

1.1.3 The Shock of the Old: Production

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Standard accounts of the history of technology tend to emphasize invention and innovation as the key events for understanding the impact of technology on society. Often the history of technology is reduced to a timeline, such as appears on the inside front and back covers of this book, that simply lists the approximate year in which a particular technology was first invented. British historian of technology David Edgerton, however, disagrees with this approach and argues that the way to understand the true impact of technology on society is to look at technology-in-use. Technologies have life cycles of use in which they move from invention, to limited production, to mass production, to widespread adoption and use, and onto eventual obsolescence where selected technological artifacts live on only as exhibits in science and technology museums. But surprisingly, some technological solutions live on existing beside newer alternates—for instance, the humble paper clip or the mechanical clock. If one looks at the history of technology in the twentieth century in this use-centric way, one realizes that “twentieth-century technology is not just a matter of electricity, mass production, aerospace, nuclear power, the internet and the contraceptive pill. It will involve the rickshaw, the condom, the horse, the sewing machine, the spinning wheel, the Haber-Bosch process, the hydrogenation of coal, cemented carbide tools, bicycles, corrugated iron, cement, asbestos, DDT, the chain saw and the refrigerator” (Edgerton, xii). One important advantage of the use perspective is that it enables us to view technology globally and not just in the countries of origin.

In this selection, taken from his book *The Shock of the Old: Technology and Global History since 1900*, Edgerton illustrates his thesis by discussing global trends in the production of goods and services.

FOCUS QUESTIONS

1. What are some examples of twentieth century technologies that fostered greater productivity in the household worldwide?
2. How did changes in the dominant agricultural technologies affect different countries around the world?
3. What accounts for the emergence of the poor countries as the major centers of manufacturing in the last quarter of the twentieth century?
4. How does Edgerton’s account of technological trends in the production of goods and services help us understand the character of the current era of globalization? Why have its effects been different in the rich world and the poor world? Explain.

KEYWORDS

branding, collectivization, green revolution, household production, leisure technologies, mass production, service industries, the long boom

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The output of the world economy has increased much faster than a rapidly growing population through most of the twentieth century. One period stands out for particularly rapid growth and change: the three decades after the Second World War. These years saw output increases which were unprecedented in world history and have not been seen since then in the rich countries. As important historical transition periods go, it is rather modestly named. It is called the “long boom,” or the “golden age,” terms which do not conjure up revolutionary change. In technological history—if considered at all—it tends to be relegated to a third or fourth industrial revolution. But in many parts of the world, including much of Europe, this was the period of the first industrial revolution, as employment shifted decisively from agriculture into industry and services. It was an era when productive processes increased very rapidly in efficiency, turning out long-known products at ever lower prices. That process has continued since, with unprecedented rates of growth, in the poor world.

The usual story of production goes like this: there has been a shift in employment and output from agriculture to industry and then to services. The first is labelled the industrial revolution. The second is called a transition to post-industrial, knowledge or information societies, linked to what many called post-modernism, what some Marxists called “new times,” and, what capitalist Wall Street gurus called the “new economy.” In one version peddled in the 1990s, modern economies are becoming “weightless” and “dematerialised.” Such accounts resurrect an old argument, as if it had never been made before, that in future it will not be land or capital which will have power, but knowledge. They promise, again, a world where “intellectual property” and “human capital” rule.

Yet this stage theory of history, focusing on *shares* of employment, easily misrepresents the whole. In the twentieth century the output of agriculture expanded enormously and it continues to do so. The long boom saw the most radical revolution in the history of rich-country agriculture: productivity increase was so rapid that employment decreased even as output increased. Industrial output expanded enormously and

continues to do so, even as employment in industry started to fall in the rich countries in the 1970s. Services too have long been growing. The expansion of employment in services is in part the extension of services that can be provided only by employing more people. To a very crude and counter-intuitive first approximation, falling employment is not necessarily a measure of failure or backwardness, but of rapid technical change. We should recognise too that the boundaries between these artificial categories are not as clear cut or revealing of underlying trends as they are made to seem. The killing of animals is usually classified under manufacturing industry, not agriculture; publishing as well as printing are manufacturing industries; some maintenance activities come under services, together with transport.

The tripartite division into agriculture, industry and services also misses a vitally important dimension—the non-market productive activities of households, a fundamental part of total production, whether in agriculture, industry or services. It has long been recognised that the standard national income (GDP) data in use since the 1950s has not included non-traded goods and services. Because there are no wages for most housework, it does not figure in most national accounts. Most unpaid work in the rich world is done by women, though by no means all. The one area where men do more than women is maintenance and repair. We know this from use-of-time studies and the “satellite” national accounts including household work created in recent years. For the rich countries the figures vary between 30 and more than 100 per cent of the conventionally measured GDP. In many parts of the world the household remains a key economic unit, both for subsistence and for production for the market, particularly in agriculture, as in the “peasant” household, that great neglected economic and cultural unit of the twentieth century. The household is a good place to start.

HOUSEHOLD PRODUCTION

The 1922 *Encyclopaedia Britannica* entry on “mass production” noted of the “factory system” that its first effect was “to emancipate

the home from being a mere adjunct to the loom or bench, and its later effect was to provide the home with means to develop the dignified status which it has now attained." Siegfried Giedion, a pioneer of the study of the mechanisation of the rich household wrote in 1948, that "One can hardly speak of household 'production.'" There is much to be said for the rich household as a place where machines are used for consumption rather than production.

Indeed domestic technologies of leisure deserve more serious consideration than they usually get in the history of technology. In the rich world the household was to take up technologies of leisure such as the radio, TV and video recorders much faster than washing machines or vacuum cleaners. The car and the telephone have behaved more like radio and television than washing machines and both were, at least at first, primarily leisure technologies. Cars were for visiting and going on trips rather than travelling to work. The telephone, though first sold as a business tool, was very quickly taken up by women, for what telephone engineers saw as frivolous use—socialising and gossiping. In largely family-run US farms in the 1920s the motor car diffused much faster than the truck or tractor. By 1920 there was the extraordinary total of 2 million cars on US farms, compared with 250,000 tractors and 150,000 trucks; by 1930 the number of cars reached about 4 million, where it stayed into the late 1950. In 1920 roughly half of all mid-western farms had cars, well over that had telephones, while less than 10 per cent had tractors, running water or electric lights; for 1930 80 per cent had cars, 60 per cent had telephones, 30 per cent had tractors, and 15–20 per cent had electric lights and running water. Around 40 per cent had radios in 1930. This pattern of acquisition by households would endure, however much some complained that slum dwellers bought televisions before sewing machines, or Japanese farmers of the 1950s bought gaudy tiles and kimonos rather than washing machines.

Yet production remained a key role of the household. From at least the interwar years the wealthier households of rich countries were seen as places requiring new domestic technologies

and a new scientific organisation of domestic work, devoted to the production of food, cleanliness, order. The seemingly private world of the domestic kitchen now had its own experts, pioneer social researchers interested in the impact of modernity, students of budgets and of time use, activist promoters of new kinds of hygienic living, and proponents of "home economics" "domestic science" and "household engineering." Many of these studies were promoted by interested parties, for example the Rural Electrification Agency in the USA, the electric appliance manufacturers and industry-funded bodies such as the British Electrical Development Association. They would not have recommended one-woman domestic production for the manufacture of domestic appliances.

One of the hoariest old clichés of the advertisers and the sponsored researchers was that new technologies in the home had relieved rich-world housewives of drudgery and given them leisure. Yet in the United States middle-class women had seen an increase in domestic work earlier in the century, with a decline only in the 1960s, long after the widespread use of new domestic technologies. Machines replaced domestic servants, changing the role of the middle-class housewife from supervisor of workers to machine-operator. The labour productivity of domestic work increased, but this led not to a decrease in work, but rather to increased domestic production. By how much domestic productivity and production have increased, and how this compares with large-scale industry or with agriculture is unclear, for the outputs of this sort of domestic production are not measured. Despite its importance in the provision of so many quickly changing outputs from increasingly clean clothes to many new types of domestically prepared food, this vast world of production is hardly charted.

But we can say something about the tools of household production. The machine tools of the rich home were very different, generally, from those of industry, as were the non-machine tools. These tools were called "consumer durables" and not "producer durables"; they were not an "investment" but "consumption." The tools of the

household were the product of large scale industry and scientific investigation, and many were cheapened very considerably by mass production. So dominant did some firms become that trade names were not just familiar, but sometimes became the generic name: we have only to think of Singer or Hoover to make the point.

Even seemingly old-fashioned tools were remade by large corporations. One particularly long-lived, though not widely diffused, type of cooking range which is now associated with nineteenth-century domesticity, provides an interesting case. The AGA range was launched in 1929, the product of a very large and inventive Swedish firm (AGA—or, in English, “gas accumulator company”) that in the interwar years made, among other things, cars, radios and film equipment. The president of the company, who oversaw its growth between 1909 and 1937, was Nils Gustav Dalén, winner of the 1912 Nobel prize in physics, for his work on inventions concerning the storage and use of acetylene, and the related automatic lighthouse, which launched the company on its path to success. Dalén personally developed the AGA range, making it the most fuel efficient ever made, in the sense that it converted a high proportion of fuel into usable heat. By 1934 it was being sold worldwide and was later manufactured in some ten countries. AGA stopped making them in 1957, but production continued in Britain; indeed still does. Another long-lived technology, it acquired the patina of retro-ebic in an era when the major expansion was in gas and electric ranges.

Gas and electric ranges, like the AGA, did not change radically from their introduction in the late nineteenth century to the present. The novelties in domestic production technology have been few. Baths, showers, sewing machines, cooking ranges, vacuum cleaners, washing machines, electric irons, refrigerators, freezers and dishwashers were all available in the interwar years, and most long before that. Most have remained much the same for many decades. The extent of use has been a story not of time and innovation, but economics, and the availability of inputs, such as electricity, gas and piped water. As countries became richer they acquired more of them. And they

became richer by producing more and more of them. The levels of consumption of motor cars, washing machines, telephones and the like which were seen in the United States in the 1920s were not to be found in the rich parts of Europe until the 1950s and 1960s. They would spread to the rest of the world later still.

THE SEWING MACHINE AND THE SPINNING WHEEL

A particularly good example of the complex history of household technology, not least because of its global diffusion, is provided by the sewing machine. In the rich countries the watch, bicycle, piano and sewing-machine industries were very much in the vanguard of the new consumer-durable industry in the years before the Great War. The sewing machine was produced on a huge scale by essentially one global enterprise, the Singer Sewing Machine Company, a pioneer not only in mass production but in mass selling through credit. In 1905 Singer had the then very large number of 30,000 workers making sewing machines in eight factories round the world, but they were dwarfed by the global sales force of 61,444 in more than 4,000 branch offices. Singer, with perhaps 90 per cent of world market (outside the USA) was selling around 2.5 million machines before the Great War, with around 1.3 million coming from the Clydebank plant in Scotland.

Through the twentieth century sewing-machine production would increase. In the late 1960s Japan, by then a leading producer, made 4.3 million, mostly for export. Thereafter production was to fall: by the mid-1990s it was down to 4 million worldwide: 2.3 million came from China, followed in order by Taiwan, then Japan, USA and Germany. In China in the 1960s, 1970s and 1980s the sewing machine was one of “four big belongings”; the others were the wristwatch, the radio and the bicycle. In the Chinese countryside in the mid-1980s, each farm family had “1 bicycle, about half had a radio, 43 per cent owned a sewing machine, 12 per cent had a television set, and about half the rural adults owned wristwatches.”

Essentially the same sewing machine was employed in various different contexts. Most went to homes, where they were used to make and mend family clothes, and to produce for the market, in vast putting-out systems. They were also installed in small sweatshops and packed into gigantic clothing factories as they developed from the 1930s.

The sewing machine also provides a wonderful example of very long-lived models not only being kept in use, but continuing in production for a long time. Treadle-powered machines, not so different from those made before 1914, were, in the 1960s, “by far the most important modern appliance” in a small town of the district of Huaylas in Andean Peru. In Mae Hong Son, northern Thailand, in April 2002, treadle-operated Singers decorated with a sticker celebrating 150 years of Singer machines were on sale alongside white goods, next to an internet café. At the other end of the world, an expensive (male) tailor working alone making men’s suits in Lecce, Italy, also used a treadle-operated Singer. Treadle-powered sewing machines feature regularly in discussions of micro-credit initiatives supported by international development agencies.

The sewing machine had a very particular place in the thinking of Mahatma Gandhi, as exemplary of an alternative approach to production. Gandhi was a strong opponent of the machine-based industries and famously argued not for mass production, but for production by the masses. Yet, he made what he called “intelligent exceptions” to this hostility to industrially-made machines. “Take the case of the Singer Sewing Machine,” he said. “It is one of the few useful things ever invented. . . .” His interviewer responded that he could not object to the factories that made them, to which Gandhi replied that he was “Socialist enough to say that such factories should be nationalized, or State-controlled.” He claimed that the sewing machine was “but one of the exceptions I have in mind. . . . I would welcome any day a machine to straighten crooked spindles” so that “when the spindle gets wrong every spinner will have a machine of his own to get it straight.” The key machine in Gandhi’s ideal world was not the sewing machine, but the spinning wheel, already a defunct technology in

India. “The spinning wheel represents to me the hope of the masses,” claimed Gandhi. “The masses lost their freedom, such as it was, with the loss of the *charkha* [spinning wheel]. The *charkha* supplemented the agriculture of the villagers and gave it dignity. It was the friend and the solace of the widow. It kept the villagers from idleness. For the *charkha* included all the anterior and posterior industries—ginning, carding, warping, sizing, dyeing and weaving. These in their turn kept the village carpenter and the blacksmith busy.” He *reintroduced* the hand spinning wheel or *charkha* to India; and it became part of the Indian National Congress flag.

TOOLS AND SMALL TRADES

Production by the masses characterised a great deal of productive activity by the poor in the twentieth century. It is perhaps not surprising that the symbol of the world Communist movement was not Henry Maudslay’s lathe, so celebrated by Marx, nor the spinning mules or the looms of the textile industry, also familiar from Marx, or the Model T. It was instead the hammer and the sickle, the first the key tool of the forge one might find in the countryside, and the second, a key instrument of unmechanised agriculture.

All through the twentieth century small enterprises operated with the simplest of tools. Even in manufacturing trades, between one quarter and a third of workers in Germany and France around 1900 worked alone. Family-owned and run restaurants were serving 1 million meals a day in Paris in 1939, a figure which fell to 250,000 in 1950, due to the rise of factory and office canteens, though growth then resumed. A Sicilian farming family in 1931 lived in two rooms and a stable—they owned a mule and chickens and few possessions apart from some “rudimentary” agricultural implements. In a proclamation issued in June 1944 a commander of the Greek resistance movement ELAS described the means of production of his community. He spoke of “The butcher with his knife, the grocer with his weights, the café owner with his chairs, the greengrocer with his scales.” In the 1980s the country-boats of Bangladesh

were made by itinerant boat carpenters, traditionally Hindus (in a Muslim nation), so poor they could not buy the materials to make the boats, or sometimes even their own simple tools.

Travelling through the poor world it is hard to miss, today, a tiny metal-working shop, in both country and city districts, where the most complex bit of machinery may well be an oxyacetylene, or electric, torch for welding. At dusk bright intermittent light from welding illuminates streets all over the world, issuing from maintenance workshops which might also make simple equipment. Or think of the tiny businesses repairing electronic equipment based on the pavements of Bangkok, or the recyclers of tyres into shoes and many other goods, to be found in many poor cities.

FAMILY FARMS IN THE USA AND THE USSR

The family farms of the North American Midwest were among the richest in the world at the beginning of the twentieth century. These farms were immensely productive, not in terms of land (for here European farmers were well ahead), but in terms of labour. From the 1920s enormous numbers of Fordson tractors appeared: they could replace five horses, and plough three times as fast. A recent large tractor can plough thirty times faster than the horse team. A key effect of the tractor was to reduce the amount of hired help on the Midwestern family-owned farm; this had the consequence too that the farmer's wife was saved the work of feeding large numbers of hired workers, a standard practice, illustrating the blurred line between the home and the farm. Interwar Midwest farm women were very heavily engaged in other non-domestic activities, tending gardens and raising poultry, and smaller but still significant proportions milked cows, did the bookkeeping and worked for a small part of the year in the fields. Even after the Second World War well over 60 per cent of Midwest farms engaged in gardening, dairying and butchering; egg production was also still high. Farm women increasingly had off-farm employment, and work in the fields, rather in these small-scale enterprises.

How different the conditions in the Soviet Union! Consider the Volga German agricultural settlement of Brunntal in the mid-1920s. The farmers here were much poorer, and lived extraordinarily self-sufficient lives. Harvesting was done with the scythe, and for some farmers with reapers and binders; threshing was carried out with horse-powered machines, rarely with a motor-powered one. There was at least one Fordson tractor, but the settlement had to supply much of its own agricultural equipment. Horse-drawn wagons were built by hand, with the help of a lathe, by a cartwright and his two teenage sons. It took four weeks of heavy labour to make; the same process with modern power tools might take twenty hours. Significantly the chronicler who told the above story listed the occupations in the settlement by families not individuals: there were families of cabinet makers, shoemakers, tailors, plumbers, felt-makers, tanners, blacksmiths and millers. There being no ready-made clothes, farmers' wives and daughters made them at home, often sewed entirely by hand, though the richer farmers' wives had sewing machines. Clothes were made from raw wool; most houses had spinning wheels. Tailors were used only for heavy clothes.

This world was brutally torn apart by collectivisation in 1929. The richer farmers were dispossessed of all their property and sent into internal exile and often death. The rest became semi-employed; some worked for the new central Machine Tractor Stations owned by the state which served three collective farms. Years of famine followed, until recovery came in the late 1930s. In 1941 all these Volga Germans were sent into internal exile in Siberia.

By 1930 the very poor USSR had about a quarter of all Europe's tractors, and two-thirds by 1939. There were many more tractors than cars in the countryside, where there was no electricity and no consumer goods of note. Collectivisation was not, however, driven by tractorisation, but by a political imperative to change the class structure in the countryside, and to extract grain from farms to feed the cities (and its new factories) and for exports to pay for tractors and other capital goods. Collectivisation went much faster than the provision of tractors. In fact, it

almost certainly reduced the power available on farms, as farmers killed their animals, including draught animals, which would otherwise have been collectivised. The total number of Soviet agricultural horses collapsed from 33 million at the beginning of 1929 to 15 million at the beginning of 1934. Rural crafts, including clothes making also fell, partly because skilled workers moved to the city, were dekulakised or were too poor. In many villages collectivisation brought about a retrogression in living standards and mechanical equipment.

Before the Second World War, collective farms had an average of seventy-five households. After it, Soviet collective and state farms would grow even bigger. These vast farms of thousands of hectares and hundreds of households were stunningly unproductive and failed to increase Soviet agricultural output much at all. Production did increase in the 1960s and 1970s but only at a huge cost in investment and labour. Paradoxically collectivisation ensured the continuation of the garden plot that had disappeared from US agriculture. From 1935 collective-farm households could operate a small plot to produce their own food, and could sell the surpluses. These family plots of approximately one acre would be very important indeed in meat, egg, vegetable and fruit production, right up to the present day.

THE AGRICULTURAL REVOLUTION IN THE LONG BOOM

The phrase "green revolution" is applied to the introduction of new varieties, irrigation and fertiliser to agriculture in the poor world in the 1960s. Partly because agriculture is associated with poverty and the past, and because of the focus on novelty, the even more significant agricultural revolution in the rich world was missed.

In the rich world agriculture in the long boom saw much greater rates of labour productivity change than industry or services, and at much greater rates than before. In high land-productivity Britain, yields doubled in the post-war years from a

very high base. New regimes of intensive agriculture through irrigation, and addition of artificial fertiliser (especially nitrate, largely produced by the Haber-Bosch process, innovated before the Great War) made plants grow fast and large. Plants were changed too. The introduction of hybrid corn (maize) in the US corn belt in the late 1930s and 1940s was just one example, though an important one, of new varieties being grown.

While traditional rice-production systems in Asia yielded around 1 tonne per hectare, at the beginning of the twentieth century Japanese farmers were getting 2.5 tonnes; Japanese farmers had doubled yields through irrigation in the nineteenth century; and in its colonies of Korea and Taiwan in the interwar years. Yet in the 1950s, though the Japanese countryside was still routinely regarded as "feudal" and backward, human excrement, night soil, was still used as fertiliser. Very quickly new housing, running water, washing machines, televisions, and then refrigerators were brought in. Agricultural machinery became plentiful on small farms, giving a unique combination of highly mechanised and very intensive output of rice. Japan was to continue to lead the way in Asia in high productivity. By the early 1960s it was getting 5 tonnes per hectare, when the Asian average was around two. Even after the green revolution had long passed, Japan still led. Today it produces 7 tonnes per hectare, compared with half that in Bangladesh.

The green revolution in rich countries made a huge impact on patterns of global trade, belying the standard image of a poor agricultural world exporting food to a rich industrial world. The USA remained, for example, a major wheat exporter, but increasingly to the poor world. It exported wheat to the USSR in the 1970s and 1980s on a huge scale. It remains a major producer of raw cotton, whose principal export market was once Britain, but is now the poor countries of the world where the cotton-spinning industry is concentrated. China imports cotton from the USA, and sells it textiles. Government policy in rich countries protected land and labour-efficient agriculture from the cheaper but less efficiently produced products of the poor world.

The gap in agricultural labour productivity between the rich world and the poor world, already large, widened after the Second World War. The green revolution in the poor countries mitigated a growing divergence between the agriculture of the rich world and that of the poor, but probably at the price of increasing inequalities within the poor world. A short Japanese wheat variety, the Norin No. 10, was the key to making the short wheat plants that could take intensive applications of water and fertiliser. The IR8 rice variety was derived from dwarf strains developed in Taiwan in the interwar years by the Japanese.

In the rich world animal husbandry was industrialised in the long boom, particularly in the case of chickens and pigs. The extreme example is that of chickens. In 1960 there were around 4 billion chickens in the world, whereas at the end of the twentieth century there were 13 billion. But the number killed for meat in a year has increased from 6 billion to 45 billion. Chickens lived much shorter lives. That was just one dimension to the industrialisation of the chicken. Since the 1930s the US broiler (eating) chicken has become bigger (nearly twice as heavy), younger (about half the age), and has taken much less feed to bring it to the size needed (less than half). This was done by making significant changes in both the nurture and the nature of chickens. A key series of steps was taken in the 1930s, among them bringing the chickens indoors, which required supplementing their diet with vitamin D, the use of electric lighting and artificial incubation. The intensive study of chicken feed resulted, by the 1950s, in a standard corn-and-soybean-based diet. The 1950s saw the breeding of hybrid chickens adapted to these artificial nurturing regimes. Many had been winners of "The chicken of tomorrow contest."

Pig production too was industrialised. Although the keeping of single pigs had disappeared in Britain by mid-century, even in the early 1960s half of all pigs were in herds with fewer than twenty breeding sows; by the 1990s 95 per cent were in herds of more than 100 breeding sows. Most lived, like broilers, indoors, and were, like the chickens, new sorts of fast-growing hybrids.

At the end of the century million-pig installations were being developed. Yet the greatest expansion in the number of pigs since the 1960s was in fact to be in non-industrialised pigs, kept in small numbers by farming households and fed with a variety of foods. In 1960 China had a quarter of the world's pigs, but today it has around half of the world's one billion pigs, not surprisingly because pork remains the staple meat in China, and meat eating has increased markedly. More than 80 per cent are still produced on a small scale, by non-specialist producers.

INDUSTRY AND MASS PRODUCTION

We have told the story of production in terms of household production, agriculture, and small firms. Yet the standard image of twentieth-century production is centred on mass production. The central idea is that the twentieth century, especially during the long boom, saw production dominated by the large-scale production of standard parts. As a result of this mass production, efficiency of production increased dramatically. This led to unprecedented rates of economic growth and material well-being for the working classes now employed in gigantic factories and firms.

Mass production has had extraordinary effects, which are difficult to grasp. At the beginning of the twentieth century one could build a house for the price of a car. Today, in the rich world, one would get little more than a small extension to a house for the price of an immensely more complex motor car. This is despite the decrease in costs of bricks, concrete, doors and windows, and any number of fittings, which are now mass produced. To take a biological example: the price of chicken has fallen much faster than beef. This observation suggests we should not equate mass production with modern production as a whole, even in rich countries since houses and beef are still produced. Even within manufacturing industry mass production accounted for a small proportion of production. In 1969 75 percent of US industrial production was batch produced, even

though in engineering mass-produced components were ten to thirty times cheaper. Yet there were very important increases in efficiency which did not come from the sort of mass production we associate with the car industry, or the making of refrigerators. Across the board productive processes were becoming more efficient.

For example, the scale of Haber-Bosch ammonia plants increased, and the inputs, such as hydrogen, were produced in cheaper ways too. The result was ever larger quantities of cheap nitrogen fertiliser, which had a dramatic effect, combined with other inputs, in increasing the productivity of land. Another powerful example might be the increasing efficiency of the use of fuel, labour and capital in power stations. The key was larger power stations operating at higher temperatures. Another would be the explosion in the efficiency of ships after the Second World War, particularly oil tankers and similar vessels. Growth in the size of ships was crucial to the sustained reduction that took place in freight rates. In the case of crude oil, for example, transport costs decreased rapidly as a proportion of crude-oil prices. World steel production trebled between 1950 and 1970, with plants becoming much larger. In other sectors production increased radically in efficiency, but without necessarily needing increases in scale. Agriculture is a good example.

CARS IN THE LONG BOOM

The mass production of motor cars was pioneered in the United States by one company and one car, Ford and the Model T. At its peak in the 1920s the Model T was produced at an annual rate of 2 million, and by the time production ceased in 1927 15 million had been built. Ford was at this time easily the largest car manufacturer in the world, and had made America easily the most motorised nation in the world. Even the richest parts of Europe would not reach 1920s' levels of US motorisation until the late 1950s, let us recall.

The great boom in car production after the Second World War was largely an American and European affair, with the European makers growing faster, though from a much lower base. In

each nation the great car firms were regarded as powerhouses of the booming economies. Even in a poor country such as Italy, car ownership went up more than ten-fold in the fifteen years between 1950 and 1964; from 0.34 million to 4.7 million cars. The number of cars just overtook motorcycle numbers, which increased from 0.7 to 4.3. Between 1955 and 1970, 2.7 million Fiat 500s were made and 3.6 million Fiat 600s between 1957 and 1975. European car workers were not yet able to buy cars themselves, but would be doing so by the late 1960s.

In the long boom the Eastern European economies, like those in the West, grew very fast. Yet, the Soviet Union and its allies, for all the emphasis on standardised production and the possibility at least of plenty for the masses, were places of low consumption. Even in the 1960s the superpower USSR made only 1 per cent of the world's private vehicles, and 12 per cent of commercial ones; in comparison Britain made 10 per cent of the cars, and 9 per cent of the trucks. So committed were the Soviets to mass production that they suffered from "premature mass production," the putting into production of not properly tested goods. But mass consumption in the richest countries was more typically about the extensive multiplication of firms, styles, types, rapid model change, the pursuit of endless novelty.

The mass producing car industry informed a whole understanding of modern production. It *was* modern industry, the place where the pace was set. The post-war years were labelled with such terms as "Fordism," at least when the mass production of cars in Europe and North America ceased to grow fast from the 1970s. Rapidly expanding Japanese car production became a model for "Post-Fordism." But just as the significance of mass production, or "Fordism," was exaggerated, so were reports of its demise. At the end of the twentieth-century Ford had capacity in Europe to build 2 million cars a year; one factory was making 400,000 Focuses per annum, and another 330,000 Mondeos. In 1996 Volkswagen worldwide turned out over 800,000 Golfs, the car that took over the production record from the Beetle, which itself took over from the Model T. The

world's largest car producers in 2000, still Ford and General Motors, were producing around 8 million vehicles each per annum, many times more than in the interwar years. Even in Britain more cars are produced today than ever before, and at world level production is not only increasing, but is still dominated by North America, Europe and Japan.

SERVICE INDUSTRIES

There is no doubt that the rise of employment in the service industries in the rich countries is one of the major economic changes of the last thirty years. A number of analysts have, perversely, identified this growth in service employment with the rise of an "information society," with connotations of weightlessness, or indeed the "dematerialised" economy. This was a fashionable, and misleading, way of saying little more than that service industries now account for very large proportions of GDP and employment. This is partly the result of mis-specification because services include a vast range of activities, many of them far from weightless or indeed new. Services include transportation, by road, rail, water and air, telecommunications and postal services, the retail sector, as well as banking and finance, and small creative industries. That such a sector is weightless is immediately contradicted by the sheer bulk of the things associated with it, the unprecedented weight of stuff in the shops, the piles of paper in any office, not to mention the proliferation of computers, fax machines and Xeroxes. One need only look at homes in the rich world to see they are crammed with stuff, which is why storage is a growth industry and moving house becomes a bigger and bigger affair. In 2003 research for a British insurance company suggested the existence of £3.2 bn-worth of unused goods, headed by sandwich toasters, electric knives, soda streams, foot spas, and ice-cream makers. There are 3.8 million unused fondue sets. One source of confusion is that vast quantities of stuff used in service industries and in homes are imported, rather than produced domestically, but that is a different issue. The USA and Britain have large trade deficits in manufactured goods, which means that they use

more than they produce; that is not to say that manufacturing ceases to be important to them.

The idea that manufacturing is not important, that what really matters is branding and design, is one of those confusions arising from thinking about only part of a story. The idea arises from the observation that *in rich countries* some giant enterprises are in retailing and control brands—the value is added by these activities, not in production. Yet branding and adding value through design are hardly new—they went along with manufacture, often in the same large company, as in the cases of Singer, or Ford or General Electric. We should not confuse the siting of economic activity with its significance. For the concentration of branding, marketing and design in rich countries, and production in poor countries, does not mean that production is no longer important. Indeed it is precisely because of the radical cheapening of manufactures through mass production and the use of very cheap labour, that they seem so unimportant to the rich. The point about manufacturing and mass production is that the latter produces goods extraordinarily cheaply, and does so all over the world. Massive economies of scale are exploited as never before on a global level to produce cheap mass-produced goods of great complexity. Think of cheap PCs, mobile phones and IKEA furniture. Mass production is now so common it is invisible.

At the beginning of the twenty-first century Wal-Mart is the largest corporation in the world, by annual sales (\$300bn in 2005/6) and by employee numbers. With nearly 2 million workers it is vastly larger not only than the biggest firms of 1900, but also than the very largest manufacturing employers of the 1960s. But it is a retailer, not a manufacturer. Indeed it indirectly employs many more millions, largely in China, mass producing all sorts of stuff for the American consumer. IKEA, again principally a retailer and designer, controls the mass manufacture of furniture, indirectly employing an estimated 1 million workers. Indeed IKEA provides a wonderful example of the arguments of this book. First, of the continuing significance of what we take to be old, in this case not just furniture, but

wooden furniture, supplied, obviously, by forests. In terms of industry it exemplifies beautifully the extension rather than the retreat of mass production, and its globalisation, producing fantastically cheap outputs. In terms of service industries it is an example of mass retailing and mass consumption of identical goods (it has made 28 million Billy bookcases since launch in 1978); it is also an example of the reduction of transport costs by flat-packing, and an example of the concentration of design and marketing activity in a rich country (Sweden). As a domestic industry it is an example of a family-owned firm, and indeed one which provides goods to be transported home by non-paid domestic workers, and assembled by them too. Such products made its founder and owner, it is alleged, the richest man in the world, richer than Bill Gates of Microsoft, who had briefly taken first place following the death of Walton of Wal-Mart.

One of the great novelties of the last quarter or so of the twentieth century was the emergence of poor countries as suppliers to the world not of food and raw materials, but of manufactures. The case of China is all the more extraordinary given its history as a Communist nation and one which had had a very particular approach to modern industry. The Chinese had systematically promoted old small-scale technologies in the 1950s. In the Cultural Revolution of the late 1960s and early 1970s, there was a concerted attack on the division between managers and workers—a distinction central to Taylorism and Fordism, and an attack too on the division of labour itself. Small-scale rural industries were promoted, as during the earlier Great Leap Forward. Although the Chinese economy grew, it did so very unstably and relatively slowly. After 1976 the Chinese Communist party changed direction, and with the abolition of collective farming and the move to household farming in the 1980s, presided over a productivity surge in Chinese agriculture. In this same period rural industries grew at a phenomenal rate, many times that of the Chinese economy as a whole. Local “township and village enterprises” were the key to this growth. The transformation of the Chinese countryside in the last twenty years is surely the fastest

and deepest in world history, affecting many hundreds of millions of people.

Millions, often women, left the countryside, and, housed in dormitories, toiled for pitiful wages in the factories of the new industrial areas. Chinese growth has been dependent on overseas investment, primarily from Japan, Taiwan and from overseas Chinese elsewhere. Multinational enterprise, Japanese included, has also been important. In these respects the industrialisation of China has been very different from that of Japan. Market Stalinism and foreign investment were critical in China's drive to industrialise. Despite its scale and speed and its impact on the global economy, the growth of China is not the product of a profoundly new economy. It has a distinctly old feel to it.

At the beginning of the twenty-first century China was sucking in vast quantities of heavy raw materials, from oil to copper, driving up world prices. It became easily the largest steel producer in the world, with rates of growth comparable to those of steel in the long boom. The “new economy” was being replaced by a very old economy driven by commodity prices. Far from the information superhighway being the conduit for all this new production, it was none other than the ship that carried the great bulk of Chinese production, and indeed world trade as a whole. In the year 2000 the world merchant fleet was rated at 553 million gross registered tonnes (a measure of the carrying capacity of ships), up from 227 million in 1970, 85 million in 1950 and 45 million in 1914. As its scale suggested, it carried more material than ever before in history, and so cheaply that the price of manufactures was hardly affected by freight rates. This industry employed some 1 million seamen, with a majority of officers from rich countries and a majority of ratings from poor countries, largely in Asia.

Most shipping still transports fuel and bulks such as ore and grain, yet manufactures were very important too, largely carried in that great invention of the 1950s, the container. Since then global container traffic, which now dominates all sea traffic excepting bulks, has continued to increase. At the beginning of the twenty-first century the largest container ships, at 90,000 GRT,

could carry over 8,000 containers, with a crew of just nineteen. The majority of the vessels were manufactured in the East. Wal-Mart is the largest single importer of containers in the USA, bringing in half a million every year, mostly from China.

The great long boom and the more recent boom in the East, China in particular, far from being primarily cases of successive technological revolutions, are in many ways inflexions of the

same technological and industrial revolution happening in succession. Of course it is far from identical, but the similarities are striking: the huge increase in agricultural productivity, the expansion of industry—not least the old classics such as steel making—and the expansion of ship-borne international trade. In both cases the revolutionary nature of each era is masked by a deep political stability in the growing countries. Politics, the nation and borders matter.

1.1.4 History as Technological Change

ROSALIND WILLIAMS

In this selection from her book *Retooling: A Historian Confronts Technological Change*, MIT's dean of undergraduate education and student affairs reflects on how the idea of historical change has become nearly synonymous with technological change and how the term *technology* has been reduced to meaning only information technology. While acknowledging the important role that technological innovation has played in human history, Williams wants to resist the idea that all historical change can be reduced to or explained by technological change. But she also observes that we are now on the verge of another great transformation of the human habitat, comparable in significance to those brought about by the agricultural revolution and the Industrial Revolution. The question is how will this transformation affect our sense of human identity? Where will we be able to find meaning and purpose in a world that is our own creation?

FOCUS QUESTIONS

1. What does Williams mean when she says that “technological innovation resembles but hollows out the idea of progress”?
2. What are some examples of previous technological revolutions, and how have they transformed the human habitat? According to Williams, what kind of transformation of the human habitat appears to be taking place because of the information revolution?
3. What does she mean when she describes the world of the information age as a reflexive, or “boomerang,” world?
4. Discuss and evaluate her claim that “history and nature are weakening as well-defined external frameworks that give meaning to human life.”

KEYWORDS

artificial habitats, information technology, innovation, progress, reflexivity, technological revolutions

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