

Killing

The history of the non-military technology of killing is confined to the chambers of horrors, black museums, the private collections of ghouls. It has no place in more respectable museums except in the special case of genocide memorials. A museum of killing technology would confront us with uncomfortable questions. Killing, like war and the military, has been seen as something barbaric which the civilising process had left behind. But the rate of killing – of all sorts of living things – increased in the twentieth century, and did so drastically. For plants, bacteria, insects, cattle, whales, fish and human beings, the twentieth century was murderous. The civilising process did not reduce killing. What it did was to remove killing from the public arena – whether the execution of the criminal or the despatch of a chicken.

Putting killing into the history of the twentieth century is a particularly powerful way of exploring the interaction of old and new. It is a story which includes, in unexpected ways, nationalism, globalisation, war, production and maintenance. It will particularly disturb our sense of technological time, and of what is significant.

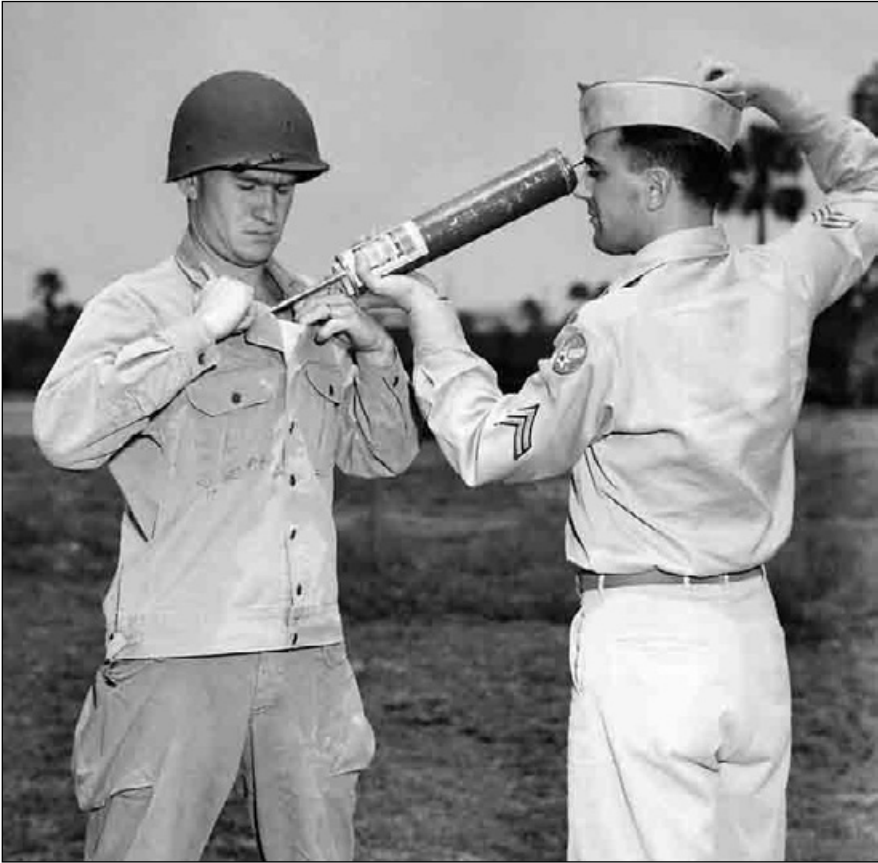
Innovation in killing

An innovation-centric history of twentieth-century killing would be focused on the killing of insects, plants and micro-organisms, principally but not only in relation to farming. Around 1900, there were few killing techniques available to the farmer: a few insecticides and fun-



21. In the supposedly transparent twentieth century even the killing of animals has been put beyond reach, not only of the public but also of photographers. In the late nineteenth century one could find stereographs of the great butchers of the New World, including this rare image of an animal being killed. The original caption read: 'Sticking Hogs, Armour's Great Packing House, Union Stockyards, Chicago, USA.'

gicides, and the hoe. The twentieth century saw many new chemicals designed to kill small living things. The 1930s and 1940s were a particularly innovative period. In the 1930s an IG Farben chemist discovered organophosphate insecticides. The organophosphates were one key set of post-war organic insecticides, the others were chlorinated organic



22. Demonstrating the use of DDT to kill lice in order to control typhus, probably during World War Two. DDT prevented mass break outs of typhus in North Africa and southern Italy.

compounds. The first and most famous of these was DDT. First used for the killing of lice and mosquitoes, it became a general-purpose and very widely used insecticide. Many others would follow, and continue to be used after DDT was increasingly restricted from the 1970s. Chemical herbicides also changed radically in 1940s. The main new one was 2,4-D, an amazing example of simultaneous discovery – four separate groups, two in the UK and two in the US, came up with it.¹

DDT, organophosphates as well as 2,4-D and other herbicides were

a crucial part of the green revolution in the rich countries. Their use transformed production and the landscape. As a result of these herbicides unwanted weeds perished in vast quantities leaving fields of uniform crops. Insects suffered from this, as well as from insecticides. These powerful chemicals introduced new and invisible dangers to the countryside. This was exposed in one of the great books of scientific activism of the century, the naturalist and science writer Rachel Carson's *Silent Spring*, in 1962.

Insecticides and pesticides also found applications in warfare. DDT was widely used, as we have seen, to clear areas of malarial mosquitoes in the Second World War, as well as to control the typhus-carrying louse. The USA's chemical warfare service looked at possible military applications of 2,4-D. In South East Asia throughout the 1960s a programme called, of all things, 'Operation Ranch Hand', used up to twenty-five aeroplanes to drop 19 million gallons of herbicide to destroy the economic basis of the Vietcong and to remove cover. The infamous 'agent orange' was nothing more than a particular mixture of standard commercial herbicides including 2,4-D.²

The killing of micro-organisms also saw a great deal of innovation in the twentieth century. Best known were the new compounds used to kill bacteria in humans, such as Salvarsan, the sulphonamides of the 1930s and the most important, penicillin, developed in the 1940s. Such compounds were used not just in humans, but also in animals, where they were essential to control disease in the tightly packed animal populations of the new industrialised husbandry. There were other applications: in the 1940s it was discovered that penicillin made chickens grow faster, for reasons still unclear. As a result, in the mid-1950s one-quarter of all US antibiotic production was put into animal feed; by the 1990s, with production much higher, it was about one half, mostly for growth promotion.³

The twentieth century brought innovation in anti-virals: treatments for herpes, polio and smallpox were developed in the 1950s, though they were in the latter cases overtaken by immunisation; Acyclovir in the 1970s; and in response to HIV/AIDS, AZT in the 1980s. Anti-

fungal treatments received an enormous boost with the 1957 launch of Nystatin. This was an unusual substance since it was patented by two female scientists who worked in the public sector, in this case the New York state department of health (hence the name). The 1960s brought Daktarin. New anti-malarials, such as paludrine and chloroquine, came out of a massive targeted research effort in the USA and Britain during the Second World War. No one has ever estimated the toll taken of the world's viruses, bacteria, mould, amoebae, insects and plants by these new poisons.

In terms of the killing of higher animals, the innovation-centric museum would have relatively little to show. The key killing technology has remained the knife blade applied to the throat, though this was in some cases, as in chicken-killing, mechanised. Fish were generally still suffocated after being caught in a net, and whales harpooned. Such significant innovations as there were came in stunning technology.

The history of innovation in killing humans is better known. Chemical warfare arose in the First World War with such agents as mustard gas and phosgene; atomic and bacteriological warfare followed in the Second. There were subsequent innovations in all these areas. In the 1930s organophosphate insecticides were recognised as exceedingly toxic to humans, and this led to effective 'nerve gases'. Tabun and Sarin were manufactured by the Germans during the Second World War, and in the 1950s Sarin became a standard nerve gas, produced in, among other places, Britain. In the 1950s the company ICI introduced a new organophosphate insecticide that proved too toxic to use. Transferred to the USA, it formed the basis for a new class of chemical weapons, the 'V-agents'.⁴ VX, one such agent, was central to the US and Soviet arsenals. Uranium and plutonium bombs led to a variety of more powerful fusion weapons, and such things as neutron bombs, which were designed to kill people without destroying things. All sorts of gruesome biological agents were developed too. Again the years of the long boom proved very productive.

Outside warfare, the innovation-centric story had few reference points. First was the gas chamber in the 1920s in the USA (the electric

chair was a late nineteenth-century innovation), and the lethal injection in the 1980s, also in the United States. Only one other country figured in this story: Germany. For the central innovation in the killing of humans, and by far the most problematic for our understanding of modernity, is the killing with Zyklon B in the Holocaust. Innovation-centredness leads to looking at Auschwitz as the great modern factory of human death.

An innovation-centric history of killing would be a great advance over the current neglect of killing. Yet in the case of killing in particular the deficiencies of an innovation-centric approach are particularly obvious. For we all know of the continuing use of long-established means of killing, particularly human beings and higher animals, things such as ritual slaughter knives, gallows, the garrotte, the guillotine or the electric chair. Just as in the case of war, killing technologies provide, as we shall see, many examples of long-lived, disappearing, reappearing and expanding 'old' technologies. Without recognising this the history of killing makes little sense.

Whaling and fishing

Whaling, often thought of as a nineteenth-century industry supplying oil for lamps and whale-bone for corsets, went through a revolution in the 1920s. The new whaling relied on hunting the difficult-to-catch rorqual whales (a family of baleen whales including the Blue, Minke and Humpback) in Antarctic waters. The killing was carried out with a nineteenth-century invention: the deck-mounted harpoon. It was hoped that new methods of killing would replace it, but nets, poisons, gas injections and rifles did not produce better results. In 1929 a German engineer called Albert Weber started working in Norway on means of electrocuting whales, which was further experimented on in the 1930s and 1940s; however the expected result that modern electricity would replace the barbarous harpoon did not materialise. The nineteenth-century killing technology would have to do.⁵

It came to be used more than ever, as whaling expanded enormously, driven by the demand for margarine and by economic nationalism.

Already before 1914 whale oil was being hydrogenated for margarine, but by the 1930s this was its main use. It was used to make some 30–50 per cent of all European margarine.⁶ In 1930–31 Atlantic whale oil production was the same as French, Italian and Spanish combined olive oil production. Whale oil margarine was mainly consumed in Germany, Britain and Holland, and supply was dominated by the Anglo-Dutch firm Unilever. In 1933 the Nazis began promoting German butter against margarine and Unilever, making a point of stressing the use of whale oil. Yet Unilever was forced to finance the building of a German-flagged whaling fleet, making Germany a whaling nation for the first time. Fats were important for national security.

The new whaling involved processing whales in floating factories that hauled dead whales into their bellies through a ramp at their sterns. The first floating factory built in Germany, the *Walter Rau*, named for the owner of the main German margarine firm, went to the southern oceans in the mid-1930s. In its first season it processed 1,700 whales, from which it produced 18,264 tons of whale oil, 240 tons of sperm oil, 1,024 tons of meat meal, 104 tons of canned meat, 114 tons of frozen meat, 10 tons of meat extract, 5 tons of liver meal, 21.5 tons of blubber fibre and 11 tons of glands for medical experiments.⁷ By 1938–9 the Germans were deploying five owned and two chartered factory ships. The Japanese also went into large-scale whaling at this time. After the Second World War Germany was prevented from whaling for some years but its factory ships were used by other powers.⁸ Whaling boomed, and up to twenty floating factories were operating in the Antarctic, more than ever before, but the catch never reached the peaks of the 1930s, and collapsed in the early 1960s.⁹ Whales are one of the most significant cases of disappearing animals of the twentieth century, more extreme than the case of elephants.

Whaling is closely related to the development of industrialised fishing, which is in turn intimately connected with refrigeration. Fishing ports had long had large refrigeration plants to make ice to chill fish at sea, but freezing fish itself at sea was not successfully

accomplished until decades after the freezing of meat. The driving force was Commander Sir Charles Dennistoun Burney, inventor of the mine-sweeping paravane in the Great War, a key figure in British airships in the 1920s and a Conservative MP. He developed new freezing equipment, and adapted his mine-sweeping paravane for trawling. Burney converted a wartime minesweeper into the 1,500 ton *Fairfree*, the first stern trawler, one which hauled in its nets just as a whale factory ship hauled in dead whales. In 1949 *Fairfree* was bought by the Scottish shipping and whaling firm Christian Salvesen, which then built the first fully designed factory stern trawler, the *Fairtry*.¹⁰

As with so many cases of innovation, it was not the innovating nation which would most use the new technology. Copies of the *Fairtry* were built for the Soviet Union, first in Germany and then in the USSR.¹¹ The first Soviet freezer trawler, the *Pushkin*, went into service in 1955, and the Soviet fleet would soon dominate world factory fishing, especially with a class of ship called the BMRT, introduced in the 1960s. The Soviet fleet became many times larger than its nearest rivals, and led the way in strip-mining the fish colonies. Catches went up so much that they reduced fish populations. The great Newfoundland Grand Banks fishery peaked in 1968; thereafter its yield plummeted.¹² Yet for all the destruction of stocks in particular areas, factory fishing continued to expand. The most modern ships, for example the *American Monarch*, of 6,000 tons GRT, can process 1,200 tons of fish a day. Since the total global catch is now 100 million tons per annum, this suggests that, say, 300 of these ships could catch all the fish now caught worldwide.¹³ Just one new ship accounts for 15 per cent of Ireland's entire catch.

Of course, the factory trawlers are not the only means of catching and killing fish – the world still has an enormous variety of fishing vessels. Around the world boat-building yards still construct fishing-boats out of wood, even though they will be equipped with engines, radar and synthetic nets. These new hybrid technologies are as new a part of the fishing fleets of the world as the factory trawlers. Other

types of fishing technology are themselves expanding. For example, around the coast of Borneo bamboo fish-traps have made an appearance in recent years.

Slaughterhouses

Just over one hundred years ago, at the very end of the nineteenth century, the British writer George Gissing visited poverty-stricken southern Italy looking for remains of Greek and Roman civilisations. In the city of Reggio di Calabria he found one of the few new things he thought worthy of praise: a 'handsome' building, which he thought was a 'museum or gallery of art'. To his surprise he found this 'fine structure, so agreeably situated, was nothing else but the town slaughterhouse'. He saw it as a 'singular bit of advanced civilisation', surprised that such a building which reminded him of 'the pole-axe and the butchers' knife' should so advertise itself. He had the odd sense of 'having strayed into the world of those romancers who forecast the future; a slaughterhouse of tasteful architecture set in a grove of lemon trees and date palms, suggested the dreamy ideal of some reformer whose palate shrinks from vegetarianism'.¹⁴ Advanced thinkers of the time, such as Gissing's friend, H. G. Wells, were attracted to vegetarianism and a vegetarian future.

On the other side of the Atlantic, another writer was to picture a very different kind of slaughterhouse. Upton Sinclair, in his great socialist novel of 1906, *The Jungle*, described the booming, corrupt, business-dominated city of Chicago. Among the giant enterprises he discussed were the great meatpackers, a world away from Europe's most modern municipal abattoirs (another, mentioned with approval, was the International Harvester factory). Here was a new kind of mass industry, with astonishing methods of production and unprecedented control over workers and government. Around the Union Stockyards was 'a square mile of abominations', where 'tens of thousands of cattle crowded into pens whose wooden floors stank and steamed contagion'. Here too were the 'dingy meat factories' with their 'rivers of hot blood, and carloads of moist flesh, and rendering vats, and soap cauldrons,

glue factories and fertilizer tanks, that smelt like the craters of hell'.¹⁵ Here was 'pork-making by machinery, pork-making by applied mathematics'. The 'slaughtering machine ran on ... like some horrible crime committed in a dungeon, all unseen and unheeded, buried out of sight and out of memory'.¹⁶

The central character in the novel, a Lithuanian immigrant, becomes a socialist. He learns that the Beef Trust was 'the incarnation of blind and insensate Greed. It was a monster devouring with a thousand mouths, trampling with a thousand hoofs; it was the Great Butcher – it was the spirit of Capitalism made flesh.' Bribery and corruption were its methods, it stole water from the city, dictated sentences for strikers; it lowered the price of cattle, ruined butchers, controlled the price of meat, controlled all refrigerated food transport.¹⁷

To understand the uniqueness and significance of these reeking factories of death, it is illuminating to cross not the Atlantic with the thousands of Calabrians who went to North America and the River Plate, but instead the Mediterranean a century later, against a new tide of migration *into* Europe. In late twentieth-century Tunisia, on several main roads through the desert there were concentrations of nearly identical small buildings lining each side of the road. Tethered next to many were a few sheep; hanging from the buildings were the still fleece-covered carcasses of their cousins. For these were butchers' shops and restaurants. As the heavy traffic roared by one could dine, on plastic tables, without plates or cutlery, on delicious pieces of lamb taken straight from the displayed cadaver and cooked on a barbecue crudely fashioned from sheet metal. Clearly this spectacle was not a left-over from the past, or the sort of thing which attracted tourists. It was something new: a drive-in barby for the Tunisian motorist and lorry-driver in a hurry.

Along the road one could see the upmarket version – a skinned sheep's carcass in a refrigerated glass case placed outside a roadside restaurant with more elaborate facilities and no live animals to be seen. The fridge was a mark of affluence here, as it had been only a few decades earlier to southern Italians, who in the post-war boom were

introduced to the delights of northern dairy produce, and many other products of the new food industry.

Refrigeration was crucial to the new globalised food industries of the twentieth century. It was used to preserve fish, meat, fruit, butter, cheese and eggs.¹⁸ But in the case of meat it had particular importance, making possible a new kind of global meat supply system. The 1911 *Encyclopaedia Britannica* claimed that refrigeration on a 'commercial scale has more powerfully affected the economic conditions of England and, to a less degree, of the United States than any other scientific advance since the establishment of railways and steamboats'. It is a big claim, both because refrigeration does not seem to be that important, and because few remember just how important the importation of refrigerated food into Britain was even before the Great War, or how important this was for the global economy. For the late twentieth-century world the claim would be stronger still, and applied not just to Britain and the USA, but to the whole world, criss-crossed as it was by refrigerated lorries carrying every kind of material in what came to be called 'cold-chains'.¹⁹ Many carried equipment made by a company called Thermo-King which, from 1940, manufactured the refrigeration gear patented by an inventor, Frederick Jones (1893–1961). He was the first black (as he is universally labelled, despite having a white father) to be awarded the National Medal of Technology of the United States. The other major company, the Carrier Corporation, pioneered air-conditioning at the beginning of the century. Its founder, Dr Willis H. Carrier, was named one of the hundred most influential people of the century by *Time* magazine in 1998.

There were alternatives to refrigeration, even in the case of meat. For example, the River Plate had been at the centre of a global meat system decades before the introduction of refrigeration. Up to 1910 Uruguay's exports were still dominated by *tasajo*, or *carne seca* (salted dried beef). Previously given to slaves in the Americas, it now fed their descendants, particularly in Cuba and Brazil, and still features in the cuisine of both countries. *Criollo* (creole) cattle were slaughtered and processed at 'saladeros', salting plants (which also produced hides



23. *The Frigorífico Anglo, Fray Bentos, Uruguay, in the interwar years, showing the chilled meat warehouse (cold store) on the water's edge. A plant had existed here since the 1860s, first making Liebig's Extract of Beef. The plant remained in operation until the 1970s and is now preserved as a Museum of the Industrial Revolution.*

and much else). Uruguay was also the centre of mass export of a new preserved meat product at Fray Bentos, the site of a specially built plant of the Liebig Extract of Meat Company. The extract, invented by the celebrated chemist Justus von Liebig, was from 1899 named OXO in the British market. The Fray Bentos brand remains famous for *canned* meat products in the British market.

Refrigeration greatly increased the long-distance trade in meat. In Chicago – a city which had grown in the late nineteenth century as a producer of *salted* pig-meat which went in barrels to markets far away – meat was chilled by ice and sent to eastern cities in railroad cars. Later, meat was also frozen and chilled mechanically. Drawing on vast supplies of cattle, the Chicago meatpackers turned into massive concerns such as Swift, Armour, Wilson & Co, Morris, and Cudahy, the Beef Trust. The giant US meatpackers had been important exporters of meat – salted, canned and chilled beef – but by 1900 they could not supply much to the world market from the

USA. That market was largely Britain, which imported half its meat and accounted for 70–80 per cent of all meat traded internationally. In some places in Britain, the proportion was higher still. For example, over 80 per cent of all the beef consumed in London in the 1920s was imported, mostly from Argentina. Indeed much of Britain's meat came from a trans-equatorial trade: from the River Plate, Australia and New Zealand. Already by 1912 there were four Southern hemisphere plants capable of freezing or chilling more than 500 beef carcasses a day, all in Argentina.²⁰ In this trade the Chicago meatpackers were to be crucial, along with British firms.

Uruguay's first *frigorífico* was not opened till 1904. Swift set up the second meatpacker (Frigorífico Montevideo) and Armour the third (Frigorífico Artigas). The fourth was set up in the early 1920s when the British Vestey family took over and remodelled the Liebig plant, now named Anglo del Uruguay as a *frigorífico*. The Vestey companies – centred on Union Cold Storage – formed one of the largest food enterprises in the world in the interwar years, rivalling the giant American firms. It owned not only slaughterhouses, but a shipping line (the Blue Star Line, created in 1911), cold-storage facilities and an enormous chain of butchers' shops (till 1995) in Britain.²¹ The Vestey firm was an early case of one of the least recognised features of twentieth-century international trade, that much of it took place not between nations, but *within* firms.

The oldest plant was taken over by the government and supplied the local market, while the Swift, Armour and Fray Bentos plants exported their products. How was the killing done? We have a description by a refrigeration engineer of the workings of the Fray Bentos plant in the interwar years. The killing was carried out in an approximately square, three-storey building, 30m long on each side. The cattle walked up a ramp to the third floor, where they were stunned with pole-axes, and then hung on a conveyor, had their throats cut and were bled. They were then taken off the conveyor and skinned, after which they were hauled up on to the rail once more for further processing. The hides and offal went down chutes, the offal to the first floor, and the hides

to the ground. The carcass was cut in half, and the sides of beef then travelled down a 100m inclined and enclosed ramp to the four-storey chilling plant on the water's edge. From the chilling plant, the sides went by covered way into the holds of the refrigerated ship.²² But there was much else going on, for every bit of the animal was used, and some 40 per cent in weight was removed to make what is called a 'dressed' carcass; this was turned into a wide range of products, from brushes to pharmaceuticals.

The killing rate in the *frigorífico* was extraordinary, especially if we remember it was done by stunning with a pole-axe and then cutting the throat with a knife. Through much of the twentieth century Uruguay slaughtered 1 million head of cattle per annum, mostly in the four plants. In the 1930s the Anglo in Fray Bentos dispatched 200 an hour.²³ According to Upton Sinclair, one Chicago plant was already killing twice that thirty years earlier. Fifteen to twenty beef cattle were stunned with a pole-axe every minute, and then killed: 400 to 500 an hour, around 4,000 a day.²⁴

These giant meatpackers were unknown in the Old World; they were found only in the River Plate, the USA and Oceania. European slaughterhouses, often municipally owned, as in the case of La Villette in Paris, were spaces where many butchers could work, killing their own cattle on a small scale, for local consumption.²⁵ British slaughterhouses were tiny, supplied local markets and were not known for humane treatment of animals.²⁶ Even the new interwar municipal abattoir in Sheffield, which had a monopoly of killing in its area, dealt with only 600 cattle a week.²⁷ The point was not that Britain was resistant to new killing technology, or did not have access to it. Far from it, for Britain owned and used such plant on a huge scale, but it was in Fray Bentos rather than Sheffield. The British worker lived in a global village – fed with beef from the River Plate and margarine derived from South Atlantic whales.

Killing animals in the long boom and after

In 1906 Sinclair described 'a line of dangling hogs a hundred yards

in length; and for every yard there was a man, working as if a demon was after him'.²⁸ Here was a disassembly line that would within a few years inspire the assembly lines of another American town, Detroit. Henry Ford himself recalled that 'The idea came in a general way from the overhead trolley that the Chicago packers use in dressing beef'.²⁹ Just as importantly, the Chicago meatpackers suggested the mechanical handling of things, and the use of gravity to pull things down through buildings, which Henry Ford also used on a large scale.³⁰ The new world did indeed pioneer both mass killing and mass production. But both would spread and grow particularly strongly in the long boom.

The second half of the twentieth century saw huge increases in world production of meat, and the generalisation of mass killing. Annual global production increased from 71 million tonnes in 1960, rising to nearly 240 million at the end of the century. Per head of population meat consumption nearly doubled over the period. It could easily increase a good deal further as the global average consumption is only about a third of the meat consumption of the richest countries. Much of the change in meat eating in the twentieth century has come from increasing consumption of chicken and pork; they provide two-thirds of all the meat consumed today compared to one half in 1970.

Killing for meat takes place on a scale difficult to comprehend. Britain alone killed 883 *million* animals for food per annum at the end of the century, made up of 792 million chickens, 35 million turkeys, 18 million ducks, 18.7 million sheep, 16.3 million pigs, around 3 million cattle, 1 million geese, 10,000 deer and 9,000 goats. The United States kills 8 *billion* chickens a year. In some cases the sheer scale of killing demanded new technologies of killing, including electric stunning and killing (with tongs for pigs and sheep), and gassing with carbon dioxide for pigs. In the case of chickens the change has been extraordinary. Chickens were killed on automated lines from the 1970s. They were strung up by the legs on a conveyor, and their heads dipped into a conducting solution. A current passing through their bodies stunned them before their necks were cut. Those not despatched by

the machine are killed by a human being. They are then plucked and gutted by machine, and chilled. The whole process takes two hours. The largest chicken slaughterhouses now process 1 million birds per week.³¹ This scale of chicken-killing is unimaginable by other means. It is difficult to envisage British local butchers and householders handling and killing 2 million chickens every day of the year.

In the case of beef, the technologies of killing would hardly change at all from one end of the century to the next – the big changes were the introduction of the captive-bolt pistol to replace the pole-axe and the chain-saw to replace the axe.³² In the years after the Second World War, however, the vast New World slaughterhouses of the early part of the century went out of fashion, and much smaller and more dispersed operations took over. The great plants of the River Plate and Chicago closed. The old Anglo plant in Fray Bentos struggled into the 1970s, long enough to be preserved as a museum, the appropriately named Museum of the Industrial Revolution, a place which figures in tourist guides to the Southern Cone. European self-sufficiency in meat, particularly in the British case, and the rise of the Common Market, which de-globalised the trade in meat, put paid to it. In the USA the great meatpackers of Chicago lost markets to new rural, non-unionised, low-skill, single-storey meatpackers, which sent out boxed meat to supermarkets instead of sides of beef to butchers (and of course to the new giant mass producers of beefburgers and the like).

Since the 1970s, and especially the 1980s, new plants and new meatpackers, more concentrated even than those of Chicago's prime, appeared. Four new meatpackers killed more than 80 per cent of US meat at the end of the century.³³ In 2001 the world's largest chicken producer, Tyson Foods, took over the biggest meat producer, IBP. IBP is, it claims, 'the largest provider of protein products on the planet'. It employs 114,000 workers and has sales of \$26 billion. Although the methods of slaughtering and processing cattle remains essentially the same, the rate of killing has been pushed up: plants in the 1980s slaughtered 175 an hour, rising to 400 an hour, down a single line.³⁴ These large plants, located in such states as Nebraska, Kansas, Texas

and Colorado (in that order) were also everywhere once again staffed by immigrants, now Latino and Asian.³⁵ The end of the unionised workforce meant not only a radical speeding up in production, but decreasing real wages. And, just as had also been the case when Sinclair wrote, the new meat industry had enormous political power.

Executions and other killings

In judicial killing respect for tradition is felt to be appropriate. Until they abolished capital punishment well after the Second World War, the British relied on the gallows, the Spanish on the garrotte, the French on the guillotine. Many continued using the firing squad, and the twentieth century saw plenty of beheadings and stonings too.

The United States showed a remarkable appetite for developing new means of execution. In the 1880s, when the state of New York looked for new ways of executing its errant citizens, they came up with thirty-four possible methods, and four real contenders – gallows, garrotte, guillotine and firing squad. They liked none, for they mutilated the body of the deceased, and in some cases had unfortunate political associations. Two new methods were suggested – electrocution and lethal injection. The first was chosen, with the assistance of Thomas Edison, who ensured that alternating current, and not his own direct current, was used. In 1889 the first victim was killed in New York. By 1915, twenty-five American states had the technology. But innovation did not stop there. In 1924 the gas chamber was introduced in Nevada, and its use too spread quickly. Hydrogen cyanide was the killing gas, produced by the simple means of dropping a bag of sodium cyanide into dilute sulphuric acid. The lethal injection was innovated in Texas in 1982.³⁶

Once introduced, a given killing machine lasted for a very long time. Thus the gas chambers, mostly installed in the 1920s and 1930s, were still in use in the 1980s and 1990s, and very old electric chairs remained in use for decades too, until – like many gas chambers – they became too troublesome to maintain. The last gassing was in 1999.³⁷ Gas chambers were replaced by lethal-injection machines, which were

much cheaper than designing and building a new gas chamber or electric chair. Another factor was that in some US states those to be executed were given a choice and most seem to have gone for lethal injection.

Lethal injection has spread around the world, just as earlier, colonial powers took their execution technologies to their colonies.³⁸ At the end of the twentieth century the Philippines introduced lethal injection; it had wanted gas chambers, but none could be bought. China began to use lethal injection in the 1990s, Taiwan allowed its use but continued shooting, and Guatemala adopted it. In Thailand the machine gun replaced beheading in the 1930s; it has recently been replaced by lethal injection.

Despite the progressive change towards lethal injection, the twentieth century saw expansion in the use of older techniques. The guillotine, perhaps the first killing technique devised to minimise pain to the executed, came into use in the French Revolution. Associated with the beheading of nobles and the Terror, it was to have a gruesome future. In the nineteenth century a number of European nations adopted it, including many German states. The new German Reich beheaded all its capital offenders from 1870, though not all by guillotine; some states retained the axe, until it was abolished in 1936. But the execution rate was, as elsewhere, but a handful a year. The great age of the guillotine was about to begin again. Under the Nazis the execution rate increased drastically – in the Nazi era some 10,000 people were executed after a judicial process, peaking at many thousands per year during the war. Hitler is reported to have ordered twenty guillotines. He introduced hanging as an alternative in 1942, using very crude gallows.

In most places judicial execution was a rare occurrence, and from the 1940s would become rarer still. It was regarded in most of the rich world as a barbarous practice which should be abolished. In the United States, some 120 people were executed ever year in the interwar years. By the 1960s there were few executions, and between 1972 and 1976 there were none for technical legal reasons. Elsewhere too the

number of executions generally fell, and many countries abolished the death penalty altogether.

The United States in particular deviated from this trend. Executions resumed in 1977, with the killing by firing squad of Gary Gilmore in Utah. But far from continuing on a downward path the number of executions surged in the 1980s and 1990s. Texas, using lethal injection, executed forty in the year 2000, leading the way back to capital punishment levels in the USA not seen since the 1950s. Although lethal injection dominated, the gas chamber and the electric chair returned to use.

The application of capital punishment has never been merely a judicial matter. The noose, electric chair and lethal injection were not neutral. Politics and race have mattered a very great deal. In Britain around twelve people a year were hanged in the twentieth century, yet the British judicially hanged over 1,000 Kenyans between 1952 and 1959 (and killed tens of thousands by other means) during the Mau Mau rebellion. Between 1608 and 1972 only 41 per cent of those executed in the USA were white, despite it being an overwhelmingly white nation; since 1930 more than half of all those executed have been black.³⁹ In some southern states the fall in lynchings of blacks in the early part of the century merely led to a rise in state executions of blacks.⁴⁰ Only since the reintroduction of capital punishment has the number of executed whites slightly exceeded the number of blacks.

Technologies of genocide

At certain times, in certain places, governments have sought to eliminate particular populations, or simply kill large numbers of people. In doing so they were sometimes forced to think about methods of killing, and sometimes to innovate in killing techniques. For example, in the Great War the Ottoman Empire decided to deport its very large Armenian Christian population from its central Anatolian territories. It was at war with Christian Russia and Armenia was on the Ottoman–Russian border. The deportations were themselves brutal forced marches with much death and killing on the way. The process did not stop until the

creation in 1923 of a Turkish state in Anatolia, now free not only of Armenians but of Greek Orthodox peoples too. It is estimated that around 1.5 million Armenians died. Other massacres were small by comparison. In the Soviet Union, during the Great Terror of the mid-1930s, hundreds of thousands were executed by shooting. In a few weeks after their capture of Nanking in December 1937, the Japanese killed, it is roughly estimated, some 100–300,000 Chinese soldiers and civilians, mostly by shooting.

It was the Germans who innovated, under cover of secrecy and war. Using conventional means – shooting, hanging, starving – the horse-drawn German forces killed many millions in Eastern Europe between 1941 and 1945, including millions of civilians. The first large-scale killing of Jews, in what had been eastern Poland and the Soviet Union, used conventional means. Four specially created and remarkably small killing squads, *Einsatzgruppen*, together with local accomplices, killed around 1.3 million Jews with small arms.⁴¹ Soon the *Einsatzgruppen* began to use gas vans on a small scale, but even the small number of these (around thirty is the largest estimate) could kill many thousands a day. Indeed the first mass-killing operation, using just three gas lorries, started in Chelmno in late 1941, taking roughly 1,000 lives a day. From December 1941 until early 1943 around 300,000 were killed. In 1942 three more extermination centres were established – Sobibor, Belzec and Treblinka. With Chelmno, they were responsible for the deaths of around 2 million people. Treblinka was the largest, killing around three-quarters of a million people. All these were small places, deep in the forest, and all were destroyed by the Germans, mostly by 1943. They killed using carbon monoxide from engine exhausts. Its advantage was not that it killed faster – it was that it spared dedicated squads of killers the grisly task of killing directly.⁴² This carbon-monoxide killing technology had already been used to kill tens of thousands of mentally and physically handicapped Aryans by 1941.

It is telling that our central image of the Holocaust is not one of small arms and engine exhausts, though these and hunger were the

great killers. It involves a large industrial site, a specialised killing gas, Zyklon B (hydrogen cyanide), and industrial-scale crematoria to dispose of bodies. The one major killing site using these means, Auschwitz-Birkenau, killed more than any other single place, around 1 million. There were survivors, and indeed much of the camp itself remained. For these and other reasons it was not typical. Auschwitz-Birkenau, the last extermination centre to come on line, and the last to operate, was not a pure extermination camp. It was an enormous labour camp, supplying manpower, with other camps in the area, for a vast new Upper Silesian industrial complex in territory incorporated into the Reich. Auschwitz-Birkenau was intended at one point to be a camp for the extraordinary number of 200,000 inmates.

Zyklon B was used in Auschwitz, as elsewhere in the Nazi camp system, to disinfect clothes to keep lice-borne disease under control. There it was found that it could kill people effectively too. Two houses were turned into gas chambers, and the designs of projected large morgues attached to crematoria, intended for the disposal of the bodies of the many who died from hunger and disease, were changed to convert them into gas chambers.⁴³ By this twisted road was Auschwitz-Birkenau created as an extermination camp with a novel killing technology.

One of the great industrial enterprises the camps supplied with labour were new plants belonging to IG Farben. The company was building, for the first time contiguously, plant for synthetic oil and rubber, and for many other intermediate and final products, exploiting the inter-relatedness of the processes. This major undertaking never produced oil or rubber but it did manufacture other materials of importance for the war effort. The conjunction tempts us to see connections with the Holocaust; both were linked to a resurgent German nationalism. Treating Auschwitz as if it was a killing factory, in the same way that Leuna or Leverkusen were chemical factories or Krupps in Essen an armament maker, is to miss other crucial aspects. The Auschwitz-Birkenau killing facilities were neither very large, automated nor smooth running, nor especially capital-intensive.

The crematoria often broke down, and many bodies were buried or burned in pits. They worked intermittently as the supply of victims was variable. The greatest killing spree of all, that of Hungary's Jews, which took around two months, was too much for the existing capacity, and needed extra killing, and especially incineration, facilities. Great sloping pits were built, with firewood as fuel. Furthermore the path that led to adapting lice-killing technology to humans and the steps that led to the processes for the manufacture of synthetic oil and rubber were very different.

The image of Auschwitz as a radically modern factory of death nevertheless remains powerful. It has served as a strong critique of modernity in general, as a stark reminder of where modern science and industry could lead. It has helped fuel a retrospective debate as to whether Auschwitz should have been bombed, as if it were a great machine susceptible to destruction, such as a synthetic-oil plant or a V-2 factory.

Simple though horrifying calculations make clear that although killing 2 million people in a year seems to be a stupefying task, it was well within the capabilities of much older killing technology. The four large slaughterhouses of small Uruguay could dispatch 1 million cattle a year with nothing more elaborate than a pole-axe; Chicago's largest were doing this even before the Great War. And, as we have seen, small arms and car exhaust took a terrible toll. Large-scale killing was not as new, nor as difficult, as the technological meditations on the Holocaust suggested.

The nature and power of the killing machines at Auschwitz in particular have been at the centre of the claims of Holocaust deniers. Much of the denier case is that it is inconceivable that so many people could be killed in gas chambers, a few gas vans and with rifles. In this sordid story a genuine expert on killing technology, Fred A. Leuchter Jr, a maintenance and repair man for execution equipment, became a central figure.⁴⁴ *Mr Death*, as Errol Morris called his brilliant film on Leuchter, made a modest career in the United States reconditioning and remodelling execution equipment after executions resumed

there in 1977. Leuchter renovated gallows for Delaware, and improved a gas chamber for Missouri.⁴⁵ He also invented an automatic lethal injection machine for New Jersey. As perhaps the only living expert on gas chambers, Leuchter was hired in 1988 to testify on behalf of a Holocaust denier – a nice illustration of the role of maintenance man as expert. He visited Auschwitz, and convinced himself that there were no gas chambers there. His report became a key document in the Holocaust denier's armoury. Holocaust denial, more accurately gas chamber denial, has led to research that shows in surprising detail how the SS built and used the gas chambers, weakening even further the denier case.⁴⁶

If in innovation-centric history too much is made of Auschwitz, the Holocaust was nevertheless novel. Following the Holocaust genocides cannot be considered a throwback to earlier barbarity, however tempting that line of argument remains. There have been modern motivations, and planning, and in an already established pattern, the use of existing tools in new ways. This is clear in two later, smaller genocides.

In Cambodia, between 1975 and 1979 some 1.7 million people were killed by the Pol Pot regime before it was defeated by the Vietnamese. Some 20 per cent of the population died, with the urban and rural Chinese, Vietnamese and Thai minorities being especially affected.⁴⁷ Enforced starvation was the main cause of death, but some 200,000 were executed, according to one estimate. They were killed in many places and by a variety of methods: shooting, skulls bashed in with shovels, hoes and iron bars, and – an innovation – suffocation with a plastic bag.⁴⁸

In 1994 central Africa was the scene of a spectacularly fast genocide. At least 500,000 Rwandan Tutsis (some estimates put the figure as high as 1 million), the minority population, were killed, 99 per cent between April and December.⁴⁹ Most victims were killed by machete (38 per cent), clubs (17 per cent) with firearms accounting for only 15 per cent of deaths.⁵⁰ The Hutu government had even acquired machetes in advance. In 1993 alone around 1 million machetes,

weighing around 500 tons and costing less than a US dollar each, were imported, around one machete for every three males in the country.⁵¹ This was something new – never before had so many been killed so quickly by machete, which appeared as a major killing machine for the first time in history. Invention happens at unexpected times and places.