The Future of the Aerospace Industry in Southern Germany 2020

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Introduction

The aim of this paper is to explore the aerospace industry in Southern Germany. To do so, industry members serve as experts to evaluate potential developments in the industry in a structured survey. With the help of the survey, the paper seeks to understand what the most important expected developments are in the aerospace industry of Southern Germany until 2020. To successfully answer this question, experts are required to provide quantitative evaluations as well as qualitative reasoning. The importance of developments is judged by two measures: the probability of a development happening and the impact it would have on the industry. Qualitative information is used to understand the reality behind numbers and clear the picture in case of inconsistencies.

Understanding how the potential future of an industry looks like enables stakeholders to take appropriate actions. Companies can change the way they operate, make sure they develop the necessary capabilities to adapt to changes in the environment, and keep earning shareholders the returns they require. Governmental institutions know what and how to regulate, and where desirable results will be brought along by market forces.

Aerospace Industry Overview

Aerospace Industry in Germany

In 2012, the European aerospace industry recorded revenues of 127.5 billion EUR and employed 498 000 people. Both numbers have experienced modest growth in recent years, supported mostly by positive developments in the field of civil aviation. The aerospace industry forms 0.65% of European GDP. (ASD, 2013, pp. 2-3)

The European aerospace industry is rather concentrated, with France, the UK, and Germany producing about 80% of total output (sizes of industries ranking as listed). Germany was prohibited
from producing aircraft after World War II and the aerospace industry gained momentum only in 1970s (Ecorys, 2009, p. 111). Since then however, German companies have made strong progress and are today at the top of this high-tech industry. The turnover of German aerospace industry increased from about 8 billion EUR in 1995 to 23 billion EUR by 2009 (Vogl, 2011, ch. Aerospace in Germany).

In 2009, 93,000 people were employed in the German aerospace industry, split into 70% in civil aviation, 23% in defence and security and the rest in space and general administration. As typical around the world, the industry employs a high proportion of university graduates (roughly 50%). The aerospace industry provides them with an attractive environment and a good opportunity to contribute to German competitiveness. This is supported by Germany’s dual education system, strong co-operation with universities and the positive image of Germany’s labour market abroad. (Vogl, 2011, ch. Aerospace in Germany)

Although employment has risen recently and this has led to decreases in productivity, these changes can be attributed to delays and technical problems in Airbus programs (A380, A350, etc.). It may, therefore, be described as an investment into future rather than inefficiency, although the pressure on financial performance obviously remains the same. (Ecorys, 2009, p. 112)

Participants in the German aerospace industry can be divided into four groups, just as on global level, with OEMs (Airbus, Eurocopter) at the top, followed by Tiers 1, 2, and 3. Many of the players (especially in lower tiers) are actually subsidiaries of automotive companies or groups that deliver to both or a number of different industries. (Ecorys, 2009, p. 114)

The German aerospace industry consists of string clusters that are often well connected to governments of German states. There are six more significant clusters: four in the Northern parts of the country (around Hamburg, Bremen, Berlin and in Saxony), and two in Southern Germany: in Bavaria and Baden-Württemberg (Ecorys, 2009, pp. 117-119). This paper focuses on the latter two.

**Aerospace Industry in Southern Germany**

There are two clear clusters of aerospace industry in Southern Germany, in Bavaria around Munich, and in Baden-Württemberg around Stuttgart. In addition to regional co-operation there are obviously strong links also to enterprises in other parts of Germany as well as the smaller but strong aerospace clusters in Switzerland (particularly around Zürich and St. Gallen) and Austria.

Bavaria is the powerhouse of German economy and home the larger of the two clusters. Around 550 companies active in the aerospace sector generate about 7 billion EUR in revenues with more than 60,000 employees. The region is home to OEMs such as EADS Defence and Security,
Eurocopter and MTU aero engines, Tier 1 suppliers Diehl Aerospace, Liebherr and Premium Aerotec have set up some of their main business sites up in Bavaria. However, the majority of aerospace companies are small, sometimes family-owned businesses, being at the top of competency in a particular area and having a limited number of products. (Niggl, 2012, ch. Strong Industry – Strong Companies)

The cluster in Bavaria is well connected to research and educational institutions, such as the Technical University of Munich, Max-Planck Institutes for Astrophysics and for Extra-terrestrial Physics, or European Southern Observatory. International airports in Munich (the 2nd largest in Germany) and Nuremberg provide easy access. The cluster is organised into an organisation called bavAIRia. bavAIRia fosters intra-cluster co-operation, networking, technology development and innovation and participates in international events and projects. (Niggl, 2012, ch. Strong Networks – Strong Clusters)

Aerospace industry in Baden-Württemberg is smaller, and the region perhaps better known for automobile engineering. The cluster’s more than 200 companies generated sales of almost 4.5 billion EUR in 2009 and employed over 14,000 people. The region is particularly strong in space industry, with Astrium, an OEM, and half the jobs of German space industry located in Baden-Württemberg. (Vogl, 2011, ch. Aerospace in Baden-Württemberg)

In addition to hosting large companies, e.g. Zollern, Liebherr, Diehl Defence, most of the aerospace industry players in Baden-Württemberg are, just as in Bavaria, small highly specialised high-tech companies (Vogl, 2011, ch. Enterprises in Aerospace). They produce top-class products but may often lack capabilities for substantial system-management competencies (Ecorys, 2009, p.121). The aerospace industry in Baden-Württemberg is represented by Forum Luft- und Raumfahrt Baden-Württemberg (LRBW) that aims at promoting inter-organisational co-operation, improve the sector’s competitiveness and foster international links. Aerospace companies in the region participate also in other industry networks, e.g. Bodensee area, a cluster initiative around Lake Constance.

Industry Analysis

In order to understand the intricate details of the developments in the aerospace industry in Southern Germany and to enable the reader to grasp the need for the particular issues included in the Delphi study, this paper combines a macroeconomic PEST analysis with the effects it has on the industry on a microeconomic level. The issues that will be studied later on are highlighted in the text.
PEST Analysis

Political Factors
Historically, the aerospace industry has been under heavy political influence. However, the developments over the past couple of decades have led to considerable deregulation and have given the industry the chance to reorganise closer to pure business principles. Nevertheless, political and strategic issues still matter: e.g. the industry witnesses a near duopoly with Airbus and Boeing.

Although the industry enjoys the benefits of free trade between the US and EU (as indicated by some of the study participants in interviews), it is still importantly influenced by differences in regulation. With the aerospace industry being a very heavily regulated one, due to general public's safety as well as global security concerns, the misaligned regulation costs the industry a lot. There has been some discussion over whether the American and European regulators (FAA and EASA, correspondingly) are able and willing to harmonise their regulations and when that may happen. The significance of this harmonisation lies in the fact that the EU and US are the largest producers in the aerospace industry.

Economic Factors
While the aerospace industry is the strongest in Europe and USA, the rest of the world is catching up fast and growth rates there surpass those in developed markets (ASD, 2013, pp. 7-8). With growth, these markets are gaining expertise and capabilities to produce supplies accepted by customers in developed markets. For German producers, this trend of sourcing more from outside EU is further supported by the relatively high costs they are facing at home markets.

Similarly, the growing aerospace sectors in developing countries consume more of the high-quality products produced in the West. Given the differences in growth rates, it is probable that also the share of non-EU, non-US customers will grow for German suppliers. This trend should be further reinforced by the high population growth rates in many of these countries, especially in comparison to the contracting Europe.

Social Factors
As pointed out above, the population of Europe is aging and contracting. The general reduction in labour force combined with social trends that have depopularised scientific or engineering-related careers causes a lack of qualified engineers for the German (but also more widely European) aerospace suppliers.

While the demand for these engineers stays relatively constant, the reduction in supply requires a correction in price. Therefore, it is highly probable that the costs to hire qualified and able engineers will grow. Given the importance of qualified labour for a high-tech industry like aerospace the cost increase may be very significant.
Technological Factors
As described above, aerospace industry is very technologically advanced. This causes even small advances in technology to require large investment in research and development. Adding the complexity of systems and the (sometimes politically motivated) heavy burden of regulation means that the cost of development and certification of new components may grow significantly.

Although the advances in technology may enable companies further down the supply chain save considerable amounts of money, the effort and investment needed to achieve these benefits is not necessarily economically viable.

It is also unclear if there exists sufficient motivation to improve technologically throughout the supply chain in order to deliver aerospace products that emit significantly less ecologically harmful substances.

Advances in computing technology have led to software components being part of a growing number of products. At the same time, the increasing complexity of systems requires increasingly complicated software and extensive testing. With computers taking progressively more responsibility over aerospace systems, the software costs for aerospace suppliers may be on the rise.

Microeconomic Effects
Increasing costs in an industry that by and large faces oligopsonistic market put companies in a tough place. As described above, the tendencies in labour market put upward pressure on labour costs, increasing complexity forces R&D and software costs to grow, and harmonisation problems in regulation lead to high costs of certification. All this puts pressure on the financial results of aerospace suppliers, meaning that the average profit margins may be expected to shrink.

There are a number of ways how companies can fight shrinking profit margins in the conditions described above. In order to benefit from the distribution of fixed costs, one option is to increase order sizes. This would enable the companies to reduce unit costs and, therefore, still earn shareholders sufficient returns.

Secondly, heavy pressure on profit margins may induce consolidation. Companies that are able to survive the new reality will be able to reorganise existing assets in more efficient ways, and undoubtedly some of these assets would come from legal entities previously not under their control. So, there exists an expectation of seeing more mergers and acquisitions.

Finally, as a very industry-specific issue, the OEMs are trying to shift responsibilities of complete modules to Tier 1 suppliers, Tier 2 suppliers are, consequently, expected to take over some of the responsibilities of Tier 1 suppliers, etc. This means more serious
responsibility and more co-ordination down the supply chain – something that the predominantly small companies in the industry are not necessarily prepared for. (Bucher, 2014, slides 3-5)

In order to acquire the necessary competencies and be able to handle the increasing risks, the companies in the industry may be expected to form significantly more partnerships and joint ventures. This would enable the scattered shareholding pattern to remain, while risks (and returns) would be shared in a manner acceptable to all.

Surely, many of the macroeconomic and most of the microeconomic issues are closely intertwined. While it is reasonable to expect that this will result also in correlated results in the estimates of their probability of realisation, the methodology used looks at the issues one by one, not considering the possible effects they may have on each other.

Based on the issues identified above, thirteen projections about the future were used in this study:

1) In 2020, the development and certification of new components is 30% more expensive than today.
2) In 2020, all companies in the aerospace industry have access to enough qualified engineers.
3) In 2020, the average profit margins are 40% lower than today.
4) In 2020, the share of non-EU, non-US customers is double that of today.
5) In 2020, labour costs are 30% above today’s level.
6) In 2020, the average number of partnerships and joint ventures per supplier is double that of today.
7) In 2020, the FAA and EASA have harmonised regulations for aerospace products.
8) In 2020, the average order size will be 50% bigger than today.
9) In 2020, the share of supplies originating from outside EU will be double that of today.
10) In 2020, Tier 1 suppliers, rather than OEMs, will be fully responsible for complete modules they produce. Similarly, Tier 2 suppliers will take over some of the responsibilities of Tier 1, etc.
11) In 2020, the number of aerospace suppliers in Southern Germany is by a third lower than today, due to high mergers and acquisitions activity.
12) In 2020, aerospace products will emit 20% less ecologically harmful substances, thanks to increased focus on ecological impact throughout the supply chain.
13) In 2020, the share of software costs out of total costs is double that of today.

Methodology

In order to best identify which trends play the most important role and what are the possible impacts the paper uses Delphi study method.
In the survey, experts see projections one by one, in scattered order, and respond to two quantitative and one qualitative question about each of the statements. They first evaluate the probability that the statement will be true in the future by choosing a probability estimate between 0% and 100%. Secondly, they estimate the impact of the projection on the industry on a 1 to 5 Likert scale.

Finally, the experts are asked to provide arguments for or against the projection becoming true, i.e. supporting their evaluations. This is done anonymously, but experts are able to see each other’s ideas after they have provided theirs.

In the second stage of the survey the experts see where their answers lie in comparison to that of the other respondents and they are given a chance to change their evaluations and/or arguments. Finally, the experts were invited to review their answers for the third at a later time, as the survey is dependent on other participants and the earlier participants may not have seen the full scale of arguments or the quantitative evaluations may have changed over the course of the survey.

The results of the survey are discussed in the latter chapters of this paper. However, for that it is important to understand the meaning and significance of the two quantitative figures.

Probability (expected value of the probability estimate) is used to estimate the expectations of the participating experts. While a very strong indication of e.g. 10% or 90% would show a virtual agreement within the industry, a result nearer to 50% may conceal different distributions of probability estimations. That is why this paper reports also the distributions of expert estimations and the degree of consensus (distance between the first and fourth quartile of probability estimations) among the participants. For projections where no clear consensus emerges it is important to consider the arguments each side provided and derive conclusions for the industry or individual companies.

The measure of impact (reported as the average of impact estimations) is used to understand to what extent the projections are relevant for the future of the industry. A projection with low probability may still require actions or plans by the industry players if its impact is potentially large. Projections with both high probability and high impact are obviously the most relevant ones for determining how the future looks like and what companies in the industry should do in order to best adapt to the future.
Results

Data Description

23 experts answered the survey with 13 projections about the future of the aerospace industry in Southern Germany. All participants were industry specialists. Responses were collected during a five-week period in April-May 2014.

Table 1 below depicts the results of the survey by reporting the probability, impact and consensus on the probability estimate on each of the projections.

The average probability of all projections was 58.0%. The average consensus estimate was 32.7, indicating “Strong Dissent”. The average impact estimate was 3.6, showing a clear relevance of the projections for the industry.

All projections but one were evaluated as having high or very high impact on the industry (meaning the impact estimate for each of them is higher than 3.0). The only projection believed to have medium impact is “In 2020, the FAA and EASA have harmonised regulations for aerospace products”. It is worth noting, though, that the impact estimate for this projection is at the upper limit of “Medium”, being at 3.0.

The projection with the highest estimated impact “In 2020, all companies in the aerospace industry have access to enough qualified engineers” scored an impressive 4.5, indicating that this must be the most pressing issue for companies in the aerospace cluster.

Eleven out of the thirteen projections were considered to be likely, with expected probabilities surpassing 50%. Projection “In 2020, the average profit margins are 40% lower than today” scored a probability estimate of 47.8% and with a very strong dissent measure requires specific analysis (see the corresponding section below). It is worth noting, however, that the projection with the lowest probability estimate – “In 2020, all companies in the aerospace industry have access to enough qualified engineers” at 36.0% probability – is slightly different from the rest as its wording is the opposite of the developments in the German economy. So, the “Unlikely” evaluation there was expected. Further discussion of this projection follows in the corresponding section below.

Two projections’ probabilities scored a consensus estimate that can be described as consensus and the remaining ones reflect dissent among respondents. While most of the statements were evaluated depicting moderate or strong dissent, there are two that stand out with a consensus estimate described as “Very Strong Dissent”. Both of these projections also have the probability estimates among three closest ones to 50%, so a detailed analysis of arguments of each side can be found in the corresponding sections below.
<table>
<thead>
<tr>
<th>No.</th>
<th>Projection</th>
<th>Probability</th>
<th>Consensus</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>In 2020, the development and certification of new components is 30% more expensive than today.</td>
<td>53.2%</td>
<td>Likely Very Strong Dissent</td>
<td>Very High</td>
</tr>
<tr>
<td>2</td>
<td>In 2020, all companies in the aerospace industry have access to enough qualified engineers.</td>
<td>36.0%</td>
<td>Unlikely Moderate Consensus</td>
<td>Very High</td>
</tr>
<tr>
<td>3</td>
<td>In 2020, the average profit margins are 40% lower than today.</td>
<td>47.8%</td>
<td>Unlikely Very Strong Dissent</td>
<td>High</td>
</tr>
<tr>
<td>4</td>
<td>In 2020, the share of non-EU, non-US customers is double that of today.</td>
<td>65.0%</td>
<td>Likely Strong Dissent</td>
<td>High</td>
</tr>
<tr>
<td>5</td>
<td>In 2020, labour costs are 30% above today’s level.</td>
<td>61.8%</td>
<td>Likely Strong Dissent</td>
<td>High</td>
</tr>
<tr>
<td>6</td>
<td>In 2020, the average number of partnerships and joint ventures per supplier is double that of today.</td>
<td>75.0%</td>
<td>Likely Moderate Dissent</td>
<td>High</td>
</tr>
<tr>
<td>7</td>
<td>In 2020, the FAA and EASA have harmonised regulations for aerospace products.</td>
<td>55.1%</td>
<td>Likely Strong Dissent</td>
<td>Medium</td>
</tr>
<tr>
<td>8</td>
<td>In 2020, the average order size will be 50% bigger than today.</td>
<td>55.8%</td>
<td>Likely Moderate Dissent</td>
<td>High</td>
</tr>
<tr>
<td>9</td>
<td>In 2020, the share of supplies originating from outside EU will be double that of today.</td>
<td>69.1%</td>
<td>Likely Moderate Consensus</td>
<td>High</td>
</tr>
<tr>
<td>10</td>
<td>In 2020, Tier 1 suppliers, rather than OEMs, will be fully responsible for complete modules they produce. Similarly, Tier 2 suppliers will take over some of the responsibilities of Tier 1, etc.</td>
<td>72.5%</td>
<td>Likely Strong Dissent</td>
<td>Very High</td>
</tr>
<tr>
<td>11</td>
<td>In 2020, the number of aerospace suppliers in Southern Germany is by a third lower than today, due to high mergers and acquisitions activity.</td>
<td>51.6%</td>
<td>Likely Strong Dissent</td>
<td>High</td>
</tr>
<tr>
<td>12</td>
<td>In 2020, aerospace products will emit 20% less ecologically harmful substances, thanks to increased focus on ecological impact throughout the supply chain.</td>
<td>57.3%</td>
<td>Likely Strong Dissent</td>
<td>High</td>
</tr>
<tr>
<td>13</td>
<td>In 2020, the share of software costs out of total costs is double that of today.</td>
<td>54.0%</td>
<td>Likely Strong Dissent</td>
<td>High</td>
</tr>
</tbody>
</table>

Table 1. Overview of survey results.

1 Probability higher than 50% is described as “Likely”, lower than 50% as “Unlikely”.
2 Consensus is described as follows: estimate at least 40% as “Very Strong Dissent”, estimate below 40% but at least 30% as “Strong Dissent”, estimate below 30% but at least 25% as “Moderate Dissent”, estimate below 25% but at least 20% as “Moderate Consensus”, estimate below 20% as “Strong Consensus”.
3 Impact estimate higher than 4.0 is described as “Very High”, higher than 3.0 as “High”, otherwise “Medium”. Please note that due to rounding some values at limits may look counter-intuitive.
Analysis of Individual Projections

Projection 1: Development and Certification Costs
Respondents argued against a 30% increase in development and certification costs by noting that there are significant opportunities to reduce costs by optimising processes, by creating larger companies that would result in steeper in-house learning curves, by increased automation, and by cutting the development process shorter and reducing the amount of tests by using analysis instead. Additionally, it was pointed out that customers are not willing to accept higher prices and that puts increasing pressure on cost reduction.

The proponents of the increased costs communicated the worries about increases in certification costs as opposed to development costs, especially due to higher requirements resulting from increased traffic and systems complexity. Some respondents discussed the increase in development costs related to the introduction of new materials that would help the industry reach new levels of efficiency but would be expensive.

Overall, it looks like there is strong intrinsic pressure for cost increases due to the increasing complexity and high level of technological development of the industry, but this is counterbalanced by the pressure from customers to not pay more. All this put the aerospace industry in a very uncomfortable position and forces them to seek additional internal capacities for improvement.

Projection 2: Access to Labour
In their comments, experts said that it is already difficult to find qualified engineers. Automotive and other sectors are more appealing to many engineers and they can also find better-paying jobs in sectors other than aerospace. At the same time aerospace requires very high qualifications and although generally engineers may be available, there will be a lack of really qualified ones. In addition, demographics and low popularity of engineering play their roles. The experts also outlined too weak co-operation with universities and research institutions. Finally, the introduction of foreign engineers was also qualified as a tough challenge due to the very conservative views held by local population in Southern Germany.

As the only reason for why the problem may not be as acute, it was said that the aerospace industry is an attractive employer for young engineers.

All in all, the problem of not having enough qualified engineers probably tops the list of problems for the aerospace cluster in Southern Germany by 2020 and its impact on the industry is considerable. Given the slow nature of changes in education and time required, it is very important that companies prepare themselves for changes.
Projection 3: Lower Profit Margins
The supporters of lower profit margins outline the static behaviour of the industry that does not allow to react to market changes fast enough. Increases in costs may be higher than those in prices, especially if OEMs and higher tier suppliers will be able to successfully push the costs down the supply chain.

On the other hand, the opponents of profit margin reduction say that the decrease will not be as large, since the margins are already very low and shareholders would not tolerate such a big decrease. They also think that there are sufficient opportunities to reduce costs and improve efficiency. Additionally, consolidation and/or specialisation in the industry might allow for higher prices to be charged.

Overall, there seem to be mixed feelings about the developments in profit margins. It is clear, however, that there exists pressure on margins and unless the industry is able to deal with them (e.g. through consolidation or process optimisation), the direction of changes is clear. The burden is on the industry members.

Projection 4: Foreign Customers
All the arguments provided by the respondents favoured the increasing shares of third countries among their customers. It was emphasized that countries such as China, Japan and India spend much more on aerospace technologies than the participants’ current markets, whose space budgets remain at best stable or even shrink. The experts also brought out the fact that the economies of developing countries grow much faster than those of EU and US. Finally, some respondents also underlined the importance of diversification.

Overall, it seems that there is a clear expectation that the share of non-EU, non-US customers will increase considerably. While the impact of this change is not estimated to be among the absolute top, it is still high and it is, therefore, necessary for the industry to cope with the change pattern.

Projection 5: Labour Costs
Respondents suggesting that the scenario may become true mostly argue that the lack of qualified labour is the main reason for increases in labour costs. Additionally, they think that such a development would take place across Europe.

The opponents of this projection rely on the conservative expectation that wage growth in Germany will not exceed 1-3% per annum and that there will be no additional pressure on wages apart from regular inflation.

It appears that there is moderate expectation that there will be considerable wage growth in the industry. However, it is unclear if it will be as high as projected, or remain lower, perhaps at the level
of standard background inflation. The importance of this question is, however, high for the companies and the development also depend on the changes in the availability of qualified labour (see projection 2).

**Projection 6: Partnerships and Joint Ventures**
All the arguments provided for this projection favour the increase in the number of partnerships and joint ventures. The respondents pointed out that this may be, if not just an opportunity to share risks, the only way for Tier 2 and Tier 3 suppliers to survive. It was also said that the increasing need to export and general systems thinking will force market participants to co-operate. Finally, partnerships and co-operation were said to yield better market opportunities than “kill the opponent” attitude.

There exists a clear expectation that more and more companies will get involved in more partnerships and joint ventures. It is therefore mandatory for successful players to create organisations and develop capabilities that are able to successfully participate in and benefit from more inter-company co-operation.

**Projection 7: Regulatory Harmonisation**
The supporters of the idea that there will be more harmonisation point out that harmonisation helps to save on costs and enables the reuse of critically important safety systems. However, the opponents believe that there are too strong industrial and political interests involved and that such harmonisation will not be possible until 2020. They believe that the protectionist interests of both sides’ governments will prevail. Additionally, the general difficulty of predicting regulation is pointed out.

The author here agrees with those saying that regulation and government moves are very hard to predict. Combining this with a low “Likely” estimation of this projection and the relatively high consensus measure (indicating strong dissent), the future seems unclear indeed. Luckily, the companies do not believe that this is among the most important issues for them as the impact measure is relatively low.

**Projection 8: Order Sizes**
The supporters of the idea that orders will grow in size outline that this is a natural development given the existing tendency for concentration in the industry. It is also pointed out that this is the pressure that industry members feel coming from OEMs and that the industry has to adapt. Finally, it is pointed out that the existing cost pressures would favour higher order sizes.

On the other side, the view depends on the level you look at. This trend is said to be true for OEMs and Tier 1s, but not for lower level suppliers. It is also (rather controversially) said that given the tendency to supply complete modules rather than individual parts, the order sizes should shrink.
**Projection 9: Foreign Suppliers**
Costs are indicated as the main arguments for why companies will look for suppliers outside the EU. Some respondents outlined in particular the labour costs (that are expected to increase in Southern Germany, see projection 5). Additionally, it was pointed out that the aerospace industry is seeing strong development in the rest of the world and that technical standards are evolving around the world.

Respondents who did not believe in the realisation of this projection mainly argued that there will be an increase but not as large as stated.

In conclusion, the share of supplies originating outside the EU will increase sharply. Respondents displayed a moderate consensus in this issue and consequently, companies must make sure they are able to tap into this resource, or risk losing competitive advantage.

**Projection 10: Reorganisation of Responsibilities**
The respondents used a number of arguments to reason in support of the projection. Some said that this shift is already happening, others indicated that this is the way that OEMs want to move the industry in. Additionally it was pointed out that responsibility will be a consequence of moving activities down the supply chain, and of focusing on core competencies. Such a development would also allow for better oversight of costs and enable OEMs to reduce capital costs.

On the other side, respondents suggested that this projection will not come true so fast, it might rather be possible by 2030.

Overall, this projection has very high probability combined with very high impact. It is an important development for the industry, and the high impact measure means that even those who place relatively low probability on it coming true have to be prepared.

**Projection 11: Industry Consolidation**
The supporters of this trend mentioned the motivation to consolidate due to cost pressures. It was also pointed out that this is the strategy that OEMs are “forcing” upon industry players and that those who are not able to cope will be pushed out of business. Additionally, some said that this tendency exists, but it will have real effects later, e.g. until 2030.

On the other hand, the opposing arguments outlined the traditionally strong SMEs in the region that they do not see disappearing. The opponents also expected that there will always be plenty of niche business ideally suited for small and highly specialised companies.

All in all, it seems that no clear consensus exists in this question. The probability of this trend becoming reality is close to 50% and there is considerable dissent among respondents. Given that this development is still expected to have relatively high impact on the future of the industry, it
would be important for companies to be prepared, be it by keeping an eye on potential acquisition targets or remaining flexible enough to be able to merge organisations.

**Projection 12: Emission Reduction**

On one side, the respondents say that this development will be a co-result of seeking the most economic solutions. It is also underlined that regulation, both at the EU level and at national level will play its role.

On the opposing side, the respondents said that developments in the industry are driven by fuel efficiency because of cost reduction, and that ecological side of these questions is unimportant. Additionally, it was pointed out that in a growing market like aviation, there will be a gross increase in emissions and no technological or environmental pressures are able to counter this trend.

Overall, although somewhat likely, this projection also stirs considerable disagreement among experts. There is also a considerable element of regulation involved, so the future of this question may rather lie at the hands of the politicians.

**Projection 13: Software Costs**

The respondents in favour of this projection coming true pointed at two main reasons. Firstly, they indicated that more and more parts will have a software component. Secondly, the said that software is getting more and more complicated and is, therefore, requiring more resources to be written and tested.

On the other hand, experts said that any rise in software costs will not outpace the growth in general cost level, in particular labour costs (see projection 5). Additionally, advances in technology will make software relatively cheaper.

In conclusion, with a 54% probability it is not entirely clear to which direction the industry is moving. Arguments of both sides are relevant and the future can go either way. At the same time, the slightly positive probability estimate and still high impact measure suggest that companies need to keep their software issues under control.
Comparison of Projections

In order to understand which of the studied trends are the most important to consider for business managers and owners, it is helpful to compare them by plotting the probabilities against consensus and impact estimates.

![Probability - Consensus Plot](image)

Figure 1. Probability-consensus plot of all projections.

By plotting the expected probabilities against the consensus estimates of all the projections we can observe a couple of things. Firstly, Consensus measures are higher for projections whose expected probabilities are closer to 50%. There is obvious logic in that and we can conclude that, indeed, there is no industry-wide understanding on where the future of these projections lies. At the same time, the projections with more extreme expected probabilities have lower consensus estimates (i.e. there is stronger agreement among respondents) and we should expect clearer trends in the future.

More interestingly, it is important to prioritise projections, by plotting the expected probabilities against the impact measures of each projection. On Figure 2, we can differentiate between numbers of groups of projections. Managers need to consider projections that have high (or low, as opposed to those around 50%) expected probabilities as these describe what the future may look like. At the same time, the projections with high impact estimates are also important, since even if their probability of occurring is not very high (or very low), they would influence the business significantly. The most important developments, consequently, are those with both high (or low) expected probability and strong impact.
Among the latter group, there are four projections (marked with green in Figure 2):

- With high probability and high impact
  - Reorganisation of Responsibilities
  - Partnerships and Joint Ventures
  - Foreign Suppliers
- With clear low probability and high impact
  - Access to Labour

The projections about increasing share of foreign customers and growing labour costs are slightly less important with somewhat lower expected probabilities, but in principle similar.

There is another clear group of four projections with low (clearly below 3.5) impact and relatively low (under 60%) expected probability (marked with yellow). The remaining three projections (concerning development costs, profit margins and industry consolidation; marked with red) are interesting, however. They all have rather high impact but at the same time the expected probability is around 50%. From a managerial point of view they matter a lot, but there is no clear understanding of how the future will look like. The next section will provide a closer look at them.

Figure 2. Probability-impact plot of all projections.
Scenario Analysis
The previous section identified three projections that have high impact estimates but no clear consensus on probability:

- Projection 1: In 2020, the development and certification of new components is 30% more expensive than today.
- Projection 3: In 2020, the average profit margins are 40% lower than today.
- Projection 11: In 2020, the number of aerospace suppliers in Southern Germany is by a third lower than today, due to high mergers and acquisitions activity.

In order to understand how the potential future may look like and what that means for companies active in the industry, the projections will be coupled pairwise. Since Projection 3 is much closer related to the other two than the remaining ones to each other, this paper will consider two sets of scenarios: combining the possible developments in Projections 1 and 3 and in Projections 3 and 11.

Scenario Matrix 1: Development and Certification Costs vs Lower Profit Margins

![Scenario Matrix 1](image)

In Figure 3, the vertical axis displays the probability of Projection 1 coming true, with the occurrence at the top end and non-occurrence at the bottom. Similarly, the horizontal axis displays the probability of Projection 3 coming true, with the occurrence (i.e. lower margins) on the right, and non-occurrence on the left.

As it can be seen, analytical probabilities from the results of the Delphi study result in four rather equally probable scenarios. It is important to consider, however, that the design of the study
provides individual independent evaluations of scenarios, i.e. potential correlation is not considered. Knowing that, the probabilities in the matrix above are probably underestimated for Scenarios 2 (high development costs can cause lower profit margins) and 3 (lower costs enable higher margins), and overestimated for the other two scenarios.

In the case of Scenario 1 realising, companies would be facing higher development and certification costs, but would be able to maintain sufficient profitability. That would suggest willingness in the market to pay for new components, even though the development is burdensome and expensive. This would require companies to have enough resources available to invest into expensive developments in order to earn profit afterwards. It would also require extensive R&D expertise to be present in order to achieve innovations and probably foster the development of larger co-operation projects or bigger companies that are able to handle development projects alone.

Scenario 2 is a pessimistic scenario, where increasing development and certification costs would, among other pressures, reduce profit margins. The development and certification of new components would be increasingly difficult as companies lack financial resources. In such case, companies will have to be able to use existing components as long as possible and, if suitable, in new ways, with fewer modifications, requiring less investment into development. Limited capital availability and increasing costs of projects would require new types of co-operation between companies, be it shared research projects, joint ventures, or something else, and even higher levels of specialisation (trying to stay on top with a wide array of products would become prohibitively expensive).

Scenario 3 is the most optimistic one — high profit margins and affordable development and certification costs would enable companies to increase the pace of technological development of the industry. This would enable companies to explore the frontiers of their business by taking new risks. Investments and venture into relatively further from the core business would become possible and competition between suppliers would grow fiercer. If the labour market will be unfavourable as suggested by Projection 2, finding and keeping key people would become the determinant of winning or losing. Barriers for new entrants would lower and new capital would be easily available.

Scenario 4 suggests low development and certification costs and low profits. Companies would not have the resources to undertake massive development projects due to having trouble generating enough profit for investments. The R&D activity would decrease and weaker companies would be acquired or go bankrupt. Competitors might take endeavours in order to develop “blockbusters” — unique products that would enable the earning of above-average profits.
## Scenario Matrix 2: Industry Consolidation vs Lower Profit Margins

<table>
<thead>
<tr>
<th>Industry Consolidation</th>
<th>Lower Profit Margins</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td><strong>Scenario 1</strong></td>
<td><strong>Scenario 2</strong></td>
</tr>
<tr>
<td>27%</td>
<td>24,5%</td>
</tr>
<tr>
<td>&quot;Sellers gain power&quot;</td>
<td>&quot;No other option&quot;</td>
</tr>
<tr>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Scenario 3</strong></td>
<td><strong>Scenario 4</strong></td>
</tr>
<tr>
<td>25,5%</td>
<td>23%</td>
</tr>
<tr>
<td>&quot;Specialisation power&quot;</td>
<td>&quot;Unattractive business&quot;</td>
</tr>
</tbody>
</table>

### Figure 4. Scenario matrix 2.

The horizontal axis of Figure 4 describes the occurrence and non-occurrence of Projection 3 just as in the last section. The vertical axis describes developments in Projection 11 – the high end of the axis denotes the occurrence of increasing M&A activity, and the low end the non-occurrence.

Similarly to the first matrix, the Delphi study probability estimates result in four almost equal scenario probabilities. Once again, since the Delphi estimates are independent, it is possible that the probabilities in Figure 4 are underestimated for Scenarios 2 and 3 (low profits would cause increasing consolidation and vice versa), and, consequently, overestimated for Scenarios 1 and 4. However, this time the influence is not straightforward since consolidation would lead to higher market power and increasing profits. All four scenarios should still be considered equally.

**Scenario 1** depicts the situation where the industry would be able to maintain sufficient profit margins but would experience significant consolidation. For companies, and their shareholders in particular, it would be important to not keep excess cash on balance sheets and have measures at place against hostile takeovers, should they have a wish to maintain ownership. Or, alternatively, is they wish to exit business, they should make sure they exit at the right moment and for a fair price, given the favourable situation with profits.

**Scenario 2** describes the industry in trouble and consolidation as a solution. Low profits would mean too small units are unable to survive on their own and simple economic efficiency would force a wave of mergers and acquisitions. Companies with sufficient financial resources should be on lookout for easy targets in stress. Those heading for trouble should make sure they sell before the collapse is
imminent, in order to get fair price. Disruptions in supply may be expected due to economic hardship and reorganisation activities.

In the case of Scenario 3, the sufficient profits would enable small businesses to strive. Specialisation would enable to earn superior profits and forms of co-operation other than M&A (meaning supplier-customer relations, partnerships, joint ventures, etc.) would prevail. For companies it would be important to maintain their strategic focus and make sure they differentiate themselves from competitors. Investing profits would have to be undertaken carefully in order to keep earning high returns. Differentiation would be more important than diversification.

Finally, Scenario 4 draws a picture of an industry with low profit margins that no-one sees a good way out for. Resources would be scarce and life hard. New business models would have to be figured out in order to grow or survive. Attracting qualified labour would be complicated and capital owners should consider if this is the business they wish to be in. Reduction of fixed costs would be of high importance.

Implications and Suggestions for the Future

Four projections (2, 6, 9, and 10) were estimated to have the most significant impact on the industry. Two more (4 and 5) have relatively similar results. They all have expected probabilities above 60% and impact estimates of at least 3.7. For discussion of implications, projections 4 and 9 will be discussed together as both concern international co-operation. Similarly, projections 2 and 5 will be discussed together as both deal with labour market developments.

Partnerships and Joint Ventures

A significant increase in the number of partnerships and joint ventures per supplier is the most probable development in the aerospace industry of Southern Germany, estimated at 75%. Such a change in an industry so far characterised by a lot of small players, often family-owned, requires adaptation.

Firstly, in order to be able to successfully manage such co-operative relationships, companies need to acquire the capabilities for doing so. This may be complicated, in particular, for small specialised companies, given the limited number of employees, know-how outside their specialisation, and historically protective attitude towards in-house expertise.

In order to be able to manage alliances, partnerships, or joint ventures successfully, companies need to make sure that they understand the benefits of the relations, that the alliances are embedded in the organisation at the right level, that they get enough top management attention and support, and that they serve clear purposes.
Secondly, whether regionally or on a wider scale, the opportunities to work together on projects are not infinite. Consequently, companies need to constantly assess the landscape in order to identify suitable partners as early as possible. An understanding of different business models, motives of competitors as well as suppliers and customers is indispensable.

Depending on the depth of co-operation, partnerships may require significant time to start delivering positive results, and this gives advantage to early movers. At the same time, partner selection is still the key to creating mutually beneficial ventures, so the evaluation of potential partners is important. It is doubtful that the majority of small suppliers will be able to develop such capacities quickly enough, so industry-level solutions, e.g. through cluster organisations like LRBW or bavAIRia, may prove to be the most efficient solution.

Finally, companies need to make sure they understand the risks connected to partnering. Information flows and communication principles may have to be reviewed and changed. While partnerships and joint ventures will require sufficient information to succeed, companies need to understand where they want (or need) to draw the lines. In this respect, human resources management becomes as important as process management.

**Labour Market Developments**

The survey results indicate that there is only a 36% expected probability that companies in the aerospace industry of Southern Germany will have access to enough qualified engineers. At the same time, the labour costs are expected to grow significantly, with a nearly 62% expected probability. Although similar tendencies can be noticed across Europe and in many sectors, the high level of technology makes the aerospace industry particularly vulnerable.

In order to best counter these developments, companies in the industry need to prepare themselves for changes. For ensuring availability, co-operation with educational and research institutions is a viable solution. The German aerospace industry is already top-class in that, however, the results of the survey show that this is not expected to suffice for the future. The co-operation needs to be extended and intensified: internships, apprenticeships, scholarships, co-led projects, etc. are just a short list of possible opportunities.

Secondly, companies need to make sure they provide key employees with appropriate non-salary benefit packages. With the expected increase in salaries, this is, on one hand, an opportunity to keep costs under control; and, on the other, compete in the labour market and ensure the availability of suitable candidates. Essentially, this means finding ways how to turn labour supply more inelastic.

Thirdly, and especially in the light of emerging aerospace industry in developing countries, companies need to make continuous investments in technology. When labour is becoming more expensive,
some of it needs to be substituted by capital: more machinery, more sophisticated machinery, and unfortunately also more expensive machinery. Investments in technology and through that into labour productivity also lessen the burden of insufficient availability of labour.

Fourthly, companies need to find innovative ways of cutting labour costs. Especially in the light of the small size of the average player in Southern German aerospace industry, companies cannot expect to keep all competencies in-house. Clear plans need to be developed for prioritisation and options such as part-time work, or outsourcing should be considered for lowering the cost burden.

**Internationalisation of Suppliers and Customers**

The share of non-EU, non-US customers is expected to double by a 65% expected probability and the share of suppliers from outside EU by an even more impressive 69%. Significant internationalisation and globalisation is foreseen to happen, forcing companies in the relatively conservative Southern Germany to deal with challenges of widening the scope of their sales and purchases. This poses obvious challenges.

Firstly, companies must make sure their organisations, in particular those for sales and procurement, are adequate and will develop the necessary competencies. This includes establishing connections with suppliers and customers in further away markets, knowing the needs and peculiarities of the customers and opportunities of suppliers. Ability to build bridges between different business cultures is an obvious must.

The logistic solutions that companies use must adapt, too. With the potential increase in lead times (both in- and outwards), other qualities of orders may change: size may grow, product mix may differ, or variation increase. Companies need to make sure that their production, warehousing and logistic facilities are able to handle the new challenges. If necessary, changes will have to be implemented and the associated costs included in growth plans.

Increasing activities in further-away markets also increases risks. The mixture of risks can change, too. Country risk, counterparty risk, risks associated with changed mode of delivery etc. need to be realised and taken appropriate measures against. Costs on legal advisors or insurance may grow and need to be understood and accounted for.

Finally, with the high technological level of the aerospace industry problems concerning geopolitical situation, security issues, and industrial espionage need to be evaluated in the light of widening geographic scope of actions. Companies will have to make sure that the more risky ventures carry appropriate risk premiums and offer satisfactory returns.
Reorganisation of Responsibilities

The shift of responsibilities down the supply chain, with Tier 1 suppliers taking over some of the responsibilities of OEMs, Tier 2 some of those of Tier 1, etc. is evaluated to have an expected probability of 72.5% – the second highest expected probability in this study.

This change means that suppliers will have to increasingly develop capabilities to design and manufacture multi-level products (Bucher, 2014, slide 4) at the same time the suppliers must remain competitive in terms of cost, quality and reliability.

In order to achieve these goals, companies must streamline the flows of information, products, and services. This requires increasing co-operation with customers and suppliers, re-design of organisational structures and developing organisational capabilities that have not been necessary so far.

With considerable interest of the OEMs, suppliers should be able to draw on initiatives created by them to some extent. However, it is also important to be able to pool and share resources, by using alternative ways of co-operation (e.g. creating partnerships) or alternative arrangements with employees (part-time work). Companies need to become more flexible and more capable. A lot of this means investments in the “soft” skills of organisations and there is strong potential of co-operation with educational and research institutions, too.

Although significant changes are foreseen for all players in the industry, companies need to make sure that amidst these changes they maintain their strategic focus and competitive advantages. Difficulties can be expected to force some companies out of the market and others enter and grow. Times promise to be interesting for researchers.

Conclusion & Summary

Four most relevant trends, that industry members should not only keep an eye on but also actively prepare for, emerged. All of them recorded a high expected probability of becoming true as well as a high rating in terms of impact on the industry.

1. Experts expect the number of partnerships and joint ventures to grow significantly. The current setting of small, often family-owned enterprises is considered ill suitable for being able to handle the increasing functions that the industry requires from each of its members. It is, therefore, important for the companies to make sure they are capable of handling new types of relationships with customers, suppliers, and also competitors, and maintain their excellence in their core business at the same time.
2. The economic and demographic situation in Germany means difficulties in labour market. The experts expect that there will both be a lack of qualified engineers as well as an increase in labour costs. The companies need to mitigate risks arising from these developments, either by carrying out necessary investments or developing the human resource and remuneration policies so that they are able to remain competitive in the market.

3. Growth in emerging markets dictates larger shares for customers and suppliers originating from outside the traditional markets of German aerospace suppliers – EU and/or USA. This means great growth opportunities for companies in the industry but also requires making sure that they are able to tap into the new opportunities and build on the excellence they already possess.

4. An industry-wide shift of responsibilities, initiated by the OEMs is expected to happen, too. Lower tier suppliers will have to take over some of the responsibilities of OEMs and/or higher level suppliers. This means increased pressure on them for acquiring the right competencies in time as well as a lot more multidirectional communication within the industry.

Many other projections resulted in probabilities higher than 50% and all but one scored high impact estimates. Consequently, all the projections explored in this study are relevant for managers in the aerospace industry in Southern Germany and it is up to them to find ways how to adapt to the changing environment and make sure their shareholders are still earning sufficient returns. Hopefully, this paper serves as a good starting point.

Although the changes are significant and may prove to be too much for some players in the industry, the aerospace industry in Southern Germany is still very strong. It enjoys reputational excellence and is able to benefit from close links to the automotive industry in the region. Strong relations with research and educational institutions, as well as inter-regional co-operation with clusters in other parts of Germany, Switzerland, Austria, Netherlands etc. enable the industry to flourish also in the future.

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