thing from the perspective of the development of programmes, it may negatively affect the recruitment of learners if these have to relocate or travel over large distances to attend the programme of their wish.

4.2 Attractiveness and capability of apprenticeship

It is highly probable that the two centres – as one of several initiatives all pulling in the same direction – will help make apprenticeships/IVET a more attractive option especially for young people, as it contributes towards the dispersion of perceptions among young learners (and their parents) that VET is a second (and poorer) choice after general upper secondary education. Whether this will result in any significant increase in the esteem of VET and a subsequent rise in the uptake of especially young learners remains to be seen, however. In 2017, recruitment for IVET among those leaving lower secondary education reached an all-time low of barely 18,5%¹⁵,

¹⁵ Ministry of Education: <https://www.uvm.dk/aktuelt/nyheder/uvm/udd/gym/2017/marts/170320-fortsat-stor-soegning-mod-gymnasiet>

but enrolment in programmes of particular relevance for the advanced manufacturing industry (industrial technicians and CNC-technicians) showed a marked upwards trend¹⁶.

It is a certainty, however, that the initiative will increase the capability of apprenticeships to embrace the latest developments in technology as it allows selected schools to modernise equipment and develop the competences of both learners and teachers. Again, however, it remains to be seen whether this will result in a general lift in quality or benefit only the involved schools and their learners.

4.3 Key success factors and lessons learned

Despite the very recent nature of the knowledge centres for automation and robot technology, it is still possible to draw out some general conclusions, since they to a large extent build on the experiences and the activities from the ‘Centres of Excellence’-project, which terminated in 2015. This project was very successful, in the sense that it introduced elements that have since been incorporated into the VET-system as systemic features; notably the ‘Talent Tracks’ and the very notion of centres of excellence/knowledge centres.

The major factor in the success of the ‘Centre of excellence’-project was its proximity to the stakeholders in the advanced manufacturing industry, i.e. the social partners. The project itself was kicked off by the employers (the Confederation of Danish Industry), who also provided funding through the Danish Industry Foundation. A national steering committee consisting of representatives from all relevant social partners (employers’ associations and trade unions) was set up to take strategic decisions over and beyond the interest of the 4 involved vocational schools, and the Trade Committees both at national and local/regional level oversaw and approved of any curriculum-related developments to ensure that they were in sync with the demands of industry.

To a certain extent, this intimate relationship with the social partners is embedded also in the new knowledge centres, but mainly at the level of individual activities and at school level, through the local and national Trade Committees and the boards of the involved schools, where the social partners are heavily represented. There is, however, no supra-institutional steering committee to resolve matters of broader interest than those of the involved institutions, and this means that there is a risk of petty, institutional issues coming to the fore at the expense of the interests of the VET-system as a whole.

¹⁶ See Eurofound 2018a, 2018b

5 Commentary and conclusions

The creation of the knowledge centres is an innovative feature of Danish VET. Inspired by, and built on, the example set by the project ‘Centres of Excellence’ instigated by the Confederation of Danish Industry, it has now been applied in a number of sectors in Danish VET.

5.1 Adjusting dual apprenticeship in the light of advanced manufacturing

The knowledge centres as well as the ‘Talent Tracks’ (Eurofound 2018b) constitute major efforts to enable apprenticeships to rise to the challenges of the technological development in industry, and in particular the advanced manufacturing industry. They were both introduced as part of the latest major reform of VET (in 2014), but it is one of the hallmarks of Danish VET that continual change so to speak is embedded in the system via the nature and the role of the national- and local level Trade Committees and their constant endeavours to keep apprenticeship programmes abreast of developments on the labour market and in technology¹⁷.

People with qualifications from IVET (apprenticeships) e.g. as industrial technicians and automation technicians are much in demand on the labour market, and a great amount of efforts is being made by employers and trade unions to attract more persons to these programmes. This attractiveness is further enhanced by demographic developments, where a large number of people with IVET-qualifications are leaving the labour market in the coming years¹⁸.

5.2 Policy implications and transferability

The free choice of learners (and enterprises) between vocational schools is a basic principle of Danish VET. Even though by far the majority of learners end up in vocational schools situated in their region, a number of learners opt for schools outside of their region because they (or their enterprises) are convinced that they will receive a better quality here. This was e.g. the case when Herningsholm vocational school as the only school offered the Talent Track for industrial technicians, where app. one third of all learners enrolled in the Talent Track came from outside of the school’s natural catchment area¹⁹. This application of market mechanisms to VET with free and open competition based on equal privileges is presumed to yield the best results in terms of quality in the bigger scheme of things.

However, giving preferential treatment to selected schools impairs these mechanisms. In the evaluation of the ‘Centres of Excellence’-project preceding the creation of the knowledge centres, the evaluation report states: ‘The four schools that were selected have through their involvement harvested valuable experiences that give them an advantage over other vocational schools in connection with the implementation of the reform. Of course, these experiences and the products developed are available to all, but the creation of the necessary infrastructure and the competence-development of teachers and staff probably count for much more’²⁰. With the creation of the two knowledge centres, these advantages have been further entrenched.

However, the knowledge centres have the support of all major stakeholders (social partners and the Ministry of Education) as a necessary initiative to enable VET to stay abreast of the rapid

¹⁷ For a description of this, see Eurofound, 2018a

¹⁸ See e.g. the report from the Danish Metal Workers Union from March, 2017: <https://www.danskmatal.dk/Nyheder/analyser/Documents/Mangel%20paa%20industriteknikere.pdf>

¹⁹ See Dansk Industri 2014a, p. 19. No numbers of learners from outside the region exist for 2017, where 6 other schools offer Talent Tracks for this programme.

²⁰ Dansk Industri 2014a, p. 35-36

developments in technology and its implications for (in the case of the centres for automation and robot technology) the advanced manufacturing industry.

The concept of knowledge centres is transferable, and centres are – as previously mentioned – not only set up in the field of automation and robot technology, but also in a number of other fields where it is deemed particularly important to integrate VET with the latest technological developments. These other fields are in the crafts sector (design & architecture and sustainability, green energy and building), welfare technology (two centres), process technology, digital trade, and databased service and business development.

References

All Eurofound publications are available at www.eurofound.europa.eu

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Annex

A.1 List of interviewees

Type of organisation	Organisation	Interviewee
Employers' association	Confederation of Danish industry	Senior adviser
Trade union	Danish Metal Workers' Union	Secretary of Education and Training
Training provider	EUC Syd	Head of section
Training provider	Herningsholm Erhvervsskole	Head of section
Training provider	Tech College Aalborg	Project leader

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