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# Impact of Mechanization in the Glass Container Industry: The Dominion Glass Company of Montreal, a Case Study.

## ABSTRACT

Development of automatic bottle blowing machines during the early decades of the 20th century revolutionized the glass container industry. Mechanization brought about standardization in bottle shapes, color, and closure types. By the early 1930s the variety of bottle shapes available had been greatly reduced, colorless glass had replaced light green and amber glass, and the cork was giving way to metal and plastic closures. This paper follows the process of standardization through the records of the Dominion Glass Company of Montreal.

## Introduction

Machine made bottles have been the dominant type of glass container available for well over half a century. The rapidity with which the transition from hand production to machine production took place has been discussed in several sources and the technology has been described in detail (Barnett 1926, Jerome 1934, Meigh 1934, Miller and Sullivan 1981). However, little has been written on the impact the new technology had on the kinds of bottles produced. Archaeologists have been content to drop concern for bottles once they have been identified as machine made, much as one would separate the sheep from the goats. It is time that archaeologists begin to consider what effects the new mode of production had on glass containers. This paper will concentrate on standardization of containers, closures, glass color and bottle forms of machine-made glass containers from their introduction in 1904 into the 1930s. Examination of the impact of the bottle-blowing machine will rely heavily on the records of the Dominion Glass Company.

Dominion Glass Company Limited of Montreal was, and still is, one of the two major glass container manufacturers in Canada. The company evolved during the last quarter of the 19th century and the early years of this century. No less than 10 different companies in three Provinces were united into one dominant company in 1890. This group was incorporated as Diamond Glass Company Ltd. of Montreal (Rottenberg and Tomlin 1982: 5–22 and King 1965). In 1903 the Company became Diamond Flint Glass Company Ltd. and finally in 1913 it became Dominion Glass Company Ltd. In 1975 the company name was changed to Domglas Ltd. Since 1890 on, this group of companies has been one of the dominant producers of glass containers in Canada. The other major manufacturer, Consumers Glass Company Ltd. of Montreal did not begin production until 1917 (Rottenberg and Tomlin 1982:17).

One factor that helped keep the Dominion Glass Company a major producer in Canadian glass production in the 20th century was the acquisition of exclusive rights to the Owens automatic bottle blowing machine in Canada. This was done in 1906, just a few years after the machine began being manufactured (Rottenberg and Tomlin 1982:16). It is the impact of the Owens machine that the author examines in this paper. Fortunately for researchers dealing with Canadian glass history, a large body of papers of the Dominion Glass Company have been deposited in the Public Archives of Canada. This was due to the efforts of Tom King, the former Secretary-Treasurer of Domglas Ltd.

Two particular sets of records in the Dominion Glass Company papers provide an insight into the impact of the Owens machine on the production of glass containers. The first is a 1926 inventory of 10,926 bottle moulds from one of the company's plants. Internal evidence in the mould list, such as mould numbers, compared with published mould lists from earlier catalogs, indicates that the 1926 inventory was of the Hamilton plant. From examination of the mould list, it also appears that moulds in that inventory represent an accumulation of moulds from at least five glass factories that operated in Toronto and Hamilton which became

Dominion Glass Company in 1914. For a detailed discussion of this see "Some notes on Dominion Glass Company's bottle mould numbers" (Miller and Jorgenson 1982).

The second set of records is a 1933 inventory of bottles on hand in various Dominion Glass Company plants (Dominion Glass Co. 1933). Because this inventory is long, only the inventory from the Hamilton Plant will be considered. Apart from having both inventories available, there are other reasons for centering this study on the Hamilton plant. One is that the Hamilton plant of the Dominion Glass Company is the successor to a series of take overs and amalgamations of five glass plants that were in operation during the period of hand production (Table 1). Mould numbers in the 1926 inventory occur in glass catalogs dating from to ca. 1896–98 (Beaver Flint Glass Company 1896–8:55–57). It is conceivable that hand moulds in the 1926 inventory could be from any of the following factories (Table 1)

| | |
|---|---|
| Hamilton Glass Works | 1865–1891 |
| Burlington Glass Works | 1874–1885 |
| Toronto Glass Company | 1893–1897 |
| Diamond Glass Company | 1891–1903 |
| Diamond Flint Glass Company | 1903–1913 |
| Dominion Glass Company | 1913 on. |

In short, the 1926 mould inventory could represent 60 years of accumulated bottle styles and social tastes. At a minimum it represents a 30 year accumulation. The other important factor about the Hamilton plant is that it was the first glass plant in Canada to be equipped with the Owens automatic bottle-blowing machine. This took place in 1907; just four years after the machine was developed in Ohio and before it was introduced into Europe.

Unfortunately the 1926 mould list and the 1933 bottle inventory contain different types of information which limits direct comparisons between the two documents. However, with some analysis, the two lists portray the changes taking place in the

TABLE 1
POSSIBLE AND PROBABLE ORIGINS OF THE MOULDS IN THE 1926 HAMILTON PLANT INVENTORY.

| Company | Dates | Place | |
|---|---|---|---|
| Hamilton Glass Works | 1865–1891 | Hamilton | Purchased by Diamond Glass Company in 1891. |
| Hamilton Plant, Diamond Glass Company later Diamond Flint Glass Company | 1891–1897 | Hamilton | Run by Diamond Glass Company of Montreal, closed in 1897, men & equipment moved to Toronto Plant. |
| Hamilton Plant, Diamond Flint Glass Company later Dominion Glass Co. | 1907–to present | Hamilton | After being closed for 10 years, the plant was refitted for production on the Owens bottle blowing machine. |
| Burlington Glass Works | 1874–1885 | Hamilton | Purchased by the Hamilton Glass Works in 1885. |
| Burlington Glass Works | 1885–1891 | Hamilton | Run by the Hamilton Glass Company until 189? when they were purchased by the Diamond Glass Company. |
| Toronto Glass Company | 1893–1897 | Toronto | Purchased by Diamond Glass Company in 1897. |
| Toronto plant Diamond Glass Company later Diamond Flint Glass Company | 1897–1913 | Toronto | Run by Diamond Glass Company of Montreal. |
| Toronto plant, Dominion Glass Company | 1913–1920 | Toronto | Run by Dominion Glass Company of Montreal until they closed the plant in 1920. |

Source: (Rottenberg and Tomlin 1982:5-10)

glass container industry during mechanization. To better understand the limitations of these two sources, it is necessary to describe the types of information they contain.

First the 1926 mould list consistently presents the following types of information:

1. The name of the bottle e.g., Philadelphia oval, French square, Heinz catsup. etc.
2. The number of moulds of each type, e.g. 2 hand, 5 sets of Owens, 1 Teeple-Johnson, 3 O'Neill, etc.

In addition the bottle's capacity is given, and the occasionally mould number is listed. The mould number can provide the link between bottles with mould numbers blown into the base and their descriptions in printed catalogs. Unfortunately, it is not possible to tell which moulds are in active use as opposed to just being in storage. Probably by World War II many of the hand moulds would have been contributed to scrap metal drives. Almost one quarter of the 10,926 moulds were for hand production. The remaining 8,386 moulds belonged to the Owens machine and the following types of semiautomatic machines: Olean, O'Neill, Miller, Teeple-Johnson, and side-lever-press.

The other major primary source for this examination of machine-made bottles is the 1933 inventory of bottles warehoused at the Hamilton plant. This inventory contained the following types of information:

1. The name of the bottle: e.g., Heinz Catsup, Ball Neck Panel, square pickle, etc.
2. The type of finish—e.g., cork, crown, continuous thread, screwtop, etc.
3. The color of the glass—i.e., flint, amber, opal, blue.
4. Type and size of boxes for the bottles.
5. Quantities of bottles on hand.
6. Price per gross of the bottles.
7. Total value.
8. Whether or not the bottles were stock or produced on contract.
9. Age of bottles; in over 90% of the listing, age was not given, suggesting the bottles were fairly new. One group of bottles which was 3 1/2 years old was listed as being of no value. Probably less than 1/10 of 1% of the bottles were over five years old.
10. Where the bottles were produced—e.g., which Dominion Glass plant.

In addition to this information the description sometimes gives the bottle capacity and occasionally the bottle mould numbers.

Unfortunately the 1933 bottle inventory provides almost no information about the technology used to produce the bottles. In one case a group of bottles is labelled hand made. Perhaps by 1933 the Owens Machine was so dominant that it was not necessary to record how the bottles were made.

Using the 1926 Mould list, the 1933 bottle inventory and printed glass company catalogs, the following areas of impact will be examined:

1. Standardization of glass containers.
2. Color of Glass containers.
3. Closures for glass containers.
4. Style and form of glass containers produced on the machine.

## Standardization

Standardization of glass containers can be partly illustrated by comparing the hand moulds with the machine moulds in the 1926 inventory. The 10,926 moulds in the inventory represent 3,106 types and sizes of bottles or about 3.5 moulds per bottle type. By 1926 the Owens bottle blowing machine had been in production for 20 years and was the dominant mode of production. Hand production, in the United States, accounted for less than 10% of the glass containers produced in 1917 and by 1925, hand production was close to nil (Miller and Sullivan 1981: 8–10). Mechanization of the glass industry in Canada closely followed that of the United States. Despite the large number of hand moulds in the 1926 inventory, hand production for that period was probably less than two percent of the glass containers produced. Hand production of bottles was limited to small runs of speciality bottles, such as perfume and toiletries. During this first 20 years of machine production, the impact can be seen by the fact that only 12% of the bottle types could be produced by hand and machine. Almost half of the bottle types, 48% to be exact, could only be hand made. Clearly the bottle blowing machine was not just introducing a new technology. It was a factor in changing the shape and form of bottles. Still another way to look at this is to look at the number of moulds per bottle type. Machine moulds averaged 6.3 per bottle type, while hand moulds only averaged 1.2 moulds per bottle type. In other words, there were four times as many machine moulds per bottle type as hand moulds. Hand moulds accounted for only 23% of the moulds in the 1926 list, yet they could

produce 60% of the types of bottle types in the inventory. Standardization of shape and size was being imposed by machine production.

In the pre-machine period the flexibility of hand production promoted a great diversity in bottle types by accommodation to the market for small runs of specialized bottles. The Owens Machine was an instrument of mass production and could not accommodate small runs (Miller and Sullivan 1981:9–10). Therefore, it caused a decrease in the diversity of bottle types as those which were not popular went out of production. The standard types produced by the machine depended on paper labels for product identity rather than the shape of the bottle.

Transition from hand production to machine-made bottles brought about basic changes in the glass industry's ability to market specialized containers to small customers. Prior to mechanization, glass factories commonly produced moulds for customers who wanted a unique bottle shape for their product. For example, the Agnew Company glass catalog of 1894 states: "Moulds furnished at cost of from ten to fifty dollars each." (Pyne Press 1972:72). Most late 19th century glass makers catalogs contain instruction for ordering special moulds by sending in a carved wooden model with the capacity written on it. These early catalogs rarely mention a minimum order for bottles from private moulds.

If a private mould was too costly, the glass factories had a cheaper version of specialized moulds which was the plate mould. Plate moulds had a removable section that could be replaced by a plate with the customer's name, logo or product name engraved on it. Thus the customer could have a stock bottle shape with his name, product or other message blown in the glass. Engraved plates in a catalog from ca. 1928 cost $4.00 each (Richards Glass Company ca. 1928 Hectograph sheet page 6). Plate moulds were cheaper and thus common for milk, beer, pop, and a variety of pharmaceutical bottles, such as ovals, blakes, and panels. The plate-moulded bottle was a standard item of production in the last quarter of the 19th century and continued into the 1920s.

Some idea of how common these specialized bottles were can be gained from an old glass worker's description of the Toronto Glass Works which was closed in 1920.

> The Hand Shop made considerable prescription ware, for which line we had hundreds of plates (to be used in plate moulds) mostly all engraved in script lettering. In fact, we had one letter cutter in the Machine Shop doing nothing else. (Stevens 1967:20–21)

Prescription ware remained the preserve of hand blowers through the first decade of the 20th century. In fact, the first prescription ware produced on an Owens machine was a six ounce oval bottle at the Hamilton plant of the Canadian Glass Company in 1909 (Walbridge 1920:80). However, even as late as 1912 when the Dominion Glass Company introduced their King Oval bottle, they started out with moulds for hand production (Richards Glass Company 1924:5 and the 1926 mould list).

While hand production of ovals continued into the 1920s and possibly the 1930s, the marketing of plated moulds began to be restricted. This was the result of the Owens Machine's limitations in the production of small runs of bottles. A Dominion Glass Company price circular for baby feeding bottles, dated 13 July 1925, states that the minimum acceptable order for special mould bottles made by machine was 50 gross, i.e., 7200 bottles (Dominion Glass Co. 1921–1926). For hand production, the minimum was half a day's work. If the customer ordered a stock bottle no minimum order was required. Unfortunately the circular does not indicate how many gross could be blown in half a day. Information on minimum orders for hand blown prescription ware from ca. 1928 suggests that a shop of glass blowers could produce between 8 and 17 gross a day, depending on the bottle size (Richards Glass Company ca. 1928: hectograph 6).

Because prescription ovals with individual druggist's plates were an important part of merchandising bottles, there is more price information available on them. Three early 20th century catalogs provide data on the rising cost of pharmacy ovals. What was extracted from these catalogs was the cost a druggist would have to bear if he wished to

have the name of his drug store moulded into his pharmacy ovals in the sizes commonly used in the trade. Those sizes were: 1/2, 1, 2, 3, 4, 6, 8, 12, and 16 ounce capacities.

The Diamond Flint Glass Company catalog, which dates between 1907 and 1913, discounted pharmacy ovals with name plates at 45%, whereas those without name plates were discounted 50%. To get that discount the druggist had to order in 10 case lots. The smaller bottles came 5 gross to the case, while the largest ones were 1 gross to the case. Therefore, 10 cases of ware, including at least 1 case each of the 9 sizes previously listed, would have cost $72.60 after the discount and would total 28 gross of bottles weighing approximately 1180 pounds.

A Dominion Glass Company's Druggists Glassware Catalogue No. 12, published between 1915 and 1920, had the same catalog price for prescription ovals but the information on discounts and minimum orders is missing. However, the number of gross per case was smaller in six of the sizes. If the minimum order was still a 10 case lot and the discount remained the same, then a druggist could have all 9 sizes of the prescription ware with his name on it in 21 gross costing $50.27 and weighing only 794 pounds.

The last catalog (ca. 1928) is from the Richards Glass Company. This company was a jobber that distributed Dominion Glass bottles and other wares to the drug trade. In their catalog the minimum order is specified for each size bottle for wares with name plates. For a druggist to cover the minimum order size and have all nine sizes, he would have to order 111 gross of bottles at a cost of $789.41, including corks. These bottles would come in 159 cartons weighing 5776 lbs. That is almost 16,000 bottles. In short the druggist would have a large chunk of capital "bottled up" just to have his name blown into his prescription ovals. It is not surprising that druggists switched to printed paper gummed labels. In addition, these plate-mould, hand-blown bottles were 71% more expensive than machine-made bottles with screw caps that could be ordered one case at a time.

Clearly by the 1920s, the era of small local firms having customized bottles for their products and trade was over. Only large companies and chain stores that could order 50 to 100 gross of bottles at a time could have specialized bottles at machinemade prices. Unique bottles became the option of large companies that had something approaching a national or international market: companies like Heinz, Coca-Cola, Cross & Blackwell, and Lea & Perrins. Smaller firms such as local drug stores, breweries, and dairies had to purchase stock bottles, which were available in less variety than during the old hand production era, and they had to depend on paper labels to give their product a distinctive appearance.

Once again, prescription ovals will be used to illustrate this point. Dominion Glass Company's *Druggists' Glassware Catalogue No. 12*, published sometime between 1915 and 1920, offers 17 different styles of prescription ovals, almost all of which were available in at least 7 different sizes. Table 2 lists these ovals along with moulds for ovals from the 1926 inventory from the Hamilton Plant and the number of oval bottles on hand in the 1933 inventory of the same plant. These three sources list 26 styles of stock ovals which were available in sizes ranging from 1/2 to 16 ounces. Less than 1/3 of the styles made it into machine production to a significant extent, and only 8 of the 26 types were on hand as open stock in 1933 (Table 2). Furthermore, a full range of sizes were on hand in only three styles, i.e., King, Queen, and the Prince of Wales ovals. In other words the variety of stock ovals available to druggists by 1933 was reduced to three or four styles, whereas before 1920 there were at least 16 styles to choose from.

In addition to the stock ovals, there were private oval moulds for such companies as Richardson Glass Company, Rexall Drug Company, Northrop and Lyman Ltd, and others involved as wholesale jobbers to the pharmacy trade. These private moulds were not listed in Dominion Glass Company Druggist Glass Ware catalogs because they were not for general sale to the public. Therefore it is not possible to tell whether the choices available in jobbers' ovals was increasing or decreasing. In the 1933 inventory, private mould jobbers accounted for just under 1/3 of the ovals with the

TABLE 2
GLASS CONTAINER SHAPES BY COMPANY

| | ca 1915 to 1920 ca | 1926 Mould Inventory Hamilton Plant | | 1933 Inventory of Bottles, Hamilton Plant | |
|---|---|---|---|---|---|
| Type of Oval | Number of sizes listed in Dominion Glass Co. cat. #12 druggists ware | Number of sizes for which there were hand moulds | Number of sizes for which there were owens moulds | Number of sizes in stock | Quantity of bottles in stock, all sizes of the type |
| Beaver oval | 10 sizes | | | | |
| Danzee oval | 7 sizes | 3 sizes hand | | | |
| Diamond oval | 9 sizes | 9 sizes hand | | | |
| Excellisor oval | 9 sizes | 9 sizes hand | | | |
| Montreal oval | 7 sizes | 5 sizes hand | | | |
| Wallaceburg oval | 7 sizes | 9 sizes hand | | | |
| Acme oval | | 7 sizes hand | | | |
| Empire oval | | 10 sizes hand | | | |
| Imperial oval | | 6 sizes hand | | | |
| Princess oval | | 6 sizes hand | | | |
| Victory oval | | 6 sizes hand | | | |
| Yankee oval | | 7 sizes hand | | | |
| Dominion oval | 8 sizes | 8 sizes hand | 1 size owen | | |
| Erie oval | 9 sizes | 9 sizes hand | 1 size owen | | |
| Philadelphia oval | 9 sizes | 9 sizes hand | 1 size owen | | |
| Pharmacy oval | 9 sizes | 9 sizes hand | 1 size owen | | |
| Toronto oval | 7 sizes | 6 sizes hand | 1 size owen | | |
| Plain oval | 11 sizes | 10 sizes hand | 2 size owens | 2 sizes | 672 dozen |
| Union oval | | 5 sizes hand | 2 size owens | 1 size | 78 dozen |
| National oval | | 6 sizes hand | 4 size owens | 2 sizes | 1,104 dozen |
| Ideal oval | 9 sizes | 9 sizes hand | 7 size owens | | |
| London oval | 9 sizes | 9 sizes hand | 8 size owens | 3 sizes | 642 dozen |
| Handy oval | 3 sizes | 4 sizes hand | 4 size owens | 3 sizes | 1,140 dozen |
| King oval | 9 sizes | 10 sizes hand | 9 size owens | 10 sizes | 14,988 dozen |
| Queen oval | 9 sizes | 9 sizes hand | 9 size owens | 9 sizes | 21,169 dozen |
| Prince of Wales oval | | | | 8 sizes | 2,124 dozen |

Sources: Dominion ca 1915–1920
Dominion 1926
Dominion 1933

following types listed: Rexall oval, Nalco oval, National Drug oval, New Rigo oval, Tamblyns Atlantic oval, Drug Corporation Certified oval, and Parke Davis oval.

Factors leading to a reduction in the variety of bottles being produced included the following.

1. The high cost of making a set of moulds for the Owens machine; this would have included a finish mould, parison mould, and blow mould for each type and size.
2. A desire on the part of the manufacturer to have longer production runs to increase productivity. For example if one mould is to be changed on a 15 arm Owens machine, the whole machine has to be shut down thus taking 15 moulds out of production. Owens bottle-blowing machines produced bottles at rates ranging from 28 to 60 per minute depending on the size of bottle being made (Walbridge 1920:99). Therefore, the downtime was kept to a minimum. In addition to lost production during the time it took to change moulds, the machine had to be adjusted when the moulds were changed. This adjustment period generally produced more rejected bottles un-

til the mould got to the right temperature and optimum running speed for the machine.

3. Some bottle shapes are more advantageous for machine production because they produce fewer rejects in addition to allowing the machine to run at full capacity. Industry studies recommended that unusual or "Bastard" shapes be avoided because they are hard to handle, and that square or rectangular shapes, flats or panels and offsets should be avoided because they are not as strong as rounded shapes (Holscher 1953:374). This group of shapes, however were popular during the hand blown period of production.
4. The amount of glass used. Slight design changes from standardized round bottles can increase the amount of glass used by 10 to 20% (Holscher 1953:375).

In addition to factors related to the mode of production, there was pressure toward standardization from bottlers and packers who purchased and used glass containers. Some of the machines that bottles had to be accommodated to once they left the glass manufacturer's hands included " . . . a great variety of mechanical handling devices—washing machines, washing machine pockets, brush spindles, inside brushes, fillers, filling tubes, cappers, pasteurizers, labelers, conveyers and cartoners, . . . " (Holscher 1953:374).

All of the above factors worked towards standardization of commercial glass containers and a reduction of styles of bottles available as open stock. Specialized bottles became the option of companies that could accomodate orders of 50 to 100 gross.

## Color

Standardization of shapes was matched by standardization in the color of glass used in the bottles. By far the dominant color of the bottles in the 1933 Hamilton inventory is "flint," which would be a colorless non-lead glass. Development of a cheap colorless glass for commercial containers dates from the 19th century. Except for "black glass wine" bottles, the common color for 19th century glass containers was a light green or amber caused by the presence of various amounts of iron impurities in the sand used to make the glass. Iron is an extremely common impurity and glass makers could deal with it in one of five ways:

1. Accept whatever color of glass that came out of the crucible.
2. Lighten the tint by better oxidation of the glass batch.
3. Mask the iron tint with other metallic oxides, such as cobalt.
4. Secure sand containing as little iron as possible, a common approach.
5. Neutralize the light greet tint with the light pink or purple tint from manganese or selenium.

In 1864, William Leighton of Wheeling, West Virginia, developed a good colorless soda-lime glass, which essentially replaced lead glass in the production of cheap pressed glass tableware (McKearin and McKearin 1948:142). This colorless glass also made inroads in the container market for druggists' ware (Whitall, Tatum & Co. 1880:5). Other types of commercial containers also began to be made in colorless glass which the manufacturers called flint glass as opposed to green glass.

Good colorless soda-lime glass was dependent on using fairly iron free raw ingredients such as sand and limestone. This meant that many glass manufacturers had difficulty producing a colorless glass. Small amounts of iron impurities were overcome by using manganese dioxide to counter the light green tint caused by the iron oxides in the glass. The use of manganese dioxide as a decolorizer became common during the last quarter of the 19th century for commercial containers but seems to have stopped around World War I. Some sources state that supplies of manganese from Germany were cut off by the War thus causing the glass industry to switch to selenium in combination with cobalt as glass whiteners.

However, while these facts fit chronologically, there were economical and technical reasons for switching to selenium that directly related to the machine production of glass. Information on selenium as a decolorizer was published as early as 1911 (Angus-Butterworth 1948:68–69). The adoption of the new process for decolorization of glass was hastened by the rise in the price of manganese and difficulty in obtaining it during World War I (McSwiney 1925b:54–55). Even if the War had not occured, the industry would have switched to selenium because it was cheaper and much more suitable to tank production of glass. Selenium it-

self was more expensive than manganese but less than an ounce of selenium was needed per ton of sand in the glass batch whereas with manganese the amount needed could be up to 15 pounds per ton of sand (McSwiney 1925b:54). In addition to the manganese, a large amount of nitrate had to be added to the batch to provide extra oxidation so that the manganese dioxide did not break down to a manganese oxide or straight manganese (McSwiney 1925b:54).

Manganese was also much more difficult to control in the tank furnace than was selenium. For manganese dioxide to develop the light purple color necessary to offset the green tint of iron, it is essential to maintain an oxidizing atmosphere in the furnace. This is most successfully done in closed crucibles which protect the batch from the furnace flame. In a tank furance the quality of colorless glass obtained from manganese is inferior to that obtained using selenium (McSwiney 1925b:53–54). In addition to the difficulties of maintaining an oxidizing atmosphere in a tank furnace, there is a problem when manganese is exposed to high temperatures for prolonged periods of time such as is common in tank furnaces. Under these conditions it tends to burn out and lose its ability to decolorize (Angus-Butterworth 1948:67). Selenium on the other hand works well in a slightly reducing atmosphere which is common in tank furnaces. Also when exposed to high temperatures over long periods of time it has greater stability than manganese (McSwiney 1925b:56). Therefore since glass bottle blowing machines such as those developed by Owens work only from open tank furnaces, it was the machines' needs that determined which decolorizer would be used rather than an interruption of supplies and higher prices during World War I.

Selenium has one other advantage over manganese dioxide as a decolorizer which is that it is more stable after production. Glass decolorized with manganese turns a light purple after prolonged exposure to sun light. In short, the cost of selenium plus its stability in the tank furnace eliminated the use of manganese dioxide when machine production became the predominant method of production.

"Flint" or colorless bottles, as mentioned earlier, were the dominant type in the 1933 Hamilton plant inventory. Amber bottles were available for beers, chemicals and some medicines. "Opal" or milk glass bottles and jars were listed as cosmetic containers and some cobalt blue bottles were listed for external medicines. No light green bottles were listed.

## Closures

For centuries, the cork was the standard closure for bottles. Its ability to be compressed and then resume its original shape made it ideal for use on hand blown bottles since these bottles had minor variations in aperture, size and configuration. A limitation which largely restricted the use of cork closures to narrow-mouth containers was that large corks for wide-mouthed jars were expensive.

Throughout the second half of the 19th century, glass manufacturers searched for economical and practical closures for bottles and jars. Two notable successes were the Mason jar patented in 1858 and the Crown bottle cap patented in 1892 (Lief 1958:12 and 17). Mason jars used a zinc screw lid in combination with a jar that had its top ground to an even plane. The metal's malleability permitted the lid to adjust to the irregular screw threads on the hand made mason jars. Crown bottle caps depended on a crimping crenelated skirt which gripped a lip ring to form a seal.

While these closures were very successful replacements for cork, they and the numerous other types invented during the second half of the 19th century did not challange the dominant role played by cork as a closure. Cork remained the most important closure until after the bottle-blowing machine was developed. One of the underlying principles of both the semi-automatic and the fully automatic blowing machine is that the finish was made first instead of last. Machine-made bottles had much less variation in their finishes and made screw tops just as easy to produce as cork closure bottles.

Until the 1920s, machine-made bottles retained the traditional shapes, and the cork remained as the most common closure. The major exception to this was the use of the crown closure for beer and pop

bottles, screw caps for canning jars and food packers' ware, and paper disks for milk bottles. A 1920 company history of the Owens Bottle Machine Company illustrates an assemblage of "old style" bottles produced by hand and an assemblage of "Present Day Bottles" (Walbridge 1920:50 and 100). In both illustrations almost all of the bottles are cork stopped.

One thing that held up the introduction of screw thread bottles was that most glass factories were not equipped to produce metal screw caps. This meant that manufacture of the closures had to be contracted out to metal fabricating companies and later plastic manufacturers. Without industrial standards for screw top closures, on such things as pitch, length, and thickness in screw threads there were disagreements between glass and closure manufacturers causing bad fitting closures. This problem was avoided when patented closures were used because the metrics were standardized in the patent (Lief 1965:27).

An example of this was the Amerseal Cap that was patented in 1906 (Lief 1965:22). This closure used four lugs which meant the jar could be easily opened or closed with a one-quarter twist of the lid. Lug finishes were difficult to produce by hand, but for bottle-making machines they presented no problem. Under machine production, the Amerseal became a very popular closure.

In attempting to develop an easy to open bottle that could compete with the Amerseal closure, glass manufactures made modifications to screw top closures. These attempts were probably aimed toward avoiding payment of royalities to the Amerseal patent owner. This drive towards a simple screw top for glass containers culminated in the development of the "Continuous-thread" closure. In England, a set of British standards on the "Continuous-thread screw Finish" was established in 1918 (Moody 1963:179). An American committee was set up after the shallow cap was designed in 1919 and it published a set of standards for Continuous-thread closures in 1924 (Lief 1965:27). This closure, like the lug-type Amerseal only required a one-quarter twist of the lid to open the containers. It had a shallow metal and later also plastic cap, which engaged a single continuous-thread on the bottle's outside rim (Lief 1965:27). That thread made just slightly over one revolution around the bottle's finish.

A great variety of closures were developed in the late 19th and early 20th centuries but as mechanization of the glass industry took command (apologies to Giedion) most of these closures were eliminated by the 1930s as the Crown, Amerseal and Continuous-thread became the standard types. This can be illustrated by the bottles and jars listed in the 1933 Hamilton plant inventory. A Dominion Glass Company's Catalogue for Packers Ware published between 1915 and 1920 lists 16 types of closures, not counting cork, for the various types of containers they produced (Dominion 1915–1920). Many of these stoppers were carry-overs from the hand made era. However, in the 1933 Hamilton list the Amerseal, Continuous-thread, crown top, screw top were the dominant types being produced. In soft drink bottles, the type of closure was almost never mentioned because the only type being used was the Crown.

Table 3 lists the quantity of 7 common types of narrow-mouth bottles which the Dominion Glass Company had in stock in 1933. This list distinguishes bottles held as open stock, and available to all customers from those contracted to individual customers. Among the 165,473 dozen bottles, the most important closure was the continuous-thread which was found on 1/3 of the bottles. Amerseal and screw caps together made up slightly more than one-fifth of the bottles. Corks were still an important closure for narrow-mouth bottles and they were on slightly over one-fifth of the bottles. Cork closed bottles may be under recorded in this inventory. For example one wonders what type of closures were on the 18.5% of the bottles for which closure information was not recorded. There does seem to be more cork usage in stock bottles, particularly druggists ovals where they were twice as common. Perhaps small merchants who ordered stock bottles were more conservative than large companies ordering specialized bottles.

Table 4 summarizes the quantities of stock and contract bottles for four common types of wide-mouth glass containers. Cork has practically disappeared as a closure type for wide-mouthed bot-

TABLE 3
NARROW-MOUTH BOTTLES FROM THE 1933 INVENTORY OF THE STOCK AT THE HAMILTON PLANT, DOMINION GLASS COMPANY

| Type | | Not given | Cork | Screw | Continuous Thread | Amerseal | Other | N = in dozens |
|---|---|---|---|---|---|---|---|---|
| Ovals | Stock | | 47.9 | 19.4 | 27.8 | 4.9 | | 41,905 |
| | Contract | | 20.6 | 10.0 | 41.6 | 27.7 | | 20,605 |
| Blakes | Stock | 1.4 | 7.9 | | 90.3 | | 0.3 | 14,202 |
| | Contract | 40.8 | | 21.5 | 13.4 | 23.1 | 1.2 | 11,678 |
| Panels | Stock | 74.2 | 25.8 | | | | | 2,097 |
| | Contract | 82.1 | 8.0 | | 6.8 | 3.1 | | 17,144 |
| Squares | Stock | 0.7 | 15.2 | 11.7 | 38.9 | 32.6 | 0.8 | 15,227 |
| | Contract | 2.3 | | 13.3 | 42.1 | | 42.2 | 6,875 |
| Club Sauce | Stock | | | | 69.7 | | 30.3 | 1,150 |
| | Contract | 80.4 | | | 6.4 | 13.2 | | 7,616 |
| Olive Oil | Stock | 1.7 | 69.5 | | 28.8 | | | 1,375 |
| | Contract | 4.3 | 95.7 | | | | | 564 |
| Inks | Stock | 61.2 | 12.2 | | 22.5 | | 4.2 | 5,027 |
| | Contract | 2.1 | 20.5 | 2.8 | 42.6 | 20.2 | 11.6 | 20,008 |
| Totals | Stock | 6.1 | 31.6 | 12.2 | 40.4 | 8.7 | 0.9 | 80,983 |
| | Contract | 30.3 | 12.1 | 7.2 | 27.5 | 16.6 | 6.3 | 84,490 |
| Grand Total | | 18.5% | 21.7% | 9.7% | 33.8% | 12.7% | 3.7% | 165,473 |

tles and jars. Amerseal, on the other hand, was used on almost half of these containers, including over half of the contract orders. Amerseal together with Continuous-thread and screw tops constitute almost 70% of the jars and bottles. Standardization of closures thus appears to be more complete for wide-mouth containers than narrow-mouthed ones.

## Bottle Forms

As mentioned earlier, the first machine-made bottles were copies of popular forms developed for hand production. During the first two decades of Owens Machine production, the form of bottles does not seem to have changed much. Because the Owens machine could not profitably do small production runs, the bottle types copied from the hand-blown types were those with a steady large market such as soft drinks, beers, and milk bottles, ovals, and packers' wares. This is illustrated by the 1926 mould list in which only 371 of the 1851 types produced by hand were copied for machine production. The remaining 80% of the hand-blown types were not carried over into machine production. These types disappear as hand blowing died out in the late 1920s.

Bottle designs for the first two decades of machine production obviously were conservative with little incentive to produce new shapes when there were so many old successful ones that needed to be copied. As the Owens machine caught up to the market and as Dominion Glass Company's competitor, Consumers Glass Company grew larger, there was an incentive and the time to create new shapes. A land fill site in Ottawa, Ontario with bottles dating from the 1920s through 1940s,

TABLE 4
WIDE MOUTH BOTTLES & JARS FROM THE 1933 INVENTORY OF THE STOCK AT THE HAMILTON PLANT, DOMINION GLASS COMPANY

| Type | Contract or Stock | Not given | Cork | Screw | Continuous Thread | Amerseal | Anchor | Phoenix | Other | N = in dozens |
|---|---|---|---|---|---|---|---|---|---|---|
| | Stock | | 2.6 | 10.4 | 59.0 | | 28.1 | | | 1,623 |
| Olives | | | | | | | | | | |
| | Contract | 4.2 | | 0.2 | 20.2 | 34.6 | 40.8 | | | 52,399 |
| | Stock | 1.0 | | 1.4 | 63.6 | 30.6 | 3.4 | | | 5,961 |
| Mustard | | | | | | | | | | |
| | Contract | | | | 14.9 | 81.8 | | | 3.4 | 19,054 |
| Jams & | Stock | 23.6 | | 13.9 | 24.4 | 21.8 | 17.2 | | | 49,834 |
| Jellies | | | | | | | | | | |
| | Contract | 11.1 | | 6.2 | 7.1 | 59.4 | 1.5 | 14.8 | | 100,808 |
| | Stock | | | 100.0 | | | | | | 1,434 |
| Vaseline | | | | | | | | | | |
| | Contract | | | | | | | | | |
| | Stock | 20.1 | 0.07 | 14.6 | 28.7 | 20.9 | 15.7 | | | 58,852 |
| Total | | | | | | | | | | |
| | Contract | 7.7 | | 3.7 | 11.9 | 54.3 | 13.3 | 8.6 | 0.4 | 172,261 |
| Grand Total | | 10.9 | 0.02 | 6.5 | 16.2 | 45.8 | 13.9 | 6.4 | 0.3 | 231,113 |

yielded a number of bottles manufactured by Dominion Glass Company during the late 1920s and 1930s with design registration dates on them. These designs stress an Art Deco style with vertical lineal mode matching the architecture, clothing, and other products of the time. While the documentary evidence is missing, these bottles seem to suggest that maybe industrial designers were making their appearance in the glass container industry in the 1930s. Two bottle types in the 1933 Hamilton Plant inventory may have been in this group. One was called "Futuristic Extract" and the other "Modernistic Jam." With these changes the glass industry was moving further from its hand blowing tradition and the flexibility it had for greater variety.

## Conclusions

Historical archaeologists are just beginning to study the 20th century. Until now, they have ignored machine made bottles beyond their identification as machine made. Archaeologists have also expressed little interest in the impact of technology in what was produced despite the fact that this area has been well mapped out by Siegfried Giedion's *Mechanization Takes Command* (1948). The Owens Automatic Bottle Blowing Machine and those that followed it increased bottle production per capita and changed consumption patterns for foods, household chemicals, cosmetics, and many other products. However, while machines increased quantity, they also created standardization that cut down in the variety of bottles available, limited the color range of commercial glass containers, and reduced the variety of closure used. The period of greatest variety for glass containers was from the second half of the 19th century until World War I. After that variety decreased as a product of standardization.

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