The Danish Robotics Cluster: The Role of the Public Sector in the Development of a Competitive Industrial Cluster

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Abstract

The question of the role of the state and the public sector in the creation of competitive clusters and innovation systems has drawn increased attention in recent years. Drawing on Mariana Mazzucato’s concept of “the entrepreneurial state”, this paper investigates the role of the public sector in the development of the Danish robotics cluster, a world-leading cluster for production of industrial robots: In what ways did public sector programs and actors contribute to the development of this cluster? When and in what ways did public institutions and programs facilitate entrepreneurs, and when did they function as agents and risk-takers? To answer these questions, the paper analyzes three layers of public institutions: the local level, the national level and the level of the European Union. What role did initiatives and agents at these layers play in the development of the cluster?

What is the role of the state and of public institutions in the process of wealth creation and in the making of competitive enterprises and clusters? In her 2013 book on *The Entrepreneurial State*, Mariana Mazzucato made the claim that contemporary discourse has been too dominated by the idea that governments are just a burden to the dynamism of the private sector: “According to this view, the secret behind an engine of innovation like Silicon Valley lies in its entrepreneurs and venture capitalists.”¹ In opposition to this view, she argued that the story of Silicon Valley, and similar examples of competitive industrial clusters, would not have been possible without very important steps taken by public actors. In other words, our understanding of innovation and economic growth is guided by a false narrative that lays too much emphasis on the private agents and too little emphasis on the many successes of the modern “entrepreneurial state”, and thus we need to understand that “the State has historically served not just as an administrator and regulator of the wealth creation process, but a key actor in it, and often a more daring one, willing to take the risks that businesses wont.”²

The narrative of the private actor as the key to economic growth has been particularly strong in the US, and thus it is no coincidence that Mazzucato’s debunking of the myth is focused on the (forgotten) role of the state in the great success stories of innovation in American industry. Mazzucato is arguably the most important contemporary theorist to deliver this argument, but she is certainly not the only one, nor the first. The role of the state in US industrial history has been stressed by numerous historians, and in scholarship on European

² Mazzucato: *The Entrepreneurial State*, p. 4.
business history it is certainly a mainstream position that the state has played a crucial role. For instance, the role of the state if often emphasized in stories of German capitalism. The Danish business historian Per Boje has even argued that this European pattern has very deep historical roots stretching back, in the Danish case, to the mid-18th century. However, in such business history narratives of German or Danish capitalism there is typically a focus on public institutions as well as private entrepreneurs, and the state is a little closer to that of a facilitator than that of an actor; but all such contributions would agree that we miss a crucial part of the truth about innovation and wealth creation if we overlook the role of the state.

But is this pattern still alive in contemporary globalized capitalism, and how does it work at the micro-level? This paper tries to contribute to these questions by analyzing the creation of a brand new and globally competitive industrial cluster: the Danish robotics cluster. What role did the public sector play in this process vis-à-vis private market actors, and to what degree does it makes sense to talk of the state as “an actor”? In what instances did the public institutions and actors set out programs, and in what instances did they actually function as agents of innovation and risk?

What is the Danish Robotics Cluster?

The Danish robotics cluster is situated in the city of Odense on the island of Funen. Odense is Denmark’s third most populous city with a population of roughly 180,000, while the island of Funen has a population just below 500,000. Since its establishment in 2015, the formal cluster organization – Odense Robotics – has been tasked with organizing, furthering and representing the Danish robotics cluster. Before the existence of Odense Robotics the Danish robotics cluster only existed as an “organic” cluster, without a formal entity organizing it. The term “Danish robotics cluster” is a moniker that is in some respects misleading because it suggests that the cluster covers the entire country of Denmark, but in reality, it is a regional cluster covering only the island of Funen. The reason that this term has been chosen in spite of these circumstances is that it highlights the fact that the cluster is the epicenter of the Danish robotics industry, as 69% of Danish robot-manufacturers were located on Funen in 2017, although the island only accounted for 7.91% of the Danish population at the beginning of 2018

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As of January 2018, the Danish robotics cluster is comprised of 120 companies that employ 3200 people, up from 85 companies with 2200 employees in 2015\textsuperscript{8}. The growth in companies from 2015 to 2017 is in part due to the admission of already existing companies into the Odense Robotics network, but it is also to a significant degree due to inclusion of newly formed innovative startup enterprises of which there have been many in recent years. In fact, 43 of the roughly 120 companies in the robotics cluster have been founded between 2012 and 2017\textsuperscript{9}, which suggests the existence of a vibrant and innovative entrepreneurial culture within the robotics community on Funen. A significant part of the growth in jobs is located either in companies that have recently transitioned from small startups to rapidly growing robotics companies, such as Mobile Industrial Robots ApS, whose staff has expanded from a mere 8 full-time employees in 2015 to 42 full-time employees in 2017\textsuperscript{10}, or from older more established companies such as Jorgensen Engineering A/S, which has grown from 84 to 128 employees in the same time-span\textsuperscript{11}.

Two commonalities that seem to be characteristic for the vast majority of companies in the cluster are that they are trading business-to-business and that many of them make products aimed at covering various niche markets within the field of industrial automation. Nevertheless, the Danish robotics cluster is comprised of a variety of different types of companies of which two groups of companies seem to stand out. The first is a group of companies specializing in providing automation solutions for the food producing industry or the agricultural sector. One example is Sanovo Technology A/S which produces automated machinery for the industrial processing of eggs\textsuperscript{12}. The significance of this group is underlined by the fact that it accounts for roughly one third of the jobs in the robotics cluster\textsuperscript{13}. Most of the companies in this group were established between the 1960s and the 1980s\textsuperscript{14}, and they were quite often founded by engineers educated at the local technical college\textsuperscript{15}. The other significant group of companies in the cluster has a very different and more recent story of origin, which had its point of inception in a research collaboration between the local university, Odense University (OU) (later the University of Southern Denmark – SDU), and the local shipyard named Odense Steel Shipyard (OSS) in the beginning of the 1990s\textsuperscript{16}. This group consists of innovation-oriented companies that work within the field of collaborative robotics or closely related sectors of that industry.

It is this second group of companies that has come to define the Danish robotics cluster in recent years because it has established the cluster as the leading center of expertise on collaborative robotics in the world. SDU is at the forefront of research within the field of collaborative robotics, while the company Universal Robots (UR), which is the undisputed crown jewel of the cluster, was the first company worldwide to

\textsuperscript{9} Calculations by Julian Lamberty on the basis of data from Danish Central Business Register: www.cvr.dk.
\textsuperscript{10} Calculations by Julian Lamberty on the basis of data from Danish Central Business Register: www.cvr.dk.
\textsuperscript{11} Calculations by Julian Lamberty on the basis of data from Danish Central Business Register: www.cvr.dk.
\textsuperscript{13} Calculations by Julian Lamberty on the basis of data from Danish Central Business Register: www.cvr.dk.
\textsuperscript{14} Calculations by Julian Lamberty on the basis of data from Danish Central Business Register: www.cvr.dk.
\textsuperscript{15} Lamberty, Julian: ”Den fynske robotklynge: Et studie af den fynske robotindustri usviklingshistorie”. Forthcoming.
successfully introduce collaborative robots to the market place, thereby gaining the position of world market leader within this particular sector of industry. The latest statistics from 2015 puts URs global market share at 71%\(^\text{17}\). Collaborative robots are defined as robots that possess the ability to work side by side with humans on the factory floor without the need for safety-fencing. This is due to their high-tech safety features and their ability to sense and interact with their surroundings. Furthermore, collaborative robots are typically rather small in size and designed to be flexible and user friendly\(^\text{18}\), which stands in clear contrast to more traditional industrial robots that are typically large, inflexible and dangerous for humans to be around. This makes collaborative robotics particularly suited for the automation of production processes in small and medium sized enterprises (SMEs), as many SMEs produce a variety of products, which emphasizes the need for flexibility in automation technology\(^\text{19}\). This means, that while the market for collaborative robots only amounted to 1% of the total market for industrial robots in 2015, the potential market for collaborative robots is vast and most likely will expand rapidly in the coming years\(^\text{20}\). UR provides compelling evidence for this rapidly expanding market, as the company has managed to increase its annual revenue from ca. 1.5 million DKK in 2008 to more than 1 billion DKK in 2017\(^\text{21}\). It was the success of UR that garnered international attention and gave the Danish robotics cluster its international reputation as a leading center for collaborative robotics. Therefore, it is not considered controversial to claim that there would be no robotics cluster with international renown on Funen without UR in whose wake other companies and startups have since attempted to follow in the years after UR’s commercial breakthrough in the beginning of the 2010’s\(^\text{22}\). In fact, the success of UR garnered so much international attention that it was bought by the American company Teradyne in 2015 for a price of 285 million dollars plus a further earn-out of 65 million dollars, if certain commercial targets were met in the following years\(^\text{23}\). As the robotics cluster was developed alongside the rise of UR, this analysis deals only with the role of the public sector in relation to this part of the story and this second group of companies.

The Local Level

As mentioned in the description of the present day robotics industry on Funen, what has brought it its international standing is its status as the leading international hub within the field of collaborative robotics. The chain of events that would ultimately bring about this status began to unfold in the late 1980’s at the local level. More specifically, the point of origin for the history of collaborative robotics on Funen can be pinpointed


\(^{18}\) Region Syddanmark: *Roboter og automatisering*, p. 42.


\(^{20}\) Region Syddanmark: *Roboter og automatisering*, p. 42.

\(^{21}\) Calculations by Julian Lamberty on the basis of data from Danish Central Business Register: [www.cvr.dk](http://www.cvr.dk).


\(^{23}\) Steno, Carsten: *A Cluster of Success*, p. 64.
to the year 1988, when Carl Th. Pedersen – who was then vice-chancellor of OU – took the initiative to arrange two meetings between scientists from the Faculty of Natural Sciences at OU and a number of local industrial enterprises with the hope of identifying opportunities for joint research projects. It must at this stage be pointed out that Danish universities are public institutions, which is why they must – for the purposes of this analysis – be regarded as local level governmental actors, thereby making the aforementioned meetings as well as all subsequent contact between the university and the local business-world instances of business-government relations. The meetings led to the establishment of a joint research project within the field of robotics between OU and OSS, one of the largest private employers on the island of Funen, as OSS was looking to develop automated robotic solutions for welding-processes in its shipbuilding in order to improve its competitiveness vis-à-vis its international rivals. The joint research programme was named AMROSE and came under the leadership of mathematics professor John Perram whose research in computer modelling was the scientific foundation of the project. The AMROSE project progressed according to plan which meant that the robotics-technology was deemed to be ready for the marketplace after six years of research. This resulted in the establishment of the spin-out company AMROSE A/S in 1996. It marked the first instance of commercialization based on the robotics research conducted at OU and must therefore be regarded as the point of origin for the establishment of a commercial robotics cluster on Funen.

The AMROSE project had been a success for both OU and OSS. Therefore, the representatives on both sides agreed that it would be worthwhile exploring whether it was possible to establish more permanent research capabilities within the field of robotics at OU. They decided to approach the owner of OSS – the world-leading shipping company A.P Møller–Mærsk – with a request for funding for the establishment of a permanent department at OU devoted to robotics research. The negotiations between OU and A.P Møller–Mærsk were difficult, but in the end the company agreed to donate 75.000.000 DKK towards the establishment of a department if the university was willing to spend an equal amount of its own funds on this venture. This constituted – at that time – the largest single donation ever given to a Danish university by a private company and exemplifies a rather unusual case in which a private company invested so directly in the build-up of what has to be regarded as a piece of public sector infrastructure that would not necessarily benefit the company directly in the short run, but could potentially support the development of its shipbuilding-subsidiary, OSS, in the future by providing it with innovative research and highly-skilled graduates within the field of robotics. The establishment of the Mærsk-McKinney Møller Institute for Production Technology – as the new department was named – would prove to be a crucial event for the subsequent development of a robotics cluster on Funen, as it established a permanent hub for research and education within the field robotics that provides the robotics industry on Funen with highly skilled graduates up until the present and is still at the forefront of

26 Steno, Carsten: En klynge der virker, pp. 25-27.
international robotics research, particularly within the field of collaborative robotics. OU’s role in laying the foundation for the development of the Danish robotics cluster is therefore a very significant one. Not only was it the university that took the initiative to arrange meetings with local business leaders, which led to the AMROSE-project, it was later also willing to invest 75 million DKK in the creation of the Maersk Institute, which is why the university must be deemed to be an active agent of innovation rather than a mere facilitating public sector institution, although it also – due to its research and education activities – functions as the latter.

As can be inferred from the above, the 1990’s was a period in which the expertise within the field of robotics grew quickly on Funen, although it is probably too early to speak of a business-cluster at this point in time. Things were, however, generally progressing in the right direction in the 1990’s. This changed markedly in the beginning of the 2000’s as the robotics environment experienced a regular crisis, which was brought about by several coinciding events. On the local level, OSS decided to abandon its interest in robotics research, which was due to a change in management and the emerging realization that shipbuilding at OSS would eventually have to be given up, as it would not be able to stay competitive in the international marketplace in the long run. This also brought about the dissolution of AMROSE A/S as the company lost its most significant client. On a broader international scale, businesses focused primarily on the outsourcing of production capabilities to low-wage countries instead, as this was at the time a more economically viable strategy than investing in automation of production facilities.

Up until this point, the local and regional governmental actors on Funen had not been engaged in the robotics environment in any significant manner, but as the future of the robotics environment was now in danger of disappearing, the municipality of Odense and the county of Funen decided to support it more actively. This was because they recognized that the expertise within the field of robotics that had been built up around the city of Odense was worth saving. One likely reason why these local governmental actors perceived the potential value of the robotics environment was that Danish industrial policy at the national level began to incorporate the concept of the “business cluster” into its industrial policy planning just after the turn of the millennium. This national focus in turn informed the industrial policy at the local level. A 2002 report commissioned by the municipality of Odense outlined a strategy for the city’s industrial policy that would more actively engage the municipality as a “Bridge builder” between local businesses, the higher education sector, and the city itself.

Furthermore, the report recommended that the municipality of Odense focused its industrial policy on supporting four sectors of industry, which were to act as locomotives for the development of the local business community. One of these sectors was the local “Metal- and Production Technology,” which became a point of focus because the fabrication of industrial production technology had traditionally been a position of strength.

30 Ibid., p. 31.
31 Ibid., p. 32.
32 This subject will be covered more thoroughly in the section discussing the national policy level.
34 Ibid., pp. 4-5.
for the business community of Odense. Furthermore, the report pointed out that there had been a considerable buildup of knowhow and expertise in related fields in the local educational sector, particularly at the Mærsk Institute at SDU, which was deemed to be an: “apt promotor and driving force in regard to the central challenge of bridge building between the existing more traditional competencies within the field of production technology and [new] IT [capabilities].”

The aim of the policy was to create: “a competitive and high-tech cluster within the field of production technology.” In more concrete terms, the more active approach taken by the municipality of Odense and the County of Fyn resulted in the establishment of Robocluster in the fall of 2002, which was an independent “growth environment” located at the Mærsk Institute that was jointly funded by local educational institutions, the Ministry of Science as well as the county and municipality. The purpose of Robocluster was to cut across the public/private sector divide and act as a hub for the robotics environment in order to promote networking and to facilitate knowledge accumulation. Robocluster would in the coming years – along with the Mærsk Institute and the local branch of The Danish Technological Institute – play an importing role in the development of the robotics cluster, as these institutions managed to obtain research funding from the EU as well as from a number of other public research councils. These Funds proved integral for upholding the robotics environment on Funen during these years of crisis. The municipality of Odense upheld its supportive policies in its revised industrial policy strategy of 2007, which more clearly focused its efforts on the robotics sector, thereby demonstrating a clearer understanding of the fact that it was robotics rather than the broader field of production technology that constituted a local area of expertise that held the possibility of developing into a successful business cluster. In other words, the municipality of Odense was committed to supporting the local robotics environment.

In the years following the publication of this industrial policy strategy, the Danish robotics cluster experienced its big commercial breakthrough initiated by the success of UR in the beginning of the 2010’s. This success further intensified support from local governmental actors, particularly because the number of jobs in the industrial sector was in rapid decline at this point in time. The closing of OSS was announced in 2009 and the last shipbuilder left the yard in 2012 when OSS was closed down for good. Meanwhile the municipality of Odense had experienced a 51% decline of jobs in the industrial sector in the period 2000-2012. This meant that the municipality was highly motivated to promote a narrative of success relating to a part of the local industrial sector, i.e. the robotics sector, and that it was very willing to commit significant resources in order to further the continued development of the robotics cluster. This first led to the founding of the organization.

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36 Ibid., p. 28.
37 Ibid., p. 29. Translation by Julian Lamberty.
38 Ibid., p. 27. Translation by Julian Lamberty.
40 Ibid.
41 Steno, Carsten: A Cluster of Success, p. 34-35.
Invest in Odense in 2014, which was an entity within the Mayor’s Department tasked with furthering the development of the local business community through various activities. One of Invest in Odense’s tasks was to provide funding for the formal cluster organization of the robotics industry on Funen, Odense Robotics, which was established in 2015. The task of funding Odense Robotics was shared between Invest in Odense and another recently formed local organization named Developing Fyn, which was a cooperation between five local municipalities on Funen, tasked with furthering the development of selected business areas - one of them being the robotics sector. Odense Robotics is therefore not a private organization springing from the local robotics industry, but rather policy initiative initiated and funded by local governmental actors, established with the purpose of promoting, furthering and organizing the local robotics industry. While private enterprises and expertise within the field of robotics had developed significantly in the preceding years, it was not until the establishment of Odense Robotics that the notion of a robotics cluster on Funen experienced a real breakthrough. This breakthrough can be demonstrated by counting the number of articles in the local newspaper, Fyens Stiftstidende, which referenced the phrase “robotics cluster”. From 2002 to 2014 only 11 articles contained this phrase, a number that rose significantly to 99 articles in the period 2015-2017, i.e. the period following the establishment of Odense Robotics. Odense Robotics has in other words been the central agent behind the creation of the narrative of a successful robotics business cluster on Funen, although it must be emphasized that this narrative is not purely fictional, as it would in all likelihood not have been sustainable if there was no substance behind it. Another important initiative organized by Odense Robotics was the creation of its so-called StartUp Hub, which can best be described as an incubator for innovative startup enterprises in the robotics industry. Its activities include a wide variety of tasks aimed at supporting startup enterprises in everything from product development, development of business plans and strategies to assisting in the task of acquiring investor capital, which are free of charge if a company is admitted into the hub. Generally, the industrial policies of the municipality of Odense and other local political actors underwent a significant change at the turn of the millennium from a policy of non-engagement with the robotics sector to policies that supported the sector in a variety of ways. On the one hand are wider industrial policies in which these local actors take a facilitating role. They have, however, also launched some initiatives which more directly put them in the role of active agents of innovation, as in the case with the StartUp Hub, where the municipality of Odense invests its resources in furthering the early development of selected start-up companies in order to ensure a steady stream of new innovative companies for the Danish robotics cluster.

Apart from the political actors, SDU has also increased its commitment to education and research related to the field of robotics in recent years. Most recently, SDU has committed 100 million DKK of its funds to a broad project entitled “Industri 4.0” to further strengthen its robotics research activities. In 2017 it established a

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48 Calculations by Julian Lamberty on the basis of data from: www.infomedia.dk.
50 Syddansk Universitet: “SDU investerer 100 millioner i Industri 4.0”. Web. 12.06.2018. URL: https://www.sdu.dk/da/aktuelt/nyt_fra_sdu/100_millioner_til_industri_4_0.
new education programme giving graduates the title of bachelor of engineering in robot technology\textsuperscript{51}. This was done in order to combat the shortage of qualified labour for the robotics industry\textsuperscript{52}, which in a recent report on the development of the robotics industry in Southern Denmark was deemed to be one of the most significant weaknesses of the sector that could threaten the successful development of the cluster in the future\textsuperscript{53}. The increased interest in the robotics industry is also apparent in the fact that Odense Robotics, the Region of Southern Denmark\textsuperscript{54} and SDU have all recently published reports dealing with the subject of the robotics industry in Southern Denmark\textsuperscript{55}. All these initiatives demonstrate that local governmental actors have put significant resources into the development of the robotics cluster in recent years in order to ensure that the significant potential that the cluster holds for regional economic development and job creation is not squandered. The analysis has therefore shown that public actors on the local level of policy making have played a significant role in the developmental history of the Danish robotics cluster. The university was a crucial agent of innovation, particularly in the early phase of robotics research in Odense, while the municipality of Odense and other political actors began to act as facilitating agents from the turn of the century, but have also in some instances acted as active agents of innovation.

**The National Level**

An early example of changes on the national level of governmental action that would have an indirect impact on the development of the Danish robotics cluster was the gradual change of Danish university politics from the early 1970s to the early 00s. During this period Danish university politics gradually transformed from one ideational paradigm – characterized mainly by the ideas of democratization and the legitimacy of governmental regulation of the university sector – to another ideational paradigm governed by the idea that research and higher education is the key to economic growth and development, thereby more directly tasking Danish universities with improving the competitiveness of the Danish private sector\textsuperscript{56}. In general terms this meant that the political sphere put increasing value on the concrete usefulness of the activities of Danish universities to the private sector. These changes in Danish university politics must be taken into consideration when assessing the motives behind the decision of OU vice-chancellor Pedersen to arrange meetings between scientists and local businesses. Although the scope of this paper is too narrow to provide further examples that demonstrate the influence that this gradual policy change had on the development of OU and its activities, it is important to emphasize that this gradual shift has informed the relationship between Danish universities and the Danish

\textsuperscript{51} Odense Robotics: “SDU skal uddanne de første diplomingeniører i robotteknologi”. Web. 11.06.2018. URL: https://www.odenserobotics.dk/sdu-skal-uddanne-de-forste-diplomingeniører-i-robotteknologi/.

\textsuperscript{52} Ibid.

\textsuperscript{53} Syddansk Universitet og Pluss: Økosystemanalyse, p. 51.

\textsuperscript{54} The Region of Southern Denmark replaced the County of Funen as a regional governmental body in 2007.

\textsuperscript{55} Odense Robotics: *Leading the Next Industrial Revolution*; Region Syddanmark: Robotter og automatisering; Syddansk Universitet og Pluss: Økosystemanalyse.

private sector to the present day, as the task of supporting the competitiveness of private sector has effectively become the raison d’être of Danish universities\(^{57}\).

Another important development on the national level of policy-making was that the concept of business clusters became a focal point of Danish industrial policy in the early 2000s when the Danish Agency for Trade and Industry under the Ministry of Commerce published two reports that focused on identifying so-called “competence clusters” in Danish industry and commerce\(^{58}\). None of the two reports, however, identified a robotics or automation cluster on Funen, which indicates that the activities in and around Odense had at this point in time not yet reached a scale, structure and coherence, that allowed it to live up to the criteria that were requisite for qualifying them as a cluster. Nevertheless, the reports show that the Danish government began to give the concept of business clusters a more prominent place in its industrial policy from the beginning of the 2000s onwards, and that this focus seems to have affected policymaking at the local level, as indicated in section dealing with the industrial policies of the municipality of Odense. Both the changes in Danish university politics and the turn towards business-cluster oriented policies in Danish industrial policies are examples of how the Danish government acted as a facilitating agent by setting a political framework, which subsequently directed certain aspects of the development of the Danish robotics cluster.

Another example of national policymaking that would prove to have a different type of effect on the development of the Danish robotics cluster was the establishment of the Danish Growth Fund in 1992\(^{59}\). The purpose of the Fund was to further and support industrial development in Denmark, especially SME’s\(^{60}\), as these were perceived to be lacking the funds and resources necessary to undertake R&D projects that were deemed crucial for sustaining competitiveness in the increasingly more internationalized marketplace, and were, furthermore, perceived to have difficulties in attracting private capital for such R&D projects, as the financial risks involved were most often deemed to be too high by private investors\(^{61}\). The Growth Fund was established as an independent body governed by a board of directors chosen by the Minister of Commerce and was given an endowment of 2 billion DKK, which it could use to give loans, subsidies or guaranties to companies that undertook the aforementioned development projects\(^{62}\). The Fund, though, was initially not to invest its capital directly in companies in order to become a shareholder, as this type of activity was deemed to be the domain of investors from the private sector\(^{63}\). This, however, all changed in 2001 when parliament passed another law that changed the way that the Fund operated\(^{64}\), as it allowed it to invest directly in

\(^{57}\) Ibid., p. 267.


\(^{60}\) Ibid., sp. 289.

\(^{61}\) Ibid., sp. 289.


\(^{63}\) Ibid., sp. 289.

companies and become a shareholder, thereby effectively turning it into a venture fund. The hope was that this would provide the Fund with the tools to support the development of Danish businesses in a more efficient way, as well as the opportunity of reaping significant economic benefits if it invested its funds successfully. This realignment of the Growth Funds activities would prove to be crucial to the development of the Danish robotics cluster some years later.

As stated in the description of the robotics cluster above, UR is today the crown jewel of the cluster and was crucial in its formation, as it became the first big commercial success and put the cluster on the map internationally as a leader within the field of collaborative robotics. This, however, was not yet the case in 2008 when UR was on the verge of going bankrupt. The company had been founded by three employees of SDU in 2005 and had then obtained 1.2 million DKK in start-up capital from the incubator Syddansk Innovation. The following years were spent developing the company’s collaborative robotic arm and by the end of 2007 all funds had essentially been spent. While the product was far along in its development, UR nevertheless found it impossible to acquire further capital from private investors, which was generally due to the fact that, firstly, the market for collaborative robotics was completely uncharted territory at the time and, secondly, there was a very conservative investment climate among Danish private investors, which were quite averse to the type of risk-taking that an investment in UR would have entailed. This is where the Growth Fund stepped in and invested 7.65 million DKK in UR, while Syddansk Innovation agreed to invest another 1.9 million DKK. These capital injections effectively saved UR from bankruptcy according Esben Østergaard, one of the entrepreneurs who founded UR. Funding was, however, not the only important asset that the Fund injected into UR. The founders of UR all had a background in the robotics research environment at SDU, but none of them had extensive experience in how to successfully run a company. The Growth Fund, therefore, insisted that UR had to hire a new CEO with extensive business management experience, which led to the hiring of Enrico Krogh Iversen, who was qualified to fill the position. Iversen saw that UR’s robotic arm had great potential, but that the company’s business strategy had to be changed if it was to maximize its commercial potential. Previously, UR had not only developed and sold their robotic arm, but had also spent a considerable amount of its resources on providing technical consultancy to its customers in order to ensure that their products worked according to the specific needs of each customer. Iversen realized that this put limits on the scalability and growth-potential of UR. He therefore decided that UR should focus solely on providing a standard robotic arm, while aggressively increasing its sales avenues via a network of global third-party distributors, who would take over the tasks of sales and technical consultancy, thereby allowing UR to increase its sales rate much more

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65 Ibid.
70 Interviews with med Esben Østergaard, co-founder of Universal Robots A/S, and Clas Nylandsted Andersen, former chairman of the board at Universal Robotics A/S.
rapidly.\textsuperscript{72} Iversen’s strategy proved to be correct, as UR’s annual turnover increased manifold in the coming years from 1.575 million DKK in 2008 to over 403 million DKK in 2015\textsuperscript{73}, when the company was acquired by Teradyne. It can therefore be concluded that the Danish Growth Fund – in a very tangible and direct manner - played a crucial role in the development of the Danish robotics cluster because UR - without which there would be no robotics business-cluster of international renown in Denmark - would have gone bankrupt instead of becoming the world market leader within the field of collaborative robotics. The Growth Fund thereby exemplifies an instance, where the Danish state on a national level of policy making acted as an agent of innovation and risk, as it acted like a venture fund and invested directly into a company, thereby assuming all the financial risks that such an investment encompasses – a risk that private investors at that time were not willing to take. Furthermore, its insistence on the hiring of a new CEO significantly influenced UR’s subsequent business strategy, which has played an important role in making UR’s rapid growth rates possible.

Two other policy initiatives must be covered to show the full spectrum governmental policy-making on the national level. Both initiatives were directly inspired by EU policies on the international level of governmental action, which suggests that EU policies often set out political agendas that subsequently influenced the policy-making on the national stage\textsuperscript{74}. The first example is the initiative taken by the Danish government in 2006 to create the so-called Globalization Strategy, which was developed with the aim of creating world-class education, innovative research and increasing the number of Danish entrepreneurs with purpose of strengthening Danish competitiveness and societal cohesion in an increasingly globalized world\textsuperscript{75}. This policy agenda entailed the establishment of the so-called Globalization Fund that was entrusted with a massive 43 billion DKK endowment, which it proceeded to distribute for various causes and initiatives within the fields of Research, Education and Innovation during the period from 2007 to 2012\textsuperscript{76}. This entailed a massive influx of funds into R&D, which has created favourable conditions for the development of the R&D and innovation-oriented robotics industry on Funen during that time.

The other initiative is the creation of a national cluster strategy in Denmark in 2013, which generally aimed at coordinating the many national- and local activities within the field of cluster related policy-making. The three main initiatives in the strategy were 1) the creation of a cluster-forum for coordinating cluster policies and activities in Denmark; 2) the implementation of activities aimed at improving and professionalizing Danish cluster organizations; and 3) an effort to strengthen the international activities of Danish clusters.\textsuperscript{77} The goal of establishing a cluster-forum subsequently also resulted in the establishment of Cluster Excellence Denmark,

\textsuperscript{72} This section draws on: Steno, Carsten: A Cluster of Success, p. 45-48.
\textsuperscript{73} Calculations by Julian Lamberty on the basis of data from Danish Central Business Register: www.cvr.dk.
\textsuperscript{74} The connection between national policies presented here and the EU policies will be covered in the section covering the EU level of governmental action.
which is a publicly funded national organization tasked with supporting the development of Danish cluster organizations, so that these may in turn become better service providers for their members. This cluster strategy was again updated in for the period 2016-18, which did not alter the strategy significantly, but heightened the level of ambition by striving to ensure that Denmark possessed a group of business clusters firmly located in the international elite. The expansion and increasing coordination of the Danish national cluster-policies in recent years demonstrates that the concept of the business cluster is becoming an increasingly more important part of Danish industrial policy and has therefore undoubtedly affected the development of the Danish robotics cluster by facilitating the development of its formal cluster organization, Odense Robotics. Furthermore, the formation of a national cluster strategy lends itself to the interpretation that it was not only created in response to EU policies in this field, but that it also represents the natural continuation of a Danish cluster policy that reaches back to the beginning of the 2000’s, when the Danish government launched its first attempts at identifying business (competence) clusters in the Danish private sector. Like most of the policy initiatives on the national level, the Globalization Strategy and the national cluster strategy put the Danish State in a role of framing and facilitating agent in relation to the development of the Danish robotics cluster, as these types of policies generally have a wider aim than specifically supporting the Danish robotics cluster. This shows that the Danish robotics cluster is not the result of a specific political choice on the national level, in other words the cluster is not the result of politicians “picking the winner”, but rather a case where a specific industrial sector, i.e. the robotics sectors, has made use of the favourable conditions given by both the market and public policies in order to establish a successful business cluster. Nevertheless, the case of the Growth Fund shows, that the state has in some instances also acted as an agent of innovation and risk that, in the case of UR, was of vital importance.

The European Level

But what about the level of EU policies? Are there any links between EU policies and the development of the Danish robotics cluster? The answer to this question must be an unequivocal yes, although EU policies – perhaps unsurprisingly – typically have had a more indirect effect on the development of the Danish robotics cluster by setting out frameworks and regulations that have had an important influence the direction of this development. The first important development on the European policy level occurred in the beginning of the 1980’s when the EC began to take a more focused and comprehensive approach to its research and development policy by instituting the first Framework Programme for Research and Technological Development (FP1), which ran from 1984-87, and the European Strategic Programme on Research in

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Information Technology (ESPRIT), which ran from 1984-1988. The general purpose of the broader FP1 was to coordinate hitherto scattered research and development projects under the EC mantle in order to foster a more comprehensive EC policy on research and technology development, while ESPRIT was more narrowly focused on furthering research in the field of information technology with the aim of strengthening both the cooperation among and the competitiveness of European companies in this sector of industry, because they were lacking behind their American and Japanese counterparts. In conjunction with European Regional Development Fund (ERDF), which had been established in 1975 with the aim of furthering regional development by investing in regional infrastructure and furthering business development, the FP1 and ESPRIT initiatives marked the beginning a more concerted effort on part of the EC to further research, innovation and competitiveness within both the business sector and the sector of higher education. Although some of the more detailed provisions of the programmes and policies have changed over the following decades, as will be shown in the following sections, the overall aim of these policies has not only stayed the same, but actually intensified and broadened in scope. The budgets of framework programmes for example have increased manifold from FP1, which had a budget of 3.3 billion Euros, to the latest FP8 (2014-2020) – known as Horizon 2020 – which has a budget of 80 billion Euros. In this connection it is interesting to note that OSS as early as 1984 participated in an ESPRIT research project that focused on robotic programming and the integration of robotics into production processes. This preceded OSS cooperation with OU and demonstrates that funding from the EU-level has had an impact on robotics research on Funen since it very beginnings. An attempt was also made to get funding from the EU for the AMROSE-project, but it was unsuccessful, and the project was instead financed with funds from the OU, OSS and various other sources at the national level.

Furthermore, the creation of the internal market of the European Union in 1992 – that secured the free movement of goods, services and people within the EU – created a larger open market, which increased the need for Danish businesses to specialize and innovate in order to stay competitive in the face of increased competition from other EU member states. The effects of this trend towards increased international competition can for example be traced on the national policy level, where – as covered in a previous section - Danish industrial policy began to focus on identifying and supporting specific Danish business-clusters in the beginning of the 2000’s. An important part of the reasoning behind this focus was that globalization and the creation of the Internal Market created larger markets, which in combination with an ever more rapid pace of

81 Ibid., pp. 78.
82 Ibid., pp. 83.
83 Ibid., pp. 76-77.
innovations in science and information technology put increased pressure on businesses to specialize in order to stay competitive. As countries and regions typically only developed competitive specialization within a limited number of fields, it was important to identify and nurture these specialized clusters in order to keep them competitive in the international market place. Thus, much broader policies on the EU level set up a framework which significantly influenced the course of Danish industrial policy.

Another broad initiative by the EU which had effects on the development of the robotics industry on Funen was the ratification of the Lisbon Strategy in 2000, which set out a development plan for the economy of the EU that centered around the objective of turning the EU into: “the most competitive and dynamic knowledge-based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion.” This plan entailed provisions for establishing of the European Research Area and for improving conditions for establishing and developing innovative business – especially SMEs. Therefore, the Lisbon Strategy marked an increased commitment by the EU to further innovation, research and business development within its member states. This was followed up a few years later with the so-called Barcelona targets, which among other provisions set forth a goal: “that overall spending on R&D and innovation in the Union should be increased with the aim of approaching 3% of GDP by 2010. Two-thirds of this new investment should come from the private sector.” While no funds coming directly from the EU were tied to this target, it nevertheless incentivized member states to increase their R&D spending in order to reach this goal. The so-called Danish Globalization Strategy of 2006 was in many ways a national policy that was formulated in direct response to this Barcelona target, as one of its central aims was to achieve these exact benchmarks. This is then another example of how more general EU policies created favourable funding conditions for the robotics sector on Funen, in this case not via direct capital injections, but by affecting the course of policies at the national level of governmental action.

While it is beyond the scope of this paper to provide a comprehensive overview of all the R&D projects conducted with participation from members of the Danish robotics cluster, a few examples will nevertheless be provided in the following section to demonstrate that EU funding has in fact directly contributed to the development of cluster. Two examples of projects funded by the ERDF are “Robots at Play – Joint Creative Growth” and “AutomationsBoost”. The first received 7.268.675 DKK in funding in the period 2008-2010 for a joint project between Robocluster, SDU and the Business College of Southern Denmark with the aim of furthering the development of a regional robotics festival. The latter received 7.497.574 DKK in the period 2015-2019 for a joint project between Væksthus Syddanmark, The Danish Institute of Technology, Sønderborg Væksthus, SDU and the private company Blue Ocean Robotics, which is aimed at creating growth in SMEs in the

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89 Erhvervsfremmestyrelsen: *Kompetenceklynger i dansk erhvervsliv*, pp. 15-38.
91 Ibid.
93 Regeringen: "Fremgang, fornyelse og tryghed", p. 10.
region of Southern Denmark by furthering the development of a number of automation products for subsequent commercialization in the market place\textsuperscript{95}. Of the 14 individual product development projects conducted under the AutomationsBoost mantle up to this point, 10 were conducted in collaboration with companies that are part of the Danish robotics cluster\textsuperscript{96}. These examples clearly demonstrate that companies in the Danish robotics cluster have not only benefited indirectly from the broad agenda-setting policies that the EU had been setting out over the past decades, but have also benefited more directly from EU policies in form of funding for a number of R&D projects.

Before this examination of EU’s role in the developmental history of the Danish robotics cluster is complete, one more area of policy-making has to be examined. That is the EU’s policy on business-clusters which was streamlined and intensified in the middle of the 2000’s with the establishment for the European Cluster Observatory (ECO) in 2006. The purpose of ECO was to provide: “a single access point for statistical information, analysis and mapping of clusters and cluster policy in Europe that is aimed at European, national, regional and local policy-makers as well as cluster managers and representatives of SME intermediaries.”\textsuperscript{97} The aim was to provide more information on European business clusters in order to give member states, regions and other interested parties the optimal opportunities for developing strategies to create world-class business clusters\textsuperscript{98}. The EU’s efforts in this policy area were further increased in 2009 with the launch of the European Cluster Excellence Initiative (ECEI), which set out: “to create a benchmarking methodology for cluster organisations to improve their internal management process and the way they offer services...”.\textsuperscript{99} The two objectives were handled by the European Secretariat for Cluster Analyses and the European Foundation for Cluster Excellence respectively\textsuperscript{100}. The part of the EU cluster policy that most directly influenced both the robotics cluster on Funen and the national Danish cluster strategy of 2013 was the ECEI’s cluster labelling system, which categorized all formal cluster organization into three categories – bronze, silver and gold - of ascending order in relation to how closely a cluster lived up to the ICEI’s benchmarks for best practice\textsuperscript{101}. This labelling system incorporated in the Danish national cluster strategies, which used it to specify a number of policy goals\textsuperscript{102}. On the local policy level, the ECEI’s labelling system has had an important influence on the organization and activities of Odense Robotics. According to the business manager of Odense Robotics, Mikkel

\textsuperscript{95} Erhvervsstyrelsen: “AutomationsBoost”. Web. 19.06.2018. URL: https://regionalt.erhvervsstyrelsen.dk/eu-automationsboost.
\textsuperscript{98} Ibid.
\textsuperscript{100} Ibid.
\textsuperscript{101} For detailed information on the benchmarking and labeling process of the ECEI go to the ESCA webpage: https://www.cluster-analysis.org/.
Christoffersen, the labelling system gave the organization incentives to work towards achieving a gold
certification, thereby in turn strengthening the internal organization and activities of Odense Robotics\textsuperscript{103}. Odense Robotics achieved the gold label of cluster excellence in May of 2017 by earning 94 points out of a
possible 100 points in the ECEI’s evaluation process, thereby exceeding the minimal requirement for gold label
certification of 80 points\textsuperscript{104} by a fair margin. That Odense Robotics managed to do this only 2.5 years after its
creation is a rare achievement according to a statement made by the director of Cluster Excellence Denmark,
Merete Daniel Nielsen, in 2017, which further serves to illustrate the concerted effort and resources that
Odense Robotics put into acquiring the gold label. The framing influence of the ECIE’s labelling system on the
development of the formal cluster organization of the robotics industry on Funen is therefore a very tangible
one. The EU’s policies on business clusters are therefore particularly well suited for demonstrating the
interconnectedness between the three levels of public policymaking. In this interplay the EU has first and
foremost acted as a facilitating and agenda setting organization. The EU’s aims to furthering research,
innovation, high-tech industry and the competitiveness of the business-sector have broadly speaking set the
agenda, which policy makers at the national level have then adapted to their perceived national needs.

Conclusions

All in all, it seems fair to conclude that public institutions have played a very important role in the development
of the Danish robotics cluster, and that an entrepreneurial success story such as the company Universal Robots
would not have been possible without these institutions and agents, just as it would certainly not have been
possible without the entrepreneurs and capitalists. It is also an important part of this story, that public actors in
several instances took risks that private actors and investors did not dare take, and that the different thinking
behind government programs has made it possible for such programs to fill an important role alongside the
capitalists in what has been described as “the Danish innovation system”\textsuperscript{105}.

It also stands out as a conclusion that public institutions have functioned both as facilitators as well as actual
agents of risk and innovation, although the first role stands out as the dominant trend. It also emerges as a
conclusion that there seems to be a pattern in which institutions at the EU level have acted mostly as the
framing and facilitating agents, while the national policy makers have functioned as intermediaries – though
they also retain the freedom to initiate their own agendas – and that public actors on the local level of policy
making have had the most direct connections to the business community, which is why they more often than
actors on the two other levels have acted as agents of innovation and risk. At least this seems to be the
overarching pattern in relation to the role that public institutions have played in the development of the Danish
robotics cluster. While this is, perhaps, not so surprising, it could be emphasized as an important finding that

\textsuperscript{103} Interview with Mikkel Christoffersen, business manager at Odense Robotics.

\textsuperscript{104} Odense Robotics: \textit{Fakta om klyngecertificering af Odense Robotics}. (Odense Robotics, May 2017). P. 4. URL:

\textsuperscript{105} Per Boje: “The Danish Innovation System”.
there are in fact many connections between the layers, and that these connections more than anything are connected by a certain zeitgeist – the idea of public institutions taking responsibility for the competitiveness of private companies, an idea that seems to have blossomed very strongly in the period of neoliberalism from the 1980s to the 2000s. In other words, this is not a case of “picking the winner”, but rather of public institutions working for the creation of favorable conditions for private actors and entrepreneurs, whose activities and successes are not sought out or directed from above. Thus, perhaps more than anything this study shows how politics, culture, and business are intertwined and that the development of capitalist systems and of companies and their interactions with public institutions is very much influenced and guided by the “capitalist spirit” of that specific period.