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Moving Beyond Cheap Labour? Industrial and Social Upgrading in the Garment and LED Industries of the Pearl River Delta

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Abstract: Based on field studies in the Pearl River Delta (PRD) in 2010 and 2011, specific paths of industrial upgrading in the garment and IT industries are identified. The analysis reveals that there exists a multiplicity of upgrading trajectories, all of which have different implications for skill development and the character of work. While the modernization of industries relies on the input of higher skilled work, primarily in the fields of R&D and marketing, this barely is the case with regard to manufacturing. While labour intensity in the examined cases is diminishing in absolute or relative terms, internal divisions between low-skilled and high-skilled work are reconfigured rather than overcome.

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Introduction

The global economic crisis of 2008–2009, which affected the export-oriented industries of the Pearl River Delta (PRD) in a particularly harsh manner, led to a new assertiveness within that region's provincial government regarding its goals for industrial transformation. While the growth model of the reform period that largely relied on labour-intensive export production with low technological capabilities had already been deemed to be unsustainable before the crisis, the virtual breakdown of the export industry in late 2008 injected an increased sense of urgency to the government's reform policy (Yu and Zhang 2009). This was expressed well by Wang Yang, the chairman of the Guangdong Chinese Communist Party (CCP) and pronounced advocate of economic transformation, who welcomed the crisis as an opportunity for industrial transformation. In a metaphor, which has become famous in the region, he said that it was time to "open the bird cages to let new birds settle down" and thus advocated a strategy of "dual transformation" of industries. In the wake of the economic breakdown of 2008–2009, this has meant nothing less than the commitment to encouraging the relocation of low-end manufacturing industries towards the periphery of Guangdong province or to other provinces, while fostering high-end industries and a modern service sector (Yu and Zhang 2009: 4; Kuhn 2009).

The policy efforts to overcome the prevalent growth model based on low-end production for export markets combined with unprecedented wage hikes in the aftermath of a series of explosive strikes centred on Guangdong's automotive industry saw media commentators proclaiming the "end of cheap labour" in China (*Time Magazine* 2011). This claim could be premature, however. On the one hand, there has been a rise in minimum wages throughout the Pearl River Delta in recent years; on the other hand, however, it is not clear whether or not industrial restructuring is also leading to substantial changes in terms of employment patterns and wage systems, which would be a precondition for qualitative improvements for workers in Guangdong province.

The aim of this article is to shed light on the implications of industrial upgrading trajectories on employment patterns and working conditions on the basis of empirical cases from the garment and IT sector obtained during field research in Guangdong's Pearl River Delta in 2010 and 2011. I refer to recent theoretical discussions about the relationship between technological change, higher skills and wages, in order to develop a research framework for the analysis of the empirical cases. On this basis, some parallels and differences are discussed, which are summarized in the last section with regard to policy recommendations.

Technological Change, Industrial Upgrading and Wage Inequality

The relationship between technological change, employment patterns and income distribution has been a subject of recent debate within the disciplines of economics and sociology. Recent labour economics literature suggests an inverse relationship between technological change and income equality. The theoretical model of Skill-Biased Technological Change (SBTC) proposes that technological innovation generally leads to a higher demand for high-skilled labour in relation to low-skilled functions. The result is rising wage inequality unless there is a strong increase in higher education that eases the scarcity of high-skilled labour. This assumption, which was originally formulated by Tinbergen (1975), has emerged as a consensus among scholars in the field of labour economics in the 1990s and has found confirmation in many empirical studies on developments in OECD countries (cf. Lemieux 2007; critically: Card and DiNardo 2002; Pavcnik 2011). However, recent research has found derivations from the model that even radicalize the original assumptions:

- Real wage losses for mid- and low-skilled workers (particularly in the U.S.), whereas the original SBTC model expected a general rise across income groups (Acemoglu and Autor 2011).
- A polarization of employment between high- and low-skilled functions primarily through the mechanization of tasks that had previously been taken over by moderately skilled employees (Acemoglu and Autor 2011).
- A positive feedback between skill supply and technologies requiring skills: a large pool of well-educated workers supports technological changes that require higher skills (Acemoglu 1998).

These findings, generated from a thorough review of aggregate empirical data on labour markets in OECD economies, are instrumental in generating questions about the relationship between technological change and income distribution in emerging economies. Although the concept of SBTC emerged within the context of advanced economies and empirical research still remains mainly focused on these, several authors have applied this approach to data from developing countries (Berman and

Machin 2000; Conte and Vivarelli 2007; Behar 2012; Pavcnik 2011: 241–247). They especially discuss the impact of technology transfer on skill demand and income distribution. The adoption of advanced technologies raises the demand for skilled labour, but this effect is "not inclusive" in the sense that it does not lead to improvements for unskilled labour (Behar 2012: 21f). A cross-country study of 23 low- and middle-income countries (LMICs) concludes that rising capital intensity "is responsible for relative shifts toward skilled labour. This does not reduce, however, the absolute employment of unskilled labour" (Conte and Vivarelli 2007: 19).

The insights on SBTC from empirical economic studies raise serious doubts about whether a technology-focussed upgrading strategy in itself can address the problem of growing income inequality that has come to put the sustainability of the Chinese growth model into question. The analysis of aggregated data on labour markets, however, conveys little information about the concrete mechanisms by which skill demand is shaped. The aim of this article is to shed some light onto these issues by case studies on the impact of technological change on a sector basis.

Theoretical models from economic sociology provide a useful point of departure for the discussion of technological changes in emerging economies, because they take account of the manner in which emerging economies are integrated into global production networks. Technological change is interpreted as a question of "industrial upgrading" and subject to the position of companies, clusters, and regions into hierarchically structured production networks in different industrial sectors (Gereffi 2005; Bair 2009; Cattaneo, Gereffi, and Staritz 2010; Selwyn 2011; Lüthje et al. 2013). The focus of analysis, therefore, shifts from general statistical data towards a breakdown of competitive relations within different industrial sectors that influence the respective upgrading perspectives. In this way, specific upgrading trajectories and their respective consequences for work can be identified. But despite the fact that industrial upgrading is generally seen as a viable strategy for socially sustainable patterns of development, the precise impact of upgrading strategies at the firm level on wages and working conditions has been strangely neglected until recently. As the editors of one recent special publication on this issue argue:

> [t]he upgrading debate has largely focused on economic upgrading and has not specifically taken into account social upgrading understood as improved working conditions, higher-skilled and better paid

> jobs. Economic and social dimensions of upgrading are often intertwined, but one does not necessarily lead to the other. In fact, we understand relatively little about the conditions under which they occur together (Staritz, Gereffi, and Cattaneo 2011: 4).

As a matter of fact, "[i]t is often implicitly assumed that economic upgrading in global production networks (GPNs) will automatically translate into social upgrading through better wages and working conditions". However, the actual picture regarding social upgrading through technological change is "mixed" (Barrientos, Gereffi, and Rossi 2010: 7), a conclusion that echoes the findings on SBTC outlined above. Empirical studies about the emergence of electronics contract manufacturing also point to this direction. These highlight how sophisticated technologies are applied in combination with exploitative employment patterns based on cheap migrant labour (Lüthje 2004; Lüthje et al. 2013). Solid empirical studies on the impacts of upgrading on employment, wages and working conditions either on a regional or sector basis, remain scarce, however. Hence the conditions that determine the impact of technological change on work remain largely unknown. Barrientos, Gereffi, and Rossi presume (2010: 14) that suppliers in GPN are affected by contradictory pressures to deliver higher quality while keeping costs low. The way in which these contradictions work out determines whether companies pursue a "high" or a "low road" of upgrading in terms of labour conditions.

In order to investigate the concrete impact of technological changes on the respective skill and wage structures, as well as on general working conditions, insights from industrial sociology provide relevant tools. They also can help to avoid a technology bias which seeks to deduce the patterns of work and income distribution directly from the character of the technologies applied in production. Rather, institutions and regulations, the "politics of production" (Burawoy 1985), decisively shape the way in which technology is applied. This insight, which currently is neither sufficiently developed in the theoretical debates on industrial upgrading nor in those on SBTC (cf. Lemieux 2007), is particularly relevant for the analysis of industrial change in China. The question that needs to be answered is how certain trajectories of technological change affect the patterns of work in the highly specific context of Chinese industrial relations that are, among other, marked by an absence of independent trade unions, collective bargaining systems and strong regulation of the wage relation (Chang, Lüthje, and Luo 2008). In the following, I will refer to criteria developed by Lüthje, Luo, and Zhang (2011: 16–25) for the analysis of "Regimes of Production" in core Chinese industries. These include questions about:

- the organization of production,
- work organization and working conditions, as well as
- labour relations.

To assess the relationship between industrial and social upgrading in the empirical cases, the analysis will be conducted on two levels. First, the specific upgrading strategies on cluster and company level will be identified. Second, their implications for the character of work will be analysed at the company level. The following section develops a concrete research framework for this task.

Deciphering "Industrial Upgrading"

Industrial upgrading (产业升级, *chanye shengji*) has become a catchphrase that is rarely absent from any discussion about the future growth perspectives of the Chinese economy. While the term is mostly used as a general synonym for industrial modernization, it can mean a plethora of different things when it comes to setting goals at the level of a specific industry, a geographically confined cluster or a single enterprise. This ambivalence can also be detected in recent government proclamations. The idea of a replacement of old, low-end enterprises by technologically more sophisticated ones received much publicity, after Wang Yang had launched his policy of dual transformation. Yet at the same time, he also promulgated the idea of a gradual transformation of existing industries:

> We need to take advantage of the strong base of traditional industries, increase the added value of their products, and accelerate transformation and upgrading of traditional industries to move them from the low end of the industrial value chain to the high end (Wang 2010).

Given this multiplicity of meanings, it is necessary to develop a clearer understanding of the general meaning of "industrial upgrading" and its different forms. A useful starting point for this is the following definition by Ernst:

> The concept of IU [industrial upgrading, F.B.] can serve as a focusing device for China's attempts to move beyond the "global factory" model and to unlock new sources of economic growth. The main ob-

> jective is to exploit the productivity-enhancing potential of innovation, in order to avoid a race to the bottom that is driven solely by cost competition (Ernst 2007).

Deliberately, this approach avoids narrowing our understanding to one particular form of transformation, a change of production models often referred to as "moving up the value chain". A widely acknowledged discussion by Gereffi (2005: 171), for instance, also starts from a general notion of industrial upgrading as a "move from low-value to high-value activities", but then argues:

> However, we can think about upgrading in a concrete way as linked to a series of economic roles associated with production and export activities, such as assembly, original equipment manufacturing (OEM), original brand name manufacturing (OBM), and original design manufacturing (ODM) (Gereffi 2005).

Yet real upgrading patterns may not always conform to a particular upgrading sequence (and, in fact, not to the one suggested by Gereffi). Especially in China, industrial upgrading has often taken on the form of a piecemeal improvement through incremental innovation without a full-scale change of production models (cf. Ernst and Naughton 2007 (on the IT sector); Lüthje, Luo, and Zhang 2011: 276 (on the garment sector)). A too narrow perspective on industrial upgrading risks overlooking the variety of dynamics with their distinctive outcomes.

A broader understanding of industrial development enables us to acknowledge the multiplicity of potential upgrading trajectories, which often consist of more than one strategic orientation pursued simultaneously. Rather than clear-cut patterns and stages, local upgrading strategies imply different approaches shaped by a variety of factors, including the type of product, the position of companies in global production networks, and the institutional embeddedness of industries. The first task regarding an analysis of concrete upgrading trajectories, therefore, lies in the identification of the particular strategic mix, which then also allows a comparison between individual cases. For this sake, I will draw on a typology developed by Humphrey and Schmitz (2002) who distinguish between:

- Functional upgrading, whereby an improvement in the position of firms would result from increasing the range of functions performed, for example from simple assembly tasks to a broader range of activities. One special case of this strategy would be an own-brand strategy in which manufacturers or wholesalers would distribute products under an own-brand name.

- Process upgrading, which yields efficiency gains by re-organising the production system or introducing new production technologies.
- Product upgrading due to which more sophisticated products can be sold at higher unit prices.
- Inter-chain upgrading, which takes place when companies make use of prior manufacturing experience when they move towards technologically more sophisticated sectors or subsectors.

Given the diversity of concrete upgrading strategies, these terms can serve as a vague distinction of strategic choices. It is important to note, however, that these approaches are not mutually exclusive. Brand building, for instance, necessarily rests upon product upgrading and often some forms of process upgrading (cf. Sturgeon and Kawakami 2011: 136). As strategies overlap, this typology serves as an instrument for identifying the specific mix of upgrading approaches at cluster or company level. In recent literature, "social upgrading" is defined with reference to the following "four pillars" in the ILO (International Labour Organization) framework for decent work:

- employment,
- standards and rights at work,
- social protection, and
- social dialogue (Barrientos, Gereffi, and Rossi 2010: 7).

These imply quantifiable "measurable standards", such as working hours and wage levels, and "enabling rights", such as collective bargaining rights (cf. Elliot and Freeman 2003). Regardless of recent reform initiatives towards this direction (Butollo and ten Brink 2012: 435–438), the Chinese law does not grant basic rights such as the freedom of association or collective bargaining. I therefore limit my analysis of the social implications of upgrading processes to "measurable standards", in particular on wage levels and working hours. Additionally, I focus on the following issues which relate to the research question on the role of technological change and its impacts on the workforce, on the one hand, and on the issues that have been singled out in literature to be of particular interest in the study of Chinese labour relations, on the other:

- Employment patterns: How far do upgraded products, processes or functions demand new skills? How are these distributed among the workforce? What is the share of migrant workers and what are their functions?

- Training of the workforce and workforce stability: How are workers introduced to their task? Is there a shortage of labour for the respective functions? How does the management prevent skilled workers from leaving?
- Wages, wage systems, and working hours: Are higher skills rewarded with higher salaries? How great are wage differentials? Are the wage systems modified due to technological changes (for instance from piece rate systems to hourly wages)? How far is this beneficial or disadvantageous to workers? How do wage systems affect overtime (OT) hours?

Research Method

For my field studies, I chose cases from the textile and garment industry, as well as from the LED industry which is a subsector of the IT industry. The textile and garment sector was one of the pioneering industries after China's reform and opening policies with FDI pouring into the region from the 1980s onwards. As one of the classically labour-intensive industries, companies in this sector have suffered from the recent increase in prices for raw materials and labour, which have led to frequent bankrupt ciesor the relocation of production facilities to other regions or countries offering cheaper production factors. By contrast, the LED industry belongs to the group of industries known as "strategic new industries" that receive vigorous support from the central government. LED lighting companies have also benefitted from large-scale investment programmes by the central government for street lights in major urban areas. These investments are supposed to be re-financed by future energy savings according to government schemes. In general, the industry will receive further state subsidies in the future as it is listed as a strategically important industry under the framework of the twelfth Five-Year Plan (*Digitimes* 2011).

During my field studies, I chose a double perspective by looking at the restructuring processes of individual companies, the data from which was then complemented with qualitative interviews with representatives of local governments, industry associations and technical schools. In some cases, I chose to include interviews with equipment vendors in order to get a better idea about the nature of process innovation and the skill requirements involved. Various interviews with independent industry experts and consultants, university researchers and NGO representatives helped me to understand the more general dynamics of industry restructuring in the PRD and its effects. All in all, the survey includes case studies from ten enterprises and is supplemented by interviews with officials from two local governments within the surveyed garment clusters, and representatives from three local LED associations. The original information from my first field visit in late 2010 was updated with another round of interviews the following year. Thus, this article is based on the evaluation of 47 interviews.

Industrial upgrading in the garment sector is closely connected to the specific structures of specialized towns (Bellandi and di Tommaso 2005; Barbieri, di Tommaso, and Bonnini 2011). Therefore, I decided to focus on two prominent garment clusters in the city of Dongguan during my field studies. In the LED industry, although regional clustering does exist, a vertical differentiation of the sector accounts for important differences between companies and therefore structured my investigation. I drew on the common distinction between upstream, middle stream and downstream production that can be found in scientific literature and economic analyses (cf. Li 2010). The data presented in this article includes case studies from one upstream, two middle stream, and two downstream companies. Apart from these, I conducted interviews with local- and city-level industry associations, through which I gathered data about both the general upgrading strategies and their local variations.

In all cases, I conducted semi-structured interviews, in which I asked questions about the general upgrading strategy, the role of government support, geographical relocation, and the above-mentioned criteria for social upgrading.

Case Study 1: Process Innovation and De-skilling of Work in the Knitwear Industry

The knitwear industry is clearly the most visible industrial sector in the surveyed cluster, with over 3,000 enterprises in the town itself and up to 10,000 in its environs. Located in a town that in 2010 had a resident population of 69,000 and a floating population of over 300,000 migrant workers, the cluster combines the functions of a production hub and a trade centre with a trade area of about six square kilometres around a new giant wholesale market building, in which a knitwear fair takes places annually.

Automation as the Main Focus of Upgrading Measures

Industrial transformation in the knitwear industry is closely connected to the introduction of the computer numerical control (CNC) knitting machine, as the following quote from a local newspaper illustrates:

> Just like the industrial revolution in the mid-18th century in England, that originated from a small spinning jenny, which then changed the entire European continent and world's history, the technological revolution through the CNC machine is being carried out quietly in [the] town and will expand to other parts of the Pearl River Delta. It will gradually replace the manual knitting machine, with the effect of spurring product design and development and upgrading production (*Nanfang Ribao* 2010).

The township government places heavy emphasis on the introduction of the CNC knitting technology and provides a subsidy of 2,000 CNY for the acquisition of each imported machine. It also strives to allocate investment from machine manufacturers in the town.

Through the introduction of CNC machines, companies can raise productivity and reduce their workforces. The new machines usually are operated for a continuous 24 hours a day, seven days a week. Whereas each worker controlled one semi-automatic machine in the past, operators in modernized factories control eight machines on average. Experienced workers can handle a maximum of 14 CNC machines at the same time. Besides efficiency, the machines provide a greater versatility of styles and enhanced quality control. They also allow for an easy digital linkage between computer-aided design (CAD) and production. The introduction of the CNC knitting machine began in 2007 and accelerated after the financial crisis. In late 2010, around 10,000 machines were in operation throughout the township, according to government information.

Brand building, though less prominent in government and company statements, also constitutes an important part of the local government's transformation strategy. This implies a combined policy of creating a regional trademark for all local products and of supporting individual companies to form regionally and nationally competitive brands. However, in August 2010, the town's mayor expressed discontent about the slow speed of brand building since there only existed a small number of brands that were recognized at the provincial level, and the prospect of building a world-class brand seemed remote (*Dongguan Ribao* 2010). This corresponds to the findings at two major companies (KNITWEAR 1 and 2) at both of which brand production was pursued, but constituted only a small share of income compared to their high volume of ODM and OEM production. This suggests that brand building so far has been introduced as a supplementary activity rather than as a replacement for the established sales model.

Impacts on the Organization of Production and Skill Requirements for the Workforce

Where CNC knitting machines have been introduced, major changes in the division of labour have taken place. First of all, the number of workers has been cut severely. According to government information, the total workforce in knitwear companies in this town was reduced by 40,000 to about 100,000 employees between 2007 and 2010, and this decline of more than a quarter was directly related to the introduction of CNC machines. Even more compelling data was provided by the town's biggest knitwear company (KNITWEAR 1) which had 5,000 knitting workers in 2007, but only 1,000 in 2010. At a smaller company (KNITWEAR 2), the number of workers in knitwear manufacturing shrank from 1,500 to 300. These figures largely bear witness to the scale of automation. However, they also reflect the re-location of parts of the companies' operations to interior provinces of China with lower wage costs, as was evidenced at KNITWEAR 2 which expanded production volumes at a second factory in Sichuan province. All of these factors contribute to reduce the labour intensity of manufacturing in Guangdong province. At the same time, automation also raises the capital requirements for knitting enterprises. CNC knitting machines currently cost between 100,000 CNY (Chinese models) and 550,000 CNY (high-end imported machines) per piece.

While the introduction of machines enhances product quality and versatility, there is little demand for skill development on the side of the operators. Their function is merely limited to maintaining the production flow by controlling the yarn supply and troubleshooting. In fact, the operators' work is mostly stripped of cognitive content since all the information regarding the style requirements of the knitting process is digitally uploaded to the machines. Accordingly, workers only receive a brief on-the-job training of one week in duration. Compared to the skill level needed to operate the previous generation of semi-automatic knitting machines, where workers still had an influence on speed, style and tightness of the knitting products, a de-skilling of operations took place. The operation of CNC machines does, however, demand new skills from workers who need to be able to coordinate simultaneous processes at several machines, but these can be acquired quite quickly. Thereby, companies are relieved of the burden of finding a great number of suitable, experienced workers under the condition of labour shortage and rising wages.

This is also reflected in the wage levels of knitting workers. When asked for a direct comparison of the wage levels between knitters of the old generation and CNC machine operators, the factory manager of KNITWEAR 1 responded that it was "the same, maybe 10 per cent more". Given that each company is able to cut the knitting workforce by at least one quarter, this reflects a substantial saving in labour cost. Furthermore, the estimated wage difference of 10 per cent is in fact negligible given the context of significant annual hikes in the minimum wage level in recent years.

In addition to wage levels, other elements of the old system of work organization in the knitting departments have been upheld within the new technological environment. Wages are still paid according to a piece rate system. This seems anachronistic, since it is the machines now that entirely control the speed of production lines, not the skill of individual workers. Piece rate incentives for workers, therefore, cannot raise total output, but are used to manage the shop floor with the least possible number of knitters. They are applied as a means of controlling the workforce. The management of KNITWEAR 1, for instance, decided to re-introduce the piece rate system to prevent workers "from falling asleep" for lack of incentives, as it had experienced with a wage system based on hourly wages. Such practices reinforce inequality on the shop floor. Wage shares based on a high share of flexible, performance-based payments, have been a hallmark of labour relations in the region and can be seen as a systemic reason for excessive overtime hours and individual "self-exploitation", as a recent comparative study reveals (Lüthje, Luo, and Zhang 2011: 366).

The failure to achieve social upgrading through this manner of process upgrading can be understood clearly when the conditions of knitting workers are compared with those of another group of employees in the garment industry, the linking workers. These workers connect the flat pieces of knitwear that are produced by the machines in the knitting departments, for example when attaching sleeves to the main body of a garment. In terms of skill level, this implies the need for a high degree of versatility due to the frequently changing designs and sizes. It also requires precision, since small mistakes in the linking process can negatively affect the overall shape and fit of a garment piece. Up until now, it has hardly been possible to replace manual labour in the linking process with fully automatic machines for technical reasons. But even though technological progress has been made, the existing technologies are too expensive in comparison with manual work, in the Chinese context, which is why they are not being applied in Guangdong. Thus, the linking process still depends on workers operating simple, mechanical linking machines. Due to the high requirements for versatility and quality, linking remains a highly skill-dependent and more complex task and, accordingly, workers receive a period of training of three to six months in duration before they join the production line. As a consequence, linking workers earn considerably more than knitters. At KNITWEAR 2, their average wage was 10 per cent higher than that of the knitting workers, while at KNITWEAR 1 the difference was as much as 20 to 30 per cent higher. In the latter company, it was said that an experienced linking worker could earn up to twice the amount of a knitter's wage.

As process upgrading in manufacturing results in a lower, rather than a higher, demand for skilled operators, the demand for higher skill requirements almost exclusively concerns the design departments of the respective companies. As knitwear suppliers strive towards ODM or OBM production models, the creation of new styles becomes a pivotal task. The local vocational school, accordingly, reports a high demand for graduates in the field of design, and government figures suggest a steep increase in the number of designers in the wool industry in recent years. Own-brand production is the most demanding in this respect. Of the more than 2,000 employees at KNITWEAR 1 in 2010, a staff of only six designers churned out over 300 stitches each season for ODM production. A shift towards a higher proportion of designers within the total workforce can be expected when OBM production models are introduced. KNITWEAR 1, for instance, inaugurated a separate, and bigger, design department in order to meet the demand of producing independent designs within its own-brand collection.

All in all, however, the need for high-skilled work due to the implementation of production systems based on independent design remains limited in quantitative terms. In all cases, designers only constitute a small proportion of the total workforce. The bulk of the workforces in the surveyed knitwear companies continues to consist of low-skilled migrant labour, despite recent workforce reductions through automation. In the face of rising labour costs in the PRD, re-location remains an option even for technologically advanced enterprises. The companies under investigation both disclosed plans to further expand existing production facilities in inland provinces with lower wage standards, while keeping their design and sales departments in their present PRD premises. If such plans should become reality, the loss of productive capacities in the cluster may foster further specialization in marketing and design in the town's knitwear industry in the future.

Case Study 2: Revolutionising Design and Marketing in the Fashion Industry

The second case study focuses on a township, located within the city district of Dongguan, which has been a prominent production and trade base for garment products since the 1980s. In recent years, the government has particularly supported the development of local fashion brands and organizes a high-profile, annual fashion fair in order to promote the products of the local industry. This is connected to a general strategy of increasing the economic significance of the service sector by progressing towards a "commercial era".

Industrial Transformation through Brand Building

Brand building requires own-design capabilities, enhanced promotional efforts and the creation of an independent sales network. The government-funded "Fashion Technology Innovation Centre" supports companies in acquiring these tasks by providing counselling and by establishing contacts for business development. In particular, it provides services for launching new brands and helps to promote new collections of existing ones.

Case studies at three major local brands demonstrate that the acquisition of design and marketing capabilities constitutes a major challenge in terms of financial investment and human resources. While high quality and a certain degree of flexibility at the level of production are important requirements for realising a brand's potential, product quality and market acceptance decisively depend on functions beyond the realm of manufacturing. In particular, they depend on unique designs and good quality of supply materials. Under the conditions of a rapidly expanding domestic market, all the surveyed companies are creating independent sales networks, sometimes complemented by a franchise system. Only the largest company (FASHION 1), a well-known brand at the national level that, in 2011, ran over 5,000 stores in China, engages in export, yet this only constitutes a small share of the company's total sales.

Enhancing design and marketing capabilities in the process of brand building not only involves challenges regarding know-how, but also in terms of the financial resources involved. All the surveyed brands rely on costly input from abroad to develop their styles by either employing foreign design studios or paying fees for counselling. For instance, a fashion brand in the middle price segment (FASHION 2) that employs only 160 workers in its Dongguan-based factory uses three design centres (in South Korea, Hong Kong and Dongguan). Another brand that employs 500 workers (FASHION 3) invested between 10 million and 20 million CNY in an advertising contract with a famous pop singer from Hong Kong in order to boost its sales. It also spends 1 million CNY each year on the fashion trend consultation services of an Italian design institute. Apart from these expenses, own-brand development also relies on investment in human capital. Highly skilled employees in design and marketing, who are often college graduates, may earn triple or quadruple the amount of line workers' wages.

Impacts on the Organization of Production and Skill Requirements for the Workforce

Compared to the restructuring dynamics in the knitwear industry, there is much less emphasis on process upgrading in the fashion industry. Although there is the option of automating some of the complementary processes of garment production, like the fixing of buttons, this does not include sewing, the core function in the industry. Consequently, sewers continue to operate one machine each. In FASHION 2 and FASHION 3 productivity rises through the acquisition of faster sewing techniques did not play any role at all. On the contrary, a new pilot factory at FASHION 1 had been equipped with more modern equipment. Additionally, the management focused on changing the organisation of production according to "lean production" principles (in this case mainly through a reduction of inventory and the improvement of workflows as well as through an improved coordination between suppliers, manufacturers and franchise stores). This involved introducing a system of stencils through which workers could easily sew new styles and avoid mistakes. By introducing this new system, FASHION 1 was able to significantly raise productivity by 21 per cent in the last four months of 2010, and projected an additional 30 per cent in 2011.

The introduction of the stencil system also provides an easy solution for the crucial linkage between design and production. In line with the company's efforts to imitate a "fast fashion" strategy, as pioneered by ZARA and H&M, production rhythm scan in this way easily switch between styles without the need for time-consuming tasks like introducing the workers to new styles. Thus, FASHION 1 is better equipped to meet the requirements for "quick response" inherent in this type of production system (Barnes and Gaynor 2006). This strategy also enabled the company to counter a bottleneck in the sourcing of experienced workers that occurred due to a general shortage of labour in the region. As the task of sewing is easier to handle with the support of stencils, FASHION1 is able to hire less experienced workers to accomplish tasks that were previously limited to more experienced sewers. According to company information, even workers with no experience could now handle complex tasks like sewing shirt pockets through the application of stencils. Similar increases in productivity through innovations in the production system were not found in the two other companies in the sample. In their cases, the link between design and manufacturing rather relied on the direct introduction of new styles to the workers by the foremen and on the work experience of the sewers.

In general, the data gives no clear indication of whether or not brand production requires a higher level of versatility and flexibility in the production process. While FASHION 1 and FASHION 2 reported additional challenges through the greater variety and higher turnover of styles, a well-known men's fashion brand (FASHION 3) reported a more stable production flow compared to its prior experience as an OEM producer, which had required high flexibility because of the quick changes in orders and the short lead time granted by buyers. Own-brand production, therefore, had diverging effects on the production systems at the surveyed companies.

The impact of brand production on the skill requirements of workers differ as well. While FASHION 2 and FASHION 3 continue to depend on a large number of experienced sewers, process upgrading at FASHION 1 has enabled the company to lower skill requirements. Workers at FASHION 1 are little-experienced and much younger (workers are 25 years of age, on average). Accordingly, the wages at FASHION 1 were particularly low (on average, 2,000 CNY in 2010, compared to 1,800 CNY to 2,500 CNY in 2010 at FASHION 2 and an average wage of 3,000 CNY in 2011 at FASHION 3). This can also be attributed to differences in the wage system. The piece rate share of only 33 per cent at FASHION 1, with more even workflows based on lean production, is comparably low when compared with the 70 per cent share of piece rate wage at FASHION 2. In fact, wage differentials among sewers seem to be particularly low and the wage system at FASHION 1 can be seen as an approximation to a system of hourly wages. In this case, the retrenchment of the piece rate wage system has an adverse effect on wages: base wages can be kept low because there is no pressure to attract skilled workers through higher wages. At the same time, workers cannot increase their wages through high performance.

Case Study 3: Polarization between R&D and Manufacturing Workers´ Skills in LED Lighting Companies

LED lighting is currently applied on a mass scale in the form of computer notebook, television and mobile phone backlighting and it is expanding rapidly in applications such as television, automotive lighting and street lighting. Industry observers expect the launch of a "third growth cycle" due to the replacement of conventional light bulbs by more efficient and versatile LED domestic lighting, thus pushing the average projected growth rate for packaged LEDs to 28.2 per cent for the period 2009 to 2015 (Yole Développement 2010).

As an energy-saving technology with high growth prospects, government policies at the provincial and national level in China devote particular attention to the LED industry. In the twelfth Five-Year Plan, the central government sets ambitious targets for the development of the Chinese LED industry. In particular, the government plans to aim at greater self-sufficiency in LED chip production, which is currently the weakest part of the Chinese LED industry. At the local level, particularly in the cities of Foshan, Shenzhen, Guangzhou and Huizhou in Guangdong province, local governments are fostering the development of the industry through technological support programmes. Additionally, an investment programme for street lighting under the framework of the national stimulus plan has acted as an accelerator of growth in the local industries (cf. Li 2010).

High expectations, however, have pushed investment beyond sustainable levels, which led to a major consolidation in the industry from 2011 onwards. Government subsidies for street lighting, which had provided additional incentives for investment up until 2010 and were then cut in 2011, had additional pro-cyclical effects on the industry and thus aggravated the recent tendency for overinvestment and consolidation.

Innovation as a Key Resource

In the face of this volatile and fast-changing market environment, successful business development becomes all the more challenging and depends on a high degree of innovative capability. While this is true for all LED producers, it affects companies differently due to the vertically disintegrated structure of the sector: "Upstream" LED companies produce wafers and chips, the core semiconductor component of any LED lighting application. These are produced in a similar manner to regular semiconductor wafers, such as those for computer chips. However, different chemical components and equipment are used. "Middle stream" LED companies deal with the production of packaged LEDs, ready-made lighting devices that can be inserted into LED applications. To this end, LED chips are "encapsulated", that is embedded into structures that condition the lighting characteristics, regulate heat dissipation and attach electric poles. At the end of the LED production chain, the "downstream" companies focus on the manufacturing of various lighting devices. They constitute the majority of LED enterprises in Guangdong province. Most companies in this region, furthermore, tend to specialize in one of the described processes, although the distinction between these production stages sometimes becomes blurred by processes of vertical integration, for example when "middle stream" companies also sell their own lighting applications.

The highest requirements for independent R&D capabilities can be found in the field of upstream production. Intellectual property rights at this level are firmly controlled by a small number of foreign companies, while the thriving Chinese industry lags behind in terms of product quality and hence the lighting efficiency of the chips. The Chinese central government heavily subsidizes the acquisition of the key production equipment for LED chips, the metal organic chemical vapour deposition (MOCVD) machines, which recently led to a surge in orders for this technology (Cooke 2010). However, Chinese chip makers need also to come up with indigenous intellectual property, in order to persist within the competitive environment of LED chip production.

The high requirements for independent R&D capabilities in this field can well be illustrated by the case of one of the few LED chip manufacturers in the region (LED 1). Employees in the R&D department constitute one third of the workforce. Research partnerships with universities and the backing of the local government, as well as the involvement of a big, foreign LED chip producer, were crucial to the development of the company's core technology. They also remain vital for the perennial task of increasing the quality of products. In the view of the management, the product quality of LED 1 lags behind that of major foreign competitors, although it is perceived to surpass that of most Chinese LED chip manufacturers. The company's peculiar core technology allows for a production model that cuts across the conventional boundaries between LED-chip production and encapsulation, that is, the production of packaged LEDs. This offers possibilities for entering mass production through automation. A considerably larger factory has been in construction since 2011, which will allow much higher production volumes from 2012 onwards. Whereas investment in R&D and production equipment is high, aggregate labour costs in manufacturing are very low and decreasing, with only about 150 operators in 2011. Although production volumes will rise considerably with the inauguration of the new factory, the company does not expect to hire more line workers. Productivity will be further enhanced by automation instead.

While a comparably high share of skilled, scientific personnel could not be found in the case studies of middle stream (LED packages) and downstream (LED application) companies, all the surveyed enterprises focus their business strategies on product upgrading and, thus, rely heavily on a large input from R&D. Each company also needs to adopt individual technological solutions due to a lack of standardization and the large variety of products. In the production of packaged LEDs, for instance, specific bonding techniques and solutions for heat reduction have to be developed. In the manufacturing of LED lighting sources, there is a wide range of options for product design and lighting modifications for end-producers, due to the large variety of LED applications. In any stage of the production chain, product upgrading the refore is essential in order to survive in this closely contested market environment. This, in turn, depends critically on engineer knowledge of optics and information technology. Apart from this communality, there is a plethora of specific upgrading strategies, as the following examples from the case studies illustrate:

- LED 2: Vertical integration and brand creation. One of the biggest manufacturers of LED packages in the region is expanding its operations to the production of LED chips and lighting devices. In particular, 90 million CNY has been invested in the creation of an own brand which will be used for the sale of its own LED applications to end users in the near future.
- LED 3: Specialization and diversification. A middle scale manufacturer of LED packages pursues a double strategy of producing LED applications as OBM and packaged LEDs as OEM. The company aims to generate higher revenues through the production of an endogenously developed high-power LED, on the one hand, while striving to increase the share of LED applications in total sales, on the other.
- LED 4: Brand building for export production. A middle scale LED application company that had been focussing on the production of LED back light modules for large computer and mobile handset companies in the region is striving to raise its share of LED application production for overseas markets. This will be supported by the inauguration of a sales office in Belgium.
- LED 5: Exploring niche markets. A middle scale LED applications company that specializes in entertainment lighting pursues a strategy of product upgrading towards the technologically more challenging field of architectural lighting. While some lighting devices are sold as OBM products within China, the company maintains a specialization as an ODM producer for its export products, which constitute the greatest proportion of its current sales volume.

Industry Reshuffling and Automation in the Transition towards Mass Production

The great diversity of strategies reflects the variety of applications for LED technology. At the same time, it is an expression of the immature state of the industry, which up until now has been dominated by small- and medium-scale enterprises. Some of the strategies currently pursued will prove to be ineffective, while others may set standards for further development. Local and international industry observers expect a continuing process of consolidation in Guangdong province, while average growth rates are expected to remain high (*Reuters* 2012; Anonymous 1). Many small- and middle-scale LED application companies thus could go out of business, mainly due to a lack of technological capabilities. At the same time, local industry experts expect large-scale companies from the field of consumer electronics, which up until now had been reluctant in terms of big investments, to take over technologically more mature companies and thus enter the market with much higher resources and a longer experience in mass production. Important preconditions for their engagement are the maturing of specific technological paths and product standards, in addition to the feasibility of mass production techniques. The latter depends on sufficient market demand, as well as technological breakthroughs regarding product design.

Observations and data from various LED factories support the assumption of an ongoing progression from manual to automated production in interrelation with enhanced production volumes. Low-volume production, particularly in the field of lighting devices such as street lamps or domestic lighting, largely relies on high manual input (LED 4 in particular). The situation is different, however, in factories that produce applications or LED packages on a large scale (LED 2 and 5). In these cases, larger volumes and higher standardization allow for the application of surface mount device (SMD) place mentor die bonding machines which are fully automatic in their operation. The transition from manual and semi-automatic die bonding towards automated processes, while being firmly established in its bigger competitor (LED 2), has just taken place at one company (LED 3) which inaugurated a new factory in late 2011. As already mentioned, further automation is also taking place at the surveyed chip manufacturer (LED 1) with the prospect of enhanced productivity at its new factory.

Low Skill Requirements on the Shop Floor

The dynamic processes of product, process and functional upgrading in the LED sector deeply affect the character of work in the respective factories. Labour intensity in this knowledge- and capital-intensive industry is further decreasing due to automation. At the same time, companies have to rely on a large pool of scientifically trained staff in order to remain competitive, first and foremost in the technologically sophisticated field of LED chip technology.

In most of the surveyed factories, the complexity of products and processes did not require higher skills and knowledge on the part of ordinary line workers. All manual mounting of LED lighting devices and die bonding is done by migrant workers who receive at most a training period of up to 15 days, in addition to a short period of accompanied working. Because of the small size of the components, however, workers' skill and experience do play a certain role in manual production, as could be observed in one company (LED 3). The management of this company prefers to hire young women who are considered more dextrous and better suited to this task. More experienced employees work faster and thus can improve their wages, which include a piece rate share.

By contrast, workers' manual dexterity hardly plays a role where SMD placement machines (in LED application production) and automated die bonding machines (in encapsulation) are used. Although the precise nature of work in both cases differs according to the nature of the product and the type of machinery, there exist remarkably similar characteristics with regard to skill requirement. In general, the machine operators, who are young migrant workers without exception, receive only a short training period of between one week and one month. They typically do not need to know about the technological content of the process they are operating and the application of the machines is designed to guarantee easy operation. The function of the workers is mostly limited to the tasks of overseeing the accurate operation of the machines, to loading and unloading them and in some cases to adjusting certain settings. More comprehensive responsibilities regarding the programming and set up of the machines, however, generally remain in the domain of formally trained engineers. This leaves little or no space for line workers to achieve upward mobility through skills development.

One company representative expressed the belief that operators in LED manufacturing needed little specialized skill by saying that new recruits needed only "a little bit of production experience, not necessarily in LED production". The skill requirements for line workers at the surveyed LED chip company (LED 1) are similarly low. At first glance this may seem surprising, given the high technological complexity of the products. New recruits only receive a few days' training, however. A spokesperson justified this by saying that workers "need to know how to do it, not why they do it". What is more, photolithography, which was highlighted as the process with the highest skill requirement for line workers, will be fully automated in the new factory under construction. Therefore, it can be expected that the skill requirements for operators will play an even more minor role in the near future.

Despite the evidence for overall low skill requirements for workers in LED manufacturing, there is an interesting exception to this rule at LED 4. Those workers who were employed in the process of encapsulation (roughly one third of the line workers) were given at least six months' training in this area. They cannot currently be recruited from technical schools with the required skill set, as these skills are not yet part of the curricula.

In general, the social composition of the workforce in LED manufacturing reflects the low skill requirements for workers. Although not all companies provided data on this, the existing information suggests that mostly young, predominantly female migrant workers are hired. When selecting new recruits, LED companies also attach little importance to prior working experience, unlike their counterparts in the garment industries. The available data from four out of five of the surveyed factories (LED 1, 2, 3 and 4) suggests that wages in the LED industry are in fact lower than those in the research sample from the garment industry, rather than higher. Generally, the total income of workers at LED factories, including overtime, hovers between 2,000 CNY and 2,500 CNY, with only small variations. This reflects the prevalence of hourly wage systems in automated LED manufacturing. These leave little or no space for skill-based bonuses on top of the low base wages. Furthermore, there is limited scope for workers to boost their income through overtime because shift systems are more rigid where SMD placement or other automated techniques have been introduced. Nevertheless, working hours can reach up to 11 to 12 hours per day.

These conditions also affect some operators of a certain type of encapsulation machine at LED 4 who need considerably higher skills to perform their functions. A representative of this company, however, stated that the salaries of this group of workers, were no higher than those of operators of less sophisticated machines or workers who deal with manual assembly tasks because their importance to the production line was no greater than anyone else's. Instead, the company provides additional benefits like improved dormitory conditions (hot water and cleaner quarters) and other comforts to these workers, but refuses to grant them higher wages or reduce their working hours. A high turnover of skilled workers, therefore, is an ongoing problem for the company. This example vividly demonstrates the contradictions of the present regimes of production in the electronics industry.

All in all, the results from the surveyed LED companies unveil a strongly bifurcated workforce in all cases, despite the significant variations in company profile and upgrading strategies. While the competitive dynamics in the industry require a high number of scientifically trained employees, as well as cooperation with scientific institutions, low-skilled and poorly paid migrant workers still constitute the bulk of employees in LED manufacturing. There is no evidence that recently introduced measures for process upgrading have led to higher skill requirements on the side of the workers. On the contrary, the available data suggests that skill requirements may be even lower due to widespread automation.

Bypassing the Workers: The Disconnect between Knowledge-based and Manufacturing Work

The presented case studies from the garment and LED industry illustrate the multiplicity of upgrading trajectories in the Pearl River Delta. Although certain similarities of approach could be detected on the level of geographically circumscribed clusters, no dominant strategic pattern emerges in the cross-sector analysis. This accounts not only for differences between the garment and the LED industry, but also for varieties within each of these sectors.

The case studies do point to some important regularities, however. Although these are not representative of the industries as a whole, or even companies at a sub-sector or cluster level, they reveal some interesting insights about the possible consequences of industrial transformation in the Pearl River Delta.

First of all, companies from both of the surveyed industries demonstrate a transition from labour-intensive to more capital- and knowledge-intensive production models. This is valid for varying levels of pertinence and speed.

In the knitwear industry, there is a reduction in the number of knitters through the introduction of sophisticated and expensive machinery, thereby increasing capital intensity while diminishing labour intensity in absolute and relative terms. In the fashion industry, process upgrading plays a less significant role, and if it occurs, it does not lead to a substantial reduction in the number of line workers. Yet, once companies pursue own-brand production models, they need substantial capital investments, an enhancement of design capabilities and the professionalization of marketing operations thereby overcoming a purely labour-intense production model. In the LED industry, while manual labour persists for the time being, there is a high reliance on investment in R&D, in particular, but not exclusively, at the level of LED chip production. The move towards higher production volumes in this industry, accompanied by the tendency towards consolidation, could moreover intensify ongoing processes of automation that enhance capital intensity and further reduce labour intensity, as observed in two factories within the sample.

From the analysis of the case studies, therefore, it can be seen that the different routes to industrial transformation are bringing about a structural change in the industries of the Pearl River Delta: from assembly and simple manufacturing towards services and innovation.

The second commonality found within the case studies concerns the implications of industrial upgrading on employment patterns. As a whole, the composition of the workforce in the cases analysed displays an increasingly high proportion of academically or technically trained personnel, for instance engineers, fashion designers and marketing staff. However, none of the upgrading trajectories analysed relies on higher skill acquisition on the side of the common production line worker. Rather, modern production techniques facilitate the detachment of knowledge-intensive work from manufacturing in various ways.

In the knitwear industry, this is expressed graphically by the fact that knitting workers are virtually bypassed with regard to the style of knitting product, which now can be digitally uploaded to computer-controlled machines. In the fashion industry, the independent design capabilities of a company barely affect the content of sewing work, but instead have a contradictory effect on production flows. In the case that this leads to higher requirements in terms of flexibility of production, as is the case with “fast fashion” production systems, the skill requirement of sewers can be kept low by employing refined management and production techniques like stencils, as was observed in FASHION 1.

In the LED industry, the contrast between high tech product development and simple, and at times manual, production steps is most striking. As the evidence from the case studies demonstrates, process upgrading through the introduction of machines barely enhances skill requirements, since work on automated production lines requires knowledge only about the interface with the machine, not the technical content of the process. The higher skill requirements for encapsulation workers at LED 4 are a notable exception to this rule, but this did not result in improved conditions for the workers. The thrust of the current management strategies indicates that solutions to such dilemmas as those faced by LED 4 (high turnover of skilled workers) may be sought in the further de-skilling of workers and automation of processes, rather than in initiatives for the social upgrading of working conditions (in order to increase workforce stability). A technology-centred upgrading strategy in this sense can, thus, even counteract substantial improvements for manufacturing workers.

The combination of automated types of work based on low skills with employment patterns that draw on the legal discrimination of migrant workers echo the conditions that have dominated the more mature sub-sectors of the IT industry for many years (cf. Lüthje et al. 2013). Thus, it seems that the LED industry is about to replicate such "Neo-Taylorist" systems of production that rely on low-skilled and low-paid work. Recently, electronics contract manufacturers, such as the Taiwanese corporation Foxconn, have come under public scrutiny with regard to these conditions. As a consequence, it is all the more pressing that problematic development tendencies in the LED industry should be addressed by the government and relevant social actors at an early stage.

The detachment of knowledge-based work from manufacturing, as observed in all of the case studies, potentially can be radicalized towards a geographical disjunction of the respective functions by outsourcing certain manufacturing stages to interior regions with lower production costs. While such tendencies could be observed particularly in the knitwear industry, there are also countervailing tendencies. In the LED industry, there currently is no tendency to establish a geographical division of labour between R&D and manufacturing. Neither is this the case in the fashion industry, which remains labour intensive at the level of production, since the sewing process can barely be automated. Companies in these sectors continue to rely on the advantages of industry clusters and dense supplier networks and, therefore, continue to base their manufacturing operations in the Pearl River Delta. Media reports about an "end of cheap labour" in Guangdong, thus, overstate the case. There is a persistence of low-skilled and badly paid migrant labour at the level of manufacturing and this concerns both, the "old birds" and the "new birds" within the industries in this region.

Conclusion

The analysis of the presented case studies largely suggests a widespread failure in social upgrading. The mounting pressures on the labour-intensive, predominantly export-oriented growth pattern in Guangdong province have provoked changes in company strategies; however, the solutions that are being chosen mostly lie in a reconfiguration of production systems based on low-skilled and badly paid migrant labour, rather than in overcoming them. On one level, there is an increase in more stable forms of employment based on higher skills, especially in the field of R&D and marketing. At the level of manufacturing, however, companies strive to reduce their workforces and to further de-skill tasks.

These findings confirm the assumptions of both the SBTC literature and economic sociology that technological change may lead to a growing polarization of employment structure and wages. Attempts to overcome the imbalances of the old growth model must, therefore, be adjusted to correct the bias of a technologically focused path of industrial upgrading. Political reformers need to address the persisting social inequalities at the point of production. Faced with a rising tide of labour unrest in recent years, the Guangdong provincial government advocated models of collective negotiations on wages as a way to stabilize workplace relations and improve labour standards. These initiatives may present a viable path for a qualitative change in labour relations, yet for the time being they could not be enforced on a broad scale since they have met with considerable resistance from interest groups attached to the low-end, export-oriented growth model.

The analysis of the presented case studies shed light on some of the issues that need to be addressed through a reformed system of industrial relations. Efforts should concentrate on the regulation of wage systems, stable mechanisms of income growth, and on incentives for stable employment and the comprehensive training of the workforce, among others. Improvements in this field largely depend on granting "enabling rights" to the workforce in order to break the unfettered prerogative of management over labour issues. Trade union elections at the factory level and collective negotiation systems, as currently discussed in Guangdong province, may widen the scope for implementing labour standards.

While such changes in the legal and political environment would allow trade unions to engage actively in measures for the social upgrading of wages and working conditions, a transformation of the tradition of trade union practice is a precondition for taking advantage of the new possibilities. Trade unions at enterprise and regional levels would need to learn how to tackle bread-and-butter issues such as wage scales, the distribution of skills and functions among the workforce, and training schemes; issues which they have had little experience of dealing with, at least in privately owned enterprises. The growing social contradictions of the development path of Guangdong province, which continue to present a serious challenge to social and political cohesion in spite of the rapid modernization of industries, indicate that Chinese trade unions urgently need to live up to their tasks in this respect.

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