A social history of a Midland business: Flower & Sons Brewery, 1870-1914 Part II

Jonathan Reinarz

Chapter Two: Science and technology in a Midland brewery

I've just read in a book by a friend
That beer, British beer, has diseases,
That Pasteur's the man who can mend
All it's alements - that is, if he pleases.

Poem in the *Brewers' Journal* (1880)

The ability of a brewer to produce an attractive product is a mysterious process; it has been accomplished, however, for centuries, even in the most primitive of breweries. As brewers organised the trade along lines which mass production made possible, the difficulty of brewing two identical beers continued to be discussed. Brewing was in many ways regarded more as an art, and less a science. By the middle of the nineteenth century, however, views appear to have been changing. A review of William Black's *Treatise on Brewing* (1835) which appeared in the *Brewers' Journal* in 1866 suggests such irregularities were vanishing from the trade. Chemistry, dependent on its own laws, had 'superseded witchcraft in every process'.[1] Although it was during this period that many of the great discoveries concerning fermentation and the importance of asepsis were being discussed in trade journals, scarcely any work has been carried out at the brewery level in order to determine how completely these new ideas were accepted by brewers and their employees.[2]

The year generally recognised as marking a turning point in the English brewing industry is 1830. It is in this year that Gourvish and Wilson suggest breweries made greater use of the lessons of science.[3] This is not, however, uncontested territory. Eric Sigsworth, in an article in the *Economic History Review*, argues that minimal chemical knowledge was imported from laboratories to breweries prior to the 1860s.[4] While some disagreement continues to surround this issue, there is less debate concerning the present century. Twentieth-century brewing is commonly believed to have undergone few changes; according to John Vaisey, among other historians of the industry, technological improvements caused no great reorganisation of the trade.[5]

Gourvish and Wilson, however, recognise that they, just as Vaisey, have incorporated a bias into their study of the industry. In their impressive survey they tend to consider predominantly the experiences of the large London and Burton breweries. Not surprisingly, the brewers who they suggest were building laboratories and analysing beer more carefully were those employed by firms such as Bass, Guinness, Ind Coope and Allsopp & Sons. Consequently, it has become necessary to look at the relationship between science, technology and brewing a little more closely. The experiences of many smaller regional breweries, such as Flower & Sons, were omitted from past studies.

Scientists were only first beginning to understand the biochemical properties of yeast in the 1860s; it was the mystery of brewing which kept people applying rules of thumb until at least the second half of the nineteenth century.[6] Although brewers had recognised that fermentation, when carried out in hot weather, could rapidly get out of control, explanations for such phenomena were unavailable.

A native of Arois in the wine-growing district of the Jura, Louis Pasteur originally analysed the process of fermentation in wine, but turned his attention to fermentation in beer between 1871 and 1876.[7] His research challenged the dominant paradigm supported by the work of Liebig, Guy Lussac and Mulder which suggested fermentation merely resulted from the decomposition, or putrefaction of cells.[8] Open to ideas developed earlier by Schwann, Pasteur proved fermentation was caused by microscopic organisms. Shortly after applying his ideas to the wine industry, he concentrated on its effects in brewing. Before doing so, however, he familiarised himself with the industry and even constructed an experimental brewery in his laboratory in Paris.[9] While communicating frequently with brewers in France and Belgium, he understood brewing not only as practised on the Continent; he visited Whitbread's and William Younger's breweries in 1871, regularly corresponded with English chemists, some of whom were employed in breweries, and revealed that fermentation, as was commonly practised in Burton, was dependent on the actions of two different yeast cells, as opposed to a single strain.[10] In 1876, he published the results of his study as they related to the brewing industry in *Études sur la Bière*, an English edition of which appeared three years later. Pasteur's ideas on fermentation, however, were already widely publicised and had entered mainstream scientific discourse in England before his work had been translated.

Copenhagen became a centre for yeast research soon after Pasteur conducted his well-known experiments. Having experimented extensively with yeasts even before he entered the laboratory at the Carlsberg Brewery in Valby (a suburb of Copenhagen) in 1879, Emil Christian Hansen proved Pasteur's theory regarding the problem of secondary and tertiary fermentations. Among other things, his

work revealed the existence of a variety of yeasts, some of which, namely 'wild yeasts', could spoil entire brews by their actions. Hansen isolated these pure cultures, identified 'good serviceable beer-yeasts' and described the importance of their different qualities to the brewing industry.[11] The results of his empirical work were published in *Practical Studies in Fermentation*, a German edition of which was available in 1884.

Naturally, one of the most important lessons scientific research at the time reinforced was the need for cleanliness. Even prior to the appearance of evidence which indicated the existence of bacteria and harmful yeast strains, brewers attempted to keep their work environments clean. The numerous vessels found in breweries were not all used for brewing purposes; many were used for washing. The need to clean casks provided coopers and brewery workers with regular work. According to Eric Sigsworth, however, until 1936 most brewery workers cleaned using only 'the brush, elbow grease, and unlimited water'.[12] Perhaps compensating for these primitive measures, most insisted that cleaning be carried out 'quickly after use'.[13] Those containers for which brewers had no immediate use were to be filled with water and drained; this was to be repeated in many breweries once a month at least.[14]

Cleaning comprised an important part of most workers' regimes at Flower & Sons. The only difference from the general cleaning routine described by Sigsworth, however, was that water was not the sole cleanser employed by the firm during periods of maintenance. As early as 1870, the firm used 'Bisul[phite of Lime] in considerable quantity for sweetening utensils and cleaning casks'.[15] Moreover, a number of other cleansing fluids were developed in these years. Messrs Crawford and Sleigh of Liverpool, for example, made a disinfectant 'which gained popularity with brewers throughout the country'.[16] In 1878, purchasing ledgers reveal that, in addition to bisulphite, Flower & Sons regularly acquired 'Robertson's Disinfectant'.[17] During a tour of the brewery in March 1881, a writer for the periodical, *Land and Water*, reported that, after each brewing, 'every utensil is thoroughly cleansed in hot and cold water'.[18] Perhaps drawing on knowledge acquired on other tours, he concludes that, 'cleanliness is *sine qua non* in every well-managed brewery'.[19]

Primarily, brewers ensured 'scrupulous cleanliness' to prevent infection.[20] Pasteur demonstrated that the diseased fermentation of beer was often caused by the infection of germs alien to the pure fermentation of the yeast. In most eighteenth century breweries this had been a common occurrence, for most vessels were uncovered, and cleaning was irregular. Although some brewers recognised the threat this posed to the success of their brew, many failed to understand fermentation. This did not, however, prevent them from controlling it.

By the end of the nineteenth century unsterile vessels were generally recognised as a 'dangerous menace'.[21] Equally dangerous was condensation which dripped from ceilings and beams into open coppers. Many brewers, such as Flowers, attempted to control this risk of infection by whitewashing all wooden surfaces in their breweries. Others attempted to control such problems more directly by introducing ventilators to their premises in order to facilitate the circulation of air. Some erected their coppers in separate rooms in order that the rest of the brewery be kept steam-free. Most installed greater numbers of shuttered windows. Nevertheless, despite taking such precautions, the prevalence of open vessels, among many other oversights, left brews susceptible to infection from micro-organisms, especially in summer (and agricultural regions) when their numbers increased exponentially.

Although strides had been made to prevent infection, considerable room for improvement remained. For example, in an inventory and valuation of Flower & Sons' premises compiled in 1888, many vessels still lacked covers. The fir, lead-lined liquor backs, which held supplies of water until required for brewing purposes, were covered using only loose boards.[22] Wood, whether used for utensils or to construct vessels, was difficult to keep clean, and often harboured infectious microbes. Although brewers were beginning to recognise the advantages of metal vessels, many were concerned that the soluble elements in these compounds would find their way into their brewed products. Consequently, the introduction of metal mash tuns, for example, generally occurred in the 1890s.[23] Moreover, a number of the largest breweries visited by Alfred Barnard during these years had begun to provide their mashing vessels with covers, if not to prevent infection, then to conserve energy or collect steam.[24] By the end of the century, even the 'old Scottish fancy' for wooden tuns was dying out and aluminium malting utensils were introduced to brewery maltings.[25] However, while the majority of surfaces which came into contact with materials could easily be cleaned, especially after the introduction of tiles to malt houses, and the replacement of wooden floors with jointless, concrete ones, the miles of copper, iron or even lead pipes found in breweries continued to create problems, especially when permanently fixed to a wall or laid underground and subsequently difficult for brewers to clean properly. These anomalies contrast with the precautions firms took to clean brewing vessels and utensils. Such evidence, however, is very revealing for it demonstrates the way scientific change was introduced to firms. Rather than recognising all of a theory's applications and introducing sweeping reforms, brewers often implemented changes haphazardly; innovations appear disjointed. In general, Flower & Sons, like most of its competitors, appears to have been unable to keep up with the more rapid progress made by scientists in the laboratory.

Besides cleanliness, research carried out during this period introduced brewers to

tools which would allow them to measure the production process more carefully. One such instrument which greatly rationalised brewing was the thermometer. According to Peter Mathias, this tool permitted brewers ‘to manipulate the brewing process exactly'.[26] While few brewers were without its advantage during this period - they have even been found in the inventories of nineteenth-century country house brewers - thermometers were improved throughout the last decades of the nineteenth century. Models developed during this period allowed brewers to scrutinize temperatures from their offices, at some distance from maltings and mash-tuns, or, when combined with alarms, were made to signal when, for example, the temperature of a brew exceeded or fell below a given temperature range.[27] Most importantly, however, rather than just permit greater manipulation, this inexpensive instrument standardised brewing. This, in turn, facilitated communication among those interested in the trade. Con-sequently, brewing textbooks became not only more numerous, but provided easy-to-follow instructions. Before the introduction of the thermometer brewers frequently referred to liquids which were to be heated 'as hot as the hand can bear';[28] the thermometer, among other scientific instruments, insured the disappearance of such subjective language.[29]

Very regularly, ledgers also reveal brewers to have purchased microscopes. Unlike the thermometer, this instrument became more common after Pasteur's and Hansen's discoveries gained recognition. Not surprisingly, the earliest microscopes were used by brewers to determine whether yeast samples had become infected by wild strains. Combined with photographic technology at the end of the last century, brewers were able to consult images of typical yeast fields for regular referral in order to facilitate the identification of both healthy and harmful strains. The instruments were applied to malting more slowly, a branch of the trade generally regarded as more conservative than the brewhouse.[30] Moreover, a microscope was not as straightforward to use as a thermometer. Consequently, it was less frequently acquired. By the commencement of the period which outlines this study, The London brewers, Whitbread & Co, one of the nation's largest breweries, did not possess a microscope.[31] Only a decade later were models such as the brewers' microscope produced by T Swift & Sons, the London instrument makers, regularly advertised, described in trade journals and, most importantly, made affordable.[32] Flower & Sons purchased what was described as Watson's microscope for £11.0s.6d. in November 1878.[33] Six months later, in what appears to confirm an increasing faith in science, they acquired a 'chemical apparatus' which cost 9s.8d. Thermometers had been used in the brewery since the 1830s. Unfortunately, very little evidence ever reveals the ways in which equipment or chemical apparatus was used.

Although these instruments were listed in the ledgers of most breweries, they were

not universally accepted by the industry. In a lecture given at a meeting of the London branch of the Institute of Brewing in 1895, Arthur Hartley, head brewer at the Emsworth Brewery near Chichester, cautioned his colleagues from relying solely on them. Instruments, of brass or glass, he argued, were 'by no means to be absolutely depended upon'.[34] This should not have come as a surprise given that few brewers regularly tested the correctness of their thermometers.[35] According to Bedo Hobbs, also a member of the Institute of Brewing and head brewer at Nicholson's Brewery, Maidenhead, accuracy was by no means the greatest problem. While he believed the microscope to be of immense value to the brewer, and few were without its use after 1880, he claimed 'too many [were] kept locked up in a case, instead of under a glass shade ready for use'.[36]

Not all brewers were guilty of this practice. William Garton and William Butler, for example, were two brewers who were said to have raised brewing from 'empiricism to science'.[37] Birmingham's Mitchells & Butlers had set up a laboratory in their Cape Hill Brewery at the turn of the century under the supervision of Butler, one of the company's directors, who was also a qualified chemist.[38] According to the firm's historian, it allowed their brewers to detect the use of adulterants, ascertain the purity of their brewing materials, study the innumerable reactions of one ingredient on another and examine yeasts; a sample of each brew was also kept for future analysis. As a result of their experiments they claimed there was no liquor - 'certainly not water, and assuredly not milk' - which was as pure as their 'Good Honest Beer'.[39] Few breweries, however, could claim such a laboratory during this period, despite its low cost when compared with the average provincial breweries' usual expenses.[40] In July 1880, the *Brewers' Journal* estimated the cost to set up even the most basic laboratory to be approximately £100; that owned by Mitchells & Butlers was certainly more elaborate. Flowers did without even the most elementary laboratory facilities until the second half of the twentieth century.[41] Most of the large breweries visited by Alfred Barnard in the last decade of the nineteenth century had only the smallest laboratories, or else a brewer's office often doubled as his laboratory.[42]

While brewers such as Flowers appear to have modified their brewing practices in light of investigations fuelled by Pasteur's research, they were also prepared to limit changes within their breweries. Research in science, however, did not seem to recognise such barriers. During the first decade of the twentieth century, chemists were, for example, conducting far more complex investigations into issues of infection. In 1909, Sorenson introduced his concept of hydrogen ion concentration. This, among other things, allowed brewers to determine the pH values of their wort and beer and thus determine the susceptibility of their product to infection by bacteria.[43] Approximately a decade earlier, important research by

Eduard Buchner and Arthur Harden, both eventually rewarded with Nobel prizes, had begun to explore the role of enzymes in fermentation science. Building on Buchner's findings, Harden demonstrated that zymase was not one enzyme but twelve, and that phosphate, through the energy-rich compound adenosine triphosphate (ATP), was the driving force not just of yeast metabolism but of all metabolism.[44] Such concepts, however, were beyond the grasp of individuals who studied basic chemistry texts only intermittently. Clearly, such ideas would have to be introduced to breweries by alternative channels.

Even a rudimentary understanding of chemistry, and a little practice with a microscope, however, gave brewers greater control over the brewing process. Increased precision and a basic understanding of fermentation, for example, introduced the possibility of quality control. As many brewers believed the quality of their product depended primarily on the liquor used, water was often the first brewing ingredient to undergo thorough analysis. Wilson's and Gourvish's work suggests this was a logical response, for it was not a firm's technology which gave it an advantage over other breweries, but its water supply.[45]

Local differences between beers were more likely the result of water supply than other factors. Most regions had water supplies suited to the production of particular types of beer. Burton water was suited to high hopping pale ales. That of London was suited to stouts and porters. A decline in the popularity of porter, and an increased demand for Burton ales, led many scientists, namely Combrune and Richardson, and, later, Shaw and Molyneux, to boil off the local water and determine the components which gave Burton's supply its distinctive flavour. The results of such analyses were often made public by trade journals.[46] Individuals, such as Professor Tilden of Mason Science College of Birmingham, to take one instance of many, lectured on the subject before he was appointed Dean of the Royal College of Science.[47] Furthermore, once the chemical constituents of a source had been determined, water supplies could be altered to suit a particular product. For example, as the popularity of Burton ales increased in the nineteenth century, brewers throughout England could produce beers which shared its characteristic 'pineapple' flavour by either softening or hardening their water supplies accordingly. Even when they did not go to such extremes, brewers had learned the importance of a reliable water source, especially vital to those who also produced mineral waters, and expended considerable sums in order to obtain one.[48]

The water used by Flowers shared many of the characteristics which made Burton ales famous. The firm's water, known for its 'excessive hardness' - the brewery lay on the Keuper marl division - flowed from artesian wells sunk in the 1890s.[49] Rather than risk the loss of a reliable water source, a misfortune which afflicted

many smaller breweries, such as the Warwick and Leamington Brewery,[50] Flower & Sons employed the services of Horace Tabberer Brown, a consultant chemist formerly employed at Worthington's in Burton, who had since set up a laboratory and offices at Chancery Lane, London, and commenced an uncertain undertaking.[51] Advised by Brown, Messrs Ebenezer Timmins & Sons of the Bridgewater Foundry, Runcorn drilled more than eight hundred feet, 'a case without parallel in the experience of the contractors', to ensure a sufficient water supply.[52] At the conclusion of the project, an eight-horse-power pump was installed to aid in the lift of water. Periodically, water samples were sent up the road to local chemists, Kendall & Son, in order to ensure the source remained free of contaminants. Between 1870 and 1914, Flower & Sons never suffered from a shortage of water and even supplied 75% of the town with a reliable source during a drought in 1912.[53]

Figure 6. Sketch of Horace Brown, Journal of the Institute of Brewing*, 22, 1916.*

The selection and use of barley also followed the systematic methods of science. Near the end of the nineteenth century, many of the country's brewers already kept grains from various suppliers separate. According to trade spokesmen, however, few were concerned with their preservation, products often being kept in sacks and stored in areas exposed to the circulation of humid air.[54] This was considered even more shameful given the great care which was exercised during purchasing. Although brewers had traditionally been involved with buying and selling grain, the criteria used to judge barley was changing. While most brewers still judged grains using artisanal methods - by their senses of sight, smell and touch - microscopes permitted such examinations to be carried out in greater detail. This certainly improved their ability to locate mould in sales samples. The role of region and soil were also recognised as an important influence on the quality of grain. As early as 1866, WL Tizard claimed the best barley was grown on calcareous land in rich, loamy soil.[55] Varieties grown in clay soil were judged to be too thick-skinned and poor in

starch.[56] Too much nitrogen in the soil created albuminous matter which clouded beer, a complaint addressed within the pages of various brewers' journals on numerous occasions.

Breweries which grew their own barley, and made their own malt, controlled its quality directly. Research in this field was conducted throughout the last decades of the nineteenth century. While employed at Worthington's Brewery in Burton, almost all of Horace Brown's investigations concerned malt and the quality of its extracts during mashing. Few breweries, however, funded such research until the first decades of this century, when Mendel's laws of heredity were rediscovered. Between 1901 and 1906, the work of Edwin Sloper Beaven allowed Guinness's brewers to determine the amount of nitrogen in barley and, thus, which varieties were most suited to their brewing needs.[57] Flower & Sons was one of many breweries which attempted to control the quality of their barley indirectly. In order to induce farmers to exercise greater care in threshing, Flowers offered prizes of £10 and £5 to those who provided them with the best dressed and screened lots of barley.[58] Careless threshing, they claimed, produced 'broken and thinning corns and this greatly [depreciated] the value of the article'.[59] Furthermore, farmers rarely cleaned their corn perfectly. Not only was the quality of barley grown in the district improved with the introduction of prizes, but, according to the firm's directors, after the first of such rewards was offered, farmers often refused to hire threshing machines 'until the owners had them entirely overhauled and repaired'.[60] These competitions lasted throughout this century, were also introduced to hop-growing regions and saw representatives from breweries, such as Guinness, regularly act as judges.

Hops affected the taste of ale more subtly. A better understanding of the product, however, allowed brewers to monitor its use more closely. Like barley, its physical characteristics came under greater scrutiny during these years. Good hops were to have large cones, stobiles of pale yellow colour and short stems; rubbed between the hands they were to feel glutinous and oily.[61] Moreover, due to its fluctuating price, brewers exercised greater care in choosing the right hops, for, in this way, less were used.[62] Furthermore, scientific research revealed the chemical properties of hops. Beyond simply giving flavour to the beer, hops were recognised for their preservative qualities. Thus, brewers finally understood the way in which hops often counteracted infection in beer.[63] Nevertheless, most analyses of hops were still carried out with the aid of the naked eye.[64] Those in charge of purchasing were primarily concerned their samples were free of mould and excessive sulphur, 'the terror of a careful brewer'.[65] A greater understanding of the products' chemical constituents came only in the later decades of the twentieth century.

The theories advanced by scientists during the nineteenth century were not all

introduced to the English brewing industry overnight. Some were accepted more slowly than others. As Peter Mathias points out in his comprehensive study of the industry, this caused an intermediary stage 'between the empiricism of the seventeenth century, and the beginning of fundamental scientific analysis in the mid-nineteenth century'.[66] While the acceptance of a theory, such as Pasteur's, suggested 'a commitment to the same rules and standards for scientific practice',[67] it also implied the rejection of many previously-held views. While they served as a forum for conveying the latest research to brewers, trade journals also enabled brewing chemists to challenge each others' findings. In such cases, conversion proved especially difficult among those most committed to established world views. For example, in Germany at this time, a group of individuals attacked the brewing industry and claimed chemistry had 'got into the beer'.[68] In the industry's defence, it was claimed that, 'although chemical knowledge [was] applied to ... materials and ... the brewing process, chemicals [were] conspicuous by their absence from the brewery'.[69] However, brewers whose businesses were still organised along craft lines, believed their forefathers, who knew nothing of chemistry, had been able to produce a better product. As a result, many brewers for a time dared not engage a person who was 'guilty of the unpardonable sin of learning chemistry'.[70] Moreover, despite the early favourable depictions of scientists in eighteenth-century England, the image of the scientist in Victorian times became increasingly bleak.[71] Evidence reveals the scientific method was resisted at Worthington's in Burton because the necessary instruments introduced by Horace Brown suggested to customers that beer was being 'doctored'.[72] Other critics felt chemistry in general was being used to discover substitutes for 'honest malt and hops', especially after 1880 when brewers were permitted to utilise materials more freely.[73] As is to be expected, often such claims were used as a defence by those still brewing according to traditional methods and who believed chemists used the ‘glamour of language to cloak ill-digested ideas'.[74] This was true in the case of James Herbert, whose *Art of Brewing India Pale Ale and Export Ale* (1872) was, in the author's own words, 'based on practical experience', Herbert having had no knowledge of chemistry.[75] Herbert confessed he was not enraptured by chemistry and was confident brewers did not require the aid of a chemist. He even went so far as to claim chemistry had 'nothing to do with the production of Malt liquors'.[76] He was not the only writer to describe ‘the imprudent way in which chemistry has been introduced into brewing and brewing books' during the last decades of the nineteenth century.[77]

The popularity of such views, however, was in decline. For example, although John Marston & Son in Burton was one of many breweries where Herbert's work was used or, at least, purchased, a little more than a decade later the firm also acquired RD Bailey's *Notes on Brewing*

(1889), which espoused a very scientific approach to brewing; it directly addressed brewers, such as Herbert, who called 'for the abolition of theory in connection with the all-important industry, brewing'.[78] While journals continued to receive letters from readers who were critical of the role played by chemists in the brewing industry, many more of their correspondents requested the periodicals' consultants to recommend readings which dealt adequately with the chemistry of brewing.

Despite the time-lag required for some brewers to adjust to the advances of nineteenth-century science, the industry generally appears to have welcomed the latest technological developments more readily. For example, many of Boulton and Watt's earliest engines were first introduced to breweries in order to facilitate milling and pumping water. Whitbread & Co. introduced steam power to their brewery in 1785.[79] Engines lasted decades and had low maintenance costs.[80] Moreover, as few of their workers were organised during the nineteenth century, brewers rarely faced opposition when they introduced mechanical innovations. Although very few were extraordinarily innovative, most brewers introduced some technological changes during this period.

By the 1870s many breweries were in need of improvement. Flowers was one of many that rebuilt their facilities in this decade.[81] Although numerous technological advances suggest this was an ideal time for breweries to modernise, Flower & Sons' decision to rebuild was related to the continued growth of their trade and developments in transportation. No longer as reliable a means of transportation, navigable waterways were superseded by railway networks. As was described in the previous chapter, Flowers moved the majority of their production facilities to a new site on the Birmingham Road, nearer to Stratford's railway lines. Many other breweries made similar arrangements, and railway sidings became a common feature of breweries built or rebuilt in these decades. After 1870, Flowers carried out fewer activities in their old brewery, located in the centre of town.

Although the new brewery was much larger than the old plant, the production process at the new facilities did not change dramatically. Some activities were made less labour-intensive through the introduction of more powerful steam engines. The movement of barrels, for example, was facilitated by a steam lift, and the loading and unloading of raw materials, as carried out in the brewery yard, was made less laborious by the introduction of cranes and hoists. Improvements made over the next decades more radically altered the organisation of labour in the brewery. An early form of pneumatic maltings was installed at the brewery in 1878.[82] Though introduced to one malt house only, the method allowed the brewery to save both labour and space, and, more important in Flower & Sons' case, pro-

duce malt of a more uniform quality cheaply and safely throughout the year.[83] Electric lighting replaced gas in the nineteenth century and largely superseded steam power in 1901.[84]

The most revolutionary of technological innovations introduced to the commercial brewing process was the refrigerator. Despite believing it caused little reorganisation after its introduction, Vaisey correctly describes it as the 'greatest scientific discovery to brewing'.[85] Aware of the importance of temperature on brewing, Pasteur, when he first carried out his investigations concerning fermentation, originally wished to free brewing of seasonality and locality. It was the invention of the refrigerator that generally provided brewers with this freedom.

Temperature control was of vital importance to brewers, not only during fermentation, but also in mashing. During mashing, temperature affected the quality of the wort extracted from malt. It also alerted brewers to the best time for adding grains to liquor. This was less straightforward during fermentation, for the resulting chemical change generated heat, and temperatures required adjustment periodically. If this were neglected, violent fermentations led to a loss of the volatile substances in brewing recipes (which gave flavour and quality to the brew).[86]

Refrigerators and attemperators allowed brewers to control temperatures more carefully, especially in summer. After the introduction of refrigeration technology, hot weather no longer threatened uncontrolled fermentation, and production continued all the year round. Moreover, the brewing process was shortened. Work days in breweries were considerably longer in a pre-refrigeration age. Brewers often had no alternative but to wait for a brew to cool naturally by way of evaporation. In a section of his wife's diary, Charles Flower describes his first memories of brewing when he spent nights, sometimes until two in the morning, in the family's Stratford brewery, 'for then it took much longer to get through an eight-quarter brewing with the old plant, than it did to get through any quantity after better refrigerators were invented'.[87]

The effect of temperature on brewing had been recognised centuries earlier. Attempts were made to overcome variations in atmospheric temperature in the period before artificial cooling methods were made more widely available. In previous centuries, brewers recommended a brewery be built with ‘its back to the sun'.[88] Lead-lined vessels in which brewers cooled individual brewings were shallow and of enormous size, so as to increase the surface area which came into contact with the air. Often, however, simply exposing the brewer's wort to air was not sufficient to cool ale prior to fermentation. As a result, ice was commercially imported from an early date. At the end of the eighteenth century, brewers even began to place attemperators in brewing vessels to control temperature. These often comprised lengths of coiled

copper piping through which cool water circulated. During cold spells, warm water could be substituted in order to raise the temperature of the wort; a variation of this sort of attemperator, or heat exchanger, which bore the name of the French engineer Jean Louis Baudelot, continued to be used throughout the late nineteenth century in a number of English breweries.

Scientific developments led not only to the development of more sophisticated refrigerators, but regularly made older cooling methods redundant. For example, after Hansen's work revealed that natural ice often contained spores, many brewers discontinued its use.[89] Moreover, cooling by exposure to air was regarded as equally hazardous. Nevertheless, by the middle of the nineteenth century, refrigeration technology provided some new alternatives which conformed to the latest scientific findings.

According to Wilson and Gourvish, refrigerators were first used in brewing in the early 1800s. Moreover, they suggest the models introduced by Burton brewing engineers Robert Morton & Co were particularly popular in England. While models patented and manufactured by Lawrence & Co and Messrs Pontifex were equally, if not more, popular, all three firms advertised in brewing journals, issued informative, illustrated catalogues and regularly participated in the national Brewers' Engineers Exhibition, held annually from 1879. Were one also to consider the numerous smaller manufacturers of refrigeration technology, brewers appear to have had many options. Ether, alcohol and ammonia were all suitable refrigerants. A refrigerator utilising ether was first invented by James Harrison in 1856, and was improved by Messrs Siebe in 1862. In 1860, given ether's inflammable nature, Ferdinand Carré invented a machine that used ammonia. As with the ether machine, operation was continuous, for it used the same ammonia over and over again. By 1862, Alexander Carnegie Kirk of Bathgate Chemical Works, who is more often remembered for his work in the development of the triple-expansion engine, invented a mechanical refrigerator to replace one his employers had purchased from Harrison.[90] Kirk's machine used the compression and expansion of air to refrigerate.[91]

A considerable amount of experimentation was also carried out by individual breweries. Of the 434 patents granted to Scottish brewers between 1850 and 1880, Ian Donnachie suggests 178 (41%) were related to attemperators and refrigerators.[92] Only 70 were related to malting and mashing. Even in March 1881, after which date many more brewers became interested in mashing and bottling technology, of the 19 patents listed in the *Brewers' Journal* in this month, six dealt exclusively with cooling technology.[93] Perhaps not surprisingly, the single patent granted to Flower & Sons related to refrigeration.

Although the firm had few patents to its name, in the eyes of contemporaries, the

Flowers were revolutionary, particularly in their application of ice-making machines to ordinary refrigeration purposes. A patent for Improvements in Cooling Beer and Brewers' Worts was granted to Charles Flower in 1867 for the sum of £50.[94] According to the *Illustrated Midland News*,

> many of the improvements in the manufacture of beer which are now in use throughout the country owe their origin to the members of the [Flower & Sons] firm, and the opportunities which they have afforded others to carry out experiments.[95]

In the early 1860s, Flower & Sons purchased one of Kirk's most powerful machines; it made three tons of ice in twenty-four hours. Ice was used by the firm to cool the chamber in which they brewed directly. This, however, led to great wastage 'on account of the relatively large expenditure of power required' to make ice.[96] Consequently, the firm attempted to use the machine to cool beer, bypassing the intermediate process of ice-making. After spending more than £2,000, the firm's management abandoned the experiment, but not the machine.[97] In 1881, the machine was observed by the writer for *Land and Water*, whose notions of cleanliness were discussed earlier. During his visit to Stratford, the machine was 'undergoing repairs so as to be in a state of efficiency when required'.[98] The machine appears to have undergone several repairs, spanning many years, and was eventually replaced in 1883 by an ammonia machine patented by London engineers Pontifex and Wood. In that same year, however, the *Stratford Herald* reported that an accident in the goods yard of the brewery damaged a piece of machinery which formed part of the firm's refrigeration unit.[99] Although in running order shortly after the accident, the machine was not sufficiently reliable to permit summer brewing.

Simply because a brewery acquired refrigeration equipment does not imply they brewed throughout the summer months. In fact, it does not necessarily mean the firm used this technology at all. In a letter written to the *Brewers' Journal* in 1867, a brewer, using the pseudonym Progress, described his reliance on traditional cooling methods. Although he experimented with refrigerators, Progress continued to use cooling backs, and kept the former as an auxiliary cooling technique. He was convinced that cooling through exposure to air was preferable to cooling without air, as was the case when the wort was passed through a refrigerator in pipes. Trade journals continued to advocate traditional cooling backs for similar reasons. Moreover, many regarded these machines to be a poor investment. Brewers' ice-making machines appear to have worn out far more quickly than their steam engines. According to Flower & Sons' managers, 'ten years is a very long life for such things'.[100]

The details relating to Flower & Sons' brewing schedule can be examined in

greater detail by using the firm's brewing journals for this period.[101] Entries from 1880, almost two decades after Flowers had purchased Kirk's machine, suggest the brewery did not attempt to brew in the month of July, and completed only one brewing in June.[102] Although they brewed on twelve separate occasions in May, fewer quarters of barley were used in order to minimise loss, should spoilage have occurred. By August, the firm still brewed on only eight occasions. This was considerably less than in February when twenty-four brews had been undertaken (see Table 7).

In the following year, Flowers attempted to brew on many more occasions during summer months. The results, however, were equally unsatisfactory. The brewing journals for this period show the beers brewed in June to have been 'thick and poor', and, as a result, the brewery received 'several complaints'.[103] After this unsuccessful month, only three attempts were made to brew in July, five in August; summer brewing was solely used ‘to keep up the supply when exhausted'.[104]

By 1887, one would expect the difficulties of summer brewing to have been overcome; the opposite appears to have been the case. Fortunately, years after this unsuccessful experimental episode, while reflecting on his career in Stratford before a branch of the Institute of Brewing, the firm's head brewer, Francis Talbot, explained the company's decision to brew during only the coldest months. According to Talbot, the refrigeration produced by the firm's new machinery was applied in a very faulty manner:

> Cold brine was carried in pipes over the whole of the fermenting rooms. It naturally followed that moisture in the air was condensed in snow on the pipes, and that under the influence of the rise in temperature in hot weather, active fermentation in the fermentation squares, and more especially with the access of hot water for cleaning in the union casks, this snow melted off and dripped into the yeast and beer at all stages. In view of the position of the pipes and the manner in which they were carried it seemed to be impossible to prevent this drip.
>
> At the commencement of the working of this machine [in 1884] it appeared to have a very satisfactory effect on the quality of the beers. The improvement was maintained for about three years; after that ... it was a distinct disadvantage. This may have been due to the fact that these pipes must have been covered with wild yeasts, moulds and micro-organisms that were not present on them when erected, and that the drip of these into the beer must have done infinite damage.[105]

Consequently, no brewing was carried out between 26 April and 12 September 1887.[106] The same occurred for most of the 1890s. As the brewery had been reconstructed approximately two decades earlier, however, excess capacity permitted its brewers to produce a sufficient quantity of ale in winter and spring to supply their entire trade in summer. Naturally,

a. 1881	Month	Brewings	Month	Brewings	Month	Brewings
	January	22	May	2	September	22
	February	23	June	-	October	25
	March	30	July	-	November	26
	April	25	August	9	December	28
b. 1890	January	23	May	-	September	9
	February	22	June	-	October	24
	March	23	July	-	November	21
	April	15	August	1	December	19
c.1898	January	31	May	13	September	29
	February	28	June	32	October	30
	March	29	July	31	November	29
	April	25	August	31	December	28
d. 1908/9	June	28	October	27	February	11
	July	33	November	26	March	25
	August	30	December	25	April	27
	September	27	January	25	May	26

e.	Year	Number	Year	Number
	1881	35,616	1898	56,280
	1890	26,376*	1908/9	52,080

*The figure does not indicate a downward trend, only a single poor year, as 56,448 barrels were brewed the following year (1891).

Table 6. Number of Brewings (per month) in 1881 (a), 1890 (b), 1898 (c) and 1908/9 (d) and Number of barrels brewed, 1881, 1890, 1898 and 1908/9 (e).
Sources. SBTRO, DR 227/206-8.

this continued until the brewers perfected existing cooling methods or had no alternative but to brew during the warmest months of the year. Only in 1899 does the brewery appear to have regularly carried out successful summer brewings. Although noticeably fewer were undertaken in May, as many as 32 brewings were attempted in June; the journal does not list any complaints.

According to Dr BH Paul, a specialist in refrigeration technology, the brewing industry was remarkable, for `so little [had] been done in applying artificial refrigeration to brewing'.[107] Writing in 1869, Paul believed Flowers to be one of the few brewers, along with Messrs Truman, Hanbury, Buxton & Co, who used one of Siebe's ether machines, to take advantage of this technology in brewing;[108] most breweries first introduced this cooling apparatus to their hops warehouses.[109] Paul knew of ‘no other brewery where artificial refrigeration [was] practised'.[110] Younger's brewery, although the largest establishment in Edinburgh, brewed only in the autumn, winter and spring in the 1870s. Even in Burton, the centre of English brewing, production was 'almost completely shut down during the summer, the main brewing operations being carried on between the months of October and May'.[111] Among those breweries studied by Sigsworth, most confined their brewing season in the 1870s to cooler months.[112] During these years, however, many other breweries began to experiment with the latest refrigeration technology. According to the *Brewers' Journal*, between 1845 and 1881, it was becoming more common to brew in summer, though the journal continued to receive letters from brewers regarding the difficulties of brewing summer ales for at least another decade.[113] Ice importation at Guinness, for example, ended in 1867, when a mechanical refrigerator was installed in the brewery. By this date the firm began to brew Double Stout in the summer, though its head brewer, like Talbot, would have continued to brew in cooler months if demand had not been as high as it was.[114] Other firms, however, continued to take precautions. At the Carlsberg Brewery in Denmark, summer brewing became common only after 1881, when Emil Hansen improved methods for breeding pure yeast cultures to replace strains that had become infected by the wild strains which appeared with the warmer weather.[115] In England, moreover, seasonal variations at breweries had only grown more exaggerated in the late nineteenth century, as fewer firms brewed lighter table beers, required for quick consumption;[116] furthermore, although able to brew at all times of the year, most brewers continued to malt only six months of the year.[117] Nevertheless, many provincial breweries followed the example of their larger or more innovative rivals and also acquired the new cooling machinery, though many firms, like Flower & Sons, undoubtedly experienced technological difficulties of their own. For example, in 1892, 'after exhaustive trials of refrigerating machines', Messrs Combe & Company instructed J & E Hall

of Dartford 'to alter all their refrigerating machines for wort cooling to the carbonic anhydride system'.[118] Shortly afterwards, Truman, Hanbury, Buxton & Co. also contracted the Dartford engineers for a new refrigeration plant.[119] While others undoubtedly made some progress in these matters, the country's smallest brewers began to acquire the new refrigeration technology only in the 1890s as patents lapsed and prices became more affordable.[120] As a result, at the conclusion of the First World War, the cooling of worts was still regarded as 'a weak spot in most breweries'.[121]

Despite the difficulties faced by Flower & Sons when the firm attempted to introduce artificial refrigeration to brewing, this episode demonstrates considerable initiative and perseverance on behalf of individuals such as Charles Flower. The decision to introduce refrigeration technology to the brewery, and the experimentation which followed, do not appear the actions one would usually associate with a classically-trained entrepreneur, who appeared to have had more time for *belles-lettres* than business. The tendency to view nineteenth-century craftsmen and industrialists as uneducated, AE Musson argues, is the result of the historian's failure to understand the possibilities of self-education.[122] Facilities existed whereby the curious could familiarise themselves with developments in their fields of interest. Examples of self-educated industrialists demonstrate that scientific knowledge was more diffused through industry than previously thought. Although many attempted to analyse chemical processes far too complex for the chemical knowledge of the period, their efforts nevertheless were often scientific in the sense of being based on rationally ordered experiments.

Whether Charles Flower's education extended beyond simply attending presentations sponsored by the Institute of Brewing is difficult to determine. Other than a copy of Ure's *Dictionary of Arts* (1853), which contains an exhaustive chapter on brewing, and some works on electricity, Charles Flower's library contained primarily travel literature and the complete works of William Shakespeare.[123] Had he been interested, however, other options existed.

At this time, universities and colleges were beginning to establish courses that offered training in chemistry as it related to brewing. Often these comprised presentations such as Charles Graham's Cantor lectures, which were delivered before the Society of Arts in 1873 and 1874. Such events, however, frequently became more regular activities; Graham's lectures on the chemistry of brewing at University College, London, began in 1878 and ended in 1889, at which time instruction at various other institutions had commenced. For example, several lectures on the scientific principles involved in brewing were given throughout the 1880s by Dr George Tate at the Liverpool College of Chemistry and at Mason's College in Birmingham in the 1890s.[124] Nevertheless, while countries

such as Germany and Belgium were establishing schools for brewing, in England, brewing knowledge was still conveyed primarily through chemistry departments at colleges and universities. Chemists within the industry recognised the need for a well-equipped brewing school or college; this was made only more obvious when such institutions began to appear on the Continent. To the disgust of the *Brewers' Journal's* editors in 1883, several of whom were trained chemists, even 'barbaric Russia [had] its richly endowed school'.[125]

At the beginning of the present century the system of brewers' instruction changed as interests in technical education increased. As the result of brewers' own efforts, the British School of Brewing and Malting was established in Birmingham in 1900; Horace Brown's half-brother, Adrian, formerly chemist to Messrs Salt & Co Ltd in Burton (1873-99), held its first chair of brewing and malting. It has been suggested that, by 1902, it was overwhelmed with students.[126] Those who taught at these institutions, however, claimed they were teaching the practical, not the scientific aspects of the trade. It has also been recognised that most firms did not recruit from these institutions,[127] though some brewers, such as Mitchells & Butlers and Guinness each employed six of the school's graduates a decade after it was founded.[128] As science did not immediately entail success for the brewer trained in modern chemistry, training was discouraged even more. Charles More has demonstrated that, even if technical education were pursued, promotion was not automatically guaranteed.[129] Advancement often depended on other criteria. Consequently, science would have to be introduced at the average brewery in other ways.

Many chemists, however, were joining brewery staffs. Most of those hired, as in the past, were employed in the Burton breweries.[130] Horace Brown had spent many productive years introducing science to Worthington's brewing process; his colleague, Dr Griess, was similarly employed at Allsopp & Sons during this period.[131] Cornelius O'Sullivan, a recipient of the Longstaff Medal, presented by the Chemical Society to the individual who presented them with the best original research over a period of three years, completed much of his research while employed by Bass & Co., which he joined in 1863.[132] Frank Faulkner, a long-time editor to the *Brewers' Journal*, and the author of *The Art of Brewing*, was appointed consulting brewer to the Beeston Brewery Company, near Nottingham, in 1882, before opening his own offices in Edgbaston, Birmingham.[133]

Sometimes, brewers themselves had had opportunities to study the chemistry of brewing. JM Green left hat manufacturing to study under the celebrated Professor Graham, before entering the brewing trade.[134] Another of Graham's students was George W Bindloss, who later became JW Green's head brewer at

Luton.[135] No evidence relating to the education of Flower and Sons' brewer, Francis Lawrence Talbot, exists. Nevertheless, the fact that he was succeeded as head brewer by his nephew, Graham Talbot, named after Thomas Graham, ‘the father of colloid chemistry',[136] suggests a certain amount of respect for the scientific developments of the day.[137] We can, however, be more certain about the qualifications of another Flower employee, Joseph O'Connor. A native of London, who joined the Flower firm in 1889, O'Connor listed himself as a brewer and analytical chemist in the 1891 Census. While his exact duties are unknown, an entry for 3 March 1891 in the firm's rough minute book indicates that a board consisting of Edgar Flower, Archie Flower and Stephen Moore resolved that Mr O'Connor be allowed to take some pupils in chemistry, 'each subject to the Firm's approval', and the fees paid by such pupils to be equally divided between O'Connor and the brewery.[138] O'Connor, however, left the firm less than a decade later.

Few breweries were run on lines which necessitated the hire of a salaried, professional chemist. Moreover, evidence suggests it was not usual for a head brewer to have a chemist's degree.[139] Most firms appear to have required, or at least paid for, scientific advice only intermittently. Not surprisingly, government legislation often triggered periods of rationalisation and experimentation. The imposition of a beer duty in 1880, as opposed to a malt tax and sugar duties, is an event credited with having taught many brewers their business. The Beer Act's passage gave brewers what has been since referred to as the 'free mash tun', and, by not restricting the materials they used, the incentive, already granted their Continental counterparts, to experiment. A contributor to the *Country Brewers' Gazette* was one of many who argued the political decree would stimulate inquiry and research. In an article, 'Beer of the Future', he suggests that, prior to the introduction of this legislation, 'only the most elementary attempts were made to study the chemical details and the scientific side of brewing'.[140] Not all brewers, however, jumped at this opportunity to experiment.

In a number of cases, rather than stimulate investigation, the Beer Act forced brewers out of business. According to the new legislation, the brewer was to submit details of the produce or yield of each of his brewing operations to the Inland Revenue. Many found themselves unable to provide details relating to the specific gravity of their beer in the books provided by taxation officers, for they had not procured a saccharometer or hydrometer.[141] Many who did purchase these instruments had not become acquainted with their use, nor did they pay attention to the `proper mixing and rousing of the worts', so as to secure a true average gravity.[142] For years after the Act's passage brewing journals attempted to instruct brewers in ways to determine a beer's specific gravity. Often a month after the method was described

in detail, journals continued to receive letters on the same subject from perplexed brewers. In this respect, the rationalisation of the brewing industry may have had a great deal to do with the disappearance of those firms not able to satisfy the demands of such legislative acts, and less with the general spread of knowledge throughout the trade.

The introduction of the 1880 Beer Act caused considerable panic at Flower & Sons. Immediately, the firm wrote a letter to the Inland Revenue claiming it 'would seriously interfere with [their] process of brewing'.[143] They believed this legislation made it almost impossible for them to brew beer of the 'same class'.[144] Rather than finding it suited to scientifically-run breweries, the directors believed the Act was in harmony with the 'old fashioned brewery of 40 or 50 years ago'.[145]

Nevertheless, Flowers had no option but to reorganise their brewing process so as to satisfy government regulations. It was a process which began with the decision to correspond with another brewery. Perhaps due to the fact that Flowers had previously been contracted by Courage to brew pale ale, the firm decided to breach their unofficial policy of secrecy and correspond with their rival. The result was a letter from Charles Flower to Courage's head brewer to inquire about their methods of mashing and glucose extraction. Flower concluded with an invitation to Stratford to see the brewery 'and everything of interest in connection with Shakespeare'.[146] Whether this offer was accepted is not recorded. In January 1881, Flower began another correspondence, this time with a German brewer, whose ideas on mashing were the 'best he [had] seen on paper'.[147] Although Flower had many questions relating to the mashing and grinding of malt after reading his correspondent's suggestions, he was 'satisfied that great improvements [would] be made upon our old English methods.'[148] Four months later, Flower & Sons' head brewer wrote to the Inland Revenue regarding some experiments with caramel. More specifically, he wanted to know the conditions which regulated its use. By September, experiments continued, only now the firm had acquired a mashing plant design by Emil Welz of Breslau, Germany and mashed according to German methods. Apparently, the machine was a success, for, six months later, Flowers ordered another.

An example such as this demonstrates the way in which a firm learns not only from its own research. Moreover, it implies that the exploitation of discoveries made during this period did not necessitate the construction of laboratories, something many of the smallest breweries could not afford, and others did not regard as worthwhile investments. Moreover, as brewing became less seasonal, few chemists even desired to remain at breweries, for such developments radically diminished opportunities to carry out their own research. In most cases, year-round brewing essentially left chemists as production managers who

periodically assessed the quality of raw materials. A number abandoned their posts at breweries.[149] Nevertheless, firms had alternatives.

Chris Freeman has pointed out that often a firm acquires information through a process of interactive learning.[150] The services provided by rivals or foreign competitors could be ways of gaining access to scientifically-advanced methods and up-to-date technology. In an article in which he examines the relationship between science and industry, David Edgerton suggests businessmen seeking scientific knowledge had many alternatives; collaboration in research and development was just one of them.[151] Rather than undertake costly research themselves, many breweries used the services of companies that specialised in carrying out standardized, routine activities. At times, even their suppliers provided breweries with considerable product information. When attempting to discover the role of science in industry, the part played by all forms of research organisation must be determined. Given that a laissez-faire stance characterised the government's policy towards science at this time,[152] it is not surprising that brewers had numerous options other than simply to carry out research independently. For example, the Institute of Brewing, from its establishment in 1890, conducted considerable research on behalf of its members; its forerunner, the Laboratory Club, provided a similar function when founded four years earlier by J Danvers Powers and Edward Ralph Moritz.[153] Within a few years branches had formed in the north of England (1891), Yorkshire (1893) and the Midlands (1894).[154]

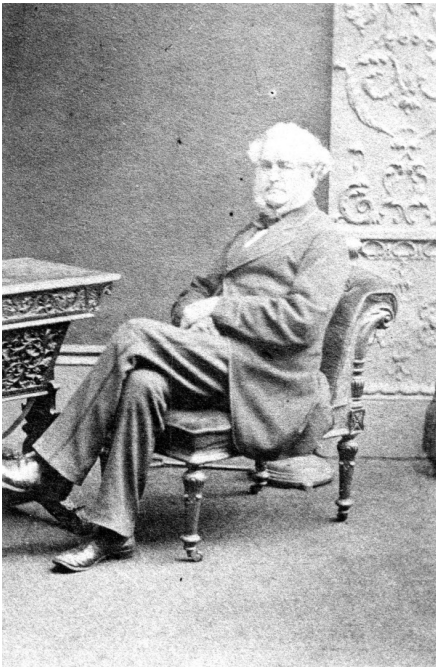

Figure 7. Frederick Kendall, c.1870. SBTRO, Photo File: Kendall.

Trade associations, such as the Institute of Brewing, organised members locally, though all branches merged under a Central Council (established in 1895) in 1903.[155] Members met regularly to discuss the trade and were entitled to journals published by the society. Besides the state of the trade, publications dealt with brewing issues, such as

government legislation, bankruptcies and the prices of grain, but also presented the latest scientific discoveries, technological advances and even some administrative approaches to running a business. Journals, such as the *Country Brewers' Gazette*, were almost entirely concerned with the scientific side of brewing. Furthermore, members of the Country Brewers' Society in the 1860s and 70s were entitled to the advice of 'an eminent chemist', Dugald Campbell, free of charge.[156] Established in 1822, its members used the society as a forum in which to discuss their main concerns, especially when they first set up their breweries, or introduced new technological processes.

Flower & Sons benefited greatly from the activities carried out by such organisations. The firm's directors were members of the Institute of Brewing, the Country Brewers' Society and the Licensed Victuallers' Association. Not only did family members and managers attend presentations, but they often chaired society meetings. On one such occasion in October 1885, Charles Flower chaired an event organised by the Institute of Brewing at which Bedo Hobbs presented a paper entitled 'The Chemistry of Brewing'. Hobbs's paper was very advanced when compared with the works of his contemporaries and provided brewers with advice on how to improve production methods using science as a guide. It remains exceedingly difficult, however, to determine the lessons with which brewers, such as Charles Flower, would leave such presentations. It is easy to tell from notes made on his copy of Hobbs's lecture that Flower did not learn 'how to brew good beer with bad materials'.[157] Another comment suggests Flower saw a place for scientists in the brewing industry: 'I don't think we can do without the Chemist'. Unfortunately, he does not elaborate on the specific role he had in mind.

Recent work on the spirits industry has revealed the importance of scientific consultants during periods of intense research and development. In his history of the Distillers Company, Ronald Weir suggests independent consultants regularly approached firms with proposals to rationalise the production process. In the case of the Distillers Company Ltd, a chemist, Dr Squire, approached the firm's managers with a proposal to improve the consistency of their yeast, the quality of which was recognised as essential to food production.[158]

The consultant chemist also appears to have been an important member of the brewing community. An obituary in the *Brewers' Journal* dated 20 October 1866 lends this idea some weight. The journal's writers reported the death of Mr MH Cowell of London, a well-known chemist, as 'many brewers [had] engaged his services';[159] apparently, judging from the firm's ledgers, Flowers did not.

The events which followed the introduction of the Beer Act (1880), however, demonstrate the ways in which the firm

relied on consultants. After conducting some of their own experiments, Flowers simply adopted a German method of mashing and introduced changes to production under the guidance of the system's inventors. Experiments, however, did not cease and, presumably, were not very successful. After many more letters to the Inland Revenue regarding the materials which brewers were permitted to use, Flower & Sons finally hired the services of Horace Brown to make four trips to the brewery over a period of twelve months and, for a fee of £100, advise on brewing and malting. In 1901, the firm used the services of another London chemist after a number of people in Lancashire had been poisoned by beer which had been contaminated with arsenic. This time they contacted Dr G Harris Morris, a frequent collaborator of both Brown and Moritz and lecturer on technical bacteriology at the Jenner Institute of Preventative Medicine,[160] to inquire about the use of coal when drying malt.[161] Flower & Sons' head brewer, Francis Talbot, informed Morris that the brewery intended to abandon coke and replace it with anthracite. However, they were hesitant about this change, for they still had a considerable stock of coke. The use of coke would be immediately halted only if it proved to be hazardous to those consuming Flowers' ale. Consequently, the firm requested Morris to test the malt samples they sent him for arsenic.

Some chemists were consulted more regularly. Flower & Sons' accounts reveal that they frequently relied on materials supplied by Kendall & Son, Stratford's brewers' chemists. Although not all of Frederick Kendall's customers were brewers, the firm's growth closely followed events in the brewing industry, and particularly developments at Flower & Sons. As cleanliness was a primary concern of brewers in the 1860s and 70s, the firm was almost entirely concerned with the production of sulphites and bisulphites of lime in its early years. Gradually, as government control over brewing ingredients relaxed, other articles, notably flaked malt, caramels and other black sugars, and, later, nonfermentable copper sugars and primings were added to the list of materials they produced and distributed. Naturally, as Flowers' trade grew, so did Kendall's. By 1890, the chemists had opened their London offices at 59 Mark Lane, near the Corn Exchange, and displayed their wide range of products yearly at the Brewers' Exhibition.[162] Significantly, a few decades after Flower & Sons built their new brewery, some of the buildings which had comprised their old site were purchased by Kendall. Not long afterwards, Frederick Kendall's trade grew to include that of breweries located throughout England. While analytical work was an important component of the brewers' chemist's business, it became even more lucrative, especially after the arsenic scare which affected the brewing trade in 1900, the same episode which had inspired Flower & Sons to contact G Harris Morris. While the firm had analysed the water sources of many for-

Alton Court Brewery Co. Ltd, Ross-on-Wye, Herefordshire
Ansells Brewery Ltd, Aston, Birmingham
Ashton Gate Brewery Co. Ltd, Bedminster, Bristol
Bath Brewery (Oakhill Brewery Co. Ltd ?)
W H Brakspear & Sons Ltd, Henley, Oxfordshire
Bristol United Breweries Ltd
Brown & Co., Shakespeare Brewery, Redditch
Cheltenham Original Brewery Co. Ltd
City Brewery, Lichfield
Courage & Co. Brewery
J Davenport & Sons Brewery Ltd, Birmingham
J Elworthy Ltd, Steam Brewery, Kettering
Flower & Sons Brewery, Stratford
E K & H Fordham, Ashwell Brewery, Nr Baldock
Frome United Breweries
Gibbs, Mew & Co. Ltd, Salisbury, Wiltshire
Duncan Gilmour & Co., Ladybridge Brewery, Sheffield
Hickman & Pullen Brewery, Wednesbury
Highgate-Walsall Brewery Co. Ltd, Walsall
Holt Bros Brewery, Burnham-on-Sea, Somerset
Hook Norton Brewery Co. Ltd
Hunt Edmunds & Co. Ltd, Banbury
Lichfield Brewery Co. Ltd
Lion Brewery Ltd, Chippenham, Wiltshire
Lockwoods Brewery Co., Northfield, Birmingham
Mitchells & Butlers Ltd, Birmingham
E E Palmer, Donnington Brewery, Newbury
P Phipps & Co. Ltd, Northampton
Portsmouth United Breweries
Rock Brewery Ltd, Brighton
Royal Well Brewery Co., Malvern
Smithers & Sons Ltd, North St Brewery, Brighton

Table 7. Kendall & Son's Customers, 1900-14 as recorded in the firm's sales ledgers. Sources: SBTRO, DR 197/12-3

eign breweries, and a handful of domestic ones, its list of customers grew to include a number of important midland breweries in the first decade of this century (see Table 7). Besides testing the purity of water samples, Kendall & Son advised and sold brewers the salts necessary to either harden or soften a supply;[163] this naturally added substantially to their permanent trade. Finally, occasionally the firm sent representatives to breweries to suggest ways in which brewing plants could be run more scientifically. Evidence in surviving reports demonstrates that many breweries had failed to modernise brewing methods in the last decades of the nineteenth century. Wooden vessels were still used until nearly rotten, wild yeasts were prevalent in material samples and the simplest rules of cleanliness were often overlooked in many small firms.[164] Consequently, chemists' most popular products remained those which they first manufactured. With the help of sulphites, which were introduced to finished beer in order to kill any bacteria, even the most negligent of Kendall's clients continued to brew in run-down plants. Marketed as Universal Preservative, Kalissaline, or Phylax, among a host of other carefully-protected brand names, these products

were produced by numerous chemists and purchased by hundreds of brewers. London's A Boake & Company, for example, besides being Kendall's greatest rival, sold their preservative, Kalium Meta Sulphite, generally known as KMS, to Ratcliffe, Ind Coope, Lewes and Saville Bros., among many other firms.[165]

The influence of chemists, such as Kendall & Son, was far from negligible. Over several decades its staff had done much to modernise brewers' practices. When Frederick Kendall, the firm's founder, died in 1883, an obituary, similar to that of Cowell, appeared in the *Country Brewers' Gazette*. He was described as 'one of the first men to make a practical study of chemistry as useful to brewers'.[166] All of the journal's readers were presumed to have known 'the success he achieved'.[167] Even greater, however, was that achieved by the chief of the firm's laboratory department, Reginald E Evans, who joined the firm in 1889, after completing his studies at the Finsbury Institute, and eventually became Kendall & Son's director in 1906. In an obituary published soon after his untimely death in 1913 at the age of 42, members of the Institute of Brewing suggested that 'few men, in the brief space of about 20 years, have made more useful and suggestive contributions to our knowledge'.[168] No doubt, Flower & Sons benefited greatly by the work carried out in Stratford under Evans's guidance.

It is not surprising that such consultants should have played an important role in the brewing industry. In many ways it is too great an expectation that brewers could have kept up with rapid developments in chemistry when they practised their trade on a day-to-day basis. Rarely were brewers even permitted to read scientific articles at work; many repeatedly demanded the study of such periodicals be considered part of their work.[169] Moreover, while early articles on fermentation were very accessible to the lay reader, as scientific knowledge accumulated, works written by professional chemists became increasingly more esoteric. Frank Faulkner provided brewers with a vernacular edition of Pasteur's work, but few chemists catered to members of the trade in this fashion. By the end of the nineteenth century, it was generally acknowledged that a brewer required a year or two of study in order to understand the chemistry of brewing;[170] few could afford the time away from the trade. While many brewers recognised the close bond which linked chemists with themselves, the majority laboured with 'the voluminous character of scientific literature'.[171] In a lecture to a branch of the Institute of Brewing in 1885, Bedo Hobbs listed the things which he believed all brewers were to learn:

> He must begin with a little elementary chemistry; learn the meaning of the technical terms, an element, an atom, a molecule, a compound, a combining equivalent, a monad, dyad, &c.; commit to memory the chemical symbols, atomic weights, and combined equivalents of the elements and the class to which they belong; the chemical symbols of

the acids, bases, and compounds commonly met with in brewer's analytical work, their character, and the qualitative tests for their presence. He must acquire some knowledge of the affinity or combining power of different bodies, and especially of the splitting up of carbohydrates and other bodies into their hydration or oxidation products ... Having got thus far through the drudgery and elementary part, he may commence the interesting work of analysis, beginning with a series of waters, which he splits up into their organic and inorganic constituents, and these again into their respective component parts.[172]

Hobbs's list was exhaustive. It is not surprising that Charles Flower left this lecture convinced of his need for a chemist. Rarely did brewers achieve this level of familiarity with the principles of chemistry; fifteen years after this list was compiled, Flowers was still unable to test for arsenic in malt samples. Nor is it surprising that the trade's initial response did not foster the sharing of information. The difficulties some brewers faced when acquiring such knowledge led to a period of increased secrecy, particularly when consultants had been paid relatively large fees to conduct much-needed research.[173]

Almost all of Flower & Sons' correspondence of a technical or scientific nature was conducted in secrecy. In a letter to Thomas Wolfe, a director of the Liverpool firm Blood, Wolfe & Son, one of the brewery's more important customers, Charles Flower described experiments in bottling and shipping carried out by the brewery. After a lengthy discussion of the ways in which they had attempted to control secondary fermentations, Flower suggests the subject be ‘confined to the numbers in [Wolfe's] firm for many of our largest opponents are more in the dark than ourselves'.[174] Furthermore, in a lengthy letter to the Revenue which lists the ways in which the Beer Act affected brewing in Stratford, Charles Flower describes the firm's brewing procedures in considerable detail. Consequently, before commencing to outline their system of brewing, Flower reminds the local officer that the information contained in the letter is ‘intended for the excise and not other brewers'.[175] Any disclosure of knowledge depended on a payment, for it was often the result of long and painful experiment'.[176]

Interestingly, few historians have questioned the ability of brewers themselves to experiment. Even if firms were receptive to scientific advances, the nature of the brewer's business environment was in many ways not conducive to experimentation. For example, it can be argued that scientific methods are in many ways incompatible with the notion of an open and competitive market. As already mentioned in the introduction to this chapter, brewers had been able to produce an attractive product for centuries. Their greatest difficulty, however, had been to do this consistently.

The implementation of scientific methods to a process, such as brewing, requires that raw materials vary as little as possible, or at least remain constant for a

period of time, particularly during periods of experimentation; in order to experiment, variables must be controlled. Were this not the case, a brewer would have had very little chance of identifying the causes of variations between brews. These ideas were perhaps best summed up by Horace Brown when reflecting on these key years of scientific discovery:

> If the brewer were always working under exactly constant conditions as regards the intensity of infection it would be comparatively easy to obtain a qualified answer to these questions, but [the] very factor of infection may perhaps be altering from week to week and from month to month, and, as a rule, he has no criterion of the extent of the variation. Hence, when he looks back on a year's average results, he is apt to attribute any shortcomings to some occult and hypothetical seasonal differences in his material, tending towards instability, whilst the real determining cause in all probability is some undiscovered centre of infection in his brewing plant, etc.[177]

As Brown suggests, brewing journals reveal some of these variations in the brewery. Besides various centres of infection, the raw materials comprising a brewer's inventory fluctuated with prices on the open market. Although stored separately, barley, sugar and hops all varied from one brew to the next. When a barley supplier changed, often so did those of sugar and hops. Furthermore, unlike firms, such as Steward & Patteson, who brewed using only English barley throughout this period, Flower & Sons brewed with malt made from barley grown in numerous countries, Tunisia, Algeria and Palestine, to name a few, in an endless array of soils and fertilizers under various climatic conditions. Since Algerian malt, for example, sold for approximately 32s. per quarter in 1881, it was preferred over domestic varieties which sold for 42s. or 43s.[178] As a result, although some breweries made the use of barley a patriotic issue, the use of foreign malt increased by 30% in 1883 alone.[179] Although entries in brewing journals reveal brewers regularly used tools such as the thermometer and saccharometer, constantly changing materials would have made it extremely difficult for a brewer to determine reasons for any variation between brews. While some of Flower & Sons' customers may have received beer of a consistently good standard, the firm's brewing journals reveal great fluctuations in quality. If the brewers had not regularly reserved the best brews for favoured buyers, such as Blood, Wolfe & Co, customers would have noticed the same great variations which are recorded in most brewers' journals for this period. Not surprisingly, a generation later, brewers still conceded that ‘no two beers are identical'.[180]

The scientific revolution associated with the experiments carried out by Pasteur during the middle of the nineteenth century does not appear to have radically changed the practice of brewing in Stratford between 1870 and 1914. Although brewers began to adopt many of the tools used by professional chemists, this did not inspire a similar

revolution in the brewing trade. Few brewers wished, or believed they could afford, to turn their breweries into laboratories. Many, however, went on to spend considerably more than the £100 which the *Brewers' Journal* estimated to be the cost of a laboratory suited to the needs of a brewer. Moreover, those who did make the necessary investments often did not follow the systematic, scientific methods required to gain greater control of the brewing process. Instead, most brewers relied on brewing societies or, more commonly, the expertise of consultants in order to incorporate scientific principles into a particular stage of production.

The real revolution in the trade appears to have been linked more closely with technology. Usually regarded as unremarkable in terms of innovations, the period from 1870 to 1914 saw brewing in Stratford change from a seasonal occupation into a trade which was conducted all the year round. While the introduction of refrigeration technology to the brewing industry is generally argued to have occurred during an earlier period, this appears to be the result of dating production change from the moment a firm purchased such technology. Moreover, successful summer brewing was an issue that was very closely tied to a better understanding of fermentation. Prior to the 1880s, many brewers were still in the dark when it came to understanding the dangers of summer brewing. As a result, although refrigeration technology permitted firms to brew all the year round, Flower & Sons still produced most of its beer between October and April until the last decade of the nineteenth century. Although suitable technology was purchased by the firm much earlier, brewing was not yet free from the influences of climate and wild yeasts. Given that the firm was often described as a leader in the field of refrigeration, perhaps the industry in general still had a way to go before it had sufficiently modernised and technological innovations had been accommodated to the production process in a way that would bring about a complete transformation in the organisation of the brewing trade.

Chapter 3: The recruitment and training of workers

Although nineteenth-century gentlemen entrepreneurs like Charles Flower scarcely received any formal scientific or technical education, few assumed positions of responsibility within their firms without having learned the practical side of brewing; a good manager had to have a knowledge of all the trade's branches. Moreover, the rudimentary training given to individuals such as Flower, despite its imperfect arrangement, frequently evolved into a more systematic form of instruction used to train successive generations of brewers and managers. By the last decade of the nineteenth century, Flower & Sons, among other mid-sized provincial breweries, was well known throughout the country for the training they offered young, prospective brewers. Successful applicants were

given the opportunity to learn all branches of the brewing trade over a period of two years. Since many brewers employed traditional craftsmen, such as coopers, maltsters and even joiners, breweries continued to instruct many tradesmen as well. Moreover, brewers' apprentices working alongside these artisans acquired a thorough knowledge of the industry's many branches. As a result of such comprehensive training schemes, pupils who successfully completed a formal brewing apprenticeship became natural managerial candidates.

Despite the high levels of instruction these young men received, they were a privileged elite. Most workers employed at Flower & Sons between 1870 and 1914 received very little training. The majority comprised rural labourers and were recruited by the firm soon after they drifted into Stratford from nearby agricultural districts. Once employed at the brewery these workers learned by 'picking up', namely, learning by doing; few received any systematic instruction.

Brewery workers' skills were clearly linked to methods of recruitment. Labour recruitment determines the skills at a firm's disposal before any training is actually given. If a worker was not hired for his particular skills, these may still have been used by the firm to determine his immediate duties. Many nineteenth-century managers concentrated on recruiting previously-trained workers not only to acquire these transferable skills, but to reduce their firms' training costs.[1] However practical, this practice did not become universal. Depending on specific circumstances and strategies, many firms continued to recruit and train relatively young and inexperienced workers to ensure they had the skills to meet their particular production requirements and would conform to existing business conditions. This is just one way managers have attempted to create loyal, stable workforces. Nevertheless, despite management's wishes, any recruitment scheme requires time to develop, and inevitably changes as a business grows, diversifies and adjusts according to variations in the economic environment.

By 1870, Flowers was Stratford's largest employer. The completion of a new brewery ensured the production of ever-increasing amounts of ale and stimulated an increase in its labour force. By diversifying into the wine and spirits trade and exploiting markets for brewing by-products, such as yeast, spent grains and even horse manure, many more opportunities existed for local residents to acquire part-time positions, many of which would become permanent in the future. Furthermore, numerous entry-level posts were being created as, for example, the number of malt houses increased and the distribution side of the business grew as the firm explored new markets.

Many vacancies were filled by relatives of workers already employed at the brewery. Historians and social scientists have frequently pointed out that, right into the

twentieth century, it was common for sons to choose the same careers as their fathers.[2] Given the importance of references and the standard letter of recommendation to nineteenth-century businesses, many employers relied on responsible, hardworking and, especially, long-term employees when recruiting. Furthermore, given the late development of labour exchanges and Juvenile Advisory Committees, youths received pro-portionately more career advice from parents and relatives than would post-World War One generations.[3] As a result, many boys chose those employments with which they were most familiar.[4]

In recent years this specific form of recruitment has been recognised as one which was practised extensively at breweries. Rarely do brewing historians not stress the association of local families over several generations with a particular, usually provincial, firm. In a history of brewing in Warwickshire, when discussing events at Flower & Sons, Ken Flint reinforces this characteristic by arguing that jobs at the brewery passed from father to son. As evidence, Flint describes not only the way in which managerial positions were usually filled by members of the Flower family, but the way in which Graham Talbot succeeded his uncle, Francis Lawrence, as head brewer.[5] Given head brewers' and managers' generous salaries, it is hardly surprising that some employees secured these posts for relatives. It would be unwise, however, to conclude an investigation into this phenomenon before examining the experiences of workers employed in the trade's other departments. While the former premise is supported by evidence relating to those individuals who held the most desirable positions in the brewery, very little research has focused on general brewery labourers.

Contemporary oral testimony suggests three generations of some local families were regularly employed at Flower & Sons. Although such evidence corresponds with existing archival material, this became common only at the turn of the century. While the firm's board of directors, after its formation in 1888, always comprised at least two members of the Flower family, Francis Talbot appears to have been the only brewer at the firm who managed to secure his position for a family member upon reaching retirement age. Moreover, although two or more members of local families, such as the Savages, Unitts and Wagstaffs, are frequently listed in the brewery's wage books at the beginning of this century, this was not the norm between 1870 and 1914.

According to nineteenth-century census returns, very few Stratford sons followed their fathers into the brewing trade. As stated in the 1871 returns, of nine boys either employed by the brewery or the sons of employees, and living with their parents the night of the enumeration, none shared the same employment as his father. Of the group, John O Gray, a brewery labourer, most closely pursued

the career of his father, an agent at the 'Horse and Jockey', the sole pub owned by Mitchells & Butlers in Stratford. The fathers of boys employed by the brewery include a blacksmith, tin-plate worker, gas-works labourer, chemist, clerk in a solicitor's office and a veterinary surgeon. John Gibbs and Samuel Knight, the two remaining sons of brewery labourers listed in the census, gave their occupations as a carpenter's apprentice and letter carrier, respectively.

Over the next two decades, the pattern changed only slightly. Of 21 boys living with their parents at the time of the 1881 census, six, like their fathers, were employed at the brewery. In the majority of cases, most directly emulated their fathers and became brewery labourers. Only one regular labourer, Frederick George Baker, was the son of a cooper. The remaining father and son, Andrew and Clifford Beesley, were both listed as brewers, though they probably worked in the capacity of underbrewers, or brewers' assistants. By 1891, the number of boys who followed their fathers into the brewing trade had increased to nine. Interestingly, approximately half were coopers, the brewery's highest paid manual labourers; traditionally, many more sons followed their fathers into this particular trade.[6] Although the number of fathers and sons in brewing increased, proportionately fewer young men than in the previous decade desired the employment of their fathers; 36 of the 45 boys comprising the sample (80%) chose different occupations.

The extent to which workers relied on other or more distant relatives in order to procure employment at the brewery is more difficult to trace. Evidence, however, suggests that occasionally brothers were employed at the brewery. At times as many as five sets can be found in the firm's registers. Some, such as Philip and Arthur Fagge, over decades rose to become senior agents with the firm. While kinship in the case of brothers can be proven by tracing individuals through census material to the same household, complex family trees are more difficult to reconstruct for an entire brewery. Certainly some individuals used highly convoluted networks in order to acquire a particularly desirable post. Proving the use of these networks, however, is especially difficult given the incomplete nature of sources. Moreover, the fact that some individuals become kin after having obtained employment creates additional confusion. What is clear from a general survey of census material relating to Stratford, however, is that, by the end of the nineteenth century, few young men followed their fathers into the local brewery's service.

Even if more boys wished to imitate their fathers' career choices, it was not always easy for young men to procure employment at breweries. In an article outlining brewery management practices published in the *Journal of the Federated Institutes of Brewing* in 1895, Arthur Hartley claims brewers were prejudiced against boy labour.[7] Alternatively, in his memoirs, *Seventy Rolling Years*, Sydney

Nevile, President of the Institute of Brewing (1919-21) and Chairman of the Brewers' Society (1938-40), thought youth to have been his 'special asset' when first seeking employment in the industry.[8] Nevile, however, also realised that, although his first employer considered the early training of a brewer as beneficial, few in the trade at the time did. Scarce any positions at breweries in 1880 were offered to young boys. To take one example of many, Gartsides Brookside Brewery did not employ a single child in this particular decade.[9] Most provincial brewers, like Flowers, took only two apprentices at a time. In addition, a few boys were hired to help feed draymen's horses; some boys arrived at the brewery as early as five in the morning to perform this task. Three or four remained for the remainder of the day to run errands, only a couple being kept on well into the evenings to take horses into the fields adjoining the brewery to graze as draymen returned from their daily rounds.[10] In 1890, the brewery, in a report to the factory inspectors, listed only six employees under the age of eighteen.[11] More frequently, children were employed for short durations to carry out special seasonal tasks, such as kiln-pricking. Usually in the summer and under the supervision of an older maltster, boys, sometimes two dozen, armed with wooden-handled spikes removed the grains which lodged in the perforated tiles that lined a portion of the floors in brewery maltings.[12] Earning 5s. a week, some of these boys returned in consecutive summers and eventually secured themselves full-time employment at the brewery.[13] In general, however, due to the physical nature of brewery labour, recruits tended to be older and, more importantly, stronger.

Most boys who entered the brewery's service were employed in less labour-intensive office tasks. Almost every senior clerk had at least one young assistant. Moreover, the firm generated a considerable amount of paperwork which usually needed to be copied into ledgers, a task generally assigned to the youngest clerks. Locals have suggested, however, that these situations were not filled indiscriminately, as even these lowly office jobs usually led to more responsible positions. Over the years entry-level office posts remained the preserve of grammar school boys.[14] Some exceptions, such as Eddie Booker, who was hired in the cask office in 1917, suggest this was more imagined than real. In the decades since 1870, however, his appointment appears to have been an anomaly. Interestingly, the prevalence of boys in the office ensured a healthy promotional system; this was not always the case in the brewery. Only with the commencement of bottling in the last decade of the nineteenth century were boys, irrespective of their education, regularly provided opportunities to join the firm, though many brewers continued to regard boy labour as ‘uneconomical'.[15]

Even after brewers began to hire boys in order to staff their bottling departments, the average age of their workers had tra-

ditionally been higher than those recorded for most other occupations. In his survey of London labour, Charles Booth reveals evidence that suggests the average brewery worker was approximately 30 years of age, while the average labourer in his survey was approximately twenty.[16] Furthermore, he attributes this to the fact that strength was valued over skill in many of London's breweries. As evidence he suggests few workers in his survey were over the age of 60. The average age of the 80 Flowers employees listed in the 1871 census is approximately 32. If clerks, traditionally younger than other brewery workers, are excluded from this sample, the average approaches 34 years. In 1881, the workforce grew even older. The average age of 147 brewery employees listed in the census exceeds 35 years.[17] A decade later the group gained 20 workers, and their average age increased by yet another year.

Given the limited number of boys recruited to the brewery, even after production increased in 1870, the firm relied on other sources of labour to meet the needs of expansion. Many workers who joined Flower & Sons during the last decades of the nineteenth century were either young adults who migrated into Stratford from its surrounding agricultural communities, or were recruited from other local businesses or more remote breweries. While considerable numbers approached the firm, a phenomenon which allowed foremen to draw up waiting lists of prospective employees, managers sought their senior employees more directly.[18]

In the last decades of the nineteenth century, the populations of many rural parishes near Stratford began to decline. In census returns for the period, individuals aged 25 to 35 years comprise one of the smallest age cohorts in these parishes. While a steady flow of migrants had always come to the town in earlier centuries, many more young adults at the end of the last century sought out non-agricultural occupations. By the 1880s, farmers in parishes such as Welford, Long Marston and Pebworth, although devoted to cultivating the soil decades earlier, converted much of the county's land to pasture and, as a result, intensively farmed only a fraction of their properties by 1916.[19] Many farmers managed their estates with minimal help, at times limited to that provided by their own children.

Most brewery employees can be traced in local census returns. Not surprisingly, many were not born in Stratford, but in nearby rural parishes. Moreover, many who settled in Stratford were first employed in the brewery's stables and maltings, where they performed tasks familiar to their rural colleagues and certainly more suited to the skills which they brought to the trade. Others, however, had long since left rural occupations and, in the process, learned non-agricultural skills; some had never worked outside the town.

Although oral evidence from Stratford's residents suggests employers informally agreed not to poach each other's work-

ers,[20] the brewery did, in fact, acquire many workers from local firms and even attracted some from distant breweries. Throughout the last decades of the nineteenth century, given the reluctance of many businesses to internalise methods of training, workers were often recruited from other firms where they learned basic rules of accounting, or practical managerial skills. Although some maltsters had been lured from Stratford's many independent malt houses, generally only supervisory posts were filled in this way. Very regularly, the brewery acquired clerks and even branch managers from banks and insurance offices. Foremen often came from other breweries, most having come to Flowers from Burton. Correspondence preserved in the firm's letter books reveals several employees' previous occupations in great detail. For example, in 1874, Charles Flower wrote to Frederick Kendall regarding the employment of Mr Parker as a subordinate accounting clerk.[21] The brewery received a favourable reply; Kendall attested to his employee's good character, behaviour and employment record, but, as was usual in such cases, the letter expresses disappointment, for most applicants did not inform their employers that they were seeking new posts.

Although having frequently played the role of the poacher, Flower & Sons lost several employees in a similar fashion. Workers who left the brewery, but remained in Stratford, frequently went to Kendall & Son, the town gas works, the police force, or one of the local brickyards.[22] Those forsaking office posts between 1870 and 1914 include a clerk who went to Kendalls, more-distant transfers to King's Heath Brewery and 'Reading bank' and one youngster who joined his brothers, shortly after coming to the brewery offices, to become an auctioneer.[23] Occasionally, the firm also lost the services of more senior staff members, such as James Stenhouse, who left Stratford for Burton in 1897.[24] Stenhouse had been acquired three years earlier from Bristol Brewery Georges & Co.[25]

While the brewery expended little effort locating willing labourers, most office posts and supervisory positions were advertised in local papers and even trade journals. Several existing letters which describe terms of employment to candidates are worded in a fashion which suggests vacancies were announced in print. Oral evidence from retired clerks also confirms that most of these openings were advertised in this way, but usually only in local papers. Given the average age of candidates, however, most boys who applied for office positions were informed of vacancies by their parents, who read newspapers more regularly.[26]

Nevertheless, one must not overlook the ingenuity displayed by the trade's younger members when seeking employment. Sydney Nevile, for example, although offered a permanent position by the firm where he received his initial training, recognised he possessed only firm-specific skills and, wishing to learn

the trade as practiced in another brewery, advertised for work on the last page of the *Brewers' Journal*, a site where brewers usually posted openings for apprentices.[27] Moreover, much information regarding vacancies was transmitted through informal, often circuitous oral networks, which allowed applicants to choose the optimum moment to approach a firm in order to request work. In many cases applications for travellers' positions came from individuals who worked in retail establishments and were privileged with an early form of 'insider information'. On such an occasion in 1885, the managers of Dutton & Co, the Coventry brewers, received a letter from a customer who, although he could continue to order the firm's ale by post, wished to become the brewery's representative for his neighbourhood soon after the usual traveller had relinquished his post.[28] Whether this enterprising individual was rewarded by Duttons with a job offer is not recorded. Given the spelling of the letter, the firm may have withheld such an offer until a more literate candidate could be discovered.

Once offered a position at a brewery, newly-recruited employees usually received some form of training. Rarely, however, were periods of instruction well-organised or entirely systematic. Only in exceptional cases were training schemes entirely 'in house'. Training, when available, was fragmented, given on the job, and involved employees learning by watching their superiors or even working out tasks for themselves.

Even the most privileged of employees rarely received training appropriate to the roles they were to fulfil within the firm. Rather than study business subjects, brewers' sons often received a classical education at Oxford and Cambridge. A literary education was seen to be an important part of every industrialists' background.[29] Given the enduring nature of these practices, economic and business historians have often criticised the training of British entrepreneurs.[30]

Not surprisingly, many brewers' first apprentices were their own sons; this was the case at Flowers. Although Charles Flower entered the family brewery in 1845 to receive his formal training as a brewer, his education had begun much earlier. After attending several grammar schools in the Midlands, including one in Edgbaston and King Edward VI School in Stratford, Charles Flower lived for a year in the London home of a family friend, Philip Rathbone, who became ‘his model of an English gentleman'.[31] As was usual among students of his age, Flower learned little which directly related to business. An active participant in Rathbone's social circle, he learned the importance of music and dance; years later, Charles still used his spare time in the brewery to practise music.[32] He stayed with the Rathbone's until 1845, when he returned to Stratford and was brought into the family firm by his father.

Usually only after having received a liberal arts education did brewers' sons

acquire a knowledge of brewing, and then only by practising tasks in the brewery. This general introduction to business was characteristic not only of brewers, but was the accepted practice in numerous other vocations. In his study of Lancashire cotton communities, Patrick Joyce suggests factory owners regularly introduced their sons to the trade by putting them 'through the mill'.[33] Among potters, a similar system flourished. Josiah Wedgwood insisted his sons be educated in this manner to ensure they were able to conduct his business successfully.[34] Most brewers were also convinced this practice offered innumerable benefits.

When Charles Flower learned to brew, he began at the copper side. From there he 'went through the brewery under the direction of [his] father'.[35] At this time the firm brewed approximately three times a week. According to Charles, this left him with plenty of time for office work. He collected cash from customers, kept the firm's account books and even did some of the brewery's travelling.[36] In October 1846, when Edward Flower left Stratford to visit relatives in America, the firm was left entirely in Charles's hands. During this time he learned the 'necessity of managing'.[37] A year later he was sent for a month to stay with Edward and Oswald Fordham, relatives in Hertfordshire, who owned the Ashwell Brewery, to study their methods of brewing and malting.[38] As a result of this particular form of training, by the time Charles Flower retired, he could claim he had 'worked in all areas of the brewery' and 'done a part of all the work'.[39]

Charles Flower's experiences were similar to those of other nineteenth-century brewers. Alfred, son of John Izzard Pryor, the well-known Hertfordshire brewer, entered his family's firm a decade before Charles Flower began brewing in Stratford. Although his education included lessons in mathematics, mensuration, accounting, surveying and the use of globes, his father also advised him to resume his interest in dancing.[40] Moreover, like Charles, Alfred Pryor spent time in another firm in order to learn general rules of business administration. Instead of remaining in England, however, he worked in Hamburg for two years with Abel Smith, a friend of the family. Eventually, Alfred entered the family's Baldock brewery, not far from the Fordhams' Ashwell Brewery, where he acquired 'a knowledge of the Brewery Department by getting up to brew with Mr Tranter [the head brewer]'.[41] Shortly afterwards, John Izzard Pryor, on one of many visits to the brewery, was pleasantly surprised to see Alfred 'with his apron on looking like a brewer'.[42] Another of Charles Flower's contemporaries, Edward Greene, appears to have been introduced to the family's firm in a similar manner.[43]

Approximately three decades later, Archibald Flower entered the brewing trade in a way not dissimilar to Alfred Pryor and his uncle, Charles Flower. However, unlike both Charles and Alfred,

Archie studied at Cambridge. Rather than study business subjects - most sons of entrepreneurs knew from an early age they were to assume control of their families' businesses - Archie, like many other brewers' sons of his generation, studied the classics. William Blackall Simonds's grandsons, Archie's contemporaries, both received training not directly related to the positions they assumed at the family's Reading brewery; Henry John was a lawyer and fellow of King's College, Cambridge and George Blackall studied sculpture in Dresden and Brussels, both admittedly excellent schools of fine art.[44] Over time, this practice also appears to have endured. The last director of the Flower firm, also a graduate of Cambridge, studied science, though nothing remotely related to brewing. Only after his capture by German troops in 1941, did Dennis Flower prepare for and pass examinations set by the Institute of Brewing, in order to alleviate some of the boredom which went with being a prisoner of war.[45]

Despite Charles Flower's haphazard training, employees who joined the brewery after 1870 had the benefit of a more standard form of apprenticeship. Over a few decades, the rudimentary training given to Flower had developed into a systematic training programme, affording pupils a comprehensive introduction to the trade. The specific nature of this apprenticeship as practised at the brewery is revealed in copies of letters written by the firm's owners and managers to the parents and guardians of brewing pupils. Not all breweries could contemplate the establishment of such a programme. Although members of the general public knew little about commercial brewing, many recognised a firm's size was of some importance to an apprentice's education. While pupils in a small firm could be expected to receive considerable attention from their masters, those in medium-sized firms had the additional advantage of modern machinery and more up-to-date methods.[46] Not nearly the size of the largest London and Burton breweries, Flower & Sons did have qualities which ensured a steady flow of apprentices after 1870. For a provincial brewery, located in a region not traditionally associated with brewing, its production facilities were very advanced. The brewery introduced refrigeration technology to production much earlier than most breweries, whether in town or country. Moreover, by 1878, the firm had installed pneumatic malting facilities. While another provincial firm, Steward & Pattesons, introduced a more advanced malting process during the 1907-8 brewing season, many other firms did not even produce their own malt.[47] Flowers almost always had. As a result, pupils regularly came to the brewery. Between 1870 and 1914, approximately 30 brewing pupils were apprenticed in Stratford.

Flower & Sons' apprenticeship programme proved a successful one and received the assent of many distinguished brewing families. Between 1870 and 1914, the brewery hosted the sons of several prominent English brewers as

pupils. Even though Flowers had lost the London brewer's pale ale contract a year earlier, in 1887, Robert Courage sent his son to the brewery as an apprentice.[48] Four years later, one of the firm's directors, Stephen Moore, wrote to Spencer Charrington to inform him that his son had been accepted as a pupil.[49] Finally, in May 1899, Charles Tetley requested a place for his son due to the firm's modern facilities.[50] Although more personal than communications with the average apprentice's parents, the fees and conditions which governed agreements with acquaintances were no different from those made with absolute strangers. Business arrangements between relatives were also subject to strict regulation, 'for fear of misunderstanding'.[51] If anything, the approval received from other brewers may have inflated the cost of training and discouraged the brewery's directors from lowering their apprenticeship premium until the last decade of the nineteenth century.

Compared to the instruction offered most tradesmen, a brewing apprenticeship was expensive, and had always been so. Apprenticeship fees listed in the 1725 Register of Apprenticeship Bindings of the Brewers' Company regularly approach the £200 figure.[52] Some pupils paid £300, one as much as £500.[53] A brewer's training was among the most expensive apprenticeships. It ranked alongside those of bankers, apothecaries, merchants and jewellers.[54] For much of the second half of the nineteenth century Flower & Sons demanded a premium of £400, half of which was to be paid when a pupil was accepted, the remainder when the period of training had been completed. In 1892, the firm made its first exception. In response to complaints from Henry B. Burton, the firm accepted a pupil for £300. By 1894 further criticism reduced the fee to £200; this premium endured less than ten years. On 17 February 1903, Victor C. Best became a pupil for £100.[55] Improvements in technical education, competition in the trade and the brewery's need for instant capital had reduced the cost of a brewer's training to a quarter of its original sum in just over a decade.

From a very early period, individuals considered apprenticeship fees to be too exorbitant. In response to claims that fees were too high, Charles Flower informed Mr Cutler, whose son, Rupert, came to the firm in 1886, that the firm had never taken less, even when pupils wished to stay for only a few months. Moreover, the trade was not flooded with apprentices. Cutler was informed that Flowers did not take on pupils indiscriminately. Few were accepted and parents were assured their sons would associate only with men of superior quality.

Less-critical clients paid the first instalment of a premium only to realise they could not afford a second payment. As this occurrence became more frequent, the firm made their method of payment more flexible. When notified that Revd Brodie could not afford the second of his son's premiums, the brewery's managers

immediately made alternative arrangements. As had been decided in the past, the directors permitted Wyndham Charles Brodie to work off his outstanding debt; he was offered the positions of brewer or bookkeeper at a rate of £105 a year. Similar arrangements were made in 1876, when the firm offered Arthur Fagge, son of Aston Cantlow's vicar, a salary of £150 a year to help in the brewery offices. Of this salary, £100 was to be deducted in the first two years. Were he to prove satisfactory in this post, Fagge would be refunded £100 in his third year. While the firm's generosity appeared limitless, should debtors have refused these offers, full payment was demanded; usually such drastic measures were avoided.

As with insolvent guardians, the brewery did not tolerate apprentices' indiscretions. In November 1878, the firm's proprietors were informed by CL Stephens that one of their pupils had suffered certain undescribed 'misfortunes'.[56] Quite possibly having speculated unwisely, a former student, unable to find employment, could not repay his debtors and requested the firm refund his premium. This, however, the managers were unwilling to do. Instead, they advised Stephens to use his influence in order to help the pupil obtain a position at Allsopps, the Burton brewers. Alternatively, the firm was willing to lend him some money, but only if the pupil's creditors paid half his debt and the pupil worked off the rest. The directors regarded the former solution to be the better, for, after such a poor display of initiative, the student needed to demonstrate that he could 'make himself a capable man of business'.[57]

The flexible nature of apprenticeship arrangements had much to do with the way in which young men were indentured. Traditionally, most apprenticeships involved pupils entering written contracts; at Flowers, as at other firms, such as Watneys, apprentices entered the brewery's service by way of an oral agreement.[58] Luckily for the historian, however, correspondence concerning these arrangements are recorded in Flower & Sons' letter books. Not surprisingly, given their informal nature, details could vary with each case. After an initial letter of introduction, the brewery invited prospective pupils and their parents or guardians to the brewery to view the premises and meet the owners and managers. As one would imagine, only those issues which arose during the ensuing discussions were addressed by the firm. If parents were satisfied with what they saw and heard, and the brewery had room for an additional pupil, a young man would be taken on, and then only after an initial payment was made. Although a receipt was issued by one of the brewery managers, no written contract outlining an apprentice's duties or the firm's obligations was drafted. When questioned on this matter in 1899 by Charles Tetley, whose son had recently begun an apprenticeship, the directors stated that never in the past had they issued any form of agreement.[59] While such inquiries led them to describe the duties

of apprentices more thoroughly, by not radically changing existing arrangements, or ever drafting a contract, the brewery maintained a very flexible system of instruction for many more years.

In her survey of English apprenticeship, Joan Lane suggests apprentices in the eighteenth century had traditionally been dependent on their masters for food, shelter and clothing.[60] In this sense, brewing apprenticeships were not traditional. William Hawkes, one of the earliest pupils to come to the firm, lived in Edward Flower's home.[61] Pupils who came to Stratford after 1870, however, lived in lodging houses located in the town. The 1871 census lists Arthur Fagge as a lodger in the home of Hannah Osborne. In the same year, Francis Lawrence Talbot, together with a young bank clerk, Charles Hensmen, lived in the home of Thomas Kite, a local printer. A decade later, conditions appear much the same. One of the firm's apprentices, Gilbert Thwaites, who became one of its directors years later, lodged with Thomas Pearson, a railway passenger guard, for the duration of his tutelage. Perhaps, given the cost of apprenticeship, the firm's directors believed private accommodation was something most pupils' families would provide without hesitation. Most brewers' apprentices, on the other hand, probably desired the independence their wealth afforded them.

Only if lodgings were not immediately available when they first arrived in Stratford did pupils live a few days in the homes of the brewery's owners or managers. For example, Mr Aikenson's son spent his first night at the brewery house with head brewer, and one-time pupil, Francis Talbot.[62] Three years later, in 1886, Charles Flower wrote to Mr Cutler to inform him that his son was welcome to stay with him at Avonbank until more suitable accommodation could be found.[63] This, however, is the same Cutler who questioned the brewery about the size of its premium, and, in this respect, Flower's concessions may have been made to appease a particularly difficult parent.

Despite not taking pupils into their homes, brewery owners and managers did take an interest in pupils' routines outside the brewery. Of particular concern to brewers were their apprentices' moral standards. In a letter written in 1876, Archibald Park, a brewery manager, informed the father of a pupil that his son had formed ‘some very undesirable acquaintance'.[64] Interestingly, Park also reveals this to have been Charles Flower's observation. It is likely that Flower had always exercised influence over pupils' relationships. Ten years later, he assured the father of a prospective apprentice that his son would not ‘become intimate with anyone but gentlemen'.[65] On another occasion, in 1878, the firm wrote to Mr W Nelson, the father of a pupil whose progress was anything but satisfactory. In particular, the directors were least impressed with the boy's lack of attention while at work in the brewery. Consequently, he was encour-

aged to `buy and keep a horse and so get a certain amount of active healthy exercise instead of too much really idle time on his hands'.[66] In this sense, although the firm was rapidly becoming one of the larger, more successful provincial breweries, personal relations between master and apprentice suffered less than one would have expected; contact between the two was not reduced. What had reduced over the years, however, were pupils' periods of instruction.

Although covering a wide range of activities, instruction at the brewery was relatively short compared to traditional apprenticeships. By 1870, breweries had replaced apprenticeship time, the lengthy period during which boys were introduced to tasks and given adequate time to practise and perfect their new skills, with learning time, which provided pupils merely with instructions essential to developing an understanding of the trade. According to Charles More, who has written extensively on workers' skills and training, the average apprenticeship in 1870 lasted five years.[67] Most masters regarded 21 as the appropriate age for an apprentice to finish his education; longer periods of instruction had been common in breweries years earlier. In 1848, Edward Kelsey, one of Edward Flower's first pupils, arrived to begin an apprenticeship which he completed in 1855.[68] By 1870, however, no pupils stayed more than two years with the firm unless offered employment after their periods of instruction were successfully concluded. At other breweries, such as Reid's in London, apprenticeship also lasted only two years.[69]

After the training period was shortened, the ages of apprentices naturally increased. According to the 1871 census, Flower & Sons' pupils, Arthur Fagge and Francis Talbot, were 17 and 19 years of age, respectively. Gilbert Thwaites, who began his training ten years later, was also 19 when he was instructed in brewing. The ages of no other apprentices are recorded in the censuses or correspondence books. Should these samples be representative of the entire group, however, it almost seems inaccurate to group brewers' apprentices among traditional boy labourers. Most enjoyed financial independence, their own accommodation and membership in a social circle comprising older, ‘respectable' members of the brewing trade.

The type of instruction reserved for young brewers set them apart from boys engaged in other late nineteenth-century trades. The Webbs' model of apprenticeship, for example, is very pessimistic. They suggest apprenticeship during this period became a form of ‘ritual servitude', as do the works of their contemporaries who framed the subject in relation to the question of boy labour.[70] Working in an ‘age sensitive to its social diseases', these social reformers predominantly addressed the institution's abuses, of which there were many.[71] Such practices, however, were rarely found in breweries. Although many industrial apprentices were assigned unskilled and

demeaning work, brewing apprentices learned an array of skilled tasks, both in the brewery and its offices. While many would have learned the importance of scouring brewing vats, this task was carried out by brewery labourers. The firm assured parents and guardians that a generous premium entitled a pupil to learn `all the knowledge [the firm was] able to impart'.[72] Apprentices would learn `everything except experience'.[73]

This, however, did not imply that pupils were free of strict duties. In a letter to Charles Doggett dated February 1883, Charles Flower claims the firm had `enough of pupils who think they can just look on at their own time and convenience'.[74] Pupils had regular duties and hours. Though rarely described in letters, these duties were clearly laid out in writing when the firm accepted Wyndham Charles Brodie as a pupil. Charles Flower assured Brodie's father that his son would be instructed in `every branch of our business in all its details, including brewing, malting, cooperage, sales and bookkeeping'.[75] When the time came for a pupil to learn the malting process, for example, instruction would 'consist of following the maltster round, listening to him + pick up information'.[76] Another pupil, George Fellows, accompanied the brewery's head maltster when he purchased barley at the local corn exchange. On such occasions Fellows was instructed on the most important features to look for when buying a sample of barley.[77] This task, among other duties, comprised a day which started at nine and ended at five.[78]

While apprentices learned a wide array of subjects, the brewery never provided a great deal of scientific training. Although the firm encouraged pupils to attend courses which taught the elementary principles of chemistry, few did so. Many appear to have had little time for such classes. Those pupils instructed at the brewery between 1889 and 1899 may have received some scientific instruction from resident chemist Joseph O'Connor, but only rarely was a chemist included among the brewery's regular staff. Occasionally, however, pupils were recommended to acquire some scientific knowledge outside the firm. This was the case in May 1867 when Charles Flower wrote to Mr Brooke to inform him his son had been accepted as a pupil at the brewery. After outlining the usual apprenticeship terms, Flower stressed the importance of a chemistry course to those wishing to learn the trade.[79] Arrangements were made for Brooke's son to attend classes with Dr Attfield, who had the use of a laboratory, to learn 'all that [was] necessary' in order to understand the science of brewing.[80] Similar arrangements had been made in 1870 for Revd JB Brodie's eldest son, Wyndham Charles. He was to be instructed in brewing by Dr Agar, with whom the brewery had made a separate agreement.[81] Surprisingly, however, this was also the last occasion the brewery made provisions for a pupil's scientific training.

Other breweries advised pupils to attend similar classes, such as were offered at Sir John Cass Technical College, set up

under the instigation of the Brewers' Company, and Finsbury Technical College.[82] However, as chemistry courses offered by colleges and universities rarely touched on the subject of brewing, such instruction frequently had to be sought elsewhere.[83] By visiting other breweries, pupils became acquainted with alternative brewing methods, but not always scientifically-trained brewers. Of course, a few Burton breweries provided exceptions to this rule, as did Lewis Clarkes' Worcester Brewery where J Ross Mackenzie, a Fellow of the Royal Microscopical Society, trained a number of successful pupils in the first decade of the twentieth century. Most wishing information concerning fermentation, malting, or even the proper storage of raw materials generally attended classes like those run by Drs Agar and Attfield.

Although few London brewers took apprentices, most of the chemists who contributed to the trade's journals established laboratories in London where they instructed brewing pupils. Gordon Salamon, ER Moritz and Messrs Gillman & Spencer were only the best-known of the consultant chemists offering these services. Apparently many attended their classes, for all three enlarged their laboratory facilities in 1885. In this year, ER Moritz extended his offices in order to build a model brewery where students could conduct experimental observations.[84] Moreover, these services were not restricted to London. Chemists who taught the science of brewing opened laboratories in most large cities throughout the country during this period. Alfred H Allen of Sheffield, Messrs Shutes & Co of Derby, Frank Faulkner and RD Loveless, both of Birmingham, all worked closely with midland brewers, and, while providing many with raw materials and technical advice, equipped some apprentices with a sufficient knowledge of chemistry to understand the brewing process.[85]

Although almost all brewers were convinced of the valuable services such chemists provided, many believed the nation really needed a brewing school, as existed in numerous continental cities. For example, those who attempted to gain a recognised qualification, as could be obtained by sitting the examinations of the City and Guilds Institute of London since 1880, usually had little choice but to prepare themselves.[86] Consequently, of the 25 candidates who sat examinations in 1890, only five passed.[87] A year later, although a greater number of candidates passed, more than 60% still failed and most continued to be 'very badly prepared' for the remainder of the century.[88] Moreover, while brewers were frequently praised for building cathedrals and parks, members of the trade could not understand why technical education still lacked a patron.[89] Not wishing to minimise the contributions consultant chemists made to brewing, commentators rightly argued that chemists could not teach students all that was required to run efficient breweries.[90]

In 1900 the industry came much closer to achieving this goal. Due primarily to

funds provided by the Birmingham Brewers' Association, Mason University College, a university 'founded by business men for business men',[91] opened the nation's first brewing school. Soon after Adrian J Brown was appointed the school's first professor of brewing, the department welcomed eighteen students, sixteen ‘working at brewing, one at malting, one at vinegar brewing'.[92] Five pupils enrolled in the school's three-year diploma course, the others opted for shorter, more specific training periods. While a laboratory had been completed in time for the centre's opening ceremony, an experimental brewery, like that constructed by ER Moritz, was still in its planning stages. Nevertheless, from its inception, brewery owners believed the project heralded the age of a scientifically-trained rank-and-file. Instead of one or two scientists on brewing staffs, leaders in the industry predicted ‘ten or a dozen'.[93]

Conditions in breweries were more resilient than expected; changes were not just slow, but, in most Midland breweries, unapparent. Until most head brewers had undergone a similar training to that offered at Birmingham's new brewing school, recent graduates had little chance of influencing brewing practices in the trade. Generally, senior brewers believed scientifically-trained pupils became over-confident. As was common in other branches of industry, traditionally-trained employees feared those who received a formal technical education prior to entering their trades. Those most critical of recent educational developments saw no need for ‘the youthful enthusiast to fire off all his "college" knowledge at the older man's head'.[94] Instead, the new generation of university-educated brewers was to give its opinion only when asked.

Hostility exhibited by traditionalists towards new recruits naturally did not improve enrolment at Birmingham University's School of Brewing, or at other institutions for that matter. An already negative message was merely reinforced when it became clear that a diploma did not guarantee a job, let alone a promotion.[95] Few members of the trade, including Flower & Sons' own head brewer, believed brewers could be 'educated [solely] in the laboratory'.[96] Educational developments, however, do appear to have raised the standards of brewing pupils. Perhaps this is most evident in the examination results returned by members of the City and Guilds Institute in the first years of the twentieth century. For example, in 1901, the chief examiner of the London Institute's board reported that 70% of brewing candidates had passed.[97] Nevertheless, most were still not instructed in the management of breweries, even when brewers had greater control over what was being taught at these institutions. Although the Flower family funded Stratford's own technical college, brewing was never incorporated into the school's curriculum; its instructors taught primarily shorthand, typewriting and bookkeeping under the rules of the Midland Counties Union.[98] As a result, managerial skills could be

acquired only practically, as done by Charles Flower fifty years earlier. Most who requested literature on the subject from trade journals were informed that such skills could still be learned only when one ‘passed through ... the fire'.[99] Furthermore, the brewing school at Birmingham suffered from its own problems, many of which were directly related to politics within the brewing industry. While the majority of brewers believed it disgraceful a school had not opened earlier, not all lent it their support once it had been established. As Charles Flower realised two decades earlier when he successfully organised the construction of the Royal Shakespeare Theatre, many people believed such grand projects should and could only be undertaken in and by residents of the nation's capital.[100] Reiterating words familiar to inhabitants of many midland towns, H Cosmo O Bonsor, MP, at the school's official opening, expressed his regret that the ceremony could not have taken place in London.[101] C Howard Tripp, on the other hand, resigned as vice-president of the midland branch of the Institute of Brewing to protest at the school's foundation, which he believed would flood the trade with brewers.[102] Naturally, temperance advocates also resented such developments. In response to Adrian Brown's new Professorship in Brewing at Birmingham, Mrs Arthur Bertrand Russell, sister-in-law of Earl Russell, initiated a campaign to raise funds in order to create a 'chair of Temperance' at the University of London.[103] Despite the existence of many vocal, some acerbic, critics, technical training had its important advocates. Sydney Nevile was one of many London brewers who supplemented his practical knowledge with the theoretical training offered by academic institutions, such as Brighton Technical College.[104] Although he admittedly suffered from a lack of confidence due to never having attended university, Nevile continued taking courses offered by consultant brewers for much of his life. Twice a week he travelled to John Heron's laboratory in London.[105] Arriving in the early afternoon, he learned about the latest methods of scientific control, adjourning to dinner with other 'enthusiasts' at approximately nine, presumably to talk about brewing for several additional hours.[106] Arthur Hadley, head brewer at Bristol Brewery George's & Co in the first decades of this century, similarly spent his days investigating the scientific aspects relating to his trade, though no evidence suggests he ever dined with Nevile in London. Apprenticed to Birmingham brewers Mitchells & Butlers at their Cape Hill Brewery, where he became ‘a competent and reliable Brewers' analyst and Microscopist', Hadley passed the City and Guilds' examinations with the highest honours in 1893, before becoming head brewer at Carmarthen United Breweries Ltd, Dyfed, JT & J Toohey Ltd in Sydney, Australia and, ultimately, assuming the equivalent post at George's in Bristol.[107] His brewing books record many of the experiments, machinery and plant designs he made during his career.[108] Moreover, numerous pages record the

advice he received from consultant brewers, whose notes Hadley often laboriously analysed and reworked to his own advantage. Both brewers' lives clearly represent the oft quoted, but not always adequately demonstrated, adage that one's education never ends.

Although unwilling to incorporate scientific training into their apprenticeship programme, managers at Flowers appear to have understood the importance of periodically updating an education. For example, in a letter to J Bonham Carter dated 3 August 1880, Charles Flower explained the way in which legislative changes affected apprenticeship. Changes in excise laws, Flower claimed, meant Bonham Carter's son needed 'to learn [the] trade afresh'.[109] Moreover, the firm's own staff was consistently prompted to relearn its craft due to the passage of legislation between 1870 and 1914.

Widespread acceptance of this belief led many established brewers to take advantage of Flower & Sons' training scheme. Consequently, not every pupil who came to the brewery did so to learn all aspects of the brewing trade. Many were improvers. As the name implies, these individuals had already received some form of training, however, later in their careers, realised they required additional instruction in aspects of the trade, perhaps due to technological innovations, or the lack of particular facilities at the breweries where they had completed their apprenticeships. George Fellows, for example, came to the brewery for twelve months starting in September 1901, but did not wish to learn any office work.[110] Although such people received less-extensive training, or stayed at the brewery for shorter lengths of time, they paid the same fees as other apprentices and were subject to conditions resembling those of other pupils. In 1871, the firm described the case of an improver, who stayed at the brewery for only 14 days after paying the usual fee. For this reason, however, it was also understood that the brewer could, in the future, regularly call on the brewery for assistance free of charge.[111]

Throughout this period, Flower & Sons realised a successful apprenticeship programme could also be a liability. Although hosting many pupils and improvers, the firm had traditionally attempted to keep their methods secret. In 1867, when arrangements were made to accept Mr Brooke's son as a pupil, Charles Flower demanded he promise not to 'impart to any one what he may learn that is peculiar to our business or mode of brewing'.[112] Furthermore, after leaving the firm, he was not to 'become engaged in concerns in any Brewery within 25 miles of Stratford-on-Avon without [their] consent'.[113] Whether these efforts were always successful is uncertain. Between the years 1870 and 1904, however, no correspondence suggests apprentices breached the conditions of their informal contracts.

Although the usual term of apprenticeship at Flowers, as at other English breweries,

lasted only two years, the firm's directors admitted that pupils did not leave the programme sufficiently trained to manage the average forty-quarter brewery. On several occasions the board advised guardians that pupils should not expect to obtain a supervisory position immediately after completing their training. In general, the brewery's managers believed an apprentice required two additional years of work experience before he was adequately prepared to take on such a post.[114] Brewers' apprentices were expected to spend much of their time improving their skills once they had obtained a permanent, subsidiary position with a firm.

Although few immediately became managers, most obtained employment immediately after completing a two-year apprenticeship. In a letter to the parent of a potential pupil, Charles Flower claimed the firm accepted apprentices only if they had some definite prospect of entering into business after having received their training. This does not seem to have been an empty claim. Between 1870 and 1900, the firm never accepted more than two apprentices at one time. Even in the first decade of this century, when the firm experienced its greatest financial difficulties, at no point did the directors accept more pupils in order to increase revenue. Moreover, not all brewers took apprentices. For this reason, unlike many other branches of the economy, the brewing trade was never flooded with apprentices.

The firm often expended considerable effort obtaining employment for pupils, if they could not offer successful candidates a place themselves; many of the brewery's best pupils were offered employment in Stratford after two years. One of the company secretary's many duties was to write letters of recommendation for past pupils. One such letter was written in April 1898 to J Miller of Messrs Truman, Hanbury, Buxton & Company's No 2 Brewery. In his recommendation, Charles Lowndes, Dennis Flower's grandfather and long-time brewery secretary, although unfamiliar with Mr F Holt's business capacity, considered him ‘thoroughly trustworthy', and found him ‘very neat in what little book work he had to do'.[115] Arthur Hartcup, who applied for a position at Morgan's Brewery in Norwich, was also praised. Brewery manager and director, Stephen Moore, testified to Hartcup's knowledge of brewing and to his ‘careful hand work in the brewery';[116] apparently the brewery had had other plans for Hartcup, for they were also ‘sorry to lose his service'.[117]

Not all apprentices, however, completed their terms at the brewery successfully. In May 1869, two years after accepting Mr Brooke's son as a pupil, the firm wrote to his father in order to complain of his continual absence from work. Although capable, Brooke's son needed 'to be more steady and reliable to be a good brewer'.[118] Only occasionally were pupils dismissed. On 4 December 1872, Charles Flower informed E Skidmore of his son's dismissal. In a rather vague letter, Flower claimed the pupil's lack of

attention caused the firm 'great inconvenience'.[119] A decade later, the firm wrote to Mr H Green to inform him that his son found the 'work of superintending brewery operations too arduous'.[120] As it was unlikely the young man would pursue a brewing career, the firm informed Green that the second instalment of the premium was not expected. If his son changed his mind, however, and gained employment with a brewery, the directors expected to receive the unpaid amount. In an exceptional case, a pupil was advised to end his apprenticeship because he had commenced the programme without his father's approval. After receiving a letter in which Charles L Wallace opposed his son's decision to commence a brewing apprenticeship, Archibald Flower responded apologetically, claiming the directors had believed they were acting with the sanction of the boy's natural guardian.[121]

Although the brewing industry at this time was organised to cater for a mass market, some branches of the trade continued to be run along craft lines; it was here that traditional apprenticeships tended to survive in their purest forms. The most obvious example of this was in the cooperage. Workers at other midland breweries, such as Mitchells & Butlers, also witnessed a number of the trade's enduring traditions.[122] What little evidence of apprenticeship rituals that survives generally relates to this branch of the trade. Many who worked or lived near Mitchells & Butlers Cape Hill Brewery remember the sight of workers 'trussing the cooper' at the end of his term of instruction.[123] Residents of Stratford recall a similar ritual having occurred in the town, when apprentices were rolled in a barrel, usually their own work, to celebrate their rite of passage at the end of their period of indenture.

Apprenticeships in this branch of the trade differed from those of brewers in several other ways. After the death of the firm's head cooper, William Lambert, a clerk responsible for recording employees' wages listed the conditions governing coopers' apprenticeships in his ledger. According to his notes, coopers trained for six years, half a year less than was common at Simonds's cooperage in Reading.[124] Moreover, most were paid during their terms at the brewery. Albert Willey, whose apprenticeship expired on 30 September 1897, received two-thirds the usual piecework rates during the last two years he was indentured.[125] Benjamin Coates had only started earning the two-thirds rate in May of the same year. Prior to that he had been on half rates. John Joseph Sweeney, who had only just been taken on in 1898, earned 4s. per week during his first year at the brewery; this was to be raised to 8s. in his second year.[126] In his third and fourth years he earned half the usual rate for piece work, which was raised to two-thirds for the final two years of his training. In the same year, the firm took another apprentice, Josiah Harold Hollis, whose father already worked in the cooperage. He was paid the same rate as Sweeney until 28 February 1899 when

his father was injured and was no longer in a condition to work. Thereafter, Hollis's father received a portion of his earnings which 'in ordinary cases would belong to the firm'.[127] Only when fully recovered was Josiah returned as his father's apprentice. The final portion of the same memorandum reveals that all such agreements were subject to the pupil's ‘good behaviour and [the] prevention of unforeseen events'.[128]

The cooper's training was perhaps the most strictly regulated of brewery apprenticeships. Primarily this was due to the organisation of the trade. While few brewery workers were unionised at the end of the previous century, by 1900, coopers' unions existed in London, Bristol, Liverpool, Manchester, Birmingham (which included coopers from Wolverhampton), Hull, Burton, Leeds, Sheffield and Nottingham, among many other smaller organisations and branches, such as the National Amalgamated Coopers, which drew their membership from more broadly-defined districts.[129] According to the regulations of such societies, representatives at regional offices were to receive the indentures of all apprentices introduced to brewery cooperage departments. Here, documents were stamped and pupils' names registered alongside those of the union's senior members.[130] As a result of increased organisation, brewery owners and managers had less control over this form of apprenticeship, and coopers' apprenticeships subsequently did not witness the modifications introduced to brewers' training schemes during these years. Organisation, however, did vary from one region to the next, with coopers in Burton and Liverpool exercising the greatest craft control.[131] Those in Scotland, on the other hand, were very poorly organised.[132] Moreover, during the middle of the last century, Henry Mayhew estimated that only half of London's coopers belonged to a union.[133] Later in the century, this figure had not changed.[134] The Webbs still found coopers to be ‘more local and jealous than almost any other trade'.[135] Consequently, conditions within individual shops did vary between 1870 and 1914, though in general, whether organised or not, brewers' coopers usually secured themselves the most generous earnings among brewery labourers.

When requested, the brewery also offered instruction in other crafts. For example, in August 1898, Francis Talbot wrote to Revd JR Crawford of East Walton, King's Lynn to inform him that the firm would accept his son as a malting pupil. The fee was only £50, for the period of instruction lasted only eight months. The sole remaining condition specified by Talbot was that his son should not visit the brewery while a pupil.[136] Presumably, Crawford would be instructed at the firm's oldest malt house in the centre of town where such conditions could be reasonably enforced.

As breweries began to grow in scale, they were often compared to small cities, due to the number of trades practised on

their premises. Workforces grew more diversified as carpenters', painters' and even plumbers' departments were established in order to run, repair and renovate sections of enormous plants. As a result, many boys came to breweries to learn trades not traditionally associated with the industry. One of the first pupils in Stratford to receive instruction in one of the brewery's new trades was Charles Savage. In June 1903, Savage became a carpenter's apprentice. At the brewery this apprenticeship lasted only four years, three years less than was usual outside the firm.[137] A year earlier, Roger Megainey became a plumber's apprentice; this apprenticeship also lasted four years. Although non-unionised, these apprentices basically worked according to regulations which governed apprenticeships in the cooperage. Like cooper's apprentices Megainey earned 4s. a week during his first year. This increased only slightly to 6s. in his second year and to 8s. in the third. In his fourth and final year this was to jump to 12s., but Megainey was dismissed before completing his apprenticeship; the firm cancelled his indentures.[138] FH Wright earned the same rates as Megainey, but unlike his colleague, Wright stayed an extra year, as he had come to learn all the trades: carpentry, plumbing and painting.

Unlike brewing apprentices, those individuals who came to the brewery to learn any of the new or unionised trades tended to be residents of Stratford. Fred Hastings, a cooper's apprentice in 1871, was the son of Robert Hastings, one of Stratford's many blacksmiths. Over these years, a new generation of local coopers replaced that of their instructors, a group born, raised and, more importantly, trained in Kent. Moreover, the firm had little difficulty finding willing replacements. John Rose, a veterinary surgeon, like other local professional men, regarded the trade as one which was profitable, and therefore respectable enough for his son. Other apprentices, such as Alfred Adkins and George Savage, also came from Stratford families. None of this new generation appears to have come from outside the immediate town, as did their predecessors.

Despite the existence of a general brewers' apprenticeship, a form of instruction which eventually evolved into a system which provided breweries with brewers, clerks and managers, ordinary brewery workers received no formal training at all. While managers did not encourage a lengthy, detailed system of training for general labourers, many workers who required a great deal of knowledge in order to perform their duties adequately were often left to pick up their trades, that is, learn them by repeatedly carrying out the tasks associated with their posts. For example, Thomas Edward Collins, the manager of the firm's wine and spirits department during the interwar period, received no training when hired as a traveller by the brewery.

After developing an interest in wine, he transferred to the wine department. Everything he learned about wines, he

taught himself.[139] Training for draymen and maltsters was seen to be equally unnecessary. The way in which brewery apprenticeships evolved has led historians to describe the labour forces of breweries during the late nineteenth and early twentieth centuries as unskilled workers, supervised by only a few skilled workers.[140] Although the average worker employed by Flowers was given very little formal training, it is perhaps inaccurate to refer to them as unskilled. As census returns from 1871 to 1891 reveal, many workers recruited by Flower & Sons came from agricultural trades and brought skills with them which were easily incorporated to the brewing process. For example, as FE Green argues in his *History of the English Agricultural Labourer, 1870-1920*, a field of roots could be ruined by an unskilled labourer, 'or given a new lease of life by the deft hand of the "ordinary" agricultural labourer'.[141] Similar skills were required in the firm's maltings where workers manipulated germinating barley grains. Moreover, before coming to the brewery many labourers had ploughed, sowed and reaped corn, thatched farm ricks, painted wagons, broken in colts, and if employed on a modern estate, repaired machinery; all of these skills could easily be incorporated to those comprising brewery workforces. Although the skills of agricultural workers are difficult to measure accurately, Charles More has suggested a useful model. He argues that the craftman's skill lays in the fact he could undertake a variety of work, while unskilled labourers are not adaptable.[142] The average worker employed at Flower & Sons had to be adaptable.

Most brewery workers in the late nineteenth century worked in more than one branch of the trade. In 1892, wage books reveal Henry Ricketts, an ordinary labourer, worked for a month in the brewery stables. After a short period loading drays and caring for the firm's horses, Ricketts returned to the brewhouse, where he performed a far greater range of tasks; his case was very usual at the brewery. Wage books record similar experiences for almost all workers. For example, between October and December 1894, eight labourers normally employed in the brewery were transferred to the various trades (carpenters', painters' and plumbers') departments, twelve joined teams of workers in the firm's maltings, three helped in the stables and one spent some time in the brewery's bottling plant.[143] Moreover, seven tradesmen also joined those men already employed in the maltings, as did one labourer from the stables. As a result of such transfers, before leaving the brewery's service, most employees had helped out in the firm's maltings, brewhouse, stables and even the cooperage. Moreover, when the firm began to bottle its own beer in 1888, workers were recruited from existing departments to supervise a workforce largely comprised of boys.[144] Not only did men in the bottling plant acquire an opportunity to work with new machinery, but a few gained valuable managerial skills.

Some workers appear to have travelled through almost all of the firm's departments. For example, between July and September 1897, William Fletcher worked in the brewery, the malt house and assisted various tradesmen.[145] He joined the cooperage department after its foreman, William Lambert, died, presumably to help with an increased work load. By October, Fletcher was again working in the brewery maltings. Another labourer who worked in as many branches of the trade was William Walsey, who came to the brewery from Herefordshire. Not surprisingly, in 1901, he was listed by the wage clerk as 'stacking hops in [the] brewery'.[146] Two years later, together with William Huckfield, he helped install a new refrigerator in the brewery.[147] Over the next year he performed duties in nearly every area of production. In 1904, after a short illness, he was once again working with Huckfield, only this time the two cleaned bricks, which were to be used in the construction of another malt house. By the end of the decade, Walsey spent the majority of his time assisting carpenters and other tradesmen.[148]

Many of these multi-talented workers were previously employed in agricultural trades. A description of their experiences at the brewery suggests the average worker was at one time very skilled. This was especially the case when most workers were recruited from agricultural parishes during the years before production occurred the year round, for the possession of additional skills would have greatly increased one's chances of employment. For example, prior to the introduction of pneumatic methods of malting, this task was largely carried out in the months between October and April. Only the most skilled workers were transferred to the brewery or stables at the conclusion of the malting season. It was in this way that, given the particular organisation of the brewery's production process, agricultural labourers had a distinct advantage over the 'town-bred, manual-working boy'.[149]

A generation later, however, the entire brewing process had changed and the advantages enjoyed by agricultural workers were few. Full-time production encouraged specialisation, which, in turn, limited opportunities for rural recruits to demonstrate their various skills. Movement between departments decreased as malting and brewing were carried out regardless of season and weather conditions. While the average worker in the last decades of the nineteenth century still had the opportunity to learn all branches of the trade and not just one task, few who entered the brewery at the turn of the century did. Workers listed in the 1871 census referred to themselves as 'brewers' labourers'. A decade later, most attempted to define their roles in the brewery in greater detail. Although many 'brewer's labourers' are listed in the census, they were now recorded alongside draymen, maltsters, cellarmen and even a full-time engine driver.

While some jobs continued to encompass diverse tasks, many more became

repetitive and menial; variety was often limited to rotation between the tasks performed in a specific department. This in turn must certainly have affected recruitment. Although difficult to prove, perhaps this, to some extent, explains why the sons of Flowers' employees at the end of the last century did not follow their fathers into the trade. If it did not greatly reduce the number of recruits, it may have limited workers' years of service. Many other developments particular to the years 1870 to 1914, however, need to be examined before this question can be answered authoritatively.

What is clearer is that, in the late nineteenth and early twentieth centuries, brewers' apprentices were the only workers receiving any systematic training in the brewing trade; surprisingly, the system nevertheless survived. Given its flexibility, however, brewery owners and managers were freed of the obligations which encouraged many other trades to dispense with traditional apprenticeships before the end of the nineteenth century. While the apprenticeship system in its rudimentary form was pliable, the average brewery worker's day became more rigid during this period. Naturally, the daily tasks of workers employed in the nation's smallest breweries encompassed great variation; the number of these establishments was on the decrease.

By the beginning of the twentieth century, Flowers had become one of the most competitive breweries in the Midlands, and, like its larger rivals, produced its ale all the year round. Continuous production, although good for business, rooted workers more firmly in their particular departments, which, in turn, fostered the proliferation of semi-skilled workers in an age already characterised by specialisation. Given these conditions, the likelihood that brewers would develop training schemes for their ordinary workers grew even more remote.

References

Chapter 2

1. *Brewers' Journal (BJ)*, 17 February 1866.
2. One of few works to examine this process at the local level is Wilson, R.G. (1983) *Greene King: A Business and Family History*. London: Jonathan Cape.
3. Gourvish, T.R. and Wilson, R. (1994) *The British Brewing Industry, 1830-1980*. Cambridge: CUP, p.48.
4. Sigsworth, E.M. (1965) ‘Science and the Brewing Industry,' *Economic History Review*. XVII, 3, p.537.
5. Vaisey, J. (1963) *The Brewing Industry, 1886-1951*. London: Sir Isaac Pitman & Sons, pp.18-9.
6. Mathias, P. (1959) *The Brewing Industry in England, 1700-1830*. Cambridge: CUP p.48.
7. Vallery-Radot, R. (1914) *The Life of Pasteur*. London: Constable & Co. Ltd, p.207; and Redman, N.B. (1995) *Louis Pasteur and the Brewing Industry*. London: Whitbread & Co., p.1.
8. Anderson, R.G. (1989) ‘Yeast and the Victorian Brewers: incidents and personalities

in the search for the true ferment,' in *Journal of the Institute of Brewing (JIB)*, 95, p.339; and *BJ*, 15 October 1903.

9. Redman, N.B. (1995) op. cit. p.4; and *BJ*, 15 October 1895. Pasteur had also installed himself in the brewery of M. Kuhn at Clermont-Ferrand in order to study brewing methods.

10. [Whitbread] (1951) *Whitbread's Brewery Incorporating the Brewer's Art*. London: Sun Printers Ltd, pp.40-1.

11. Corran, H.S. (1975) *A History of Brewing*. London: David & Charles, p.264.

12. Sigsworth, E.M. (1965) op. cit., p.541.

13. *BJ*, 21 April 1866.

14. Sambrook, P. (1996) *Country House Brewing in England, 1500-1900*. London: The Hambledon Press, p.77.

15. SBTRO, DR 227/106

16. *BJ*, 15 January 1893.

17. SBTRO, DR 227/9

18. *Land and Water*, 5 March 1881.

19. Ibid.

20. *BJ*, 15 March 1885.

21. Sigsworth, E.M. (1965) op. cit, p.537.

22. SBTRO, DR 227/118

23. *BJ*, 15 May 1893; and Corran, H.S. (1975) op. cit. p.186.

24. Barnard, A. (1889-91) *The Noted Breweries of Great Britain and Ireland*, Vol. 1. London: Sir Joseph Canston & Sons, p.368; Corran, H.S. (1975) op. cit. p.195.

25. *BJ*, 15 May 1898.

26. Mathias, P. (1959) op. cit. p.12.

27. Sambrook, P. (1996) op. cit. p.21; Barnard, A. (1889-91) op. cit. Vol. 1, p.367; and Vol. Three, pp.425-6.

28. *BJ*, 15 March 1885; Talbot, F. (1924) ‘Fifty Years' Experience of the Quality of Beer as it has Varied During that Period,' in *JIB*, 30, p.398; and Barnard, A. (1889-91) op. cit. Vol. 1, p.179.

29. In 1884, however, the editors of the *BJ* still called for the development of a universal brewing nomenclature, see 15 June 1884.

30. Barnard, A. (1889-91) op. cit. Vol. 3, p.434; and *BJ*, 15 July 1905.

31. Redman, N.B. (1995) op. cit. p.4. Whitbread's purchased R. & J. Beck's microscope in 1871 for approximately £28 approximately a week after Pasteur's visit.

32. *Country Brewers' Gazette (CBG)*, 17 January 1883. Swift & Sons' microscope was recommended to almost all of the *Brewers' Journal's* subscribers who requested information concerning such instruments from the periodical's scientific consultants.

33. SBTRO, DR 227/9. The price was comparable to several of Swift & Sons' basic models.

34. Hartley, A. (1895) ‘Practical Notes on Brewery Management,' in *Journal of the Federated Institutes of Brewing (JFIB)*, 1, p.374.

35. *BJ*, 15 August 1893.

36. SBTRO, DR 227/121. A copy of the lecture is included in Flower & Sons' scrapbook. See also *BJ*, 15 July 1912.

37. *BJ*, 15 March 1905; and Corran, T (1984) ‘William Garton,' in David Jeremy, ed., *Dictionary of Business Biography*, Vol. 2. London: Butterworths, pp.491-4.

38. Hawkins, K.H. (1984) ‘William Butler,' in David Jeremy, ed., *Dictionary of Business Biography*, Vol. 1, pp.533-5.

39. [Mitchells & Butlers], (1929) *Fifty Years of Brewing, 1879-1929.* Birmingham: Mitchells & Butlers Ltd, p.17. Although the brewery was relatively advanced in their decision to build a laboratory, all of their

coppers still lacked covers. For a description of the new buildings see the *BJ*, 15 March 1880.

40. *BJ*, 15 December 1912.

41. Interview with Dennis Flower, 1 August 1996.

42. Barnard, A. (1889-91) op. cit. Vol. 1 p.22.

43. Sigsworth, E.M. (1965) op. cit. p.550; and Anderson, R.G. (1993) 'Highlights in the History of International Brewing Science,' in *Ferment* (1993), p.197.

44. Anderson, R.G. (1993) op. cit. p.196.

45. Gourvish, T.R. and Wilson, R. (1994) op. cit. pp.82-3.

46. *BJ*, 15 March 1867.

47. *CBG*, 3 January 1883.

48. Interestingly, although the purity of water was usually determined by scientific means, brewers still employed diviners or dowsers trained in the art of rhabdomancy in order to discover underground sources, see, for example, *BJ*, 15 March 1895; 15 July 1896; 15 January 1897; 15 May 1897; 15 June 1899; and 15 February 1905. Brewers who hired diviners in these years included R. & W. Randall, Guernsey, Ashford Breweries, Kent and the Anglo-Bavarian Brewery in Shepton Mallet, Somersetshire.

49. *Birmingham Gazette*, 22 November 1895; *BJ*, 15 June 1895; and 15 December 1895.

50. Warwickshire County Record Office (WCRO), CR 1097/123; and Luckett, F., Flint, K. and Lee, P. (1982) *A History of Brewing in Warwickshire*. Warwick: CAMRA, p.34. The firm lost its water supply as a result of railway construction.

51. *Stratford Herald*, 22 November 1895.

52. ibid.; and Knox, D. (1956) 'The Development of the London Brewing Industry, 1830-1914 with special reference to Whitbread and Company.' B. Litt, University of Oxford, p.142. At Whitbread & Co., as at most other London breweries, water was pumped from a depth of approximately five hundred feet.

53. *Stratford Herald*, 16 February 1912.

54. *BJ*, 15 September 1884.

55. *BJ*, 17 February 1866; and Ure, A. (1878) *Dictionary of Arts, Manufactures, and Mines*, Vol. 1. London: Longmans, Green & Co., p.301.

56. Bailey, R.D. (1889) *Notes on Brewing: A Plain and Brief Summary of a few Theoretical and practical points which come under the notice of every brewer*. London: Sheppard and St John, p.59.

57. Sigsworth, E.M. (1965) op. cit. p.550; and Palladino, P. (1996) 'Science, technology, and the economy: plant breeding in Great Britain, 1920-1970,' in *Economic History Review*, XLIX, 1, p.119. The Guinness Research Laboratory was started in 1901 under the direction of Horace Brown.

58. The Newark maltsters Messrs Gilstrap, Earp & Company had offered similar prizes, amounting to £50, since 1889, see, for example, Brewers' Journal, 15 May 1898. By the end of the last century, these contests had become very popular in even the smallest communities and were usually held in the local corn exchange. London's largest competition, founded by Henry Stopes, took place in Agricultural Hall.

59. *Stratford Herald*, 15 September 1899. Each year approximately 50 farmers competed for the cash prizes offered by the brewery.

60. *BJ*, 15 April 1900.

61. ibid., 15 October 1883.

62. Vaisey, J. (1963) op. cit. p.89.

63. Recently, research has qualified this view. For example, see Rose, A.H.(1977) *Economic Microbiology*, Vol. 1: Alcoholic Beverages. London: Academic Press. Although hops are a preservative, lactic-acid bacteria have developed tolerances to hop substances once proven to exhibit bacteriostatic powers.

64. *BJ*, 15 October 1902. In his *Hop Judging for Brewers* (1910), C. Oscar Grindley suggests that, 'with care and little trouble a buyer by rubbing hops down and using his sense of smell, together with his sense of sight can, in most cases, become a sufficiently good judge of the intrinsic value of hops to be a guide for his purchases'.

65. Barnard, A. (1889-91) Vol. 1. op. cit. p.358.

66. Mathias, P. (1959) op. cit. p.65.

67. Kuhn, T.S. (1970) *The Structure of Scientific Revolutions.* Chicago: University of Chicago Press, p.11.

68. *CBG*, 6 June 1883.

69. Barnard, A. (1889-91) Vol. 1. op. cit. p.180.

70. *CBG*, 6 June 1883.

71. Haynes, R.D. (1994) *From Faust to Strangelove: Representations of the Scientist in Western Literature*. London: Johns Hopkins University Press, p.127; and Wiener, M.J. (1981) *English Culture and the Decline of the Industrial Spirit, 1850-1980*. London: Penguin Books, pp.17-9.

72. Sigsworth, E.M. (1965) op. cit. p.538; and Brown, H.T. (1916) 'Reminiscences of Fifty Years' Experience of the Application of Scientific Method to Brewing Practice,' in *JIB*, 22, p.270.

73. *CBG*, 6 June 1883.

74. *BJ*, 15 July 1880.

75. Herbert, J. (1872) *The Art of Brewing India Pale Ale and Export Ale, Mild Ales, Porter and Stout*. Fifth edition, Burton-on-Trent: published by the author, p.5.

76. ibid. p.5. Interestingly, Herbert also recommended Flower & Sons' ale which he regarded as `equal to the best Burton brands', see p.8.

77. *BJ*, 15 July 1867.

78. Bailey, R.D. (1889) *Notes on Brewing: A Plain and Brief Summary of a few Theoretical and practical points which come under the notice of every brewer*. London: Sheppard and St John, p.38.

79. [Whitbread] (1951) op. cit. p.11.

80. Mathias, P. (1959) op. cit. p.97.

81. Other breweries rebuilt during this period include the Tadcaster Tower Brewery, Henry Mitchell's Cape Hill Brewery, Birmingham, William Butler's Springfield Brewery in Wolverhampton, Richard Warwick's Northgate Brewery, Newark-on-Trent and Reid & Co., London.

82. SBTR0, DR 227/9

83. The need to economise on space was clearly more pressing for brewers manufacturing their product in larger cities where additional land was more costly and difficult to obtain.

84. *Stratford Herald*, 18 October 1901.

85. Vaisey, The Brewing Industry, p. 86.

86. Mathias, P. (1959) op. cit. p.19.

87. Flower, S. (1964) *Great Aunt Sarah's Diary, 1846-1892*. Stratford: Privately Printed, p.7.

88. Sambrook, P. (1996) op. cit. p.32.

89. See also Anderson, O.E.(1953) *Refrigeration in America*. Princeton, New Jersey: Princeton University Press, p.69.

90. Singer, C., Holmyard, E.J., Hall, A.R. and Williams, T.L, (1958) *A History of Technology, The late nineteenth century, c. 1850 to c. 1900*. Vol. 5. Oxford: Clarendon Press, 1, p.149; Ensor, R.C.K. (1936) *England, 1870-1914*. Oxford: Clarendon Press, p.108; and Anderson, O.E.(1953) op. cit. p.77.

91. Thévenot, R. (1979) *A History of Refrigeration throughout the world*. Paris: International Institute of Refrigeration, p.444.

92. Donnachie, I. (1979) *A History of the Brewing Industry in Scotland*. Edinburgh: John Donald Publishers Ltd, p.180.

93. *BJ*, 15 March 1881.

94. SBTRO, DR 227/141

95. *Stratford Herald*, 28 January 1870.

96. Paul, B.H. (1869) 'The Artificial Production of Ice and Cold,' in *Quarterly Journal of Science*, XXI, (1869), p.10. Considerable wastage also resulted when firms attempted to store ice. By the 1880s many brewers had given up using natural ice, especially as chemists began to realise that the element frequently contained spores, which interfered with fermentation.

97. SBTRO, DR 227/121

98. *Land and Water*, 5 March 1881.

99. *Stratford Herald*, 16 March 1883.

100. SBTRO, DR 227/110

101. Unfortunately, the diffusion of ice-making technology during this period cannot be reconstructed using journals published by the refrigeration industry, as the earliest British periodical, *Ice and Cold Storage*, was first published in 1898.

102. SBTR0, DR 227/206

103. ibid.

104. Talbot, F. (1924) op. cit. p.399.

105. ibid. p.400.

106. SBTR0, DR 227/207

107. Paul, B.H. (1869) p.10.

108. The introduction of refrigeration to Truman, Hanbury, Buxton & Co.'s plant is discussed in some detail by the brewery's former chief engineer in Scamell, G. (1871) *Breweries and Maltings: their arrangement, construction, and machinery*. London: A. Fullarton & Company. According to Scamell (p.72), 'No brewery of any size should be without ice-making machinery'.

109. Thévenot, R. (1979) op. cit. p.78.

110. ibid.

111. Teich, M. (1983) 'Fermentation theory and practice: the beginnings of pure yeast cultivation and English brewing, 1883-1913,' in *History of Technology*, 8, p.119; Molyneux, W. (1869) *Burton on Trent: its history, its waters, and its breweries*. London: Trübner & Co., p.249; Corran, H.S. (1975) op. cit. pp.223-4; Anderson, R.G. (1989) op. cit. p.341; and Brown, H.T. (1916) op. cit. p.284.

112. Sigsworth, E.M. (1965) op. cit. p.536.

113. *BJ*, 15 July 1884. See also 15 October 1889; 15 July 1890; and 15 August 1891.

114. Lynch, P. and Vaisey, J. (1960) *Guinness's Brewery in the Irish Economy, 1759-1876*. Cambridge: Cambridge University Press, pp.220-1.

115. Thévenot, R. (1979) op. cit. pp.77-8. The Carlsberg Brewery installed Linde's machine in 1879. See also Boje, P. and Johansen, H.C. (1998) 'The Danish Brewing Industry after 1800: Entrepreneurs, market structure and technology,' in T. Gourvish and R. Wilson, eds., *The Dynamics of the International Brewing Industry Since 1800*. London: Routledge, p.61. The excess capacity of the plant allowed the firm's managers, as at Flower & Sons, to pursue

such a strategy.

116. Sambrook, P. (1996) op. cit. p.163. Winter brews were larger, less frequent and stronger.

117. Corran, H.S. (1975) op. cit. p.218.

118. *BJ*, 15 December 1892.

119. ibid., 15 October 1895.

120. ibid., 15 December 1893.

121. Riley, W.A. (1919) 'Brewery Labour Problems,' in *JIB*, 25, p.163; and Wilson, R.G. (1998) 'The Changing Taste for Beer in Victorian Britain,' in T. Gourvish and R. Wilson, eds., *The Dynamics of the International Brewing Industry Since 1800*. London: Routledge, 1998, p.101.

122. Musson A.E. and Robinson E. (1969) *Science and Technology in the Industrial Revolution*. Manchester: Manchester University Press, pp.72-3.

123. SBTR0, DR 50/1

124. *BJ*, 15 December 1891.

125. ibid, 15 August 1883.

126. Gourvish, T.R. and Wilson, R. (1994) op. cit. p.62.

127. ibid.

128. *BJ*, 15 March 1911; and 15 March 1912. Mitchells & Butlers actually hired Thomas Henry Morley, the first student to graduate from the School of Brewing and Malting and the son of Birmingham University's Secretary. Morley eventually became the firm's head maltster, see ibid., 15 October 1913.

129. More, C. (1980) *Skill and the English Working Class, 1870-1914*. London: Croom Helm, p.220; see also Landes, D. (1982) *The Unbound Prometheus: Technological change and industrial development in Western Europe from 1750 to the present*. Cambridge: Cambridge University Press, p.346; and *BJ*, 15 February 1898.

130. Sigsworth, E.M. (1965) op. cit. p.539. For a discussion of the work of Burton's earliest chemists, see Morgan, N.D. (1981) *The development of biochemistry in England through botany and the brewing industry, 1840-1890*. PhD Thesis, University of London.

131. Barnard, A. (1889-91) Vol. 3. op. cit. p.148.

132. See O'Sullivan's entry in DNB. Interestingly, O'Sullivan is the only brewers' chemist listed in the reference work's numerous volumes.

133. *BJ*, 15 December 1882; and 15 March 1891.

134. SBTRO, DR 227/140

135. ibid.

136. Kamminga, H. and Weatherall, M. (1996) 'The Making of a Biochemist I: Frederick Gowland Hopkins' Construction of Dynamic Biochemistry,' in *Medical History*, 40, p.287.

137. SBTRO, DR 227/140

138. SBTR0, DR 227/103

139. *BJ*, 15 July 1912. This was the opinion of Robert Slater Boddington, who shared his views concerning brewers' educations during a trial for the wrongful dismissal of a rival's employee.

140. *CBG*, 3 January 1883.

141. ibid., 17 January 1883.

142. *CBG*, 17 January 1883.

143. SBTR0, DR 227/106

144. ibid.

145. ibid.

146. SBTRO, DR 227/106

147. ibid.

148. ibid.

149. Anderson, R.G. (1993) p.194.

150. Freeman, C. (1994) ‘The economics of technical change,' in *Cambridge Journal of Economics*, XVIII, 5, p.470.

151. Edgerton, D.E.H. (1987) ‘Science and Technology in British Business History,' in *Business History*, XXIX, 4, p.88.

152. Alter, P. (1987) *The Reluctant Patron: Science and the State in Britain, 1850-1920*. Oxford: Berg Publishers Ltd, 1987, pp.1 & 13; and Rose H. and Rose, S. (1969) *Science and Society*. Harmondsworth, Middlesex: Penguin Books Ltd, pp.33-7.

153. Bird, W. H. (1955) *A History of the Institute of Brewing*. London: W. Heffer & Sons Ltd, pp.2-3. Moritz received his training at the Royal School of Mines. His informal meetings with students evolved into the Laboratory Club with a membership of 10 in 1886, 250 in 1890.

154. By October 1894, the midland branch had 83 members, 130 in 1896, see *BJ*, 15 October 1894; and 15 February 1897.

155. Bird, W. H. (1955) op. cit. p.3.

156. *BJ*, 15 February 1867.

157. SBTRO, DR 227/121

158. Weir, R. (1995) *The History of the Distillers Company, 1877-1939: Diversification and Growth in Whiskey and Chemicals*. Oxford: Clarendon Press, p.8.

159. *BJ*, 20 October 1866.

160. Renamed the Lister Institute of Preventative Medicine in 1903.

161. SBTR0, DR 227/110. Although malt absorbs trace amounts of arsenic when dried in coke-fired kilns, in this case, arsenic came from contaminated glucose. Made by boiling rice in water and sulphuric acid, the glucose manufactured by a Lancashire firm, Bostock & Co. of Garston, near Liverpool had absorbed the iron pyrites which were used in the acid's production.

162. *BJ*, 15 December 1890. Kendall's offices were moved to 59 and 60 Chancery Lane in May 1896. Two years earlier, Kendall & Son had also opened offices in Lille, France.

163. Having standardised the water supplies of those breweries which consulted them, perhaps these chemists were also largely responsible for standardising the products brewed in England during these years.

164. SBTRO, DR 197/170

165. No. 165 *BJ*, 15 February 1909.

166. *CBG*, 4 July 1883.

167. ibid.

168. See Evans's obituary in JIB (1913).

169. *Journal of the Operative Brewers' Guild*, November 1917.

170. Lott, F.E. (1895) ‘Notes on the Training of a Brewer,' in *JFIB*, I, p.179.

171. Frankland at ‘Annual banquet of the midland section of the Institute of Brewing,' in *JFIB* (1895), p.46. Only in 1914 were practical brewers provided with a more accessible periodical of their own in the form of the *Journal of the Operative Brewers' Guild*.

172. SBTRO, DR 227/121

173. *BJ*, 15 November 1895. According to the journal's editors at the end of the nineteenth century, some brewers were still using blind thermometers in order to conceal the temperatures at which they mashed and brewed.

174. SBTRO, DR 227/106

175. SBTRO, DR 227/106

176. ibid.

177. Brown, H.T. (1916) op.c it. p.341.

178. *BJ*, 15 June 1881.

179. ibid., 15 January 1884.

180. Brown, B.M. (1934) ‘Science and the Brewer,' in *JIB*, 40, p.6.

Chapter 3

1. Drummond, D. (1989) ‘"Specifically Designed"? Employers' Labour Strategies and Worker Responses in British Railway Workshops, 1838-1914,' in *Business History*, XXI, 2, p.10. In her article, Drummond suggests railway companies regularly recruited previously-trained workers as a result of their particular labour strategies.

2. Lane, J. (1996) *Apprenticeship in England, 1600-1914*. London: University College London Press Ltd, p.231; More, C. (1980) pp.65-6; and Dearle, N.B. (1914) Industrial Training: with special reference to the conditions prevailing in London. London: P.S. King & Son, pp.79 & 237-9.

3. An employment bureau was set up specifically for brewers in 1919, see Bird, W.H. (1955) op. cit. p.24; even earlier, in 1881, an experimental brewers' employment agency was started in London by Thomas Blake, a ‘Brewery Consulting Expert and Valuer whose knowledge of the requirements of principals and brewers' assistants [had] been matured by an experience of 25 years in the trade'; see *BJ*, 15 April 1881.

4. The factors influencing the choice of occupation among London boys was investigated in detail by Berington, and published as *Occupational Misfits* (1933). The question of career choice, however, was investigated earlier by Bray, R.A. (1911) *Boy Labour and Apprenticeship*. London: Constable & Co. Ltd; and Dunlop, O.J. and Denman, R.D. (1912) English Apprenticeship and Child Labour: A History. London: T. Fisher Unwin.

5. Luckett, F., Flint, K. and Lee, P. (1982) op. cit. p.46.

6. Gilding, B. (1971) *The Journeymen Coopers of East London: Workers' control in an old London trade*. London: History Workshop, pp.i and 50; and Mayhew, H. (1982) *The Morning Chronicle Survey of Labour and the Poor: The Metropolitan Districts*, Vol. 6. Horsham, Sussex: Caliban Books, p.12.

7. Hartley, A. (1895) ‘Practical Notes on Brewery Management,' in *JFIB*, 1, pp.368-9.

8. Nevile, S.O. (1958) *Seventy Rolling Years*. London: Faber & Faber, p.11.

9. *BJ*, 15 September 1887.

10. Even these opportunities, however, had begun to decline by the end of the nineteenth century as green-meat became recognised as a luxury. Nevertheless, a number of brewers continued to turn out their horses, though usually only in summer, see Sheather, C. (1912) ‘The Care and Management of Heavy Horses,' in *JIB*, 18, p.642.

11. SBTR0, DR 227/83

12. ibid., especially 6 July-28 September 1883 and 1 July-30 September 1892.

13. ibid., DR 730/36; and DR 227/83

14. Hewins, A. (1985) *Mary, After the Queen: Memories of a working girl*. Oxford: Oxford University Press, p.14 & 24-6. This work describes class distinctions in Stratford during the interwar years better than any other history of the town; SBTRO, DR 730/15; and interview with Eddie Booker, 25 June 1996.

15. Riley, W.A. (1919) op. cit. p.149.

16. Booth, C. (1970) *Life and Labour of the People in London*, Vol. 3. New York: AMS Press, Inc., p.114.

17. Clerks are included in this and the remaining samples.

18. Hewins, A. (1985) op. cit. p.14.

19. Reinarz, J. (1996) *A History of Dorsington*. London: Noctua Press, pp.81-2; and *Stratford Herald*, 21 July 1916; 15 September 1916; and 13 October 1916.

20. SBTRO, DR 730/25

21. ibid., DR 227/106

22. SBTRO, DR 227/83

23. ibid.; and DR 227/98-99

24. *Stratford Herald*, 26 February 1897.

25. SBTRO, DR 227/110

26. ibid.; and interview with Eddie Booker, 25 June 1996.

27. Nevile, S.O. (1958) op. cit. pp.29-30.

28. Coventry City Record Office (CCRO), 919/2/20

29. Musson A.E. and Robinson E. (1969) op. cit. p.207. Despite recent criticisms of this practice, Horace Brown, one of the most respected chemists working in the brewing trade at this time, often spoke of the advantages conferred by a 'thorough classical, literary, and mathematical education'. In a lengthy article published by the JIB in 1916, Brown suggested such an education was a necessary balance to scientific training. If given a choice between these forms of instruction, he favoured that of the *literae humaniores*, see Brown, H.T. (1916) op. cit. p.345.

30. See, for example, Chandler, Jr., A.D. (1977) *The Visible Hand: The Managerial Revolution in American Business*. Cambridge, Massachusetts: Betknap Press, pp.292-3; Wiener, M.J. (1981) op. cit. pp.22-4; LeGuillou, M. (1981) 'Technical Education, 1850-1914,' in Gordon Roderick and Michael Stephens, eds., *Where Did We Go Wrong? Industrial Performance, Education and the Economy in Victorian Britain*. Barcombe, Sussex: Falmer Press, p.173; Pollard, S. 'Entrepreneurship, 1870-1914,' in R. Floud and D. McCloskey, (eds.), *The Economic History of Britain since 1700, Vol. Two: I860-1939*. Cambridge: Cambridge University Press, pp.75-6; and Godley, A. and Westall, O.M. (eds.) (1996), *Business History and Business Culture*. Manchester: Manchester University Press, p.192.

31. Flower, S. (1964) op. cit. p.4.

32. ibid., p.5.

33. Joyce, P. (1982) *Work, Society and Politics: The Culture of the Factory in Later Victorian England*. London: Methuen & Co., p.24.

34. Pollard, S. (1965) *The Genesis of Modern Management: A Study of the Industrial Revolution in Great Britain*. London: Edward Arnold Ltd, p.109.

35. Flower, S. (1964) op. cit. p.4.

36. ibid.

37. ibid., p.6.

38. ibid. Despite the family connection, contact between the Fordham and Flower families was irregular after Charles's visit to the firm.

39. *Stratford Herald*, 20 July 1888.

40. Curtis, G. (1970) *A Chronicle of Small Beer: The Early Victorian Diaries of a Hertfordshire Brewer*. London: Phillimore, 1970, p.25.

41. ibid., p.31.

42. ibid., p.32.

43. Wilson, R.G. (1983) op. cit. p.61.

44. Pudney, J.A. (1971) *Draught of Contentment: The Story of the Courage Group*. London: New English Library, p.96; and Barnard, A. (1889-91), Vol. 4, p.10.

45. Interview with Dennis Flower, 1 August 1996.

46. Dearle, N.B. (1914) *Industrial Training: with special reference to the conditions prevailing in London*. London: P.S. King & Son, pp.347-9.

47. Gourvish, T.R. (1987) *Norfolk Beers from English Barley: A History of Steward & Patteson, 1793-l963*. Norwich: Centre of East Anglian Studies, p.83.

48. SBTRO, DR 227/110

49. ibid.

50. ibid.

51. ibid., DR 227/106

52. Mathias, P. (1959) op. cit. p.23.

53. ibid., pp.23-4.

54. Lane, J. (1996) op. cit. p.23.

55. SBTRO, DR 227/110. The last correspondence contained in the private letter book is dated 9 June 1904. Letters do not refer to pupils after Best's arrival. Consequently, arrangements governing brewing apprenticeships after this date are unknown.

56. SBTR0, DR 227/106

57. ibid.

58. *BJ*, 15 July 1898. The London brewers also charged pupils £200 for an apprenticeship lasting two years.

59. SBTR0, DR 227/110

60. Lane, J. (1996) op. cit. p.2.

61. Flower, S. (1964) op. cit. p.1.

62. SBTR0, DR 227/110

63. ibid.

64. SBTRO, DR 227/106

65. ibid., DR 227/110

66. ibid., DR 227/106

67. More, C. (1980) op. cit. pp.70-1.

68. SBTRO, DR 227/140

69. Janes, H. (1963) *The Red Barrel: A History of Watney Mann*. London: John Murray, p.129.

70. Howell, G. (1877) 'Trade Unions, Apprentices, and Technical Education,' in *Contemporary Review*, XXX, p.72; and More, C. (1980) op. cit. p.47. In the printing trade, for example, apprenticeship was regarded as a way for masters to obtain cheap labour. For a complete description of this argument see Skingsley, T.A. (1979) & (1980) 'Technical Training and Education in the English Printing Industry' Part 1 & 2 in *Journal of the Printing Historical Society*.

71. Dunlop, O.J. and Denman, R.D. (1912) op. cit. p.309.

72. SBTRO, DR 227/106

73. ibid.

74. ibid., DR 227/110

75. ibid. Although Brodie learned about the cooper's work, he was not permitted to perform it himself. Coopering had been protected by legislation in England at an early date in the Act 23 HVIIIc.4.

76. SBTR0, DR 227/110. These details were described in a letter dated 30 May 1899 from Francis Lawrence Talbot to Charles Tetley.

77. This topic is outlined in greater detail in the previous chapter.

78. SBTRO, DR 227/110. Fellows's progress was reported in an anonymous letter to his father dated 1 December 1902.

79. ibid., DR 227/106

80. ibid.

81. SBTR0, DR 227/106

82. Knox, D. (1956) op. cit. p.150. Other universities and colleges which provided courses relevant to brewers included King's College, London, where Dr R.T. Hewlett gave courses in bacteriology, University College London, whose Demonstrator of Applied

Chemistry, Alfred Chapman, carried on a series of lectures commenced by Charles Graham and the Manchester Municipal School of Technology which received a model brewing plant in 1903 in order to aid the instruction of pupils, whose numbers reached fourteen in that year, see *Brewers' Journal*, 15 February 1903. Heriot Watt's now well-known laboratory for research in bacteriology and fermentation was opened in 1905 under Dr Emil Westergaard, see *BJ*, 15 August 1905; 15 October 1905; and 15 November 1905.

83. Most of the chemists active in the trade during the middle of the nineteenth century had obtained their chemical knowledge by attending classes at the Royal School of Mines shortly after it was set up in 1850 to train mining inspectors, see, for example, entry for O'Sullivan in DNB.

84. *BJ*, 15 December 1884,

85. By the 1890s, the list of chemists who offered to instruct brewing pupils appeared endless. Just some of those consultants who provided these services included Basil William Valentin F.C.S. in Birmingham, Messrs Matthews and Lott and Frank Thatcher in Burton, Drs A.K. Miller and W.L. Hiepe in Manchester, and F.W. Fellowes, the Newland brothers, Arthur Ling, Messrs Jewson and Senior (formerly of Gillman & Spencer), all originally based in London. A few fortunate pupils even took courses offered by Professor Alfred Jorgenson at his Carlsberg laboratory in Copenhagen, see *BJ*, 15 July 1894.

86. Interestingly, a number of consultant chemists who instructed pupils in chemistry as it applied to the brewing trade had largely educated themselves. For example, Gordon Salamon had established a laboratory in his father's house and Adrian Brown cultivated barley in his own garden, see, for example, their obituaries in *JIB* (1918) and (1919), respectively.

87. *BJ*, 15 November 1890.

88. *BJ*, 15 November 1891; and 15 October 1898.

89. ibid., 15 July 1885.

90. See, for example, Bowly, J.E. (1896) ‘The Consulting Brewer, his Dangers and his Uses, with some Practical Brewing Notes,' in *JFIB*, 2.

91. Hodson during ‘Meeting of the Midland Counties Institute of Brewing, 18 January 1900,' in *JFIB* (1900), p.88; and *BJ*, 15 July 1898. Birmingham brewers contributed approximately £20,000 to the scheme. Many other midland brewers, however, also contributed to the school under a scheme known as the Birmingham University Fund. Flower & Sons, for example, donated the standard £250, divided into five equal payments made over five years, see SBTRO, DR 227/10; and *BJ*, 15 October 1899.

92. Hodson during ‘Meeting of the Midland Counties Institute of Brewing,' in *JFIB* (1900), p. 91. In comparison, Berlin's brewing school attracted 32 when it opened in 1883, 42 in 1890, see *BJ*, 15 May 1890. Like the Birmingham school, it had an experimental brewery, but its students were chiefly older men, brewers and managers.

93. ibid.

94. Stanley-Smith, W. (1902),’`Labour in the Brewhouse,' in *JFIB*, 8, p.131.

95. *BJ*, 15 February 1898.

96 Talbot, F. (1924) op. cit. p.405.

97. *BJ*, 15 June 1901. Three years later only 15% of candidates failed, November

1904. See ibid., 15

98. *Stratford Herald*, 9 February 1900; and 25 May 1900; Interestingly, in its first years, the school did not have sufficient subscriptions to carry out the whole scheme.

99. *BJ*, 15 June 1884.

100. Pringle, M.J. (1994) *Theatres of Stratford-upon-Avon, 1875-1992*. London: Trinity Press, p.14; and Beauman, S. (1982) *The Royal Shakespeare Company: A History of Ten Decades*. Oxford: Oxford University Press, pp.13-14.

101. Hodson during 'Meeting of the Midland Counties Institute of Brewing,' in *JFIB* (1900), p.92.

102. *BJ*, 15 January 1900.

103. *BJ*, 15 August 1901.

104. Nevile, S.O. (1958) op. cit. p.29.

105. Heron established his consultancy in London in 1895. Originally educated at the Royal College of Chemistry, Heron was an assistant to Horace Brown at Worthington's before being appointed head chemist to the Anglo-Bavarian Brewery in 1883 and Garton, Hill & Co. in 1885, see Heron's obituary in *Brewers' Journal*, 15 April 1913.

106. Nevile, S.O. (1958) op. cit. p.39.

107. Courage Archives (CA), CA/C/221-3; *BJ*, 15 August 1893; 15 August 1894; and 15 October 1899.

108. CA, CA/B/8

109. SBTRO, DR 227/106. The most influential of such changes during this period was the introduction of the Malt Tax in 1880. The way this affected production at Flower & Sons is described in the previous chapter in greater detail.

110. ibid., DR 227/110

111. SBTR0, DR 227/106

112. ibid.

113. ibid.

114 SBTRO, DR 227/106

115. ibid, DR 227/110

116. SBTRO, DR 227/110

117. ibid.

118. ibid., DR 227/106

119. Ibid.

120. ibid.

121. ibid., DR 2271110

122. According to the *Times*, 26 October 1996, the tradition continues only at Theakston's brewery in Masham, North Yorkshire.

123. [Mitchells & Butlers], (1929) op. cit. p.35. This involved pouring a pint of ale and a handful of wood shavings over the head of a cooper's apprentice before sealing him in a cask and rolling him around the brewery yard; see also Gilding, B. (1971) *The Journeymen Coopers of East London: Workers' control in an old London trade*. London: History Workshop, p.54; and Childs, MJ. (1992) *Labour's Apprentices: Working-Class Lads in Late Victorian and Edwardian England*. London: The Hambledon Press, p.83.

124. SBTRO, DR 227/84; Interview with Dennis Flower, 1 August 1996; and CA, BA/S/10. According to Booth, as opposed to conditions in Stratford, the terms governing the apprenticeship of London coopers was strictly enforced for seven years at this time, see Booth, C. (1970) op. cit. Vol. 1, p.255. On the other hand, some coopers believed apprenticeship in general needed to be revived by the end of this period, see Sweatman, H.C. (1916) 'The Work of a Brewery Cooperage,' in *JIB*, 22, p.188.

125. SBTRO, DR 227/84

126. SBTR0, DR 227/84

127. ibid.

128. ibid., DR 227/85

129. Board of Trade, Report on Trade Unions (1902).

130. CA, EH/M/5

131. Gilding, B. (1971) op. cit. p.50.

132. ibid., pp.52-3.

133. Mayhew, H. (1982) op. cit. p.13.

134. Booth, C. (1970) op. cit. Vol. 1, p.263.

135. The Webbs in Gilding, B. (1971) op. cit. p.81.

136. SBTR0, DR 227/110

137. Hewins, A. (1981) *The Dillen: Memories of a man of Stratford-upon-Avon*. London: Elm Tree Books, p.44.

138. SBTR0, DR 227/84. Whether it was as easy to dismiss a cooper's apprentice is uncertain. The ledger does not reveal the reasons for Megainey's dismissal.

139. SBTRO, DR 730/38

140. Donnachie, I. (1979) op. cit. p.34.

141. Green, F.E. (1920) *A History of the English Agricultural Labourer, 1870-1920*. London: P.S. King & Son Ltd, p.4. Not surprisingly, Wynn's (1993) history of the farm workers' union is entitled *Skilled at all Trades: The history of the farmworkers' union, 1947-84*. London: TGWU.

142. More, C. (1980) op. cit. p.32.

143. SBTR0, DR 227/84

144. ibid., DR 227/83. Only after the First World War were women regularly recruited to this department at Flower & Sons.

145. ibid., DR 227/84

146. ibid.

147. SBTRO, DR 227/84. Presumably, he did more than simply carry refrigerator components into the brewery. Having entered the trade in 1879, Walsey was middle-aged by this date and would not have been used for his physical strength alone.

148. ibid., DR 227/85

149. Webb, S. and Webb, B. (1913) *Industrial Democracy*. London: Longman, Green & Co., p.liv.