



New growth opportunities for Germany's engineering sector

Technology leadership and outward investment

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Far from merely posing a challenge to German engineering firms, new global trends of the future also offer various additional opportunities for continued growth. Provided that these traditional suppliers to the manufacturing sector manage to spot the new mega-trends in good time, they will be able to build on these to develop promising strategies that enable them to adapt, survive and – ultimately – grow.

German engineering firms must prepare to confront several trends over the medium term. The first of these is that the world's engineering markets are undergoing a radical transformation. While growth in some traditionally fast-growing markets has temporarily almost ground to a halt, a new, bipolar world of engineering markets is emerging. The United States and (once again) China are set to become especially promising centres of growth going forward.

Further future trends are, secondly, the gradual shift in product focus towards customised system solutions; thirdly, the growing importance of not purely price-related competitive factors such as sustainability; and – more generally – fourthly, the reconfiguration of the global division of labour in the engineering sector as the classic distinction between producer countries focusing on standard machinery and others focusing on speciality equipment becomes increasingly untenable.

The ability to cultivate tried-and-tested strategies while responding flexibly to forward-looking trends is crucial to success. Because competition in the engineering sector continues to intensify owing to the growing internationalisation of supply and demand, machinery prices and sales margins remain under pressure. Intelligent cost management, imaginative sales strategies and customer-centred value-added services will therefore continue to top the agenda.

The trend towards Industry 4.0 presents a huge opportunity for the German engineering sector because it can capitalise on its superior automation expertise and special IT skills to further enhance its international competitiveness. This will, among other things, make the production of machinery in small volumes with numerous variants even more efficient in the increasingly interconnected engineering factory of the future. Robot solutions offering greater flexibility will be possible.

Internationalisation & technology leadership will spur growth. Foreign markets of the future will gain further importance as more than just key sales regions. The strategy of internationalisation also needs to be expanded, ideally through the construction of German production facilities and, consequently, the manufacture of German machinery in the countries concerned. Far from merely benefiting (German) customers in other industrial sectors, German engineering firms' innovation prowess also helps these entities themselves in their core machinery markets. The growing shortage of engineers in Germany is a cause for concern, not least because it is undermining Germany's specialisation strategy.



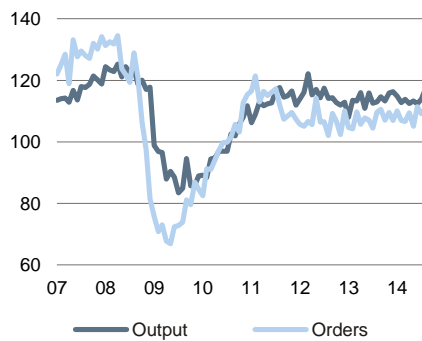
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Business activity in the engineering sector has recently been faltering

Output has remained more or less flat in recent years

1

Engineering in Germany, output and orders, real terms, seasonally adjusted, 2010 = 100

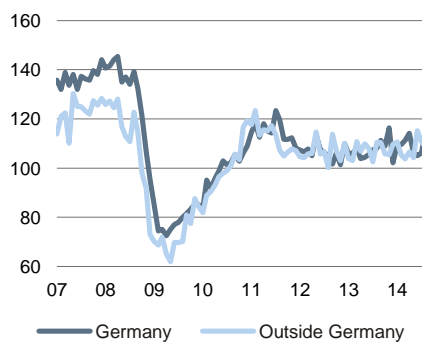


Source: German Federal Statistical Office

Orders present a mixed picture

2

Engineering in Germany, new orders received, real terms, seasonally adjusted, 2010 = 100

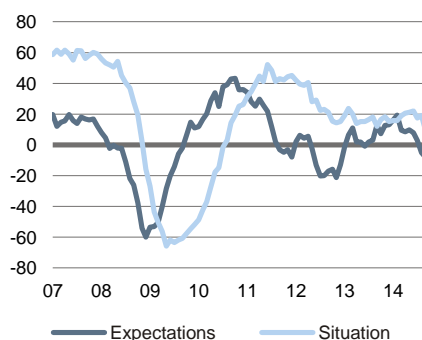


Source: German Federal Statistical Office

Expectations have recently dipped into negative territory

3

Engineering in Germany, balance of positive and negative company reports



Source: ifo Institute of Economic Research

The global financial and economic crisis, which escalated in 2008 and whose effects partially remain with us to this day, left its mark throughout German industry, including in one of its largest and most important sectors – engineering. This is hardly surprising when you consider that German engineering firms – albeit often in competition with foreign providers – supply the basic machinery and equipment needed for the production processes used in virtually all industrial and business segments. This is why their customer base includes sectors as diverse as the automotive industry, construction and agriculture. An additional factor is that a German engineering segment of more than purely historical significance – machine-tool engineering – often manufactures for other engineering segments as well and is therefore doubly affected by macroeconomic trends. Moreover, global trends have a disproportionate impact on engineering firms because they usually sell more than half of their machinery and equipment abroad. Consequently, this sector has a high export ratio of 62%.

It was therefore hardly surprising – merely a logical consequence of global, inter-industrial and intra-industrial relations – that the onset of the global crisis in 2008 immediately saw a dramatic fall in engineering orders in both domestic and international business. This caused German engineering output to plummet by a price-adjusted 26% in 2009. And despite the fact that production grew impressively in the following two years – by 11% in 2010 and 14% in 2011 – and subsequently remained flat, the previous output peak reached in 2008 will still not have been achieved by the end of 2014. The fairly upbeat growth forecasts issued at the beginning of 2014 had been discarded by the middle of the year in the wake of the Ukraine crisis and the associated decline in sales of German machinery and equipment in the key Russian market, which in 2013 had been the fourth-largest export market, accounting for 5.2% of exports. The stronger demand stimulus recently emanating from China and Western Europe is unlikely to be enough to enable production to do anything more than flatline in 2014.

This normalisation in the German engineering sector since the sharp decline witnessed at the end of the last decade might tempt some to draw the rash conclusion that if German engineering firms can overcome a global crisis that was virtually unprecedented in its severity, then there is no need to worry about the future of this industry. A certain amount of optimism is, indeed, warranted by several benign engineering trends, such as the number of people working in this sector, although these figures are dependent to some extent on the industry's manufacturing performance over time. This trend reveals that the employment situation in German engineering improved considerably in the years up to 2014. Headcount in this sector had topped the one-million mark by May 2014, thereby reaching a level last seen in 1993 (i.e. in the aftermath of German reunification). Even so, the intervening period of more than two decades witnessed stark readjustments on the back of diverse economic and structural trends.

However, we would caution against viewing the future with insouciance given the various challenges that could – and, in many cases, probably will – arise from both current developments and a number of medium- and long-term trends. The engineering sector needs to devise forward-looking adjustment strategies in good time to ensure that it is well equipped for the future. If this industry adopts an intelligent approach to the foreseeable trends of the future by seeking innovative solutions and exploring new avenues, it could transform developments that often still appear to be major and serious challenges or even setbacks into growth levers for the future.



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Foreseeable future trends pose medium-term challenges for engineering

Four future trends

Significant medium-term trends for the future of the engineering industry have recently been emerging increasingly clearly. It is important for this traditional supplier to the manufacturing sector to spot these trends at an early stage, because only by building on these can it devise sustainable strategies that will enable it to adapt, survive and even grow.¹ We believe there are at least four mega-trends that are likely to pose a particular challenge for the engineering sector in future:

- Firstly, key global engineering markets are undergoing a transformation, and growth in some traditionally fast-growing markets has slowed significantly. But a new, bipolar world of engineering markets with two promising centres of growth – China and the United States – is emerging.
- Secondly, the product focus is shifting markedly. Integrated and system solutions tailored to customers' specific requirements appear to offer considerable potential.
- Thirdly, there is a growing trend towards non-price competitive factors such as service, quality, reliability and – increasingly – sustainability.
- And, fourthly, the global division of labour in the engineering sector is in a state of flux; the classic distinction between producer countries focusing on standard machinery and others focusing on speciality equipment is becoming increasingly untenable.

Global markets are undergoing unprecedented change: beginning of phase three

Constant change throughout the world poses a challenge

Events in Europe and the rest of the world have always been crucial to Germany's export-intensive engineering sector. The past quarter of a century can roughly be divided into three phases. First was the period in the 1990s, which was probably most emblematically characterised by the fall of the Berlin Wall. One of the predominant issues in engineering during those years was the industrial catch-up process taking place in Eastern Europe and as far as northern Asia, because it held out the promise of rising capital expenditure. Second was the era of the major emerging markets Brazil, Russia, India and China – the so-called BRICs – the composition of which subsequently underwent various additions and modifications. Engineering firms' main focus here was once again on the substantial capital spending required by these emerging markets to build state-of-the-art production facilities. Today the issue of the BRICs is slightly less relevant given the current weakness of the Russian economy and the corrections taking place in Brazil and, to a limited extent, India as well.

The beginning of phase three sees the US regain its former importance ...

US becoming a major player again

We have now probably reached a third phase – a multi-polar phase consisting of rapidly growing countries from economic regions that are very differently constituted and at varying stages of development. These include the United States, which is perhaps the classic Western industrialised country *par excellence*. At the end of the last decade – in the aftermath of the financial crisis – the US was still giving considerable cause for concern as a manufacturing and

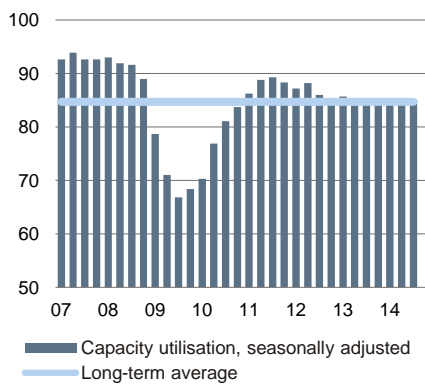
¹ See also the analysis of trends based on surveys of German engineering firms conducted by McKinsey and the German Engineering Federation [VDMA] (2014). The future of German mechanical engineering, especially pages 38 to 46.



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Average utilisation of German capacity 4

Engineering in Germany, capacity utilisation (%)



Source: ifo Institute of Economic Research

business location. It has now regained its former status as a highly attractive place for industrial firms to invest in, and it is expected to become truly re-industrialised. A major reason for this is that, compared with other countries, the US has relatively low energy prices and costs, which have largely resulted from the use of its own substantial unconventional oil and gas supplies, and we reckon that these will probably become even more important in future. The fact that this is a key locational factor is illustrated by the investment behaviour of foreign – including European – industrial companies, which are now increasingly deciding to locate some of their production facilities in the US, having shunned the country for years. It is, of course, the case that the higher the proportion of energy costs as a percentage of the total costs in the industrial segment concerned, the more attractive the United States becomes as a manufacturing location, with metal production and base chemicals among the best examples of this phenomenon.

... but China remains a key player as well

The other key player in phase three is again China, the world's most populous country. Thanks to its new and rapidly expanding middle class, China continues along a growth path that has remained impressively high in global terms, even if this trajectory has now become somewhat flatter than it was when the country embarked on its catch-up and development process during the previous phase.

Unlike the US and China, Europe is not one of the drivers in phase three – or not for the time being, at least. The old continent continues to suffer from a chronic dearth of capital investment across all sectors² despite the relatively strong performance of German industry after output collapsed in 2009. Although Germany has fared better than most of its European competitors in the intervening period, even it has for years now been giving cause for concern as an industrial location in which to invest.³

German engineering is facing challenges

Strategies should be varied around the world

Today's multi-polar global economy, in which major players such as the US and China – which, of course, operate under totally different economic systems – are driving growth, poses a further challenge for German engineering firms. This applies, on the one hand, to their regional presence in terms of their sales, service offerings and, ultimately, manufacturing. Different approaches may be appropriate for these two most promising key sales markets and regions. On the other hand, however, it is questionable whether, in addition, German engineering firms' core competences – i.e. the research and development of innovative new engineering solutions – are or should be available across regions. In other words: can/must internationalisation be restricted if the German engineering sector is to thrive in the long term?

Shifting product focus: customer preferences are becoming increasingly specific

Integrated and system solutions are gaining importance

The global engineering market is currently characterised not only by stark regional differences in growth rates but also by signs of rising demand for customised integrated and system solutions. This means that engineering

² For details see Michelsen, Claus (2014). Europa im Investitionstief. DIW Wochenbericht no. 27, page 652. Gornig, Martin/Schiersch, Alexander (2014). Investitionsschwäche in der EU: ein branchenübergreifendes und langfristiges Phänomen. DIW Wochenbericht no. 27, pages 653 to 660.

³ See Heymann, Eric (2013). Carbon Leakage: A barely perceptible process. Deutsche Bank Research. Current Issues. Frankfurt am Main.



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Downstream services are becoming more important ...

solutions are increasingly having to be tailored to customers' specific requirements. The implications of this for German engineering firms looking to benefit from this trend are, firstly, that they need to intensify their client relationships to identify their engineering requirements sufficiently quickly and thoroughly. And, secondly, they need to constantly acquire and supplement their own customer-specific expertise because, without knowing about the trends of the future in each of their client sectors, they cannot offer any engineering solutions that are tailored to individual customers' requirements.

Trend towards customised system solutions

The international trend towards customised system solutions for machinery and equipment requires – and ultimately brings about – an expansion of the product offering. This plays very much to the strengths of German engineering firms. Firstly, as innovation and technology leaders in many engineering segments they are best placed to undercut more basic but inexpensive local engineering solutions overall by integrating additional advanced technology. And, secondly, engineering clients are also increasingly having to meet growing requirements stipulated by end customers. This trend favours German engineering firms in particular because for decades now they have been international leaders in terms of their ability to specialise, and they are well known and highly valued for this expertise.

Pulling all the levers

To respond to the gradual shift in the required product focus towards customised system solutions, more than three-quarters of the engineering firms surveyed by McKinsey/VDMA plan to adjust their product ranges.⁴ They believe that they need to pull three levers to achieve this. Firstly, they aim to intensify their customer relationships to ensure that they are included in the product development process at an early stage. This is clearly not easy to do because it requires the engineering firms to build their own expertise in their customer's field of specialisation and, in addition, they need to maintain a high level of confidentiality. Secondly, they simultaneously need to mitigate the general rise in costs resulting from sharper customer focus. To lever in cost savings, these engineering firms will be looking to standardise and modularise their production much more in future. And, thirdly, they intend to make their product management even more rigorous at all processing stages to avoid inefficiency and, therefore, costs.

Non-price factors are becoming more important in the competition for customers

Whereas the sale of machinery and equipment in the past essentially followed the logic of a price-demand function, this has been changing more and more in recent years. Non-price factors now increasingly play an important or even decisive role. Sales determinants over and above the original sale price are additional aftersales and other services offered by engineering firms and – related to these – factors such as product quality, reliability and, increasingly, (environmental) sustainability.

Sale price is not the only relevant criterion

Whereas even the non-price competitive factors affecting standard machinery are often similar, they are more varied in the case of speciality equipment – which is what German engineering firms focus on – because they are based on the individual engineering solution devised in each case. Efficient aftersales services for machinery sold do, of course, require substantial resources and, consequently, incur additional costs. This challenge is also increasing because of the international character of the engineering market. The situation is compounded by the SME structure typical of German engineering firms which, superficially at least, hampers the provision and maintenance of activities such as ongoing services that are downstream from traditional sales operations.

⁴ See McKinsey/VDMA (2014), page 41.



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... and, as a side effect, are reducing susceptibility to volatility

Nonetheless, there is a clear trend towards additional service offerings downstream from the actual sale of machinery and equipment. A key determinant of success here is speed – i.e. short response times. This, in turn, depends on the structure of the service network in question, the qualifications of the people working in it, and the time needed to obtain spare parts. The sizes of the small and medium-sized enterprises (SMEs) in this sector suggest that it might be a good idea for several firms to collaborate internationally on services – possibly in the form of shared service stations. Moreover, it would seem appropriate to establish and expand further online services because they shorten response times where necessary and also act as a useful customer retention tool. Further growth in service business going forward would have the benign side effect that the sharp fluctuations in business activity typical of the engineering sector – which, because the global economy is becoming increasingly integrated, are likely to be more strongly synchronised than in previous decades – would be slightly dampened and, consequently, mitigated. This is especially true of engineering segments that are particularly prone to volatility, such as machine-tool engineering.

The reconfiguration of the global division of labour poses new challenges

The global division of labour used to be clearly defined

The global division of labour that prevailed for decades was between producers of standard machinery – such as Japan and the United States – on the one hand and manufacturers of speciality equipment – such as Germany and Italy – on the other. This bipolar model has been in a state of flux for some time now and is becoming less relevant. Probably the most serious challenge to this traditional distinction between engineering producer countries is the advance of China, because in recent years this country has emerged as more than just a buyer of cutting-edge engineering solutions.

China: the bringer of change

China is increasingly catching up technologically as an engineering producer as well. Long gone are the days when China, in its drive to industrialise, was content to focus merely on producing standard machinery of a more basic kind.⁵ In the past few years there have been growing indications of the country's intentions. It was China's idea, for example, that the engineering technology leader – Germany – should concentrate mainly on the high-end – i.e. technologically the most sophisticated – engineering segment. The plan was that this would then leave both the lower and middle engineering segments for China to expand into. However, German engineering firms were (rightly) not too keen on this new global division of labour. It soon became clear to them that any surrender of the middle engineering segment had to be prevented at all costs. Having considered the matter carefully, they realised that unless they also supplied the middle engineering segment at the same time, it would not be commercially possible for them to thrive in the extremely specialised high-end engineering segment over the long term, because only the middle segment – with its small-scale production runs – enables companies to carry out consistently sophisticated and highly specialised engineering at a reasonable cost.

Competition in the global engineering market is set to intensify further, partly because of emerging European engineering markets such as the Czech Republic. But companies from China in particular are likely to become even more important in this respect. Firstly, this will happen in their domestic market

⁵ For details and analysis of China's forward-looking strategies as a machinery producer and their implications for Germany as a competitor – specifically in eight engineering segments (including machine tools, textile equipment, foundry machinery and wood-processing equipment) – see Euro Asia Consulting/VDMA (2014). Implications of Chinese Competitor Strategies for German Machinery Manufacturers.



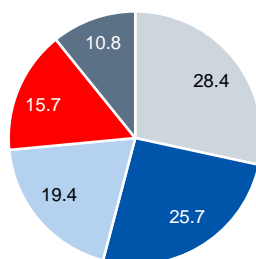
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Competition is intensifying

Germany leading in engineering patent applications to European Patent Office

5

2001 to 2010, share (%)



- EU-27 (excl. Germany)
- DE
- USA
- Japan
- Other countries

Sources: Eurostat, German Engineering Federation (VDMA)

of China, where the industrial value-creation process across all segments – from automotive production to the construction industry – is progressing apace. China has been the world's largest engineering market for some time now because – to give just one reason among many – it has overtaken the US as both the global leader in car manufacturing and as the world's largest car market. Secondly, the Asian emerging markets in particular will continue to use inexpensive and high-performance Chinese machinery and equipment in their ongoing process of industrialisation. And, thirdly – of particular relevance to German producers – Chinese firms are also looking to expand in Europe, not least in Germany.⁶ And to ensure that they can supply the high-tech segment – a German core competence – Chinese manufacturers are increasingly acquiring or merging with local companies.

However, China's cavalier attitude to patent law, which has helped the country while it has been catching up technologically in recent years, will increasingly become a potential liability for it in future. Research and development, which underlie all high-tech equipment, are hampered if innovations and technological advances are not legally protected and therefore cannot be monetised. Nonetheless, the statistics for the period since the mid-1990s reveal that China can certainly be successful in Germany. Since then, German imports of machinery and equipment from China have grown sharply: whereas in 1994 China supplied only 1.5% of machinery imported into Germany, by 2013 this proportion had risen to 7.1%.

This intensification of competition will not happen uniformly across all parts of the engineering sector. New entrants to the market will be especially attracted to engineering segments whose technological requirements are still relatively modest. Experts therefore expect the Chinese to target areas such as packaging equipment and food & beverage machinery.

Speciality engineering – the domain of German manufacturers – will, of course, undergo adjustments that impact on competitors. For example, Italian engineering firms – long regarded as among the most serious rivals by virtue of their similar product focus – are being held back by the weakness of domestic industry. A case in point is the evident structural problems facing the Italian automotive industry which, in turn, act as a drag on the local engineering firms supplying goods such as machine tools.

See future trends as an opportunity for further growth

Don't miss out on growth opportunities

The future trends outlined above present growth opportunities as well as various challenges. However, exploiting these opportunities means, first of all, regarding the associated challenges as theoretically achievable tasks rather than as threats. It should be noted that there is no one solution to all future trends for each individual engineering firm. This is not possible purely owing to the sizes of German engineering firms, most of which are small or medium-sized enterprises. Nonetheless, an intelligent approach to such future trends should yield considerable rewards.

As in previous decades, competition in engineering (and most other industrial sectors) will continue to grow in future – not least because of the increasing internationalisation of supply and demand. Going forward, firms therefore need to use even more intelligent cost management and imaginative selling strategies to mitigate the resultant pressures on machinery prices and sales margins. Given the future trends described above, the following business strategies are

⁶ See Euro Asia Consulting/VDMA (2014), pages 2, 8 and 9. The future production of technologically sophisticated manufacturing equipment is even a stated objective of China's twelfth five-year plan.



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also likely to be potentially useful and promising for engineering firms looking to achieve success.

Exploit the huge opportunity presented by the trend towards Industry 4.0

Industry 4.0 provides German engineering firms with new opportunities

6

- 1st Industrial Revolution (end of the 18th century) through the introduction of mechanical production facilities with the help of water and steam power
- 2nd Industrial Revolution (end of the 19th century) through the introduction of mass production and the division of labour with the help of electrical energy
- 3rd Industrial Revolution (1970s) through the use of electronic and IT systems that further automate production
- 4th Industrial Revolution (today) based on cyber-physical systems

Source: German Research Center for Artificial Intelligence (DFKI)

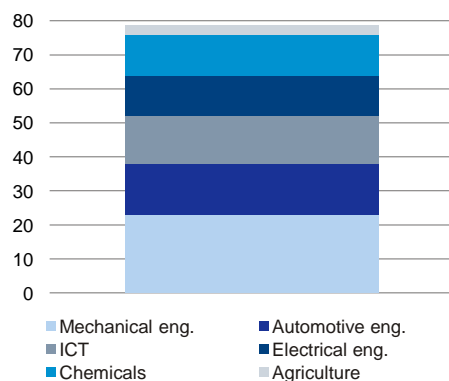
There are few things that immediately appear so perfectly suited to the German engineering sector as one of the most hotly and publicly debated industrial topics of our age – namely the trend towards Industry 4.0.⁷ This term is used by experts to describe the so-called 'fourth industrial revolution'. The first three stages in this evolution can be fairly clearly defined – unlike stage four. Stage one began with the power loom, stage two with the first production line, and stage three when information technology and electronics were integrated into the automated manufacturing process. The latest phase in this evolution – stage four – represents a further major advance towards fully interconnected production. The two protagonists of this 'new manufacturing world' – the United States and Germany – initially approached this issue from different directions. Whereas the US emphasised information technology as the driver behind this process and talked of the 'Internet of Things' or the 'Industrial Internet', Germany tended to focus more on even better interaction between mechanical engineering and electrical engineering facilitated by IT. In fact, however, these were merely two different ways of looking at one and the same new stage of evolution.

The trend towards Industry 4.0 plays very much to the strengths of German engineering firms in particular and should therefore further enhance their competitiveness. It is universally accepted that Germany plays a leading role in automation engineering, has special IT skills and possesses a highly advanced electrical engineering sector. Germany is therefore likely to benefit from the new Industry 4.0 trend because it can satisfy the globally rising demand for state-of-the-art automation engineering. Moreover, domestic production of machinery in small volumes with numerous variants, among other things, will become even more efficient and, consequently, more profitable thanks to the integration of Industry 4.0 in the fully interconnected factory of the future. This trend will also facilitate more flexible, customised and, therefore, varied robot solutions that further improve the interaction between man and machine.⁸ This will create new opportunities for German small and medium-sized engineering firms in particular and should secure and enhance their competitiveness in the machinery markets of the future.

Six industrial sectors account for one third of the potential EUR 267 billion

7

Cumulative value potentially added by Industry 4.0, Germany, 2025 vs. 2013, EUR billion



Source: according to Fraunhofer Institute for Industrial Engineering (IAO) / Bitkom

Continued internationalisation will facilitate growth

Although the trend towards Industry 4.0 is essentially likely to strengthen the position of the German engineering sector over the coming years, it will not obviate the general need for this industry to continue along its path of internationalisation. Any forward-looking strategies for this sector that only targeted the German market would be doomed to fail. This market is too small and, besides, its long-term growth prospects are not strong enough. But nor would it be appropriate to follow strategies that consisted purely of supplying foreign markets with machinery and equipment produced exclusively and fully in Germany. The transforming world that has appeared over the past two decades and that continues to evolve – albeit with constantly changing growth centres –

⁷ For further information on this subject see Heng, Stefan (2014). Industry 4.0: Upgrading of Germany's industrial capabilities on the horizon. Deutsche Bank Research. Current Issues. Frankfurt am Main.

⁸ See Schürmann, Hans (2014). Mittelstand entdeckt Robotertlösungen. VDI-Nachrichten. August 29, page 15.



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increasingly (also) requires companies to maintain a local presence in their international markets.

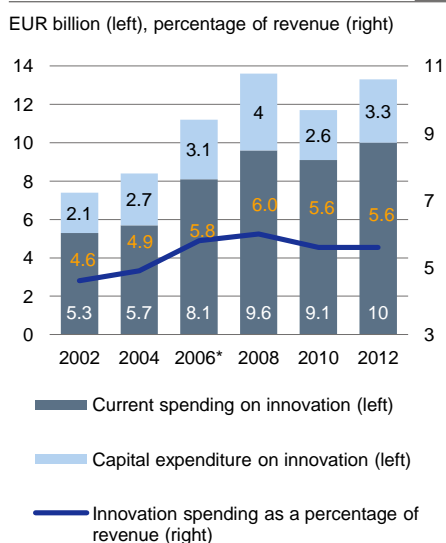
Any sensible internationalisation strategy for the engineering sector needs to take account of individual countries' future market and growth potential, which currently and in the medium term – see the section above entitled "Global markets undergoing unprecedented change" – appears to be especially pronounced in China and the US. There is, of course, no one perfect solution for all engineering firms. Limits are imposed here even by the different sizes of companies involved. Whereas larger engineering companies – generally the exception in Germany – can often operate in several fast-growing countries or regions at the same time, the SME structure typical of German firms restricts their field of activity from the outset. A further limiting factor is the distance to be bridged in each case. Neighbouring European countries, for example, can usually be serviced from the domestic German market and therefore require little or no permanent local presence. As the distances between markets increase, however, it becomes more necessary to undertake product-supporting activities. And this still applies in the 'flatter world' made possible in recent years by the rapid advances in information and communication technologies.

Initially it may well make sense for small and medium-sized engineering firms in particular to complement their sales of machinery and equipment in foreign markets by establishing and/or expanding local product-supporting branch offices, possibly in collaboration with partners faced with similar challenges. The purpose of these branches would be to provide special supplementary services such as repairs, maintenance and – if necessary after a certain period of time – refurbishment of the machinery supplied. In exceptionally positive scenarios – in other words in 'safe' customer markets that generated reliable sustainable growth – the engineering firms could round off their internationalisation strategy by building their own production facilities and manufacturing 'German' machinery and equipment locally in the markets concerned. Because here, too, a company's size can place restrictions on its expansion abroad, it may well be appropriate for small engineering firms in particular to join forces with competitors that are confronted with similar challenges.

Secure technology leadership by strengthening innovation

Innovation spending in engineering on the rise

8



* New definition of engineering used from 2006

Sources: Centre for European Economic Research (ZEW) / International Statistical Institute (ISI), VDMA

A country does not simply become a technology leader 'out of the blue' in such a globally important industry as engineering. It typically requires considerable effort to achieve this goal. Germany's route to the top in the last century was fraught with difficulty. Its industry was in ruins after the end of the Second World War. At the time it seemed almost unthinkable that Germany could reindustrialise. Nonetheless, it managed to catch up. Thanks to a string of innovations that reduced the costs that customers paid for energy and materials, the German engineering sector was a pioneer in this catching-up process and, subsequently, even in the successful rise of key customer industries such as the automotive sector.

If the German engineering sector can continue to strengthen its innovative capabilities today, there should be no need to worry about the future of its many customer industries. Far from merely benefiting customers in other sectors, this innovation prowess also stabilises the engineering industry itself in its own core machinery market. Mechanical engineering – alongside automotive engineering, electrical engineering and chemicals/pharmaceuticals – is one of the most research-intensive industries in Germany, with its internal research & development (R&D) expenditure accounting for one-tenth of the total for the German economy as a whole. German engineering firms' innovation spending has been rising fairly constantly (except for a correction following the stand-out year of 2008 in the wake of the financial and economic crisis), reaching EUR 13.3 billion



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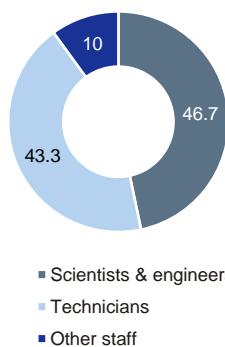
in 2012, of which three-quarters was current expenditure on innovation and one quarter was capital spending. It is therefore hardly surprising that the engineering sector's investment intensity – defined here as the ratio of innovation spending to total revenue – is, at just under 6%, more than twice as high as the average for the German economy as a whole (2.7%). The rise in investment intensity over time – albeit with fluctuations in economic activity – demonstrates that engineering firms regard their strong innovative capabilities as a key factor in their continued success. The German engineering sector has recently been earning roughly one quarter of its revenue from new products – and experts consider this proportion to be a key indicator of the commercial success of product innovations.⁹

The growing shortage of engineers is hindering specialisation strategies and needs to be addressed

R&D staff at German engineering firms mainly scientists, engineers & techn.

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Employee groups as a percentage of the total, 2011



Sources: Stifterverband für die Deutsche Wissenschaft e.V., VDMA

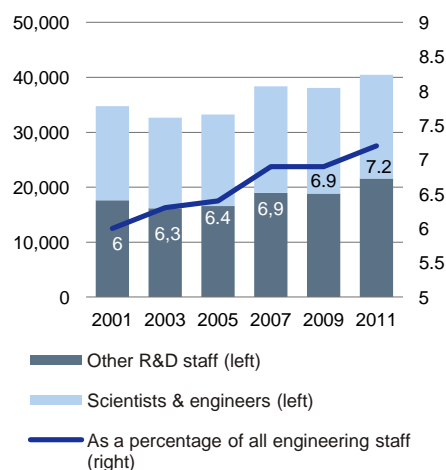
A key determinant of this success is R&D staff, which recently accounted for more than 7% of the total headcount in the German engineering sector after making up 'only' 6% at the beginning of the last decade. Of the almost 41,000 people directly employed in R&D at German engineering firms – as recently statistically recorded by Stifterverband für die Deutsche Wissenschaft e.V. – scientists and engineers accounted for the largest proportion (just under 47%), closely followed by technicians (43%), with other R&D personnel accounting for only 10%. However, these figures understate the numbers of people actually working in R&D because many SMEs do not have R&D departments of their own. The VDMA estimates that 17% of those employed in the German engineering sector in 2013 worked as engineers, half of whom were assigned to R&D. We can therefore see that both the number and proportion of engineers in this sector has been rising for decades.

This trend is really hardly surprising when you consider that German engineering firms' specialisation in the middle and upper segments requires them to constantly compete in the research 'race'. However, this race can only be won if considerable amounts are consistently invested in the latest technology trends, cutting-edge production facilities and – underpinning all of this – forward-looking and high-quality engineering expertise. A key factor promoting Germany's technology leadership in this field is the country's twin-track approach to training and apprenticeships for engineers, technicians and skilled workers. This training, which focuses on application and implementation aspects, encourages diverse innovations around new types of machinery and their translation into efficient manufacturing processes and has proved to be an important locational advantage.

R&D staff at German engineering firms increasing

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Employees: absolute terms (left), percentage (right)



Source: Stifterverband für die Deutsche Wissenschaft e.V.

In future, however, Germany's human capital – which has remained a valuable and reliable asset for decades – threatens to pose a huge risk to the engineering sector. The reason for this development is the foreseeable demographic trend, because all serious forecasts are predicting that Germany's population is set to decline. And although the number of people employed in the German engineering sector only recently regained its previous levels in absolute terms, we can already see that surveys are producing findings that make sobering reading as far as German engineering firms' ability to innovate is concerned. These questionnaires reveal that (even during the crisis years of 2008 to 2010, i.e. at the height of the economic and financial crisis) 30% of the engineering firms surveyed were unable to recruit a sufficient number of the skilled staff needed for their R&D (this proportion was 'only' 20% in the period 2004 to 2006). The growing shortage of engineers is likely to continue – especially in the light of demographic trends – and it therefore needs to be constantly monitored and requires intelligent counter-strategies to boost

⁹ See VDMA (2014). Kennzahlen zu Forschung und Innovation im Maschinenbau, pages 2 to 15.



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innovation in German industry. These strategies could include easing immigration restrictions on foreign skilled workers (something that is already done in some areas) and further improving working conditions, flexible working hours and living conditions (for young families, for example). If potential product and/or process innovations in the engineering sector were not to materialise in future owing to staff shortages, this would naturally also have an adverse impact on Germany's typical customer industries and their international competitiveness.

Conclusion: if the engineering sector can exploit global trends, it can expect to generate growth

The German engineering industry has been following a similar cyclical trend for decades now, although some segments – machine-tool engineering in particular – are even more prone to volatility than the sector as a whole. If engineering firms manage in future to provide their customers with downstream service offerings in addition to the actual sale of machinery and equipment, the net effect of this would be not only to expand their total volumes of sales but also to smooth out the economic cycle by making their business more consistent. It is, of course, true that different sales and service strategies will be required to exploit the more pronounced future bipolar growth of North American and Asian markets described above. However, German engineering firms appear to be ideally prepared for, and suited to, both of these regional markets thanks to their traditionally strong focus on international business.

Product diversity remains an advantage

German engineering firms are likely to benefit both from the particular diversity of their product offering – which comprises more than 30 segments – and from their specialisation. The sector is therefore well equipped as it looks to the future. There is still strong global demand for many types of German speciality equipment because their quality is unrivalled; in addition, German manufacturers can also satisfy demand for the latest standard machinery of the middle engineering segment. And in the medium term we are likely to see even stronger demand for these two engineering segments from the world's two most dynamic growth centres. Although China has been trying to expand its presence in the high-end engineering segment by launching its own products, it has not yet really made a breakthrough here. And sophisticated standard machinery made in Germany remains highly popular in the United States. Moreover, the German engineering sector is currently receiving a helping hand from exchange rates because the euro's relative weakness against the US dollar is boosting exports of German machinery and equipment to the United States.

Good prospects

The German engineering sector should be able to capitalise on the new trends that it is facing. The global trend towards Industry 4.0 will ultimately further enhance the international competitiveness of German engineering firms, not least owing to their automation expertise. The advancing global process of internationalisation will also play to German manufacturers' strengths because their sales regions have for many years now extended well beyond Germany and even Europe. This means that in the increasingly integrated workshop of the world they will be good companions to the other German industrial sectors – such as the automotive industry – that are likewise expanding their international footprint.

The shortage of engineers needs to be addressed

German engineering firms need a suitably qualified and research-intensive workforce if they are to maintain and further extend their technology leadership. The industry itself and the politicians responsible would be well advised to focus even more on addressing the shortage of engineers, in our view. If the German engineering sector can resolve these outstanding issues and capitalise on the



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positive trends of the future by translating them into business ideas, it is bound to grow and prosper even in an increasingly globalised and interconnected world.

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