

The background image shows a factory environment with several industrial robotic arms. One prominent arm is orange, and another is blue. They are positioned around a complex metal engine component. Bright sparks are visible where the robots are working, suggesting a welding or grinding process. The scene is lit with dramatic, low-key lighting, highlighting the metallic surfaces and the dynamic activity of the machinery. The bottom half of the image is overlaid with large, semi-transparent geometric shapes in shades of blue, purple, and pink.

# Machines replace Humans? Automation and upgrading at car suppliers in China

Yang Tao and Luo Siqi

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# Introduction

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Under the buzzwords “second machine age” and the “fourth industrial revolution”, the increasing deployment of industrial robots and artificial intelligence has come to the working world. In recent decades, many have worried that advancements in machines and technologies would mean technological unemployment or even lead to the “end of work”. Although the exact number of jobs lost to industrial upgrading and transformation remains debatable, worries have not faded. The manufacturing sector is the most illuminating case in point.

While many have focused on the number of manufacturing jobs lost, others have concentrated on how the qualitative aspects of labour have been affected. For example, changes in required skills emerged as a key topic, encompassing deskilling, reskilling and social skilling. Shifting power relations between employees and employers are another area attracting attention. In the context of Marxism and industrial relations, the debates range from the purpose of new technological designs to the choice of technologies to the implementation process.

This complex, yet inconclusive series of debates on technology and labour has now reached China. Industrial upgrading and transformation have become an important approach in fulfilling and sustaining China’s

strategic goal of establishing itself as a world-leading manufacturing power. In May 2015, the State Council of China issued Made in China 2025 (MiC 2025), a plan that set becoming a major manufacturing power as a key task for China given the on-going restructuring of global manufacturing and the dramatic changes in the Chinese economy. The effect of such changes on labour is far from clear. A closer look is therefore needed to assess the impact of technological change on work and industrial relations in China, starting with a review of current policy and the economic environment. The automobile industry, a highly capital- and technology-intensive sector and the earliest to be automated in the industrial world, serves as an illustrative case.

The following analysis draws on empirical research conducted in 2017 with the support of Volkswagen Group China,<sup>1</sup> examining eight typical first- and second-tier auto parts and components suppliers for the supply chains of Japanese-Chinese auto manufacturers in Guangdong Province, South China’s manufacturing hub. Research on the implementation of automation projects at these factories and the impact these projects have had on work and labour relations reveals that the processes of automation have been incremental but unbalanced and points to several avenues for dealing with these issues, among them rebuilding skills-training systems.

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1. For a detailed introduction and discussion of this research, see Yang 2018, the original (Chinese-language) research report on which this publication is based.

# Background: industrial upgrading in China

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Little attention has been paid to the relationship between automation and labour in China. To be exact, the national government and local governments have exerted great effort to promote the transformation and upgrading of industries as per MiC 2025, but corresponding upgrades to the benefit of workers has largely been neglected or has lagged behind.

A series of national policies have clearly identified industrial transformation and upgrading as the key to establishing China as a manufacturing power. Due to the recent and on-going trade conflict between China and the United States, emphasis on MiC 2025 has quieted, and some policy measures have been adjusted, such as subsidies for new-energy vehicles, but overall, progress continues to be made. MiC 2025 and the upgrading of the Chinese industrial sector in general encompass three steps: accelerating the transformation and upgrading of manufacturing sectors, improving the quality of technological development, and enhancing the core competitiveness of manufacturing. Similarly, the Thirteenth Five-Year Plan (2016–2020) highlights the importance of innovation and of improving the fundamental capabilities of the manufacturing sector. These policies and related supports have resulted in unprecedented growth in the use of robots.

According to the International Federation of Robotics (IFR 2017), China has become the largest robotics market in the world. In 2016 alone, 30% of industrial robots worldwide were sold in China. Robot density has been rapidly growing, from 25 per 10,000 workers in 2013 to 68 in 2016, and it is estimated that enterprises in China will acquire 40% of the industrial robot supply in 2019 (United Nations 2017).<sup>2</sup>

At the same time, the Communist Party of China and the government have repeatedly referred to the “transformation and upgrading” of industrial workers. The “craftsmanship spirit” of Chinese workers, considered key to upgrading the manufacturing sector, is the catchphrase endorsed by Prime Minister Li Keqiang and

repeatedly mentioned in the government’s 2016 work report. In a similar vein, the Politburo’s Leading Group for Overall Reform called for the “upgrading of industrial workers” to resolve problems related to such labourers and to improve labour quality, guarantee workers’ rights and benefits by law and to create an idealistic, faithful, skilled, innovative and responsible group of industrial workers. Following on these approaches, the All-China Federation of Trade Unions (ACFTU) in January 2017 announced that it would strengthen industrial workers groups to ensure skills development for the new innovation-driven manufacturing strategies.

The transformation and upgrading of workers is the other side of the coin in regard to industrial transformation and upgrading. Policy emphasis involves providing knowledgeable and skilled workers for the above-mentioned grand strategies. Nevertheless, in practice, more attention has been given to the upgrading of companies and technologies, rather than the workers. In fact, many provincial and local governments, including Zhejiang and Guangdong Province, refer to their efforts as “machines replace humans” projects. Furthermore, the Ministry of Human Resources and Social Security, the Ministry of Education, the ACFTU and other relevant organizations were not major contributors to the development of MiC 2025 (Luethje 2017).

Many questions about automation and labour remain and cannot be answered without empirical evidence being collected at the micro level. For instance, on the one hand, why and how do enterprises deploy automated lines and robots? Is the process primarily driven by the national policies for industrial upgrading? In the quest to achieve the technological leap propagated by the government, have the automated production processes in various enterprises been introduced in a disruptive fashion? On the other hand, what exactly has changed on the labour side? Have there been massive job losses? Has the quality of work improved or declined? What has been the impact on industry–labour relations? The research presented here explores the answers to these questions.

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2. Robot density is based on the ratio of robots to every 10,000 workers (IFR 2017).

# Car suppliers in the Pearl River Delta: automation and labour relations

To examine the process of automation as well as related changes in work and industrial relations, researchers conducted a survey of eight (mostly first-tier) auto parts suppliers in Guangzhou and Foshan, two key auto-manufacturing cities in the Pearl River Delta (PRD) in South China's Guangdong Province.

Japanese automobile manufacturers occupy an important position in the automotive industry in the PRD. The three large joint ventures of Guangzhou-Honda, Guangzhou-Toyota and Dongfeng-Nissan have complete industrial chains in the region. They represent the leading firms for a large network of suppliers, most of which are privately owned or foreign direct-invested enterprises. The eight suppliers surveyed are either wholly Japanese-owned or Sino-Japanese joint ventures and have Japanese brand-name carmakers as their main customers. Their products range from core components, such as engines and transmission boxes, to peripheral parts like window switches and car logos. The number of employees ranges from 500 to more than 2,000, which is typical for auto suppliers in China.

The dynamics of capital-labour relations in South China were reshaped this century by major strikes in the auto industry. In 2010, all eight suppliers experienced work stoppages that were eventually resolved through collective bargaining. Since then, trade unions have become firmly established at these suppliers, with enterprise union congresses electing union chairs and committees. The organizations conduct standard union activities, including collective bargaining negotiations over wages (Luo and Yang, 2019). Compared to the overall state of industrial relations in China, those between these suppliers and workers can be considered quite advanced.

In 2017 at each of the eight enterprises, researchers conducted questionnaire surveys, in-depth interviews and focus group discussions with 30 to 35 employees, mostly front-line production workers, but also technicians, managers and office clerks (see Table 1). The workers' average tenure was relatively long, at about 7 years. Considering that most Japanese auto parts suppliers

only came to Guangdong Province after 2004, their workforces nonetheless appear to be more stable and older than those in other manufacturing sectors in South China, such as the electronics and textiles industries.

The mantra of "machines replace humans", a key feature of the upgrading processes in China's manufacturing sector, is reflected in the strategies of these car suppliers. Since 2010, all eight companies have been undergoing varying degrees of automation upgrading, with automation rates at least doubling from 2013 to 2017. Most employees were potentially or actually affected by the upgrading of machines and technologies. These changes were not, however, driven by government policies. Rather the enterprises introduced them themselves, to deal with labour issues and to enhance market competitiveness. Also of note, the automation processes at the eight car suppliers emerged as gradual and incremental, not "revolutionary" or "disruptive".

Table 1: Questionnaire respondents: basic information.

Gender	Female	35.8%
	Male	64.2%
Age	Born in the 1970s	10.6%
	Born in the 1980s	53.8%
	Born in the 1990s	35.6%
Education level	Junior high school	6.6%
	High school	17.7%
	Technical secondary school	41.2%
	Tertiary vocational school	23.9%
	Bachelor degree or above	9.5%
Type of work	Regular workers	95.0%
	Dispatched labour and interns	5.0%
Position	Front-line worker	59.5%
	Manager	19.0%
	Technician	5.5%
	Office personnel	16.0%

### Forces driving automation

Although national and local government enthusiastically promoted “machines replace humans”, the eight auto suppliers, as noted, voluntarily pursued their own projects of industrial automation. Since 2010, all of them gradually increased investment in mechanization and automation for two major reasons: labour costs and market competitiveness.

Regarding the former, two problems in particular concerned them: rising labour costs and personnel management. Beginning in 2010, collective bargaining increasingly raised workers’ wages, benefits and annual bonuses so that standard wages rose to levels considerably higher than local minimum wages, as shown by data from two representative companies in Table 2. The average wages of workers at the eight suppliers grew more than 10% annually starting in 2010, to about 5,460 RMB per month (819.50 US dollars) in 2017. On top of monthly wages, workers also received average annual bonuses of about 13,000 RMB (around 2,000 US dollars).

This continuous growth in wages, especially base wages, led the companies to consider alternatives. “In terms of costs, the cost of machines is fixed, but labour costs keep changing [increasing]. The company has a clear request in this regard — promoting automation”, said one of the interviewed managers. Because workers at these companies had previous experience with collective action, some immediately went on strike when their wages or annual bonuses did not meet their expectations. Even when brief, these strikes typically resulted in major losses for enterprises. To better manage employees and avoid strikes, several suppliers accelerated automation

processes in an effort to reduce manpower. As one manager remarked, “Machines are easier to manage than humans”.

The enterprises have since focused on three factors to increase their competitiveness in the market: production costs, stability of manufacturing environment and quality of products. As suppliers to major global car brands, their product prices are greatly influenced by the latter two factors. Different types of auto parts and different positions along the supply chains are important in determining profit margins. In general, profits are highest for the carmakers and then they progressively decrease down through the tiers of suppliers. Parts suppliers may enjoy their highest profit margins the first year of each new car model’s production run. In the years that follow, they have to gradually reduce their prices according to the demands of their clients. To stabilize production, clients might require suppliers to add more machines, increase automation rates or reduce the number of front-line workers. Other reasons clients push suppliers to increase automation are to improve product quality and to reduce defect rates. Thus, in terms of market competitiveness, the suppliers’ automation projects are heavily influenced by the major carmakers.

### Incremental change versus disruptive transformation

The eight car suppliers adopted two main approaches to rationalization and automation: renovating old lines and building new lines. The newly introduced equipment typically included advanced robotic arms and various types of automated tools, such as welders, painting

Table 2: Wages increases at two surveyed companies, 2011–2017.

	2011	2012	2013	2014	2015	2016	2017 Average wages (per month)	2017 Guangzhou minimum wage standard (per month)
Company 1	8% + 450 RMB	19.3%	16.3%	10.0% + 1,000 RMB	12%	9% + 180 RMB	6,507 RMB (975.56 US dollars)	1,895 RMB (284.11 US dollars)
Company 2	15.2%	15.23%	15.53%	12.31%	9.5%	8.8%	5,418.50 RMB (812.37 US dollars)	

machines, sewing machines, infrared analysers, wrenches, and tractors. The automation process generally started small, involving specific positions or specific tasks, and then progressed to certain work processes and then to fully automated new lines. Compared to making gradual improvement to traditional lines, it is much more costly to build new production lines due to the significant up-front investment required.

Renovating old lines requires mechanizing or automating existing production lines. Due to cost and other factors, this is generally undertaken for lines using generic equipment. Specialized equipment is often designed to produce for one car model, but generic equipment can be adjusted to produce for a number of different models. While specialized equipment in these enterprises produces large quantities of similar products using limited and rather unskilled manpower, generic equipment produces for a range of different products. At the eight surveyed suppliers, the majority of workers were employed to operate generic equipment. One of the companies emphasized that its automation strategy encompasses manual labour plus highly automated machine tools, not automation alone. Based on meticulous calculations of labour and machine costs, the company expects to recover its investment in generic equipment within a maximum of three years. Exceptions to this calculation also exist when car assemblers request that certain work be done by machines.

New automated production lines are usually installed to meet the requirements of a new car model. Although new lines are costly, producing for new car models often means higher profit margins, allowing the recovery

of initial costs within two to three years and on rare occasions within one year. Fully automated lines are often equipped with multiple robots, monitoring sensors and a high-definition camera system for defect recognition. In one case, the full automatization of one production line reduced the number of workers from 40 to only four.

Regardless of the approach the parts suppliers adopt, they all have common features. The primary feature is cooperation with the Japanese parent company. The suppliers' relationship with the carmakers provides them with significant support from Japan, such as with importing and adjusting new equipment and training technicians. At the same time, the suppliers rely on technical assistance from the machine or robot manufacturers, which sometimes are subsidiaries of the same Japanese corporate group. The suppliers can deal with programming and some maintenance work, but are unable to resolve major automation failures. While some of those surveyed complained about the high cost of repairs, they all must nonetheless call on the machine or robot manufacturers when systems fail.

The differing positions of each supplier along the supply chain affect their respective automation strategies. For those on the first and second tiers, the cost of new machines might not be too economically stressful. As profit margins are squeezed at the lower tiers, however, suppliers feel more financial pressure; it often takes them longer to recover investment costs. In sum, the lower the position of a supplier in the supply chain, the more likely the company is to choose to renovate old lines rather than install new lines when pursuing automation.



# The automation process

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## Impact on employment

The surveys revealed a seemingly contradictory scenario of “machines replacing humans, but without redundancy”. While certain positions were reduced in number or even eliminated by the automation of certain production lines and sections, employment at the eight companies as a whole did not dramatically decrease. Machines gradually replaced workers in performing the following:

- 1) Strenuous manual tasks, such as moving heavy materials and products;
- 2) Relatively simple and repetitive tasks, such as chip shooting, screw twisting, and welding;
- 3) Work involving health hazards, such as electroplating and painting; and
- 4) Maintaining product quality control.

While strenuous manual tasks were almost entirely relegated to automated machines, the other three tasks were only partially automated, depending on the product.

At all eight suppliers, the numbers of robotic arms and automatic equipment gradually increased, but the total workforce did not dramatically decline due to automation. From 2013 to 2017, the largest reduction in workforce stood at about 15%. The other companies retained a stable number of employees or even experienced a slight increase.

The managers at all the companies mentioned the adoption of “no redundancy” as a basic principle, meaning that they did not actively dismiss workers. Instead, almost all reductions in employees were achieved by “natural” market mechanisms. First, these employers reduced the numbers of newly recruited workers to take advantage of the natural trend of workers leaving the company due to attrition and relocation. Furthermore, some enterprises were increasing their production capacity due to the booming Chinese auto market, which contributed to relatively stable employment numbers. Internally adjusting positions and new jobs in new production fields are common ways of re-deploying workers displaced by machines.

## Impact on work quality

Although machines and robots have not put the majority of labourers out of work, they have changed job content, intensity of tasks and skill demands. The effects of these changes on work have been mixed; the same holds for workers’ attitudes towards them. Nevertheless, despite promises of higher-skilled and better-paying jobs, the surveys showed that most workers’ skills have not developed, but the tasks workers perform and their responsibilities have increased. Of importance, labour standards have not improved either.

The automation process has been facilitated by two work-related mechanisms at the eight companies: the multi-skill work system and job rotation, both of which are key elements of lean production methods similar to the Toyota Production System. Each production line has several multi-skilled workers, that is, people who can be flexibly assigned to different tasks and may at any time fill in for another worker, such as someone who requests leave or resigns. Because this approach is designed as a channel for career development, many employees actively learn to become multi-skilled workers. At the surveyed companies, about 60% of workers had a job rotation, with an average cycle of 2.6 months. Almost all of them believed that they could learn more skills through such rotations, and more than half said that job rotation made their work more interesting. Employees who are capable of working at different positions are usually given priority to work in the highly automated new production lines.

Clearly, multi-skilling does not necessarily provide individual workers with more sophisticated skills. In fact, most work is simplified by the process of automation. What multi-skilling really means is that each worker has to master more work procedures and often take on more responsibilities. Thus, although each individual task is simpler than before, the worker must often perform more steps along the production line. Some workers are even capable of doing all the tasks of an entire line. This is especially the case with those assigned to highly automated lines, where workers are required to master multiple procedures so they can learn to discern signs of malfunctioning and take simple counter-measures.

While the work of many individual workers has become relatively easier, it has also become more intense, simple and boring, especially for front-line production workers. Work intensification is indicated by the shortened average time cycle (i.e. workers have less time to perform a task) along the production lines at most of the surveyed companies. Some workers feel more tired after the automation transformation, while others do not.

While the nature of work has obviously changed, labour standards for that work have not improved. First, workers' wages have not increased in sync with automation upgrading. According to data from the enterprises, there is no direct connection between mechanization and automation on the one hand and workers' interests on the other. Most workers said their wages did not change significantly after the enterprises adapted new machines or new technologies, and a few even mentioned decreases in wages and benefits. Workers at nearly all positions, including technicians, who are ordinarily expected to become more important, have not directly benefited economically from mechanization and automation. In most cases, training did not bring wage increases either. Furthermore, the "old" problem of lengthy overtime work was still prominent at many of the surveyed companies.

### **Worker attitudes**

Although many workers know that machines might be installed to substitute for people, they do not seem to be deeply concerned. Workers realize that one goal of companies in pushing mechanization and automation is to reduce the workforce with the aim of lowering labour costs. Among the workers surveyed, more than half were unworried about the prospect of their job being done by machines or new technologies. Slightly less than half were

"a bit worried", and only a few were "very worried". They reasoned that machines need humans to function and that they could learn new skills in that context.

Most workers accepted the "machines replace humans" programs of their companies because they believed that acquiring knowledge about new technologies could prepare them for eventually being replaced. Even when facing the tangible threat of being replaced by machines, almost 75% of front-line production workers still believed that it was rational for their enterprises to automate, with only about 20% disagreeing. Workers in favour of automation often cited science and technological developments as means to overall social progress, while those who disapproved of such programs often did not give clear reasons for why they felt that way.

One controversial issue is the position of the trade unions. The car suppliers' employees have been pioneers in union activity and collective bargaining in China since 2010. That workers organized efficiently, and yet wages continued to increase under collective bargaining initially motivated the employers to accelerate the pace of automation. Collective bargaining negotiations at the eight suppliers (usually conducted twice a year) have not, however, touched on topics related to automation. So far, the democratically elected trade union leaders have not come to view automation as a major concern. On the contrary, some union chairs consider automation a potential solution to the emerging sustainability problem of collective bargaining over wages: With workers at the suppliers having come to expect significant wage increases each year, union leaders find it increasingly difficult to continue to meet expectations. One union chair at a leading supplier commented, "If our company has 1,500 employees instead of 2,000, but profitability remains at 10%, each employee would receive more pay and benefits".

# Conclusions: incremental upgrading and growing imbalances

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The data collected from the eight car parts suppliers reveal several key departures from popular notions regarding the disruptive or revolutionary potential of new technologies that have taken root in the current discourse over intelligent manufacturing in China and globally.

On the employer side, the main motivation for automation has been to reduce labour costs, better manage workers and enhance the competitiveness of their products. The Chinese government's highly propagandized policies were not the major driving force for automation processes, especially initially. One obvious reason is the predominantly foreign ownership of the companies, which were never the main target of the government's policies. As of June 2017, the suppliers had received little or no financial support from government for automation projects. In Guangdong, subsidies for robots were typically provided for Chinese-branded machinery, which is not much used by foreign-invested firms. For instance, the Japanese car parts suppliers prefer to import their automation equipment from Japan.

Another unexpected finding is the limited impact on job numbers. Disruptive or sudden technological revolutions have the potential to cause huge job losses. The automation processes at the observed companies have not, however, led to dramatic reductions of the workforce. In fact, a few enterprises have more employees than they did five years ago. The reasons are manifold.

One key factor is that the automation processes, as shown at all eight suppliers, have been incremental. Automation has mostly been progressively adopted in one position after another; wholesale shifts to brand-new automated lines have been rare. Such incremental progress gives companies time to adjust workers' positions and limit new recruitment. An important result of an incremental approach and the principle of "no redundancy" is that workers are not antagonistic to rationalization. In some cases, it even has the support of labour representatives. Nevertheless, there could be much more disastrous consequences if the same automation process were to be implemented in more labour-intensive, lower-end companies and sectors. It is clear that the functioning

framework of grass-roots factory unions and collective bargaining have contributed to the gradual and relatively cooperative manner of workplace transformation.

Even though automation has been incremental, obvious problems have emerged. Of particular note, skills and compensation are becoming increasingly disconnected. In the course of mechanization and automation upgrading, workers have continuously expanded their skills through training, but their wages have not risen accordingly. Skills-based wages, an important part of total wages, provide direct remuneration for the acquisition of new skills. It is therefore necessary to effectively connect skills and wages through skill-based wage systems that ensure that when workers' skills change rapidly, the adjustment of skills-based wages does not lag behind, failing to reflect workers' actual skills. More important, if a separation of skills and wages becomes the norm, the motivation for workers to learn new skills shifts from wage increases to keeping their jobs, so as not to be replaced by machines or discharged by their employer.

A deeper concern is that the simplification of work through automation and the accompanying mechanisms making labour more interchangeable has reduced workers' bargaining power. Skilled auto workers are traditionally viewed as having strong bargaining power. They possess the necessary expertise for production, which requires a long period of training, making them difficult and expensive to replace. The relatively higher wages of technicians represent proof of this. Increased automation at the eight suppliers, however, has resulted in simpler operations at many positions, such that workers are now easier to replace. The operation becomes so simple that, as one manager put it, "Anyone who has two arms and legs and a sane mind could do it". Consequently, when the companies recruit workers, they often care more about applicants' attitude and learning abilities than their having exceptional skills. Moreover, the multi-skilled work system and job rotations, by allowing each worker to master more tasks, has led to the loss of skill uniqueness and blurred the lines between the division of labour. As someone remarked, "No one is irreplaceable". In the end, automation effectively prevents workers in

key positions or who possess core skills from using these attributes as leverage as in the past.

The social imbalance in the automation processes has been obvious and may be exacerbated by the loss of bargaining power by labour. Decisions on whether to upskill workers in the automation process have depended primarily on the employer. Such dependency is seen not only in workers mainly relying on internal training to learn and expand their skills, but also in employers' efforts to alleviate the negative technological impact on their positions. When enterprises are pursuing higher automation rates by replacing workers with machines, the transformation is made smoother when positive relations result in workers' trusting that their enterprises will not allow them to lose their jobs. This relationship is nonetheless highly unbalanced, as workers are in subordinate positions and must entrust their future careers to their employers.

For various reasons, of course, not all companies can fulfil workers' expectations of "no redundancy". For instance, many enterprises may be unable to provide replaced workers new jobs by expanding production. Especially during economic recessions or when facing

financial problems, enterprises often move first to lower labour costs. In the face of the massive decline in growth and mounting overcapacity in the Chinese car industry since 2017, employment security threatens to become a growing problem. Furthermore, the "no redundancy" principle cannot guarantee that workers will not eventually become unemployed. The principle has been a voluntary and unwritten promise of the employers and can be ignored at will.

The problem also lies on the labour side. Workers have not engaged in the decision-making processes on automation in any form. Employers alone have decided when, where and how to automate; according to the majority of workers surveyed, they typically have no capacity to constrain employers' actions. The relatively well-established collective bargaining mechanism has not taken up the issue, instead focusing exclusively on wage increases and annual bonuses.

Ultimately, automation upgrading, given workers' dependence on their employers, has not led to more balanced labour–capital relations, but instead has created further imbalance, in which capital is strong, and labour is weak.

# Policy recommendations: balancing industrial and labour upgrading

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Based on the data collected, much more attention should be paid to vocational education and training, human resource management, wages and benefits, skills certification and related issues of privacy and the workplace. Most of these topics include substantial reform of labour laws. Despite the measures the surveyed enterprises have adopted to alleviate labour-capital conflicts stemming from automation, problems remain, with more to come.

One trend is clear: In the long run, fewer workers will be needed to sustain the same level of production. This will be a particularly negative development for low-skilled workers in labour-intensive and low-end industries and companies, as machines and technologies can easily and rapidly replace such employees. The quality of work is another problem area in pursuing automation. Even in places where automation does not necessarily lead to job losses, work at individual positions can become simpler and easier. As workers assume simpler tasks and supervise more procedures than previously, however, they may come to feel more pressure, bored and insufficiently compensated.

Given the findings outlined above, three approaches should be considered to promote balanced industrial and labour upgrading. First, all parties should develop multiple and more effective skills-training systems. Not just companies, but the government, trade unions, vocational schools, social organizations and others as well should become providers of skills training for workers, thus creating a multi-pronged system that extends beyond the individual enterprises.

Such a skills-training system requires the two basic inputs of funding and time. The reason most workers choose to receive training at their enterprises is because the company is capable of providing these inputs. These enterprises arrange the time to train them for free. Reducing overtime hours through the effective implementation of labour laws is key to guaranteeing that workers have adequate

time for skills training. In addition, more flexible training can be provided through school–enterprise cooperation, union-supported programs and exposure to foreign training systems.

Although the official trade unions in China offer subsidies to workers to earn skills and education certificates, such programs have not kept pace with what enterprises have come to require in recent years. In short, they are largely irrelevant in regard to automation upgrading. In this respect, governments at different levels should include skills upgrading in official policies and devise effective measures to implement them. For instance, the government could issue new regulations on funding and time allotted for training and provide incentives to enterprises that provide skills training rather than merely buying automation equipment. Such skills provisions should be included in all local government programs to advance the upgrading of manufacturing at the local and sectoral levels.

Second, trade unions should assume a more active role by representing workers in the transformation and upgrading processes at enterprises. As shown in other countries, democratic worker participation is an important mechanism through which constraints can be applied to employers, but at the same time does not hinder industrial upgrading or organizational and technological innovation at the enterprise level. Workers can obtain relevant guarantees from their companies, such as wages increases, skills upgrading and better benefits, rather than standing by as passive observers in the automation process. Others having a role to play in strengthening workers' voices in the automation process and allowing for more balanced upgrading include the Workers and Employees Congress and its Opening of Factory Affairs program,<sup>3</sup> employee directors and employee supervisors.

Third, collective bargaining should continue but become the key mechanism for adjusting and balancing labour–capital interests in the industrial transformation and

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3. Opening of Factory Affairs is one of the basic institutions for the democratic management of enterprises in China. It requires that important issues related to the development of an enterprise and the interests of employees, except business secrets or other matters protected by law, be made public to the Workers and Employees Congress.

upgrading process. If the current pace of workplace transformation continues, trade unions and workers should consider adding the following to collective bargaining:

- Gradual reductions in overtime hours while maintaining compensation and wage standards: Automation provides space for shorter working hours, since normal work time on new machines can increase total production.
- Reform of existing skill and pay ranks to address the obvious mismatch between the existing systems of job classification and the actual skill levels of workers: The wage systems often do not reflect the real value of workers' skills. Although a few companies have changed their skill ranks or promotion systems, workers

and trade unions did not have a say in the process or the results.

- Coordination between trade unions and governments at high levels to reform labour policies to respond to new technological trends: Further automation may cause dramatic changes to front-line work, not just in the number of jobs and the character of skills, but also in work categories and wage determination.

These changes exceed the capabilities of any single enterprise, which is a key reason for extending collective bargaining from company-based to sectoral or industry-wide agreements. Trade unions and government departments at the upper echelons must therefore remain engaged and coordinate on these issues.

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