China has a Shortage of as many as 20 Million Senior Technicians. (China as a) Major Manufacturing Power -- Who Will Make it (大国智造谁来造)?

Note: These are Jeffrey Ding's informal and unofficial translations -- all credit for the original goes to the authors and the original text linked below. Jeff is a Rhodes Scholar at Oxford, PhD candidate in International Relations, Researcher at GovAI/Future of Humanity Institute, and Research Fellow at the Center for Security and Emerging Technology. These are informal translations and all credit for the original work goes to the authors. Others are welcome to share* ***excerpts* *from these translations as long as my original translation is cited. Commenters should be aware that the Google Doc is also publicly shareable by link. These translations are part of the ChinAI newsletter - weekly-updated library of translations from Chinese thinkers on AI-related issues: https://chinai.substack.com/*

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In the industrial field, the normal personnel structure is 1 scientist, 10 engineers, and 100 technical personnel.

In China, high-quality industrial workers, one of China's core competitive competencies, are the human resources on which many entrepreneurs depend, but at the same time, entrepreneurs have the least motivation to provide soil (to cultivate high-quality industrial workers).

Today's 20 million talent shortage is due not just to a surface-level income comparison but also a more profound historical reason. This also allows the resolution of the crux of the matter to go beyond simple transplantation and replication.

On November 27th, during the historic moment of Alibaba's return to the Hong Kong stock exchange, a young bell ringer standing at the C position attracted a lot of attention. His name is Yuan Wenkai, the person in charge of 4PX Express logistics warehouse.

In just five years, Yuan Wenkai transformed from a tally clerk who had graduated from an ordinary Guangdong vocational school into an expert in automation management. He increased the sorting capacity of the logistics warehouse by 20,000 orders per hour, enough to withstand the surge of Single's Day (November 11th) cross-border logistics orders.

China still lacks a lot of technical staff like Yuan Wenkai.

In the "Top 100 Ranking of Job Shortages for National Recruitment in the Third Quarter of 2019," along with tally clerks there are also technical jobs such as turners, welders, and multi-process CNC machine tool operators and adjusters. Manufacturing jobs and related positions accounted for almost a third of the list.

I've visited some large privately owned factories in the Pearl River Delta, and it was easy to feel a structural change.

Although there was no shortage of young people there, there were more middle-aged laborers. Companies are also more inclined to hire workers with certain skills, who are not only very experienced but also able to work a little bit of overtime.

In Japan, the proportion of senior technicians in the entire industrial workforce is 40%, and in Germany it is as high as 50%. In China, this proportion is only about 5%. There are also many cases of the talent shortage of 20 million hindering China's manufacturing transformation.

Paradoxically, in the eyes of entrepreneurs, although they rely on the core resource of high-quality Chinese industrial workers, which is one of China's core competitive competencies, compared with German and Japanese SMEs, these entrepreneurs often lack motivation to provide the soil for cultivating talent.

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1 Talent faultlines

Dongguan, which is relying on robotics and automation technology to try to move into the future, is a microcosm of China's transformation.

This year, in Dongguan’s published catalog of shortages in skilled trades, the demand for CNC machine tools operators and equipment maintenance electricians ranked ahead of AI engineers.

In past interviews, the author learned that whether it is the trend of integrated design of metal casings inspired by Apple or the demand for new materials (such as ceramics) for 5G mobile phone casings, not only has manufacturers' demand for high-end CNC equipment surged, but their demand for higher levels of experience in machine operators has also increased. It is said that even equipment maintenance electricians need to know a little about PLC.

In Shenzhen, not far from Dongguan, and even all of Guangdong, middle and senior technicians such as turners, fitters, and welders have also been on the list of skilled job shortages for several years.

序号	工种代码	工种名称	等级要求
1	03-048	制冷设备维修工	中级以上
2	03-126	服装设计定制工	高级以上
3	03-804	眼镜定配工	高级以上
4	03-805	中央空调系统操作员	高级以上
5	09-015	钳工	中级以上
6	09-018	车工	中级以上
7	09-019	铣工	中级以上
8	09-024	电切削工（电火花机操作工）	高级以上
9	09-024	电切削工(线切割机操作工)	高级以上
10	09-030	电工	中级以上
11	09-033	电焊工	中级以上

The situation in the Pearl River Delta has also been acted out in the Yangtze River Delta, another manufacturing base.

This year, the Ningbo Human Resources and Social Security Bureau surveyed more than 800 sample companies and found that the proportion of senior skilled workers in the manufacturing (and service) industry is only three percent, which is very scarce, and nearly half are only lower-rank workers.

****Excerpted end of this section****:

- Similar issue in Hangzhou and Wuhan
- Interview with Wang Wei (pseudonym), a former project manager of a large steel company, who tells story of how when one mid-level engineer took annual leave, the entire production line shut down for two hours because none of the junior engineers could do critical maintenance work

2 Constrained Transformation and Upgrading

For China, where most small and medium-sized manufacturing companies are still in the industry 2.0 (Ford's assembly line scale), successful cases of transformation through automation are not the whole story or even a typical plotline.

Around us, it is not rare to find cases where shortages of tens of thousands of technicians are hampering China's manufacturing transformation.

One of the most important reasons why China cannot make high-end ice skates under the feet of Yuzuru Hanyu (a talented Japanese figure skater) is the extreme lack of experienced technicians. A similar story happened in the lighter industry in Wenzhou.

******Excerpted case of lighters: A few years ago in Wenzhou, the lighter industry, which had an annual output of more than 500 million and occupied nearly 70% of the world market share, experienced a fierce trade war and was forced to transform and upgrade. Now, with rising labor costs, they have lost significant market share.******

China very much lacks talents capable of using foreign advanced production lines, and the maintenance and conservation of machines are issues as well.

That's why for many manufacturing companies, they won’t want robots even if you gift the robots to them. More than one robotics startup will encounter this dilemma when it comes to product promotion.

Take welding robots, which account for 40% of industrial robots. Buying a robot is only the first step of a long march, and the purchase price is only one-third of the total cost.

It takes a long time from the purchase of the welding robot to debugging it for proper production, and it also requires very experienced professional technicians.

A robot is just a tool. How well it works still depends on the experience or knowledge of manual welders. For example, if undercuts occur during welding, an experienced technician is still required to help adjust welding parameters, torch angle, or power.

In fact, robot programs compiled by experienced welders have relatively better actual welding results.

Although China has many technicians trained by vocational schools and advanced colleges and universities, how many can truly independently design jigs and compile robot programs?

Programming is just one of the potholes, and the subsequent operation and maintenance costs are not low. Regardless of whether there are collision guns, blowholes, or damaged fuel tanks or pinch guns during the operation process, trained and experienced technicians are required to handle them.

So that’s why many automated car manufacturer workshops still need one robot debugger or welding engineer to accompany every 4 welding robots.

It can be said that the quality of a company's welding robots is based to a large extent in the people that surround them, so a company needs to ensure a stable talent team.

For non-standard equipment, small batch welding, specialized welding positions, equipment maintenance welding (usually partial and small areas, can’t even call it batch), the time to program the robot may be greater than the time to complete the task using manual welding.

At this time, companies will choose to give up on using robots and turn to skilled technicians for help.

This explains why the diffusion rate of welding robots in China is only 20-30%, and the proportion in Germany and Japan is as high as 70% or even higher. German and Japanese senior technicians account for as much as 40% or more of the workers, whereas the lack of mid-level and senior welding talents in China has limited the diffusion of welding robots to a certain degree.

In the Changan auto workshop in Chongqing, the currently highly automated welding and assembly workshop still requires more than 100 workers divided into three shifts, mainly for

"small jobs" such as precision grinding and polishing that are not convenient for robots. Some Chinese smartphone manufacturers still rely on skilled fitters to grind smartphone cases to remove marks left by CNC milling.

In this regard, Cobot Technology CEO Miao Li explained that machines can replace work involving hand-eye coordination. For example, at present, machines are more powerful than factory managers at sorting shiitake mushrooms.

However, for tasks such as welding and polishing, which require an operating intuition, they will require people to do for quite a long time.

Excerpted section on more examples of non-standard tasks and industries that machines haven't penetrated: shoes (cites example of Adidas closing its automated shoe factory), clothing, lens production all require skilled workers

The quality of the technicians will limit the effectiveness of not just automation technology but even those artificial intelligence technologies that can currently be implemented.

When developing the first intelligent shiitake mushroom sorting line in China, Cobot Technology found that the recognition rate of the algorithmic model reached 85% and then stalled. Through analysis, they found that many of the original data were mislabeled.

The level of non-professionals is not as good as that of the workers that do the mushroom sorting workers, and the level of assembly line workers is not as good as the director of the workspace. It was actually the factory manager who had the best performance level at annotating data. When they asked the factory manager to help annotate the mushroom images, the algorithm's recognition rate immediately jumped to a new high.

"The director also counts as a senior technician in the classification of shiitake mushrooms, right? Can you say that the level of the technicians does not affect the implementation of the algorithm?" Miao Li asked rhetorically.

Some companies engaged in predictive maintenance of industrial equipment have also told us that they need experienced machining technicians in aspects such as the extraction and modeling of vibration signals for rotating machinery.

So, what exactly caused today's huge shortage of mid-level and senior technicians?

3 The cost of low-end manufacturing

There are many reasons, and income is definitely a very important reason. What's more, human beings have the ability to compare society from the age of four or five.

Someone with a master’s degree in AI who works for a large Internet company can get 20,000 to 30,000 (RMB) a month; a full-time Didi driver in a second-tier city, if he is online for 10 hours a day, the average monthly salary is about 15,000.

In sharp contrast to this, assembling technicians in a large factory like ABB have the opportunity to get 140,000 to 150,000 a year. Moreover, this number is the salary ceiling for most senior skilled workers. Considering that they are usually in their forties, the gap with AI talents has evolved into one that is difficult to cross.

However, there is a deeper reason for the huge shortage in technicians at the moment. Miao Li reminded me to look at the problem from the perspective of supply and demand. The key is who needs so many mid-level and senior technicians? Has the Chinese market really needed them in the past few decades?

"Those that need senior technicians are either state-owned enterprises or private enterprises that have done a pretty good job. What is the proportion of these?" He asked rhetorically.

In fact, before the appearance of the "Lewis Turning Point" (2003), the technological content of enterprises never constituted a bottleneck for development.

China's rise as a manufacturing power is essentially the rise of world-class assembly plants.

In processing and assembling, the competition is based on low-cost labor, sales, and management/coordination, not technical personnel. The highest value-added parts of the industrial chain, such as design, research and development, and branding are not in China.

Even in the glorious decade of Chinese electronics, Chinese companies can only get 4% of the profits from Apple mobile phones. Samsung's gross profit is as high as 40%, which is 8 times that of Foxconn.

More than 90% of the manufacturing industry is small and medium-sized enterprises, which rely on low-cost competitive advantages to embed in the low-end manufacturing links of global value chains. Many small and medium-sized private enterprises employ migrant workers. According to the relevant statistics of the National Bureau of Statistics, even after the Lewis turning point, one third of farmers have poured into the manufacturing industry. Small gradations in the workforce would include those who graduated from technical secondary school, technical school, and there are basically no mid-level or senior technicians.

Excerpted one teacher from a vocational college in Guangdong's portrayal of the students: *no score benchmarks to get in to college, some students did not have a junior high school diploma, and many would leave school for long periods to help out at home*

From another perspective, due to low added value, low profits, and unstable orders, the life cycle of a company is often very short.

The life cycle of small enterprises can reach 12 years in Japan and Europe can reach 12 years, more than 8 years in the United States, and only 3 years in China. This also leads them to have less energy or even the opportunity to train mid-level and senior technicians. Training these employees relies on experiential practice, and not only are the cost of experiential learning very high, but the cycle is also very long and the growth is very slow.

Therefore, these companies also formed their own methods in practice: once they encounter difficult technical problems, they seek expert consultation and contract the work out.

At least for a long time, this model can address basic issues and successfully avoid the embarrassment of accidentally making wedding clothes for a competitor.

This is why mid-level and senior craftsmen such as "The Craftsmen of a Great Country" are mostly concentrated in large state-owned enterprises, and they are often high-end manufacturing companies such as Hudong Zhonghua Shipbuilding, CRRC Qingdao Sifang Locomotive, COMAC and other high-end shipbuilding, high-speed rail, aircraft and even spacecraft manufacturing.

******Excerpted section about importance of welding for shipbuilding -- and scene-setting for how China's machine tool industry benefited from low-value add model***

At that time, foreign high-end CNC machine tools alone could not meet the market demand, and the quality of Chinese labor force also could not use those high-end tools. Coupled with lower labor costs, Chinese machine tools can occupy the mid-to-low-end market through price and service advantages.

There will eventually be a shuffling of the low value-added model based on quantitative advantages. Under this challenge, the question of who will bear the crux of the talent shortage is currently testing the wisdom of the manufacturing industry and the Chinese education system.

4 Breaking through the 2-D Wall

At present, 75% of German secondary school graduates enter the field of vocational education to continue their studies. Apprentices receiving dual education started studying at the age of 15 and have already completed their apprenticeship when they need to face family and life pressures around the age of 30. An honorable income and social status allow them to have more control over their lives.

In China, taking welders as an example, the average period of technical improvement and experience maturity is more than 18 years (higher than that of Germany by many years). At the stage of completing life's major events and burning the most money to have children, the mechanics may not be able to finish their apprenticeship, and their income is probably between 3000 and 5000 or 6000 RMB.

Many people attribute the German manufacturing quality and economic miracle to the "dual education system", and the large number of high-quality skilled workers it trains has become a strong backing for Made in Germany. Chinese companies, educational institutions, and local governments are trying to imitate and even introduce German vocational education.

For example, Guangdong, the “flagship” of the nation’s vocational education, has clearly established 10 national first-class, internationally renowned high-level technician colleges within five years, under the school-enterprise, dual education system. The Sino-German Siasun Education Technology Group even acquired the German Teutloff Vocational Training Institute, and wanted to use the original German vocational education to solve the talent gap of senior technicians and engineers.

However, there is still a factor that is rarely mentioned here: the company itself.

In Germany, half of micro-enterprises have vocational education qualifications, while more than 90% of large enterprises have vocational education qualifications. Enterprises are one of the main bodies in the vocational education system and the main source of funding for running schools. On the other hand, they are also the main force for absorbing these students.

Many German SMEs can not only become century-old stores, but they also be willing to plant trees themselves and wait for the flowers to bloom. Where does this driving will to bear the risks of the future come from? Why do Chinese small businesses live on average for less than three years and prefer to use ready-made people?

******[excerpted section connecting Weber’s “Protestant work ethic” to German companies’ investment in long-term talent cultivation], which concludes with the sentence: “This is probably the spiritual core that Chinese companies will find difficult to reproduce in the short term.”******

It is worth noting that recently, Shenzhen Technology University, China's first university of applied technology, was established in Shenzhen. ****[excerpted sentences about Jiangsu and Guangdong also incorporating technical colleges into higher education institutions]****

If some good technician colleges can be incorporated into higher education institutions, the historical duality and estrangement between "talent" and "labor force" will gradually be broken. To improve society's (talent) allocation system and change the future vocational education pattern, it will no longer be "水中日月."