The Quotidian Labour of High Tech: Automation, Innovation, and Ordinary Work in Shenzhen's Electronics Markets

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Introduction

China's economic trajectory is often described in terms of a progression from cheap manufacturing towards increasingly "high value" forms of work and production. The former "workshop of the world" is now becoming something else - a space of innovation, or a space of creativity, or a space of design perhaps. This kind of rhetoric is especially prevalent in discussions of the "Silicon Valley of China": Shenzhen. This city, more than any other, has become the focus of hopes, dreams, and fears of Chinese technological development.

Most accounts of Shenzhen's development point to the growing importance of home grown high-tech in the city's economy. In this narrative, Shenzhen was once just a factory site for overseas brands (Foxconn's manufacturing of iPhones, for example) but has progressed to have its own companies and products. The rise of indigenous brands with global reach (including Huawei, Skytech, ZTE, and Xiaomi) from Shenzhen points to China's move "up the value chain." These industries are driven by a cast of characters that includes entrepreneurs, engineers, start-ups, hackers, makers, and industrial robots.

Indeed, automation of factories plays a significant in the imaginings of how such economic progress is likely to proceed. According to Bloomberg, China installed 87,000 industrial robots in 2016 and that number continues to increase rapidly. Xi Jinping has called for a "robot revolution" in which robots will replace workers in order to "bolster Chinese competitiveness and sustain rapid growth."[1] On the other hand, hackers, makers and entrepreneurs are valorised as sources of economic growth and technological progress. Silvia Lindtner's work, for example, has focused on the role of "do-it-yourself" makers as "individually empowered" – crafters of subject positions that see their hardware hacking as

[1] Orlik, Tom. 2017. China's Future, Reshaped by Robots. *Bloomberg View* 24 August: https://www.bloomberg.com/view/articles/2017-08-23/china-s-future-reshaped-by-robots

part of a larger attempt to remake China's economy, politics, and citizenry.[2]

Both parts of this model are consonant with a Silicon Valley-driven view of the world: either the hacker as rebellious individual out to change the world or AI-driven robots as central to transformations of work. It holds that innovation springs from individual genius and will be accomplished through technological change, especially by implementing changes in manufacturing work.

Such views are problematic for several reasons. First, they obscure both workers and the actual practices of work in China. By making workers invisible, they assume that innovation and development will emerge in China in ways that are similar to the west and that China is merely following patterns and paths established elsewhere. Second, these views take for granted that innovation and creativity amount to "progress" over manufacturing, and that technologies will be the way to achieve that progress.

There is now a substantial literature on automation and manufacturing that challenges these assumptions. David Noble's foundational history of machine tools in the United States argues that calls for automation have long been justified by appeals to worker shortages and the need for economic and technological progress. Drawing on work on the industrial revolution by David Hounshell, Merritt Roe Smith, and Arthur Chandler, Noble argues that the touted benefits of automation (cost saving, for example) take decades to materialise, if they do at all.[3] In a different context - laptop manufacturing - Ling-Fei Lin has showed how the purportedly clear separation between low-value manufacturing and high-value design is in fact an extremely murky one. In many cases, manufacturing and design are tightly and intricately bound together and the manufacturing process itself is often the most difficult part of laptop chip production. This undercuts the notion that there is a clearly hierarchy between manufacturing and design, or that economies should aim to move "up" from one to the other.[4]

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[2] Lindtner, Silvia. 2015. Making subjectivities: how China's DIY makers remake industrial production, innovation, and the self. *Journal of China information* 28, no. 2: 145-167.
[3] Noble, David F. 1984. *Forces of production: A Social History of Industrial Automation*. New York: Oxford University Press, p. 335.
[4] Ling-Fei Lin. 2016. Design Engineering or Factory Capability? Building Laptop Contract Manufacturing in Taiwan. *IEEE Annals of the History of Computing* 16: 22-39.

The aim of this paper is to turn attention to the actual practices of work in "high-tech" industries in Shenzhen. This means turning attention to multiple kinds of spaces in the production of high-tech electronics. By examining such spaces, I hope to shed light on the relationship between Shenzhen's "innovation economy," automation, and the kinds of work that people actually do in making "high-tech" products.

I focus here on three kinds of spaces in Shenzhen: the Huaqiangbei electronics markets, small-scale factories, and industrial design workshops. I aim to show that the "ordinary" kinds of labor that are performed in these spaces are critical to the innovation economy that Shenzhen is now famous for. Unlike at Foxconn and other large-scale electronics manufacturers, in this small-scale work there are no robots to be found. This is intensely human work that seems unlikely to be replicable by machines. The human networks and connections are critical to the size, speed, and density of the markets, allowing devices and prototypes to be built and shipped rapidly, for parts to be available, and for customers to be available. All the kinds of work described here – the middle-tech and often invisible work – relies on distinctly human qualities.

It is often acknowledged that Shenzhen's "maker" scene (and Shenzhen's innovation economy more widely) depends and subsists on networks of small-scale sellers, industrial designers, and factories. But it is less clear what actually goes on in those spaces and how that work relates to the work of "making" and innovating. This essay aims to describe this work and attempt to situate it with respect to the background of factory work and automation. The work described here is taking place alongside the automation of factories and the introduction of robots into large manufacturing firms. But, by focusing attention on different kinds of work and different kinds of spaces that support the local economy, we can begin to see just how the development of labor (and its relationship to technology) in East Asia is following complex and multiple paths. We need a way to describe these developments in ways that don't fall back on Silicon Valley models of "making" and "automation."

To achieve this, I talked to many individuals, both local and international, working in various industries within Shenzhen. This includes "makers," those working in electronics markets in various capacities, industrial designers, and small-scale factory owners. I have visited the Huaqiangbei electronics markets on several occasions since 2014, both with and

without a local-language-speaking guide (my recent guide spoke Mandarin, Cantonese, Hakka, Teochow, and some Fujian). I have also visited both industrial design firms and one small-scale factory in the city.

The paper will open by presenting some background on Shenzhen itself, its history, and the development of the electronics industry in the city. The following three parts will then describe, in turn, the kinds of work taking place in small-scale factories, industrial design workshops, and electronics markets, respectively. The final section will analyze the implications of these various types of work for thinking about automation, innovation, and high-tech manufacturing.

The emergence of Shenzhen's electronics industries

Shenzhen is best known as China's first Special Economic Zone (SEZ). The city emerged after 1980 as part of Deng Xiaoping's reform and attempts to open up China to the world. The location of the city was critical – directly adjacent to British Hong Kong, the SEZ could leverage on Hong Kong's wealth and international connections. In particular, many Cantonese people in the Guangdong region had family networks that stretched across the Hong Kong border. In the 1980s, it was these relatively wealthy Hong Kongers who provided capital to their relatives to set up factories in Shenzhen where land and labour were cheap.

Shenzhen economy started largely with garment manufacturing. However, by the late 1980s this was beginning to transition to other industries such as electronics manufacturing, much of it driven by overseas investment. Companies such as Hon Hai Precision Industry Co. (also known under the name Foxconn) from Taipei set up factories in Shenzhen, bringing manufacturing expertise with them. Such opportunities for work attracted massive amounts of migrant labour to the city; especially young women came to work in garment factories and later the electronics factories[5]. This is the main reason why the city grew from around 300,000 people in 1980 to over 20 million people today: the place is now a massive, sprawling, modern, metropolis.[6]

[5] Pun Ngai. 2005. *Made in China: Women Factory Workers in a Global Workplace.* Duke University Press.

[6] For a general account of the history of the Pearl River delta region after 1979 see Vogel, Ezra F. 1990. *One Step Ahead in China: Guangdong Under Reform*. Harvard University

The development of an electronics industry was part of the plan for the Special Economic Zone from an early stage. The inability of Shenzhen to rapidly develop heavy manufacturing, the proximity to the electronic manufacturers of Hong Kong, and the rising demand for consumer electronics both domestically and globally made electronics an appealing industry for Shenzhen.[7] During the early 1980s, several electronics factories were established as joint ventures between state-owned enterprises and Hong Kong electronics companies. For example, in 1979, Guangdong Overseas Farm Management Bureau partnered with Hong Kong Ganghua Electronics Company to open a factory for electronic product processing. Similarly, the Overseas Chinese Town Economic Development Parent Company entered into partnership with the Hong Kong Ganggua Electronic Corporation to establish the Guangdong Guangming Overseas Chinese Electronics Industry Company, later trading as the Shenzhen Konka Group. Such factories produced radio, color televisions, and, later, LCD screens.[8]

As with the textile industries, early electronics manufacturing was driven by foreign investment. In some cases, this worked via the *sanlai yibu* ("three imports, one compensation") system in which raw materials, unassembled components, and prototype models would be imported into China and processed for re-export. Foreign firms would provide equipment, technology, and management in exchange for labor and land. In some cases, the factory operation and ownership would be turned over to the mainland partner after a specified period.[9]

The Shenzhen government also encouraged the integration of large-scale foreign manufacturing firms into domestic firms and state-owned enterprises. For instance, in January 1985, Epson invested $HK 10 million to create Yexin Technology Co., producing and exporting Epson printers from 1987. In April of 1985, Phillips also signed a technology

Press.

[7] Wenying Fu. 2015. *Towards a Dynamic Regional Innovation System: Investigation into the Electronics Industry in the Pearl River Delta, China*. Springer, pp. 133-136.

[8] Fu (2015), Appendix D contains a detailed timeline of the development of the Shenzhen electronics industry in the 1980s and 1990s derived from the Shenzhen Economics Chamber of Commerce's Shenzhen Electronics Yearbook from 2004.

[9] Wu, Bin, Jian Chen, Shujie Yao. 2013. *China's development and harmonization: Towards a balance with nature, society, and the international community.* Routledge.

cooperation agreement with Shenzhen Xianke Laser Technology Co. for the production of laser sighting systems.[10] In some cases, such joint ventures were associated with military institutions or personnel. The Communication Army Division of the General Staff Headquarters established one of Shenzhen's first electronics factories in 1979 (Hongling Electric Appliance Processing Plant).

The most prominent example of the relationship between the military and electronic in Shenzhen is the case of Huawei. In 1984, Ren Zhengfei – a former People's Liberation Army officer – was placed in charge of an electronics company under the control of the Shenzhen South Sea Oil Corporation Group. Although Ren failed in this enterprise, he soon founded a new business in Shenzhen under the name Shenzhen Huawei Technologies, selling, with the help of his parents, balloons, fire alarms, and dietary supplements out of his apartment. Commercial success came only when Ren became an agent for Hongnian, a Hong Kong-based telephone switch company. During the early 1990s, Huawei was able to develop and begin production of their own program controlled telephone switches, ultimately competing with multinationals such as Siemens and Alcatel who dominated markets both in China and overseas. In Shenzhen, Huawei was allowed to establish itself first as a privately held company, and later as a jointly held (and largely employee-owned) corporation.[11]

By the mid-1980s, Shenzhen's electronics economy was marked by close cooperation between domestic and state-owned firms. In 1986, with the encouragement of the Shenzhen City Government, local electronics manufacturers created the Shenzhen Electronics Group Company (later Saige Group) as a joint venture between 117 local companies. In 1988, the organization built the "Saige Electronics Supply Market" in the Huaqiangbei area of Shenzhen. This market not only centralized the supply of parts but provided for sharing of information and capacity amongst the Saige members. The growth of personal computer manufacturing in Shenzhen was also strengthened by intra-industry ties. In 1987, China Computer Development Company relocated their production base to Shenzhen, forming the China Great Wall Computer Development Company and establishing the Shenzhen

[10] Fu (2015), Appendix D.

[11] Yang Shaolong. 2017. *The Huawei Way: Lessons from an international tech giant on driving growth by focusing no never-ending innovation*. McGraw Hill. See also: Chang, Li-Chang. 2017. "Dynamic Organizational Learning: A Narrative Inquiry into the story of Huawei in China." *Asia Pacific Business Review* 23, no. 4: 541-558.

Computer Industrial Association.[12]

After 1990, the local government acted to further strengthen Shenzhen's electronics industries by encouraging further foreign investment within five strategic industries (PCs and software, telecommunications, microelectronics, optical-electro-mechanical integration and new materials). Moreover, firms were given increased opportunities for funding through the opening of capital markets and local legislation allowing for employee ownership of companies. Such opportunities encouraged many talented migrants to relocate to Shenzhen, developing a high level of entrepreneurial activity related to electronics.[13]

Shenzhen's electronics market was dramatically transformed by global shifts in the consumer electronics manufacturing in the 1990s. At this time, a new type of electronics manufacturing emerged called "electronics contract manufacturing" that:

> Comprised all essential elements of production, procurement, and logistics chains required to make electronics products… As opposed to the traditional subassembly of certain products or components, [contract manufacturers] commanded comprehensive resources in production, technology, and logistics.[14]

The increased outsourcing of electronics manufacturing by western and Japanese companies allowed Shenzhen to grow its electronics manufacturing base as these firms sought to

[12] Fu (2015). See also: Fu, Wenying, Javier Revilla and Daniel Schiller. 2012. Regional innovation: systems within a transitional context: evolutionary comparison of the electronics industry in Shenzhen and Dongguan since the opening of China. *Journal of Economic Surveys* 26, no. 3.

[13] Fu (2015). See also: Cassandra C. Wang. 2013. *Upgrading China's Information and Communications Technology Industry: State-firm Strategic Coordination and the Geography of Technological Innovation*. World Scientific; Wang Huijiong and Li Shantong [undated] Development of Pearl River Delta /Guangzhou / Shenzhen city region – case study of the process of innovation and learning in dynamic city-regions. Available at: http://www.unido.org/fileadmin/import/41704_DynamicCity_doc_CaseStudyChinapearlriverWANGandLI.pdf; Cheng Fangfang et al. 2014. Science parks and the colocation of high tech small and medium sized firms in China's Shenzhen. *Urban Studies* 51, no. 5: 1073-1089. Tan Puay Cheh, Zhou Tienan, Lin Wei Dong, Ho Ken Yi Melina. 2002. Consultative Study: Shenzhen in 2008: A potential electronics manufacturing hub? MBS Diss. Nanyang Business School.

[14] Lüthje, Boy, Stefanie Hürtgen, Peter Pawlicki, and Martina Sproll. 2013. *From Silicon Valley to Shenzhen: Global production and work in the IT industry*. Rowman and Littlefield. pp. 37.

relocate production to low-costs regions around the Pacific Rim. Much of this expansion occurred within large manufacturers such as Taiwan's Hon Hai Precision Co and its subsidiary, Foxconn. Opening its first mainland Chinese factory in Shenzhen in 1988, Foxconn saw massive revenue growth during the 1990s, acquiring contracts from Cisco, Dell, Apple, and Hewlett Packard and becoming the world's largest global contract manufacturer by 2005. Contract manufacturing – and the related ODM (original design manufacturing) model spread from notebook computers to PCs, MP3 players, and cell phones.[15]

By the late 1990s, Shenzhen had a large workforce with experience in the electronics manufacturing industry and a dense clustering of electronics manufacturing firms. Although massive manufacturers such as Foxconn were able to fill large orders for multinational consumer electronics firms, the growing global demand for DVD players, MP3 players, and cellular phones meant that smaller markets also existed, both within China and other developing economies. Because many of these consumer devices were being manufactured in Shenzhen, smaller firms could quickly gain knowledge and know-how through imitation, reverse engineering, or outright copying. Employees of Shenzhen companies such as Huawei and ZTE had familiarity with selling products to developing markets, especially internationally. By the early 2000s, such conditions had given rise to an entirely new electronics industry in Shenzhen based not large-scale manufacturing for multinationals, but rather on rapidly prototyping and manufacturing of cheap consumer electronics for developing world markets, often in small production runs. Such manufacturing was often based on small tweaks of existing technologies, running roughshod over intellectual property laws.

Although Shenzhen's factories continued to engage in contract manufacturing for global brands, this opening up of a small scale economy allowed significant space for innovation. Rather than assembly work for multinational firms, Shenzhen began to become a hub for the development of new products for local firms who appealed to new markets predominantly in developing economies.

[15] For more on these phenomena see: Hu, Kelly. 2008. Made in China: The Cultural Logic of OEMs and the manufacture of low cost technology. *Inter-Asia Cultural Studies* 9, no. 1: 27-46; Lüthje, Boy. 2004. Global Production Networks and Industrial Upgrading in China: The Case of Electronics Contract Manufacturing. East-West Center Working Papers. Economics Series. No. 74. Available at: http://scholarspace.manoa.hawaii.edu/bitstream/10125/3712/1/ECONwp074.pdf

This went alongside Shenzhen's developing reputation as a home of counterfeit goods. This also began with garments, especially with the copycatting of luxury brands such as Gucci and Prada. Such items can still be easily purchased in Shenzhen, especially in the shopping malls directly adjacent to the main Hong Kong border crossing at Louhu. By the late 1990s, with the spread of electronics manufacturing in SZ, "shanzhai" had also spread to numerous consumer electronic devices: mp3 players, TVs, and eventually mobile phones, suffered the same fate as Gucci bags. Importantly not only does the line between "real" and "fake" remain blurry with electronics (consumer electronics are often made in the same factories) but also this is not necessarily mere imitation. More precisely, what perhaps began as mere imitation led to more innovative practices, including recombinations, specialization, hybridisation, adaptation and so on. Some of the best examples are phones that are designed for specific market segments (the elderly, children, Muslims, etc.), specialized functions (dual SIMs). These are often produced in short production runs at very low cost and hence are sold mostly either domestically to less well-off Chinese, or abroad to emerging markets in Southeast Asia, Latin America, the Middle East, or Africa. These good are cheap partly because they ride roughshod over IP rules, but also because put together quickly, cheaply, leveraging on the large number of specialized suppliers, designers, and factories in Shenzhen.

This practice has become known as "shanzhai" – literally "mountain stronghold" in Mandarin - denoting an escape from the government rules and in particular here, escape from the rules of international intellectual property. The meanings and resonances of shanzhai are now multifarious and complicated, but suffice it to say here that "shanzhai," although at first perhaps used as a pejorative, has become, at least for some a sign of national pride, and a marker even of creativity.

Factory

These general descriptions give very little idea of how the work of producing electronics in Shenzhen actually proceeds. The rest of this essay is devoted to describing the kinds of spaces and kinds of work in and through which electronics actually get made. I begin here with the description of a small-scale factory on the outskirts of Shenzhen that I visited in the summer of 2017. Although Shenzhen is home to large-scale factories such as those that belong to Foxconn and other contract manufacturers, small-scale factories such as the one

described here are ubiquitous in the city and form the core of its work. As I shall argue, such factories and the flexible work they offer, are critical to the way in which electronics manufacturing functions in Shenzhen.

On a hot and sultry Saturday afternoon in July, I caught the Shenzhen metro to the far north of the metropolis. As I emerge from the shiny, new underground station, the street-scene looks familiar — large, busy highways are criss-crossed by overhead pedestrian bridges that connect large blocks. Most of the buildings look quite new, although many are poorly constructed and already beginning to show signs of wear and tear. I have come here to meet Hong, a small business owner, who has agreed to show me around his factory.[16] He is late — Saturday is work day for him and his staff. But eventually, I get his WeChat message to wait for him at a nearby bus stop. A few moments later, he pulls up in an exquisitely new black BYD (Build Your Dreams) SUV. I jump in and we're on the way. Hong is snappily dressed in khaki pants and a black polo shirt with gold logos emblazoned on the pocket. He's in his early forties and he speaks English well - a slight Australian lilt, a result of his university education, is even detectable.

The factory is no more than a five-minute drive from the station. We turn off the main road and begin to drive up a ridge that sits over the road; the factory itself, like many businesses in Shenzhen, is in a kind of compound that contains several buildings including other factories and worker dorms. We pause briefly at a barrier before continuing to follow the road up the hill. The factory-building itself is one amongst many, mostly painted in faded pastel blues and greens, and standing eight stories high.

The entranceway is a wide loading dock with a cargo lift on one side. We take the lift to the eighth floor. Hong rents the whole floor as his factory. The other floors are similarly occupied with small-scale factories manufacturing consumer goods such as toys and smart-watches — one company has placed a grimy display-case of colourful smart-watches for kids in the entranceway. We exit the lift onto Hong's factory floor and he gives me a tour: adjacent to the lift lobby is a space filled with cubicles for the factory office and administrative staff; a few of them are working at their computers or on the phones. Beyond that there is a small kitchen for the staff and then two further offices, one for the vice-

[16] I use pseudonyms to refer to my informants.

president, and then an enormous office for Hong himself. Aside from the huge dark-wood desk, the office contains three large sofa chairs arranged around a table with a tea service arranged at its centre. It is here that Hong would entertain his clients, serving them tea and chatting about new designs and products.

Hong takes me to a shelf along one wall of the office to show me the products he is currently producing. They are cameras designed to be installed in shops or homes that wirelessly feed images to your smartphone. The cameras can be viewed and controlled in real time; re-aligned, zoomed, set to record, set to take still shots, or set to motion-detect modes. Because the cameras work via the Internet, a user could be surveilling their premises in Australia while on vacation in China. Hong pulls up some feeds on his phone to demonstrate — it feels like spying over Skype.

The office shelf itself contains maybe as many as a dozen different models, some smaller, some larger, some prototypes, some newer models. Hong's factory is constantly refining as revising its designs, sometimes borrowing or copying from other camera designs and sometimes developing his own ideas. This is where Shenzhen itself becomes important for this kind of work: "everything is already here" Hong stresses. Ninety percent of their production materials are locally produced; even the chipset is from Huawei, a local company. This allows new ideas to prototyped in as little as twenty days, Hong tells me. In this kind of work, "what matters is not the size but the speed"; even the ideas themselves are not very important since they can be tried and tested so quickly.

The factory floor itself is across the hall from Hong's office, and not much larger than it: perhaps fifteen meters by twenty-five meters, with windows running along the far wall. The workers are arranged along three rows of waist-high benches. At each position, a drill-like tool hangs down from the ceiling. The rows of benches form a kind of production line within the room, with each worker responsible for attaching a different piece in the camera assembly. The last row of benches, under the windows is the quality control area where the devices are inspected and tested before being packed into the boxes that are stacked up against the far wall. All in all, the room contains about thirty people.

Hong employs about eighty people overall, including the office staff. Like other factories in and around Shenzhen, the workers work from 9am to 6pm with an hour and a half

break for lunch, five days per week, plus every second Saturday. Mostly migrant workers, they live within the factory compound in dorms of between six and eight. The workers are both men and women. As we leave the compound in Hong's car, we pass several groups workers - mostly dressed in jeans and colourful T-shirts - walking down the hill towards the underground station, probably to meet up with their friends elsewhere in the city.

There is little "automation" to be seen in this factory. Some of assembly process for Hong's products requires small powered hand tools, but much of it is manual labour, requiring dexterity and practice. What matters here, as Hong remarked, is not the scale — the factory is remarkably small — but speed and flexibility: the ability to produce quickly and move from one design to another quickly either to meet the demands of new customers or to keep up with the latest technologies. The supply chains are mostly local, drawing on the thousands of other small-scale factories and businesses in and around Shenzhen.

It is this kind of factory, this kind of business, that is critical to what Shenzhen's electronics industries are able to accomplish. It is precisely this localness, the small-scale, and the human-centeredness of the work that allow businesses like Hong's to rapidly adjust to new technologies or new markets and to prototype (and then retool for) new designs.

Industrial design

Factories form only one part of the ecosystem of electronics manufacturing in Shenzhen. Evidence from my informants suggested that it may actually be industrial designers that are the most important links in the economy of the city. Designers not only do the work of transforming ideas and products concepts into manufacturable products, but in doing this, they link together consumer electronics companies with factories and with suppliers in the electronics marketplaces. Big and small consumer electronics firms, both Chinese and overseas, rely on designers and design firms (such as the one described here) to connect them to networks through which they can source materials and actually produce their products.

On a different, but no less steamy, day I visited this very different kind of workplace in Shenzhen: an industrial design firm. Unlike the factory, the industrial design complex — part of Shenzhen Design Industrial Park — was located much closer to downtown Shenzhen in an area called Nanshan. Nanshan, lying just to the west of the central business district, is rapidly

gaining a name for itself as Shenzhen's high-tech zone. With Shenzhen University's main campus at it centre, the area is now home to TenCent, ZTE, and many other internet, electronics, and biotech firms.

Turning off a leafy main road, the Shenzhen Design Industrial Park greets the visitor with a spectacular array of brightly coloured shapes and buildings. Many of the structures are covered with metallic green, red, and blue exoskeletons, cut into various grids, ovals, and polygons. There are sculptures and other large objects lining the pathways, including a replica of an old British police box and an almost-full-sized car made entirely of wood. This is meant to look like a creative and "designy" space.

My destination is a company called Artop Designs. I enter a long and high-ceilinged lobby — the floors and walls have been painted matte black and large water feature dominates one end of the room — and wait for my host for the afternoon. I had been introduced to Mark at a Shenzhen makerspace, a place he hangs out for fun; his day job is as an industrial designer here at Artop.

Along with one of his colleagues, Mark shows me around his workplace. Artop is one of the larger design firms in the complex — it cover six floors of a relatively large building. Much of the first floor is occupied by the lobby and a large conference and display room behind it. I can get a sense of the scale of the business here too because one large wall is filled entirely with individual pictures of Artop designers and engineers, most of the them in goofy poses; I guess that there are over one hundred of them. In fact, Artop is a large company, employing over one thousand designers, not just in Shenzhen but in Chengdu, Shanghai, and six other Chinese cities as well as Sydney.

An adjacent wall forms a kind of design museum of Artop's products. The range is enormous: phones, and other consumer electronics of course, but also medical equipment (a CT scanner for pets!), household appliances, and military hardware. Artop works with both local and international firms to guide them through the design, prototyping, and manufacturing process. "Complete industry chain design and innovation," Mark tells me, includes not only the physical design of products but also research and development, developing a supply chain, user testing, branding, marketing, guiding products through the production process, and help with intellectual property (they have separate patent services

office).

The main floors of the building, the third, fourth, fifth and sixth, are where the designers work. Designers and engineers are seated at low wooden desks, mostly tapping away at laptop computers. Again, the decor is rough hewn but chic — these floors look like the offices of a boutique architectural firm. The work that goes on here is critical to the firm's business, but Mark and his colleague stress to me the importance of designers leaving their desks, especially to visit factories. Good design is a back-and-forth process: customers may have an idea, but the job of Artop's employees is to make sure it can become a reality. This means ensuring that it is feasible — that it can be built and scaled up for mass production. This most often means physically going and checking on what factories can and cannot do.

The second floor of the building is different — certainly the most unusual space. On my first glance, I thought that perhaps it was a library (in fact many design books and magazines were kept there). But in fact this was a sort of library of materials. Rows and rows of shelves contain plastic samples, cloth samples, metal samples, in a variety of shapes and colours. It is here that designers come to work out what materials they can use to build their products — a sample of almost every material, texture and colour available available in Shenzhen's factories can be found here. Each sample is carefully coded such that it points back to a particular factories or specific suppliers that can produce or stock that material.

It is in both the interaction between Artop designers and factories and in the "materials library" that the significance of Shenzhen itself becomes important. Mark stressed to me what made Shenzhen so critical for their business. First, Shenzhen (and the cities surround it, especially Dongguan) have long been homes for suppliers of electronics; this had the dual advantages of "information and location." Factories have the latest technologies and the latest materials, getting it first and developing it fast This give firms here an immediate advantage over those in other cities. The sheer size and speed of the market here also means that designers quickly become experience and knowledgeable, giving them a further advantage over their competitors.

As well as the factories, the electronics markets at Huaqiangbei were important partners too — parts could come quickly from contacts and suppliers located there. But also

the markets were sources of new ideas and new designs too; design firms including Artop contributed to the design and development of "copycat" electronics such as shanzhai phones. Close cooperation between the various parts of this ecosystem (designers, factories, electronics markets) - what Mark described as "win-win coexistence" was essential for success.

Second, Mark stressed the role of the business environment in Shenzhen. As the "first open city in China" it had attracted immigrants, mostly young people, from all over China. According to Mark at least, this meant more openness (including to foreign firms), less orientation towards the government, and more "business" orientation. People here not looking for graft, but rather to make money and get things done. This made for a business environment that was superior to other cities in China.

"Design" is now lauded in the west as a new and celebrated kind of "knowledge work" that is central to the innovation economy.[17] In Shenzhen, "design" is part of the ordinary work of electronics manufacturing. As I have suggested here, the most important aspects of design are not "ideation," but rather working closely with suppliers of materials and with factories to produce manufacturable products that can be scaled-up to mass production. In other words, as Ling-Fei Lin has suggested, the importance of design is that it is tightly integrated into the processes of manufacturing. In Shenzhen, it is precisely the dense social networks that exist between designers, factories, and suppliers that allow products to be quickly produced and reproduced.

Electronics markets

In the final section of this essay, I turn to the what might be considered the heart of the electronics industry in Shenzhen: the electronics markets at Huaqiangbei. It is here that the scope, range, and diversity of activities of electronics-making can be best appreciated. The markets serve a range of purposes: they sell finished goods to customers in China and overseas (often through middle-persons of various kinds); they supply materials to manufacturers and small factories both in Shenzhen and elsewhere; and they act as

[17] For instance see: Miller, Peter N. 2015. Is 'Design Thinking' the New Liberal Arts? *Chronicle of Higher Education* 26 March. https://www.chronicle.com/article/Is-Design-Thinking-the-New/228779

wholesalers, resellers, distributors, and middle-persons for a range of electronics-related goods. Perhaps most importantly, they serve as a public space within which the range of actors in electronics design, manufacturing, and sale can interact and observe the range of products and activities on offer; the markets serve as a highly visible marker of the diversity of what is made and re-made in Shenzhen.

Huaqiangbei is an area located in the central business district of Futian in Shenzhen. It's boundaries are a little fuzzy, but it is comprised of an area of about three large city blocks by three large city blocks within which there is a massive concentration of electronics retailers. There are some makerspaces here (although those are also spread around other parts of the city) and also some retail shops selling iPhones, Huawei, Xiaomi, and a huge variety of other consumer electronics goods. However, the majority of businesses in Huaqiangbei are small vendors selling a wide variety of consumer electronics components: wires, screen, power supplies, batteries, resistors, circuits boards of various kinds, capacitors, etc.

From the outside, these markets look something like medium-sized, windowless shopping malls. Upon entering, however, the electronics shopper is greeted with a complex warren of almost-overlapping businesses. Often spread over between four and eight stories, individual stalls can be as small as about two square meters (some are even smaller, a few are larger). Despite the size, rents are high, especially for prime positions in the markets: one informant told me he paid RMB10000 per month (about $1500 USD, a high price for a very small space with few amenities).

On the inside, the markets also differ in appearance quite considerably. I have examined two of these markets in detail: Golconda and the Longsheng Communications Market. Golcunda the building was a little older and more run-down; inside, it smelled intensely inside of cigarette smoke and tea. Longsheng is a little nicer: brighter inside and cleaner (here smoking seems to be confined to the stairwells, not inside the market itself). Some of the newer markets are shinier still, with more conventional worldwide brands (Apple, Sony) operating on the ground floor and many of the small- scale vendors on the upper floors. Generally, the further up into the buildings you go, the darker and dingier these markets seem.

The people working here are young, as in much of the rest of Shenzhen. And it is

immediately noticeable that there are many women, perhaps more women than men. The rest of this section describes the kinds of work that are taking place here, roughly in order of how common they appeared to be.

i) Assembly

One of the major kinds of work is various forms of "assembly" of electronics components for sale. This word is to be construed broadly here, and there is a range of complexities of activities involved. For example, one of my informants' business was to sell screens, mostly for tablets. When I first asked about this, it seemed that this was merely a kind of wholesale business – on-selling the screens from manufacturers to tablet manufacturers in China and overseas.

However, some minor assembly work was involved – I watched for several hours my informant and his employees completed one order in which they took the screens and attached the button and the associated wiring to the back side of it: the button and wiring assembly was attached to adhesive paper and their work was to remove it and place it correctly on each screen and then wrap the screens for shipment. Similarly, the next door stall was wrapping mobile phone batteries in plastic for shipment. This is hardly complex work, but it is no doubt a critical doubt a part of the economy of consumer electronics manufacturing.

Compared to these very simple tasks, other stalls had what an informant described as "small factories." Here, I observed workers using soldering irons to actually wire components together, or using desktop sized pieces of equipment such as metal presses and cutters to shape and cut logos cases for phones or tablets, for example. At one stall, I paid a few dollar for an Apple logo to be cut into a blank metal phone case.

This kind of work is continuous and even overlapping with what goes on in "real" small-scale factories in other parts of Shenzhen, such as the one I described above. There is an overlap in personel too: many of the workers in these markets are former employees in Shenzhen's factories. One of my informants had worked in a bicycle factory in Shenzhen before opening his own small electronics business in the Longsheng Communications Market. It is hard to know exactly how widespread such circulation is, but it is likely that

other business owners in the market had worked in electronics assembly and manufacturing elsewhere, allowing them to draw on their contacts back in the factories as both suppliers and customers.

ii) Recycling and Repair

The second most common type of work was repair and recycling of electronic parts, especially mobile phones and tablets. In some cases, this would involve a one-off customer wishing to get their phone repaired: phones or tablets would be sent to particular booths within the market specializing in particular types of repair (eg. screens or batteries). But this appeared to be small fraction of the repair business within the electronics markets. More importantly, the markets have become clearing houses for old, discarded and broken phones (and other devices). Discarded phones are collected or bought by these small businesses and refurbished for re-sale as second hand phones. Many of these small businesses have extensive networks either in China other parts of the world including Thailand, Vietnam, the Middle East and Africa where the market for such second-hand phones is large (because people can't afford new phones).

In Shenzhen, collection point for old phones and tablets can be found across the city, often on the street outside other kinds of businesses. Such phones no doubt end up at locations within the Huaqiangbei markets. Even when phones cannot be salvaged as second hand, these businesses operate in stripping them down and selling the parts, recycling the various valuable components of the phones, either as spare parts or raw materials. Some vendors had huge piles of old phones on their workspaces waiting for such treatment.

iii) Testing

Hand-in-hand with repair goes testing. The testing of components and finished consumer electronics products is also a big part of the activities at the markets. This is sometimes part of the assembly and repair and recycling businesses, but sometimes separate. Often, particular vendors specialize in testing particular parts and have specialized equipment and skills for doing so.

For example, I watched as one worker in the markets connect screen after screen to the body

of an iPhone (or similar) and performed a routine of standardized set of tests on each one: attach the screen, move finger up, move finger down, move finger left, move finger right, swipe up, swipe down, disconnect the screen and proceed to next one. This took about thirty seconds per screen. Another booth had a specific device for charging up tens of phone batteries at once in order to test them. Another had a much more sophisticated machine into which she could plug mobile phone chips – she could then execute a series of commands on a laptop attached to the device which would check that the chip was booting up correctly. Since many of the goods could be described as "grey market" (coming from, for example, extra shifts at factories), such testing is no doubt critical for ensuring that products are working or meeting specifications. Individual vendors have customer relationships to protect, so testing is important to making sure they can guarantee not necessarily the highest quality products, but at least products that are working.

iv) Packing and Shipping

Many of the customers for all of the goods sold in the markets are either in other parts of China or overseas, especially in the developing world. In many cases, these customers may never be seen in person. For customers in China, orders are even received via WeChat, for example. The electronics markets are also one of the few places you are likely to find foreigners in Shenzhen. There are a few Europeans, but it is easy to pick out amongst the crowds many individuals from Russia, the Middle East and Africa, in particular. These individuals are either looking to buy parts for assembling phones or other electronics in their home countries or looking to buy finished products (such as shanzhai phones) for resale overseas. They will likely be placing medium sized (500-1000 units) or even large (5000 to 50000 units) orders.

Because of this, a huge amount of the work of these markets is packing and shipment. I've already noted the work of packing screen and batteries. In Golconda market in particular, most floors are strewn with packing detritus and there are sweepers and cleaners constantly removing it. Most days, between 10.00 and 11.00am and about 9.30 and 10.30pm the floors of the market are swarming with packers, dollies, boxes, bubble wrap and so on. Dedicated delivery people are constantly ferrying things in and out and loading them onto trucks in the

alleyways between the markets.

Some whole businesses are based on packing. I spoke to one women who had a whole table full of thousands of tiny screws neatly arranged in small boxes in front of her. An a finished iPhone is held together by about twenty different kinds of screws of various lengths and sizes that go in different places inside the phone. This woman was packing small plastic ziplock bags containing one complete set of all the screws necessary to assemble one iPhone. These packets could then be sold to other businesses who either assembled or repaired iPhones.
At the entrances to almost all the markets one can also find dedicated stalls for shipping. Often they prominently display the logos of DHL, FedEx, etc., but many of them have nothing to do with these multi-national companies. These businesses are responsible for delivering the products of the market to customers all over China and the rest of the world. These activities as critical to the markets' work – the speed, scale, and global reach that these markets can have depends critically on all these activities. It is noteworthy here that one large part of the success of Taobao (Alibaba) is that they have created their own delivery services around China to deliver products ordered online (a practice being emulated by Amazon)[18]

v) Branding

There is also a significant amount of work in the market that is focused on what might loosely be called "branding." These operations are usually also on the ground floor, near the shippers, suggesting that it is something that businesses do as they are getting their products out the door. Here, I include activities such creating logos for products that can be placed on stickers or cases. For example, designs can etched or stamped, or cut, into the metal cases of phone or tablets.

These services can very quickly produce any logo at all. Businesses can put an Apple or Samsung logo on their phones, or something resembling recognisable brand (there are lots of "pear" phones available) or they can design their own. Some vendors will print stickers or sticky labels. If a business needs one thousand "Toshiba" stickers to put on the laptops they

[18] Clark, Duncan. 2016. *Alibaba: The House that Jack Ma Built*. Ecco.

just assembled, these can be printed up rapidly and on the spot.

All this is certainly part of the shanzhai economy too. The ability to produce and ship completed goods (including labels and brand names) — including "copycats" and "lookalikes" — is part of "Shenzhen speed." In 2014, when I first visited these markets, there were also older women (and they did seem to be all women) who stood outside the electronics markets with what looked like big calculators in their hands. Their service was to provide fake receipts – if you wanted a receipt to say you had actually bought five hundred Toshiba laptops, they would sell the necessary documentation for a few dollars. These vendors too served an important purpose within this copycat "grey economy."

vi) Caregiving

Finally, I want to note several other kinds of work that take place in these markets that are certainly in plain view, but easily overlooked or rendered invisible. The stalls within the electronics markets are most often family-run small businesses. One of my informants got into the business via his sister-in-law, setting up shop almost alongside her. Extended family and local networks are also important – two young girls working together in one stall came from the same home town and had known each other there; now they worked together in the market.

The Golcunda market, in particular, was obviously a family space. Lots of children were running around or playing with toys or asleep in strollers. Childcare was very clearly part of the work taking place in these markets. The very long hours and labour intensive work of assembly and packing means that children in many cases had to be in the markets with their parents. Indeed, the markets also provided a flexible kind of environment for this – work (for example, packing boxes or assembling parts) could be done in between or simultaneously with child care.

Also within these markets were other kinds of stalls that supported the electronics work: food sellers, mini-mart type stalls, stalls selling tools, and I even found stalls selling bottles of liquor (presumably for celebrating a big deal). Perhaps even more unexpectedly, one stall told only teapots; tea is an important part of market activities – most stalls have quite an elaborate tea set somewhere on their counter or inside the stall. This is likely because this is because

offering and drinking tea together with a potential customer or client is an important part of the ritual of doing business; tea is also critical to the ecology of shanzhai electronics.

* * *

It may seem strange to focus on childcare and mini-marts in a discussion of electronics manufacturing. However, my argument here is that it is precisely this kind of "ordinary labour" that enables Shenzhen's "innovation economy" to function as it does. It is precisely the human scale and social dimensions of these forms of work that allow dense and overlapping networks of suppliers, factory bosses, and designers to function. Without the human and social practices of tea-drinking, child care, and other "ordinary" activities, these markets could not operate at the scale, density, and pace that they do; and it is these very features that make Shenzhen's electronics economy so unique.

Conclusions

I take inspiration here from an *Atlantic* article by Debbie Chachra entitled "Why I am not a maker" from January 2015. Chachra argues against the rhetoric and privileging of "creators" and the maker movement:

> Walk through a museum. Look around a city. Almost all the artifacts that we value as a society were made by or at the order of men. But behind every one is an invisible infrastructure of labor – primarily caregiving, in its various aspects – that is performed mostly by women… The cultural primacy of making, especially in tech culture – that it is intrinsically superior to not-making, to repair, analysis, and especially caregiving – is informed by the gendered history of who made things, and in particular, who made things that were shared with the world, not merely for hearth and home.[19]

Following Chachra, I argue that the electronics economy depends critically not just on "makers" or robots but on all kinds of other labor, including the labor of caregiving that Chachra refers to. One could also put this in terms of class, rather than gender: the "maker" movement is a movement of the upper-middle classes: it is practiced by the globally mobile citizens, in China and elsewhere, for consumption by wealthy consumers. It is not so much

[19] Chachra, Debbie. 2015. Why I am not a Maker. *The Atlantic* 23 January: https://www.theatlantic.com/technology/archive/2015/01/why-i-am-not-a-maker/384767/

that there are no female makers in SZ – there certainly are; but rather, it is at once clear from walking around HQB that the "shanzhai" economy depends critically not just on "makers," but on all kinds of other labour, including the labour of caregiving that Chachra refers to. What seems most interesting to me about Shenzhen's electronics is that it not only relies on, but seems to spring in large from lower-middle class and low-class work – devices made by small factories and shops, sold by small enterprises, and specifically designed for the less wealthy, especially those in developing countries.

David Li, who runs the Shenzhen Open Innovation Lab (SZOIL) told me a story about who he thinks the "real innovators" are in the city. Go to the markets, he advised, and look for the middle-aged Chinese men in the polo shirt with a nice leather bag. They would probably be flying business class from some other part of China and staying in an up-scale hotel. These men, he said, are the real ones who come up with new ideas for new products, based on market research they conduct back in their home towns. They come to Shenzhen, as they have been doing for many years, to see their friend the factory boss and presents their ideas. Together out-of-town businessman and the factory boss decide which idea are feasible. Then, they hire some industrial designers to design and prototype it. This takes place incredibly rapidly, over just a few weeks while the businessman and his friends spend a few weeks at nice dinners, singing Karaoke, and playing golf. They then take a few suitcases full of prototypes back to their home towns to try to generate orders. This is a particular kind of story that no doubt has a lot of truth to it: the real makers are not young entrepreneurs in a makerspace but older businessmen playing golf.[20]

What is significant about this is that the core of Shenzhen's work depends not on automation, roboticization, or other forms of "high tech" work. Rather, the process depends most critically on all the kinds of "ordinary" work and people described here and the tight networks and connections that exist between them. It is these connections that facilitate the speed of creativity and innovation that allows products to be built and shipped rapidly: they enable parts to be available and for the parts, in various stages of assembly, to move rapidly between buyers and sellers. All the kinds of work described here – the middle-tech and often invisible work – creates the ability to do things fast, to change fast, to be flexible, to make

[20] See more detail at: http://hallamstevens.org/index.php/2017/08/20/open-innovation-in-shenzhen-an-interview-with-david-li/

fast, and to ship fast.

It is not just the absence of robots and automation here that is important. More significantly, what I want to call attention to here is that the types of work that seem to be at the heart of Shenzhen's unique forms of innovation are precisely those forms of work that seem *least subject* to regimes automation. Design, personal and family networks, small-scale factories, small-scale assembly, recycling, repair, and the other kinds of activities described here all seem very unlikely to be automated. They are important precisely because the are human and social activities.

This suggests that we need to critically rethink accounts of automation and innovation that derive from Silicon Valley. Rather than assuming that progress and "high-value" work is developed through automation and "scaling up," close attention to how electronics manufacturing actually operates in Shenzhen suggests that it is precisely the human and non-technological elements of this economy that makes it uniquely successful. It is all the kinds of diverse and "ordinary" labour, tightly organised into social networks, that makes "Shenzhen speed."