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## [ CHANGING PERCEPTIONS TOWARDS ENGINEERING: ENSURING OUR COUNTRY'S MANUFACTURING FUTURE ]

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## Carl Patrick

# WCMT - Changing Perceptions towards Engineering: Ensuring Our Country's Manufacturing Future

## 1. Synopsis

Travelling throughout the globe, focusing on key areas of engineering excellence to find a solution to the shortage of skilled workers in the engineering marketplace within the UK, visiting Luxembourg, Germany and 6 states of the US.

My approach was to identify the issues within the UK as expressed by my current associates within the manufacturing marketplace, and compare them to that of the countries mentioned above.

- Do other countries produce more and better quality engineers?
- Does the next generation of potential engineers view the career path as a positive option?
- What exposure do they have to engineering before deciding on a career?
- What incentives and encouragement do they have?
- What can the UK gain from looking at these countries in regard of education, policy, funding and promotion?

## 2. Introduction

At 16 years old I left school in 2002 with very good grades into an open careers market where it was easy to find employment. I had attended several careers advice meetings whilst at school; the advice given for full time college with the aim to continue to university for Business Studies was undesirable, the thought of incurring large amounts of debt before the ability to earn seemed a backwards step. I was working in a warehouse when my careers advisor contacted me to complete the careers advice paperwork, he said he knew of a company that was offering an apprenticeship in mechanical engineering and that I would be paid as I learned on the job and at college, this is what I then decided to do.

On my very first day I realized that I had absolutely no prior knowledge of what engineering was or what was involved in me becoming an engineer in the future.

I soon realized that my role as an apprentice was going to be a huge learning curve crossing many areas and disciplines where the opportunities could be vast and varied.

I decided I wanted to progress my knowledge (and in turn my wallet), so I offered the highest skilled programmers within the business a proposal; buying their lunch in exchange of their training me.

Now 16 years later and a lot of lunches purchased for the skilled programmers, I am a Pre-Sales Project Engineer for the fastest growing machine tool supplier in Europe, Mills CNC. Where the job entails designing of processes, writing CNC part programs, training in machining and programming and offering technical support to companies within mechanical engineering throughout the UK and Ireland.

Now established, known in the market place and somewhat travelled within the mechanical engineering community, I have seen first-hand the diminishing skills and interest in the trade.

### 3. The UK skills shortage.

The 2016 Hays Global Skills Index found that Britain's skills shortage within engineering had worsened for the fifth consecutive year. The survey said many UK university degrees offered neither the technical or vocational knowledge that businesses wanted and that more than half of UK graduates were working in non-graduate roles. The skills gap has worsened by 8 per cent over the past five years, it also found.

The engineering sector is responsible for 26 per cent of the UK's GDP. In 2015, engineering businesses contributed £486bn to the UK economy, more than the combined contribution of the retail, wholesale, financial and insurance industries.

However, despite its obvious importance for the UK's economic growth, the industry is facing some major hurdles that could hamper its future prosperity. The lack of skilled workers available in the market is the number one concern, according to a report published by the professional organisation, EngineeringUK.

According to estimates, the UK would need at least 20,000 extra students graduating from engineering disciplines every year, in order to be able to meet the demand for engineering skills.

These vacancies are currently filled by EU workers or other migrants. With the UK decision to enact Brexit, and the pending withdrawal of the UK from the European Single Market and the area of free movement; businesses are concerned they might struggle to find the required talent.

The UK engineering universities enjoy an outstanding reputation, but mostly attract foreign students. Only 25 per cent of postgraduate engineering and technology degrees are currently awarded to UK citizens.

Almost 5.7 million people work in the engineering sector in the UK, representing approximately 19 per cent of the total employees of registered enterprises. About 80 per cent of registered engineering enterprises have four or fewer employees.

More than a half of all employees however, work for an enterprise with over 100 employees.

In future, the sector will have to adjust to changes including increasing automation and the decreasing demand for low-skilled workers. The demand for high-skilled workers, on the other hand, is expected to grow.

The latest Labour Market Statistics published by the Office for National Statistics (ONS) show that the UK employment rate (the proportion of people aged 16-64 who are in work) had increased to the highest on record, to 73.5per cent in 2015 compared with 72.8per cent in 2014, demonstrating that demand for labour is more than keeping up with population growth.

Unemployment, in 2015 was at a rate of 5.5per cent, which was well below that experienced during the recession and the subsequent period of uncertain recovery. There were 740,000 job vacancies, close to the highest on record and an 8.5per cent increase on the previous year.

But if there is a record rate of people in employment and employers are posting record numbers of vacancies, why are people still unemployed and why are recruiters reporting such large numbers of candidates for each position advertised?

The UK continues to lag behind countries such as Germany, the US and France in terms of productivity (the amount of output produced for every unit of labour).

Part of the answer comes down to the fact that there may be mismatches between the skills available in the UK labour force and the needs and expectations of employers.

The problem facing the UK is not just a shortage of skills, but a mismatch between the skills people have and the requirements of the jobs they currently occupy. This is symptomatic of long-running difficulties businesses have experienced in workforce planning, exacerbated by the rapid pace of technological change and shifting consumer preferences.

The Employer Skills Survey (ESS) interviews more than 90,000 employers and reports every two years, with the latest data referring to 2013.

In that year, total vacancies had increased by 12per cent on 2011 and were back to pre-recession levels, but the proportion remaining unfilled because of a lack of candidates; with the right skills, experience or qualifications had also increased from 16per cent to 22per cent. This is equivalent to 146,000 skills shortage vacancies.

The ESS also provides insight into skills mismatches, identifying members of employers' existing workforces who were not "fully proficient" in their current jobs. In 2013, some 15per cent of employers reported that they had employees with skill gaps, equivalent to 1.4 million staff or 5per cent of the workforce.

#### **Apprenticeship starts in England by standards in 2015/16**

Property Maintenance Operative	720,000
Dual Fuel Smart Meter Installer	440,000
Power Network Craftsperson	410,000
Digital and Technology Solutions Professional	350,000
Installation Electrician/Maintenance Electrician	300,000
Network Engineer	200,000
Mechatronics Maintenance Technician	150,000
Software Developer	140,000
Infrastructure Technician	120,000
Manufacturing Engineer	100,000

Table source: FE data Library

The ESS indicates that manufacturing employers were most likely to encounter skills shortages when recruiting (accounting for 30per cent of hard-to-fill manufacturing vacancies) and that job roles in the skilled trades (machinists, engineers, technicians etc.) in particular, were likely to be affected. According to the ESS, employers invested £42.9bn in training in 2013. Wider costs are harder to quantify.

For employers, skills issues can reduce their ability to respond to customer needs and stay ahead of competitors, adopt new technologies or to fully utilise existing equipment or ways of doing things. Skills have long been identified as one of the key reasons for the UK's "productivity gap" with other major Western economies.

Unfilled vacancies are likely to lead to increased workload and stress for other employees. Where individuals are poorly matched to the skill requirements of their job, this can have significant impacts on job security, self-confidence and career progression.

Education is frequently blamed for failing to equip young people with the relevant work skills.

## 4. Young people (UK)

As we have seen, despite the demand for skilled workers in the UK rising, the numbers of apprenticeships has been decreasing steadily; successive governments have tried initiatives such as “Improving Engineering Careers” and “Develop Engineering Skills In Smaller Companies”, however the trend of decreasing interest is still present. 2018 has been dubbed “The Year of Engineering” by the British government, this is a fantastic start towards solving the issues the UK faces, the “T Level” programme, which is in the consultation stage at the time of writing, is also of significance as it sees mechanical engineering at the top of the skills matrix being a “T20” award. As well as researching on behalf of the WCMT, I am also a STEM ambassador. I’ve been asked to attend several schools and colleges in my local area to give talks on engineering and technical trades as viable career options to 14-18 year olds. Through my talks with teachers and students alike, I have found there is a genuine lack of understanding of what engineering is, what the earning potentials are and the routes that can be taken to join an apprenticeship. Further to the lack of understanding, it seems that the budget within schools in the UK to train engineers is lacking. In January 2018 I was asked to give a talk at a school in Warwickshire to year 11 students with regards to their engineering assignment which was to produce a functioning outdoor lamp. The children had been tasked with designing, pricing and producing the lamp, my input was to assist in to how manufacturing techniques and costs can affect design. Whilst talking with the teacher, I was alarmed to find that the budget for equipment for the combined “Technical/Vocational Courses” which included Engineering, Cooking, Textiles and Woodworking was £2,000 for the entire year group, this equates to just over £16 per student for the year.

During my time at various schools and colleges in Warwickshire, talking with students has become an invaluable insight into the mindset of the generation towards careers in engineering. The general opinion I received was that parents are a huge influence into children’s desired career paths. Parents, who it would appear, believe that becoming an engineer isn’t a desirable career option. The overall perception of engineering from the children I had met during my STEM events was that “engineering is a boring, dirty and underpaid job...”

# 5. Overseas countries: comparison

## 5.1 Fanuc Luxembourg

I was extremely lucky to have industry connections through my work which allowed me to gain access to companies throughout the world. My first visit was to Fanuc European Headquarters in Luxembourg. Fanuc are the global number 1 supplier for CNC controls which dominates 80-85 per cent of engineering companies globally, they also manufacture a range of machines in metal cutting, eroding and plastic forming, as well as being the global leader in automation with their range of robots.

Fanuc are aware of the issues facing engineering, not so much in Japan & Germany, but in smaller European countries including the UK. "To combat this", says Thomas Renz (Technical Support Manager of Robo Machines Eastern Europe) "Fanuc have put together a team to cover worldwide subsidiaries to train engineers periodically and on demand as applications dictate, with the aim to bring all subsidiaries to the same standard as the German and Japanese".

"Along with the obvious reduction in business costs (after the initial outlay) for this training." continues Thomas "... Fanuc endeavour to promote from within and pay its engineers generously as we understand training new, inexperienced staff to replace leavers of the business is far more expensive than retaining staff and having a philosophy of constant improvement of skills, which is achieved by promotion from within".

Fanuc run apprenticeship programmes and typically have hundreds of new apprentices worldwide each year; apprentices throughout their 5 years of working alongside fully skilled engineers in each department. The apprentice will then agree with management which area/section of the business is best suited to his/her and business needs subject to market conditions and the individuals' particular area of excellence and/or interest. This apprenticeship acts as a great way to learn about engineering from all aspects before joining a team to become an expert in one area whilst having a good understanding and appreciation of all others, so to be the best possible engineer for the business and the market.

FANUC's desire to innovate and evolve doesn't just apply to its product range; it follows the same principles with its workforce via an apprentice and degree student 'sandwich year' programme. Darren Whittall explains: "The apprenticeship programme started in 1997 – apprentices spend up to five years learning all aspects of the business and are encouraged to progress academically." Chris Sumner (European Service Director & Vice-President Fanuc Europe) who previously was General Manager of Fanuc UK was the pioneer behind Fanuc's Apprentice Programme, recruiting 4 per year in the UK (minimum) for the last 20 years. I met Chris in the Luxembourg office of Fanuc. "We are extremely proud of our apprentices, most of who are here today some 20 years after joining..." Chris points to a gentleman on the phone talking to customers, "He was an apprentice starting in 1997, and now he is manager of Europe for CNC Control Options, obviously it's human nature to move, but Fanuc has a very low turnover of staff, I attribute this to the development we put into staff, along with the culture of being treated well equals a huge return for the business, so its win win from all points of view."

Whilst I was at Fanuc Luxembourg, I spoke to many engineers from different countries and in different areas of engineering: Service, Applications, Metal Cutting, Wire Eroding, Plastic Forming, Research and Development, Robotics, Technical Support and Management.

The overwhelming differences I found from my discussions with these engineers are:

- Parents have a much more positive view of engineering as a good career choice for their children, actively persuading them to begin a career within the technical trades. When asked further as to why that was, the resounding response was that parents understand and view engineering in a positive light, they understand that there is a lot of information to learn and, once skilled, a progressive, long and rewarding career is possible.
- Tuition fees are significantly lower in comparison to average earnings, so coupled with the above point; European engineers typically enter their first role with a technical qualification or degree.
- The expected salary (in comparison to the national average) is typically 100per cent-140per cent.

The struggle to recruit skilled workers is a recurring concern within the UK manufacturing industry. Earlier this year an EEF report revealed that three-quarters of manufacturers have struggled to recruit skilled workers in the last three years. This doesn't reflect the situation at FANUC UK, who receives in excess of 50 applications for every vacancy, and over 30 for most apprenticeship posts we advertise; says Andy Armstrong, UK Sales and Marketing Manager.

"At FANUC we believe that our success in attracting young engineering talent can be attributed to our longstanding commitment to engage with local schools, colleges and universities. Open days, internships and work experience placements, combined with social media activities and attendance at career fairs have all helped to remove the stigma that manufacturing is a low paid, unexciting and mundane work environment. Our view is that young people today view engineering pathways within the automation sector as an enticing career with stability and long term prospects." says Andy.

## 5.2 Ceramtec Stuttgart

Ceramtec is a company with global presence, my partnership with Ceramtec was formed many years ago during product development in Coventry for high volume production of cast iron pulleys, which Ceramtec offer the best cutting solution for the abrasive materials. Ceramtec also produce products for medical implants, kitchen appliances sensors and transducers as well as many more.

My contact Michael Nanz who is a Speciality Applications Engineer from Ceramtec's Engineering Department.

Michael gave me a tour of the company headquarters and manufacturing facilities, talking me through his own career path. This was later demonstrated to me by visiting Ceramtec's training centre, ran by Konstanze Gruza, Personnel Specialist, it was explained to me by Konstanze that although Germany isn't "...where it once was.." regarding engineering, "generally interest is still high.." she attributed this to Ceramtec, as well as most other companies in Germany, actively engaging with the community, partnering with schools, colleges and universities in the local area. Ceramtec hosts open days for its partner schools, colleges and universities to show what they do, what they can offer and the type of career which can be expected if successful in joining the business. Ceramtec views its new apprentices as investments. For the first 2 complete years of an apprenticeship, the apprentice will be based two thirds of the time in the training centre, and one third of the time at a cooperative state university. this is known as "Dual Education System" where all of the training is recognised by industry and regulated by the German government. "Being regulated by the government means we as a country can be assured that each company's apprenticeship programmes will produce engineers of the desired level." says Konstanze. I asked if

the costs involved in running such a programme was a burden on the company's finances? "The costs are controlled, but not viewed as a burden, we recruit apprentices every year, the retention levels after 5 years of completing the apprenticeship is around 80per cent, which may sound not as high as would be expected after such an investment. However, as almost all engineers are apprentice trained/qualified, when we take on staff to replace people retiring or leaving the business, we know that the skill level will be that as if they served their apprenticeship here. Due to the government regulations regarding apprenticeships being so well controlled, the system really does work well for industry. The costs of partnering with schools, colleges and universities isn't a large expense, but this seems to be where we compete with other companies in getting the interest at an early age of joining the company as an apprentice, not only do we benefit from this, but the local community too, we don't have to search the whole country to find the interested people, we generate the interest ourselves."

Michael Nanz is now completing a masters degree as well as being principle engineer for the department, looking after key customer accounts in the UK, Ireland, Switzerland and France. He attributes his successes to Ceramtec and considers himself to be very lucky to have been given the opportunity to continue his education whilst earning.

### **5.3 Fanuc Japan (Oshino Mura)**

Arriving into Haneda airport Tokyo, I was immediately surprised by the sponsors of the airport suitcase trolleys which were sponsored by Fanuc and some machine tool manufacturers, this confirmed to me that there is a greater presence of machine tools and awareness of these brands/industries in Japan.

During my travelling to Fanuc's headquarters which is nestled in a forest at the foot of Mount Fuji, I saw many billboards and advertisements for some of the machine tool manufacturers which are based in Japan. It seemed at a glance that engineering and technology is held in high regard and as Japan is the world leader in technology developments it seemed appropriate that the technology is promoted in such public places.

I was hosted by Ryuji Sasuga who is Managing Officer for Fanuc; he introduced me to the Vice General Manager – CNC Software Laboratory, Hasegawa Satoshi. It was explained to me that post WW2 Japan had little to no natural resource to trade with the rest of the world.

The Japanese government therefore invested heavily in education and technology, which is now their number one export, says Hasegawa "the skills and innovations of the Japanese people is our most profitable export and ultimately is what keeps the nation successful in the global market place".

It was also explained to me by Hasegawa that "the general opinion of students in Japan, is that to become an engineer is most desirable. Students who do not possess the necessary skills in mathematics will then, on failure to become engineers, become lawyers, accountants or bankers..." continues Hasegawa " Also, staff turnover is very low, this is due to 2 things, firstly the honour system in Japan, and secondly the culture of promotion from within." It was then I began asking all of the Japanese Fanuc employees what job title they joined Fanuc as, and how far they had progressed. The resounding response was "in all areas of the business we learn different but transferable skills; it

makes sense to promote from within to build on existing skills rather than outsourcing and potentially losing company ethics”.

Japan's biggest three exports today are Vehicles (20.9per cent of total exports), Machinery including computers (19.8per cent) and Electrical machinery equipment (15.1per cent), all of which rely heavily on the aforementioned investment in education.

## **5.4 Fanuc US**

My host at Fanuc US was Dean Steadman, a British engineer formally service manager at Fanuc UK, who is now Education Manager. His main role is to promote the benefit of education of providers purchasing the correct and industry relevant equipment to ensure the necessary skills are in place when new workers enter the marketplace.

America has many parallels to the UK in the issues facing the labour market, in particular, skilled engineers; however, there seems to be many initiatives: state, federal or privately funded to combat these issues.

The USA is as we all know United, but states are free to compete against states to attract large companies which bring large tax revenues both to state and federal governments. The main competitive points to attract companies are financial incentives such as free land to build and tax relief for an agreed amount of years and infrastructure to meet the businesses needs, but in recent years, skills have become the most important factor. “Why spend billions in a new facility if there are no workers capable of meeting the needs of the business.” explains Dean “the competitiveness of the states has lead to a country wide reform in technical education, now the majority of high schools, community colleges and colleges have large budgets on technical training...”.

Dean organised several visits during my time in the USA to help me better understand the solutions being offered to the industry facing skills shortages.

## **Lab Midwest**

I travelled to Lab Midwest to meet Matthew D. Kircher who owns the business which provides schools colleges and technical training centres with equipment and modules for CNC, Welding, PLC programming, maintenance and design. “The business is growing rapidly as businesses in the area are in ever more demand for skilled workers in these industry sectors.” says Matthew. “In particular we have seen huge growth in the engineering and skilled trades sectors. This we believe is due to the competitiveness of states to be the most attractive option for large businesses to start trading. The state funds the majority of the schools investment for these programmes as failure to do so in the past saw large gaps in the market and companies relocating to areas which had better skills. What we are very proud of is being able to offer children and industry alike the opportunity to produce work ready individuals who already have a level of work experience which is industry relevant, rather than just coaching them to pass exams. Competent Engineers have never been in higher demand and LAB Midwest provides the tools needed to train them. Our tools include curriculum, equipment and eLearning systems used in preparing the next generation of engineers in fields including Mechanical, Manufacturing, Industrial, Biomedical, Chemical, Materials and more”.

## **Beloit Memorial High School**

Beloit Memorial High School educates 9th- 13th grade students (13-18 year olds); I was hosted by Mitchell Briesmeister who is Career and Technical Education Director for REACH Advanced Career Education department at the school. Being shown round the school was very impressive, the engineering department has facilities to teach welding, CNC and conventional machining, design, PLC and construction to each grade year of the school. As a part of the school's mission, they develop students to allow them to pursue their desired fields, careers and areas of interest. I was shown around the machining department which had a wide range of manual and CNC controlled machines inside, so much so that many companies in the UK would be envious of the equipment available to the students. Mitchell explained "The state funds the equipment which is purchased on the advice of the advisory board. The advisory board is made up of industry business owners and councillors, who both see the skills required by industry and how return on investment is assessed and ultimately are in charge of what equipment is purchased for the school". Continues Mitchell, "The advisory board is tasked with ensuring the budgets allocated by the state and federal grants are spent on the correct and industry relevant equipment; which will give the best chance for employment options for the students, and meet industry demands for skills."

## **The TMA (Technology and Manufacturing Association)**

Some schools do not have the funding available or space to have a technical department, machine shop and technology centre. These schools, such as Beloit Memorial High School, are also seeing demand from local industries to produce work ready individuals with relevant skills. The TMA offers their facility which includes the machines, robots, modules and industry knowledge as a "membership basis". This means all local schools, colleges and universities can pool their available finances to get access to the best equipment and training to their students through the NIMS training programme (National Institute of Metalworking Skills) at a fraction of the cost of purchasing and maintaining. "NIMS are nationally recognised and approved by the United States Department of Labour." explains Jack Kirkorianz who is Lead TMA Instructor. "Students will typically be guided and trained by the TMA for 2 of 3 semesters in the last 2 years of high school with an exam final and a year placement to build experience and hopefully lead to full time employment."

Companies such as Fanuc US will provide companies like TMA with equipment at cost value for students to learn and develop skills. The TMA has a range of Fanuc, Doosan, Haas, Mazak and Star machinery in their machine shop in a range of configurations. Again the equipment is purchased as advised by the advisory committee to suit real world industry needs.

TMA President Steve Rauschenberger is a passionate advocate of the TMA's work. "The students get the kind of instruction that can lead to a high paying career in manufacturing. The high school or college avoids the daunting start up costs of establishing a training centre and the industry gains a new set of bright and willing minds." states Steve. Of course there are many delighted business who contribute to the TMA, they will use the resource to train or retrain their staff, "often the best talent we've had, has been from within..." says Paul Prikos, President of X-L Engineering "...as they say, you

can train someone and risk having them leave, or you cannot train someone and risk having them stay.”

Whilst it was visiting the TMA, there was a class underway from Ridgewood High School, I engaged with the students who were 12th and 13th grade (17-18 years old), they collectively stated that they are learning more than they would have in the traditional type course at high school, using the applied maths seems to make complex mathematics far easier to retain. Again all the students stated they wish they could have started the NIMS programme a year or 2 earlier and hope to use the skills they are developing to forge a career for themselves in engineering.

## **Ramtec**

Ramtec (Robots & Advanced Manufacturing Industry Certifications) based in Marion Ohio, has partnered with real-world manufacturing facilities to identify the needs of industry. In 1997, a series of passionate educators saw that preparing for the future meant building on the traditions of the past. With a deeply rooted history as a manufacturing hub in the 1800's, Marion could once again be the exemplar of efficiency and productivity through building a highly-skilled, technologically adept workforce responsive to today and tomorrow's industry needs. These educators joined together to change the way others looked at preparing for this future. Chuck Speelman – Tri-Rivers Superintendent campaigned tirelessly to gain funding from the federal and state government to start the Ramtec programme at Tri-Rivers High School. Being community focused, Chuck saw the potential of training in the skilled trades to uplift the area and prospects of the students, “Since in the US, large employers will offer tender to states to propose an offer to the company, we were falling behind when it came to skills. Since starting the Ramtec mission, large companies such as Nissan have expressed much greater interest in building facilities in the area.” says Chuck. “Where at first we were approaching industry to become partners with Ramtec, now we are being approached by suppliers. The power of industry demand has now seen us being a medium of shaping the education programme tailored to the industry. We, therefore develop highly skilled engineers who leave the programme ready for employment and in demand.”

## **5.5 Renishaw**

Renishaw is a global company with core skills in measurement, motion control, healthcare, spectroscopy and manufacturing. My contacts at Renishaw were Howard Salt – President of Renishaw US and Kevin McNally – Exhibition Manager. In Kevin's career, he has worked in almost all of the departments within the business which has given him a great sense of worth in the training and philosophy Renishaw places in developing its staff.

Renishaw exhibits at approximately 150 trade shows per year, “Due to ramped and continuous growth, recruitment is becoming an issue.” states Kevin. “Partnering with community colleges is already paying dividends in the recruitment area as well as increasing awareness about engineering and demonstrating Renishaw products to the next generation of decision makers. There are only three true creators of wealth..” continues Kevin “.. Farming, mining and manufacturing, all other jobs are as results of money being moved from these initial three. America is now aware of this and is actively playing catch up to keep America sustainable. Partnering with Greenville Technical College

has already given us several new recruits and inspired others in the area of North Carolina to pursue a career in engineering, so it really is a snowball effect.”

Kevin McNally was the 6th ever employee of Renishaw PLC when it was formed in Wotton under Edge, Gloucestershire. During his 41 years at Renishaw, Kevin has identified the current day as a crucial time to act to ensure the UK's manufacturing future.

## 6. What can we learn from 'competition?'

After travelling throughout the countries listed previously, it seems that engineering is in fact seeing a global skills shortage. However the UK is still lacking initiatives that are producing the correct skills the industry demands and in comparison to the detailed countries, perceptions towards engineering are increasing the world over.

To change the perception of mechanical engineering as a career, we can look to the USA, Germany and Japan and take some simple key steps towards the changing of perceptions which will lead to an upsurge in skills being available to the industry.

In Germany and the USA in particular, the interest in pursuing a career in manufacturing is sparked at a young age through exposure, schools have equipment and partnerships with local industry. Here in the UK we cannot reasonably expect school leavers to decide upon a career in engineering if he/she has no knowledge or exposure to it before that point.

## 7. First steps (recommendations)

The UK government must realise that targeted investments made in schools will rapidly reform the industry and generate large tax revenues in return.

Encouraging partnerships between schools and engineering businesses, speakers in schools and open days at local industry facilities to expose the next generation of potential engineers to the trade they may not know exists. In post Brexit Britain, we can draw parallels to the USA in where we (the UK) will be freer to become more competitive and therefore attractive to large businesses to locate. Investment is needed now rather than later to ensure our country's success in the future. Any investment must be justified, but also relevant, which is why government should form advisory boards to include industry leaders to decide on what equipment and facilities are purchased.

It would be impractical to expect funding, space and teachers skills for such equipment in every school in the UK; usage of TMA (Technology and Manufacturing Association) type training centres are a cheaper and potentially more effective option. The UK can already boast of having several such centres including the MTC (Manufacturing Technology Centre) Coventry and UTC (Universal Technical Colleges), these could be utilised in the same way the TMA operates to reach a broader audience at a lesser cost.

Advertising of the industry at present is mainly achieved through news stories; potential engineers need to see modern equipment to spark interest in pursuing the career path, when politicians are visiting business to demonstrate booming engineering or the lack of skills. An easy way to spark interest would be to hold the interview in a facility which has high tech modern equipment.

Rebranding of apprentices from becoming involved with "Skilled Trades" to "Young Industry Professionals" will also aid in breaking the stigma some parents attached to skilled trades.

## 7. Conclusion

Skills shortages are a worldwide issue, the UK has a great opportunity to break the cycle of diminishing skills. If the above points are addressed, the issues the UK faces can be solved within one generation.

Investment is required to help the industry solve the issues it faces, this can be managed efficiently when using the USA as an example regarding advisory boards, introduction to engineering at a much earlier age (than current in the UK) and encouraging businesses to engage with education providers. Changing perceptions towards engineering is in itself a step towards addressing the skills gap, exposure at a much earlier age will see new ambitions forming and aid both perceptions and recruitment into engineering.

## 8. Acknowledgments

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- Renishaw Chicago – Kevin McNally gave up his day to show me round the new premises in Chicago and explain how important “getting to the youngsters in time” is to Renishaw as a business.
- Fanuc America – without doubt the largest contributor to the project and mission, someone who shares the passion (and has subsequently turned into a career) for developing the next generation of engineers and promoting engineering as a fulfilling career, Dean Steadman. Dean arranged his schedule for two weeks to incorporate the project and propose visits accordingly, showing me the target that the UK can look towards and hopefully replicate here, a massive thank you to Dean and his colleagues at Fanuc America.
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