process. These premium priced "Cosmetic Grade" gases were found to be satisfactory by most perfumers. And finally, the Wheaton Industries Co. advocated the use of a special, triple-coated "Lamisol" bottle (adhesive/Rigisol-PVC/Plastisol-PVC) that could be produced on their "E-machine" at rates of 105,000 to 120,000 units per day. They proposed such bottles for aerosols over ½-oz. (15 ml) in capacity, except for low pressure formulas in bottles up to 1-oz. (30 ml) in volume; especially if the amount of gas was low or from 10 to 20% water was present in the formula. The Lamisol bottles were suggested to fill up to at least 4-oz. (180 ml) bottle capacity and pressures to 40 psig at 70°F (21.1°C).

With these innovations in place and tested for both hydrocarbon and P-152a ($CH_3 \cdot CHF_2$) propelled formulations, by about 1979 the aerosol fragrance industry was again ready for expansion. A total of twelve contract filler lines were available, nine in the east, two in the midwest and one in the Los Angeles area. Most of these lines could produce at 60 to 80 bottles per minute. Marketers include Chesebrough-Ponds, Inc., Revlon, Inc., Avon Products, Inc., Coty, Inc., Faberge, Inc., Estee Lauder, Inc. and others, but all are moving into the area with considerable caution.

During 1978, one of these firms indicated that their target volume was 35 million units per year within five years. Volumes of this magnitude (if coated) could not be produced on the Wheaton aerosol bottle line, and a second line would cost about $1.4 million in 1978 dollars. It would be 157 feet long and take slightly over a year to build. A substantial portion of the present line is used in the production of pharmaceutical aerosol bottles, such as about 6 million bronchodilators for Riker Laboratories, Inc., in 1978.

The aerosol cologne formulations have been extended into a number of other products that are not normally thought of in the same context as straight fragance items. One is the perfumed, after-bath talcum powder spray, where Avon Products, Inc. is the undisputed leader. They offer perhaps twenty fragrances in a mini-market, totalling around 18 million units per year in 1981. A 4-oz. fill in a 202 × 406 can size is typical. Another is a sachet spray, with about 2 or 3% perfume oil, ethanol and hydrocarbon propellent, packed in a 202 × 406 can. It is designed for spraying clothes, either when folding them after washing and drying, or for spraying lingerie and other articles while in the drawer. Many body mists are nothing more than cologne products, although some also contain some rather complicated formulas high in moisturizing ingredients such as squalane and glycerine/volatile-silicone combinations. These products are packed in aluminum tubes (typically 3-oz.) or 202 × 314 to 202 × 406 cans. Finally, the after shave, skin bracing formulation contains at least 0.4% perfume in a 50:50 (wt.) water-ethanol mixture, to which a bit of glycol, menthol and higher pressure hydrocarbon propellent are added. The suggested can size is the 202 × 509. The aerosol approach has not been a popular one, since it involves spraying onto the fingertips, then patting down the face, underarm or legs. The application can be made in the same way and almost as easily using the regular glass or plastic bottle forms.

Skin Care Aerosols

With the growing sunbelt population, the increased interest in skin care and sun care products by health and beauty editors in the consumer press, and the burgeoning number of older people, sales of skin protective products have suddenly shot up to Brobdingnagian levels. Typical data on sun care products alone are indicated in Table XVII.

The "Coppertone" products are estimated to have more than 31% of the total market and about 50% of the aerosol sector. An indication of the lustiness of this business is the introduction of the "Mmm! What a Tan!" line of lotions and oils in 1980 with a $2 million advertising budget.

Product formulas vary widely, but the major sunscreen is homomenthyl salicylate, with about 1.4 million pounds used in 1979 in over half of all units sold. PABA esters, on the other hand, enjoy the largest share of dollar sales. Greasy ingredients, such as coconut oil, cocoa butter (theobroma oil, USP natural)

TABLE XVII.

Market Performance of Sun Care Products

Year	$ Volume Total Market	$ Increase Total Market	% of Population Using Sun Care Products	$ Volume Aerosol Segment
1974	93MM	4%	18	—
1975	99MM	7%	20	—
1976	118MM	19%	23	9.5MM
1977	143MM	21%	26	11.0MM
1978	154MM	6%	29	13MM
1979	161MM	4%	32	16MM
1980	166MM	3%	33	—
1981	171MM*	3%	34	—

*Sunscreens grew from 30% to 37%. Plough, Inc. brands, led by the Coppertone line, remained stable at 40% share.

and parafin wax were replaced in the early 80s with non-greasy items like "UCON Fluid LB-625", C_{12}-C_{15} alcohol benzoates and polyethylene emulsions, such as "A-C 627", all of which act to resist water and hold the sunscreen in place for a longer length of time. The aerosol products are usually anhydrous and contain from 35 to 40% of hydrocarbon "A-40" to "A-46" propellent blend.

In early 1980, sun screening agents were added to skin care creams, lotions and aerosols. If screening claims are made, the FDA classifies the product as an O-T-C drug, according to proposed rules. But in addition a warning may be used, such as, "Over-exposure to the sun may lead to premature aging of the skin and skin cancer. The liberal and regular use of this product may reduce the chance of premature aging of the skin and skin cancer." Such language is considered very helpful to product promotion. As little as 1 to 2% sun screening agent will give a minimum SPF (Skin Protection Factor) of 2, and this is considered sufficient for products not marketed primarily as sun protection types. For instance, Lanvin-Charles of the Ritz, Inc. recently introduced sun screens to its "Revenescence Moist Environment Body Treatment" and "Optimum Balance" skin care products, and several firms are marketing an aerosolized lotion that incorporates an insect repellent, poison plant urushiol absorbent, sun screen and mild germicide, pressurized with nitrous oxide.

The skin care market (considered separately from the sun care segment) increased to about $220 million in 1980. In 1981, aerosols had almost no stake in this business. The current 1980 leader is "Vaseline Intensive Care" (23%), followed by "Wondra" (10%), "Jergen's Lotion" (9%), "Keri Lotion" (8%) and "Rose Milk" (4%, down from a high of 14%). Products by Gillette, "Silkience", and Clairol, Inc., "Condition", are expected to be introduced in 1981, adding to the overall market volume. With proper positioning, many experts feel the aerosol form has a place in the skin care area: perhaps as an elegant aluminum or necked-in 202-diameter can, with a suitable spout and nitrous oxide formula capable of producing a very heavy foam.

Insecticides

Insecticides represent the original aerosol market, starting in about 1943 with the World War II "Bombs", and graduating to the non-returnable can in 1947. They have had an interesting, if unspectacular growth. Representative production figures during the 1970's are shown in Table XVIII.

TABLE XVIII.

Unit Sales of Aerosol Insecticides; 1970 - 1980

(Millions of Cans)

Year	U.S.A.*	England	Japan	Western Europe
1970	105	20	46.6	—
1971	109	24	51.0	—
1972	127	26	53.4	179
1973	135	27	60.4	184
1974	125	36	68.5	212
1975	102	42	49.0	203
1976	114	47	50.7	243
1977	120	68**	59.8	262**
1978	132	85**	68.9	234**
1979	138***	61	90.8	—
1980	150	62	68.1	—

*Includes insect repellents but excludes pet sprays, such as flea and tick insectidides. Both categories were about 12 million in 1979.

**Many of these were exported, especially by England and Holland.

***The CSMA figure of 199 million units is strongly disputed by industry.

Several European countries reported sharply decreased consumption of insecticides during the 1970s. For example, France dropped from 30 to 14 million, and Italy dwindled from 53 to 31 million during the 1974-1978 period. The Netherlands showed a level production between 1972-1978, but after 1976 about half of this was exported to Nigeria, the Middle East and other locations.

There are four major subdivisions of the insecticide category. They are shown in Table XIX, compared in volume sales with the two main liquid categories.

TABLE XIX.

Aerosol Product Sales During 1979 - 1980

Type and Class	Per Cent of Combined Liquid & Aerosol Sales	
	1979	1980
Aerosol Residual Spray	35	36
Aerosol House & Garden	10	9
Aerosol Flying Insect Killer	16	14
Aerosol Fogger (Indoor and Outdoor types)	13	13
Liquid Residual Sprayer	23	25
Liquid Flying Insect Killer	2	2
All Others - Aerosol & Liquid (As Hornet & Wasp Sprays, Mothproofer Sprays, etc.)	1	1

Solid types, such as mosquito strips, powders, roach traps and pastes are not included.

Insecticides are highly seasonal. Sales during the first three months of the year are at levels in the range of 7 to 20% of sales during early May, depending on class. The residual aerosol is the largest single class, with 1979 sales of 48 million units and 1980 sales of over 54 million units.

The residual insect spray is composed of about 1 or 2% of active materials, dissolved either in low-odor petroleum distillate, or blends of that solvent with n-butyl Cellosolve and other liquids in order to dissolve certain solid toxicants, such as the carbamate types. The propellent is almost always CO_2, although two intermediate size marketers use hydrocarbon blends. The active ingredients are toxic substances at this time, but technology has been developed on the use of "bio-rational pesticide" materials, such as biochemical pest control agents isolated or derived from natural sources (pheromones, insect growth regulators, enzymes, etc.), microbial agents and other ingredients whose pesticide efficacy is not based on inherent toxicity. The EPA, which acts to pre-register and control all insecticides, has looked favorably upon these new agents and may reduce significantly the development data requirement in order to get them onto the market in greater numbers. Only one or two types appeared commercially in 1981.

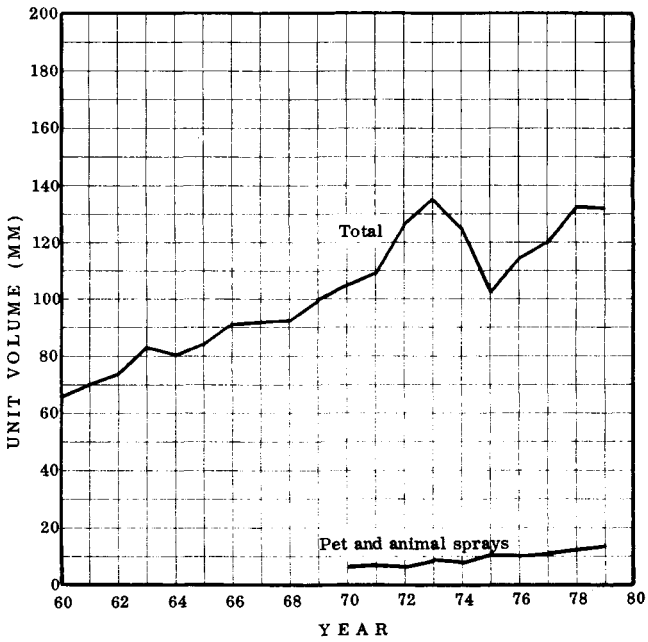


Figure 6. Aerosol Insecticide Market Volume

Includes insect sprays for animals; excludes insect repellents.

For 1979, the 199 million unit CSMA figure is discounted in favor of figures from other marketing reports.

The largest insecticide class for flying insects is the oil-out emulsion formula, where the active ingredients amount to only a few percent, the balance of the formulation being about 65% deionized water (with detergent, inhibitor(s) and possibly a perfume), and 30 to 32% hydrocarbon propellent in the A-40 to A-46 range. Pyrethrins have been used classically for such products, but their use is dwindling, due to the present price of about $200/lb. (100% basis) and the long term uncertainty of supply. The use of various forms of allethrin, resmethrin, sumethrin and neo-pynamin is increasing; the last of these was priced at about $57/lb. in 1981. Some insecticides have been developed in France and Japan that are rated at 10 to 50 times as bio-toxic as pyrethins, but they have not been used in the U.S.A. to any extent, as of 1981.

The major insecticide marketers include S.C. Johnson & Son, Boyle-Midway Division, Chevron Chemical Co. and the d-Con Co., Inc. Each has a substantial line of individual products. Special insecticides have been developed for use in food kitchens, dairy barns, for aircraft disinfection and for flea and tick control on pets. One unique formula uses dry, finely divided silica as a toxicant. This inside fogger, with 17% of the market, is designed to lock open and spray to emptiness, ridding an entire house of insects.

The aerosol pet spray market has remained fairly static at about 19 million units per year. Nevertheless, with Americans owning some 48 million dogs, 27 million cats, 25 million birds, 250 million fish and 125 million assorted other fauna, (44.6 million American households included a pet in 1980), the potential for increased sales is certainly a real one. About two-thirds of the aerosol market is held by insecticides, mainly dog flea and tick sprays. Insecticidal cat sprays and pet shampoos with insecticidal properties are less important. Other products include miticidal products for birds and birdcages, grooming aids, litter-box deodorants and training sprays. Indoor and outdoor dog repellents are generally placed in a separate category. They include formulas based upon methyl nonyl ketone, to prevent the phytotoxic and/or staining effects of urination. More recently an off-shoot of the $44,000,000 "Mace" market has developed to afford protection against wild or rabid small animals. The combined category unit sales volumes are shown in Figure 6.

Cigarette Lighters

Disposable cigarette lighter packs are not considered an aerosol category in the U.S.A., but are in a number of other countries. Of the 275 million produced in 1980, about 150 million were made by the Bic Pen Corp., 75 million by Gillette Co., and about 50 million by Colibri Corp. of America and other marketers. Worldwide disposable cigarette lighter sales increased from 45 million units in 1971 to about 800 million in 1980. The lighters sold for as little as $0.29 each in the U.S.A. during 1981.

Insect Repellents

In 1979 the overall market for insect repellents was about $22 million, down from the $35 million level in 1971, but growing to a probable $27 million pace in 1980. About 80% of the business is held by S.C. Johnson & Son, Inc. with their various "Off" brand products, and aerosols accounted for about 70% of the total. Other important marketers include Cutter Laboratories Inc. and the d-Con Co. Inc. division of Sterling Drugs Inc. As of 1981, the growth of non-aerosol types exceeded the aerosol segment. For example, Cutter Laboratories Inc.'s Consumer Division has reported that their "Cutter Stick" repellent showed a sales growth of 129% in 1978.

"DEET" (N,N-diethyl-m-toluamide) is the principle active ingredient and is commonly used at 20% in the aerosol products. The spray aerosols used ethanol as the diluent and small amounts of either hydrocarbons or CO_2 as the propellent. Aerosolized lotions are also available here and there, often using N_2O to produce a very dense, easily spreadable foam.

"DEET" gives very effective protection against most mosquitos (which the other important repellent: "6/12", 2-ethyl-1,3-hexandiol does not), but neither are effective against several important biting insects, such as the Bodega Black Gnat (*Leptoconops kerteszi*). "R-11" and "R-326", offered by the MGK Co. are also used to a slight extent.

Furniture Polishes

This category first became important in about 1963 and grew to about 100 million units in 1970 and 109 million in 1972, when the older oil-in-water emulsion polishes slowly gave way to the new water-in-oil types, as exemplified by brand leaders "Pledge", offered by S.C. Johnson & Son, Inc. and "Behold", marketed by The Drackett Products Co. The market in 1980 is estimated at about 130 million units. This is the household product category and does not include the automotive polishes which amount to about 5 million units. Other significant marketers are Colgate Palmolive Co., with their product "Woodcrafter", Alberto-Culver Co. offering "Kleen Guard" and Scott, marketing "Liquid Gold".

Except for "Liquid Gold" and several very small volume paneling and cabinet sprays, the usual furniture polish contains about 5% silicones, waxes, perfume and emulsifier, 20% odorless petroleum distillate of the naptha, ligroin, petroleum ether, benzine or heptane type (typical TCC flashpoint = 40°F or 5°C), 63% water and 12% hydrocarbon propellent blend. About 85% of all U.S.A. furniture polishes contain silicones, representing about a $15 million market in 1980. The addition of silicone products provides easy care and a higher gloss but evaporation may eventually dull the finish. When the silicone gets into the varnish or lacquer, refinishing becomes more complex. A long term problem with the water-based polishes is that they have the ability to lift and crack thinly applied finishes.

The furniture polish market is more advanced in the U.S.A. and Canada than elsewhere. For instance, in 1979 only 6.9 million units were sold in Japan. It is also interesting to note that retail prices have not increased in the United States during the last ten years or so. For example, a 14-oz. (400 g) can of "Kleen Guard" sold for as little as $0.84 during 1981.

Paints, Coatings and Finishes

This market is one of the largest in the industry. At its high point in 1977 it accounted for 15.4% of all aerosol products, but this will decrease to about 13.5% in 1981 for a variety of reasons. The modest decline is mainly due to a relative lack of advertising, with marketers saying there is no longer enough profit to justify investing in media activities. In a related move, a disproportionate amount of SKUs (shelf space rating) are pushed toward high end-cost specialty paints, since so little money can be made at the low end. The low end is thus offered less, and consumers are balking at the apparent price increases. Some low end quality problems are becoming more noticeable, such as lack of "one-coat hiding power" "washability", "durability" and so forth. Some consumer groups are now pressing hard for a rating system, to avoid disappointments after getting the can home and using it.

TABLE XX.

Unit Sales of Aerosol Paints; 1974 - 1980

Year	U.S.A.	England	Japan	Western Europe
	(Millions of Units)			
1974	257	13.0	16.9	45
1975	278	15.0	18.4	45
1976	306	16.5	23.4	50
1977	331	21.5	27.9	64
1978	309	28.0	35.7	88
1979	301	28.5	38.2	—
1980	286	24.0	36.3	—

Recent sales figures show that aerosol paints are growing rather well in Europe, but only slightly in Japan, while U.S.A. sales have been slightly negative since 1977, see Table XX. The increases abroad are said to be due largely to the continuous introduction of new and improved items, along with more trade show and media promotional activity.

The market is very highly segmented. Scores of marketers fill their own products and often fill for others as well. The number of paint shades is legion, and therefore the size of any one production run is apt to be quite small, with cans generally paper labeled. Possibly the largest single run of any paint product took place in 1980 when New York Bronze Powder Co. ran slightly over 500,000 lithographed cans of a specialty spray enamel, called the "Nearest Thing to Chrome". Many paint fillers sell directly to retail accounts. Some have between 500 and 1000 accounts, which means that business procedures often get quite complex.

The five-year outlook for the U.S.A. aerosol paint business seems to indicate a slow decline to a plateau in the 250 million units per year area, since the industry is not generating any more new users except in the younger (replacement) bracket. The inexpensive $0.99 paints are devastating the good $1.49 types, turning the profit picture downward with resulting cuts in quality control, formulation options (acetone is now replacing methylene chloride, and solids content is being reduced), the use of fewer directional and more cheaper sprayheads and so forth. In 1980 a DME type water-based paint formula was developed by Conn Chem Div. in Toronto, followed by other water-based paints patented by Seymore of Sycamore, Inc., Sycamore, IL. Perhaps these innovations will act to free up some advertising funds to help ward off the general slow dwindling of the overall market. In England, 1979 paint sales were up 2%, to 28.5 million.

Laundry Aids

About 30% of all households used starches and sizings during 1980 and 1981, generating a business of about $45 million. The leading starch is "Niagara Spray" starch with "Easy On" starch running an important second place. In the related sizing field, the acknowledged leader is "Magic Sizing" with a 70% share. All non-aerosol alternates amount to less than 10% of the starch and sizing category.

Laundry prespotters in all forms make up a $130 million business, being used by 46% of all households. But here the heaviest sales are in the liquid product area. They do not have the size limitation and higher per ounce cost of the anhydrous aerosol counterparts, and may impart less residual "kerosene type" odor to fabrics because they are water-based. The leading aerosols are "Spray 'n Wash" and "Shout", but both are slowly declining in sales volume.

Air Fresheners (Including Disinfectant/Deodorants)

This rather large market is divided into two distinct product types: the air freshener and the alcohol-based disinfectant/deodorant sprays. Nearly all air fresheners consist of 0.4 to 1.0% perfume, about 68% water, small amounts of emulsifier and inhibitors, and about 30 to 32% of hydrocarbon propellent blend in the A-40 to A-46 range. A few have actual deodorant materials, such as 3,5,5-trimethylhexanal. Still fewer are ethanol or isopropanol based, with these solvents replacing the water in order to give a more elegant, drier spray. The other variety is characterized as a surface disinfectant and space deodorizing product. It contains typically

TABLE XXI.

Unit Sales of Air Fresheners (Including Disinfectant/ Deodorant Aerosols) in 1970 - 1980

Year	U.S.A.	England	Japan
	(Millions of Units)		
1970	162	13.0	2.1
1971	164	—	2.4
1972	176	—	4.3
1973	188	—	9.5
1974	202	25.0	7.7
1975	153	23.0	11.2
1976	125	28.5	11.1
1977	136	25.0	8.2
1978	132	35.0	8.9
1979	122	30.0	8.5
1980	120	37.0	7.8

either about 0.1% of o-phenylphenol (or similar) or mixtures of quaternary ammonium chlorides, with about 15% water, a large amount of ethanol, traces of corrosion inhibitors, perfume and other substances, and either 20% hydrocarbons or 5% carbon dioxide.

The unit volumes sold in the U.S.A., England and Japan are shown in Table XXI.

During 1981, mass merchandiser retail prices for aerosol air fresheners were as low as $0.88 per 7-oz. water-based type and $1.14 per 7-oz. disinfectant/deodorant type. Marketer advertising strongly favored the various alternates, such as the odor absorbent canister products, indicating that the aerosol forms may suffer further sales reductions.

Home Insulation Aerosols

A new aerosol market has been generated in the early 80's as a result of the increasingly high cost of home heating and air conditioning. It is based upon two product types: polyurethane foam and caulking compounds. The rigid polyurethane foam had its beginnings in the U.S.A. about 1960, when Allied Chemical Corp. showed sample cans of a two-component system to the industry as a sales promotional tool. A can of toluene isocyanate and one of a polyol/catalyst/propellent were combined by pressing the (special) valves together so that the high pressure mixture flowed into the non-pressurized unit. The final can was shaken, whereupon it became very warm, fluid and ready to use. This cumbersome process, also somewhat dangerous due to the toxicity of the isocyanate, was not a marketing success, and the industry awaited the development of a single component system.

Several years later, single packs were developed in West Germany, and still later the ICI formulas started to appear in Europe. They were unreliable, often becoming very thick or solid in the can after five to ten months storage. The foam also formed a hard, adherent core in the valve nozzle between uses. In 1977, the first of these products appeared in the U.S.A., under the tradename of "Great Stuff", marketed by Insta-Foam Products, Inc. firm under a license from Rubicon Chemicals, Inc. For a long while it had the drawbacks of the early European formulas, but it appears that these are now resolved. Other U.S. follower products include "Poly Cell", made by the Poly Cell Division, W.R. Grace & Co.; "Foam-O-Fill" (filled in Ohio, using German technology); "Easy Insulator", by Scott-Page, Inc., and "Touch-n-Foam", by the Convenience Products Division of Clayton Corp.

During 1981, this market was estimated as about 5 million cans per year in the U.S.A. with a value of about $15 million wholesale. Retail prices varied between $4.99 and $6.99 per standard 14 av. oz. (400 g) can, except for the "Touch-n-Foam" product, where the marketing approach is one of lower prices; e.g. about $2.79 per unit. The growth rate is about 30% per year, based primarily upon "Great Stuff" figures. Since probably less than 1% of potential buyers are even aware of the product, the sales potential is very large. "Great Stuff" now holds about 65% of the U.S.A. market.

Some growth retardation came about as a result of product instability in the can, now corrected, at least in one or two formulations. One marketer sought to convince buyers that the problem was corrected by encasing the can in a polyethelene bag containing "Drierite" granules. In the case of "Easy Insulator", the marketer claims a minimum shelf life of 14 months, according to tests still in progress. Mass merchandising techniques were still largely untapped in 1981, although Insta-Foam Products, Inc. made a beginning by using point of purchase type materials, such as display cases tied into a fall presentation by a home center, placing the display next to fiberglass insulation and similar energy-saving commodities.

There are two distinct use patterns. The builder/contractor now purchases about 20% of the U.S.A. volume (80% in Europe) for foam insulation, especially around window bucks and door jambs. This is an especially large market for the "Poly Cell" product. The rest of the purchases are made by the home handyman, who uses the foam to fill large crevices between the masonry foundation and the wood sills of the house, around electrical outlets where an air draft is indicated, around ducts or pipes where they go through sheetrock or other walls and so forth. In many cases a number of cans are required. Fortunately the government allows a substantial tax credit on such energy-saving purchases.

The can is in the 211 × 612 range, and generally in a "DOT Specification 2Q" strength to withstand the pressure increase that accompanies the exothermic reaction of the isocyanate and polyol ingredients, when they are added (separately) to the can, and then mixed quickly together with a shaking operation. A temperature rise of 55 °F (30 °C) is sometimes seen, although the usual increase is about 45 °F (25 °C). A Clayton Corp. valve is used, normally with a nylon stem,

although the "Poly Cell" product uses a special Swedish valve. Polyethylene adapters and ¼" (7mm) diameter straws are often used to inject the product into deep cracks and crevices. After use, the product forms a solid plug in the last inch or so (about 25 mm) of the straw, and this much is then snipped off before the next use. The standard 14 av. oz. (400 g) fill is sufficient to produce as much as 175 feet (53 m) of ½ inch (12 mm) diameter bead, or the equivalent of around 15 standard 11 av. oz. (312 g) tubes of caulking compound.

The primary ingredient is an isocyanate, either toluene isocyanate (as in "Great Stuff") or the less volatile and thus lower toxicity methylene diisocyanate (MDI), which is used in "Easy Insulator". The isocyanate is mixed in the can with about 0.8 part of a special polyol. A bit of reaction catalyst is also needed. This can be added as a separate ingredient, such as an aliphatic amine, or internally, as a part of the structure of the polyol. The isocyanates are available from Mobay Chemical Corp., Upjohn Co., Rubicon Chemicals, Inc., and Union Carbide Corp. The polyols can be obtained from Dow Chemical co., Mobay Chemical Corp., Union Carbide Corp., Wyandotte Corp. or other suppliers. All have relatively low equivalent weights and a moisture content of 0.15% maximum, or 0.08% typical. If water is present above about 0.20%, the aerosol product will undergo a degree of thickening that will render it unusable in many cases.

The Environmental Protection Administration allows the use of chlorofluorocarbon propellents in these products, and indeed they are often found to be the propellents of choice. "Great Stuff" uses a blend of P-11 and N_2, while Foam-O-Fill contains P-11 and P-12. "Touch-n-Foam" uses 20% hydrocarbon A-70 blend. About 30% of a 90:10 mixture of P-12 and dimethylether (DME) has been found ideal for certain formulas.

The product is extruded from the aerosol as a very rough-surfaced foam. Upon standing, it rapidly undergoes a secondary expansion, with an evening out of the surface, forming a fairly hard, glossy crust. It is strongly adherent to most surfaces. Flexible polyurethane foams can be made by reducing the cross-linking density of the polyol, so that a preponderance of linear polymer is formed.

The caulking market is now about $250 million in the U.S.A. and acrylic emulsion products like "Easy Caulker" have brought the aerosol into this new arena. At least 2 million units of the product should have been sold in 1981, for a retail sales volume of $10 million. "Easy Caulker" is delivered as an exceptionally dense foam and is most useful in filling gaps or crevices of ½" (14mm) or smaller, leaving the larger ones to the polyurethanes. The 11 av. oz. fill is the equivalent of 4 caulking cartridges, and sufficient to lay down as much as 140 feet (43 m) of ¼ inch (7 mm) bead, smooth on top and conforming to the surface. Growth of this market is estimated as 30 to 100% per year, since market reception has been phenomenal.

Food Products

Food aerosols have long been an enigma to marketers. They have become important only in the U.S.A.; other countries have only a few million units per year at best and many have none. Regulations in the U.S.A. have limited propellent choices to n-butane, isobutane, propane, CO_2, N_2O, N_2 and Freon Food Propellent C-318 (perfluorocyclobutane), although some of these are not permitted to be used in other countries — most notably N_2O. Rather interestingly, N_2O is generally denied because of its anesthetic qualities (laughing gas), yet this effect can only be obtained upon breathing large amounts of the virtually pure propellent gas, something that is impossible to do with an aerosol can. Outside the U.S.A., the use of P-11 and P-12 is sometimes permitted in the formulation of cookware sprays. In Canada, P-11 is still allowed, on the basis that it is a solvent, not a propellent.

The largest food category is the whipped cream product, dating back to the late 1940s as one of the earliest of all aerosols. The concentrate is a synthetic dairy cream, compounded and pasteurized immediately before filling. It is cold filled into cans of about 18 fl. oz. (typically 564 ml) capacity, filling them about 60% by volume with product. The units are sealed with a suitable valve and either CO_2 or N_2O propellent is introduced by a gasser-shaker process until the pressure reaches the equivalent of about 110 psig at 70°F (21.1°C). In a few cases, a particular blend of CO_2 and N_2O is used, where the tartness of the first is counterbalanced by the sweet taste of the second.

The Avoset Co. has long been a leading captive and contract filler in the filling of sterile whipped cream aerosols. The finished concentrates are flash sterilized by heating to about 280°F for such a brief period that there is essentially no cooking or browning of the ingredients. From this point on they are handled in a closed sterile transfer system, going into a special Hope filler,

and then into aerosol cans that have been sterilized by very brief heating to about 450°F. Chemically sterilized aerosol valves are applied and crimped in place, after which the units are gassed with CO_2 (generally) that has been passed through a 0.2 micron filter to strain out any trapped microorganisms. The finished units do not exhibit any spoilage, but at room temperatures there is a slow degradation, probably the result of enzyme related chemical changes. Because of this, the units are stored at about 34° to 38°F (1° to 3°C), remaining stable for well over a year.

The whipped cream products are filled by specialty firms that have the necessary heat exchange units, refrigeration rooms and other production requirements. The major contract fillers do not participate in this business. Since the non-sterile types undergo a slow degradation, even when stored below 40°F, arrangements are usually made to provide for the swift delivery of finished stocks to retail outlets (using refrigerated trucks), where they are then sold in store coolers.

The U.S.A. consumption of aerosol food products is described in Table XXII.

The second largest category of food aerosols is the cookware spray, sometimes called the frypan lubricant. This product was pioneered by Gibraltar Industries, Inc. under the name "Pam", originally a dispersion of 3% selected lecithin derivative in 97% P-11/P-12 chlorofluorocarbons. A small amount of isobutane was later introduced as a cost-cutting measure. The formula was so elegant and effective that it remained unchanged until the FDA mandate to curtail use of chlorofluorocarbons barred it from further sale in 1978. In the interim Gibraltar Industries Inc. had been purchased by the Boyle-Midway Division and was operated as the Pam Products Unit of that firm. Contingency reformulation work started about 1975, carrying through ethanol compositions and so forth until the present line of products was developed. Similar activities were carried out for the second-place brand, "Mazola No-Stick", a product of the Best Foods Division, CPC International Inc. Now in 1981 at least 25 frypan lubricant sprays are available (some strictly institutional), and nearly all of the water-based type. Their combined unit volume was estimated at about 40 million (in 1979 and 1980).

TABLE XXII.

Unit Sales of Food Aerosols Including Whipped Cream Products; 1972 - 1980 (U.S.A.)

	(Millions of Units)	
Year	All Food Aerosols	Whipped Creams
1972	90	46
1973	112	57
1974	122	48
1975	150	70
1976	151	73
1977	125	64
1978	143	67
1979	141	71
1980	130	60

Figure 7. Various Aerosol Fry-Pan Release Products

Lecithin is used to prevent the sticking of food residues to cookware. GOLDEN TOUCH, LEAN FRY and PAM are products of Boyle-Midway Division. MAZOLA NO-STICK is a product of the Best Foods Division of CPC International, Inc. All are low calorie, except for GOLDEN TOUCH and COOKING EASE, which contain considerable amounts of vegetable oil and may be used for basting, "buttering" popcorn, potatoes and so forth.

The water-based versions use the lecithin and sometimes an auxiliary non-ionic food-approved surfactant to achieve a reasonable stable emulsion, which is then pressurized with about 20% hydrocarbon propellent. Traces of color, flavor, citric acid and other items are often added. The water is present only to make the overall product essentially non-flammable. In contrast to the clear films laid down by the anhydrous predecessor products, water-based sprays produce an opaque, yellow-white foam layer which has undoubtedly made millions of customers wonder if they received the correct product. The thin foam coating dries out quickly when the frypan is heated, leaving a translucent or transparent film behind. If the coating is sprayed directly into the pre-heated frypan (ignoring label directions to avoid such action) the result is vigorous boiling, steaming and popping of water globules that can sting the hands if one gets too close.

An interesting offshoot of the frypan lubricant is the vegetable oil spray. It is possible to disperse up to about

Figure 8. A Grouping of Aerosol Food Items

The Butter Flavoring Spray and Imitation Grape-Ade Spray Mix (plus other items) were sold by the Jewel Home Shopping Service Division. The can of TOPPEROO Ice Cream and Desert Topping (Marshmallow and three others) were test marketed by the Best Foods Division of CPC International, Inc. The aluminum piston-operated can of SNACK MATE American Pasteurized Process Cheese Spread (plus other cheeses) is marketed by Nabisco, Inc.

2.5 to 3% lecithin derivative in corn oil (or the less expensive soy bean oil) then add butter flavor and a carotene colorant. This gives a "butter oil" which also has pan release properties. To aerosolize, about 4.4% N_2O or 4.2% CO_2 is added by a gasser-shaker operation. The resultant product is dispensed as a fairly coarse spray, suitable for "buttering" popcorn, spraying upon vegetables, lubricating frypans and giving a pleasant butter flavor to eggs or other items to be fried, even for the very rapid "buttering" of sliced bread or toast in institutional kitchens. Specific popcorn sprays do not require the lecithin ingredient. They can be applied to popped popcorn, but even better, they can be used to spray unpopped kernels (salted) in a hot air or other popper, so that when the kernels pop they will become coated with butter flavored oil which can then act additionally to hold the desired salt onto the surface. The sales volume of this innovative product was only about a million units per year in 1981, but it seems destined for growth.

Two food products are somewhat unique in that they are packaged in "Mira-flo" (piston-type) 202 × 405 aluminum cans. Their combined volume, as reported by The Can-Maker's Institute, was 30 million units in 1979. The larger, estimated at about 25 million units, is a sizable line of 4-oz. cheese spreads, marketed by Nabisco, Inc. The other product is a cake decoration icing, sold by Pillsbury Co. It can be used to lay down various inscriptions or designs on iced cakes, and several colors are available.

A large number of food aerosols have come and gone, and of course many potential products never quite made it to the store shelf in the first place. Some interesting ones can be mentioned. One is a soft drink concentrate, capable of producing from 17 to 50 non-carbonated beverages per can. Problems involved can corrosion (eventually), since several were acidic citrus types, pressurized with CO_2, which itself forms carbonic acid in water, plus consumer problems with putting in the proper amount into the ice water base. A chocolate syrup additive for milk drinks often resulted in a doubling of the amount of milk consumed, so that secondary economic considerations argued against repurchase. A puffed mayonnaise product was offered on the basis that it had fewer calories per teaspoonful, but consumers perceived it as a new item, with no connection with ordinary mayonnaise, and were confused as to what to do with it, other than decorate jello-type preparations. Ice cream toppings are feasible, in such flavors as marshmallow, cherry and chocolate, but only can be prepared using a typical 9 av. oz. (255 g) can. After a lengthy research program, an aerosol pancake batter was developed about 1972, but the cost per pancake was considered excessive: one four-inch (100 mm) diameter pancake per ounce (28 g) cost $0.14 (1982 dollars). There were heavy costs in the batter processing system required, and the ever present faint possibility of a marketing and product liability fiasco in the event something should go wrong and allow microorganisms to proliferate in the aerosol can; this despite thousands of microbiological tests that gave the product a clean bill of health, if made correctly.

The "Sepro" can, marketed by the Continental Can Co. since the early 1960's, has received some attention in terms of food aerosol developments. Products such as peanut butter, butter, margerine, jellies, honey, toothpaste have all been looked at, and the last two are commercially available, although in very low volume. The high package cost has been a significant deterrent. Also, there is a certain imagery that food aerosols have insecticide cousins and should not be placed on the table, along with condiments and other food items. Given all these constraints it is reasonable to suggest that there will probably not be any particular flare of activity in the food aerosol segment during the next few years.

Aerosol Production

A majority of marketing analysts believe that the aerosol industry has reached the point of saturation in the U.S.A., Canada, many Western European countries, and so forth, and will not continue to grow beyond the increments related to population growth unless significant new products are developed. Perhaps the highest aerosol sales density ever recorded took place between about mid-1973 and mid-1974 in the U.S.A., when a volume of significantly over 3 billion units per year drove per capita consumption to 14.1 units per year. In contrast to this, the per capita use during 1979 in various major markets is shown in Table XXIII.

The 28% decrease in per capital usage between the peak year and 1979 in the U.S.A. is due largely to the exceedingly bad publicity and government regulations that followed in the wake of the CFC/ozone controversy that surfaced in 1974. (The added effect of the 1980 recession widened this to a 35% decrease, since per capita usage was only 9.15 units.)

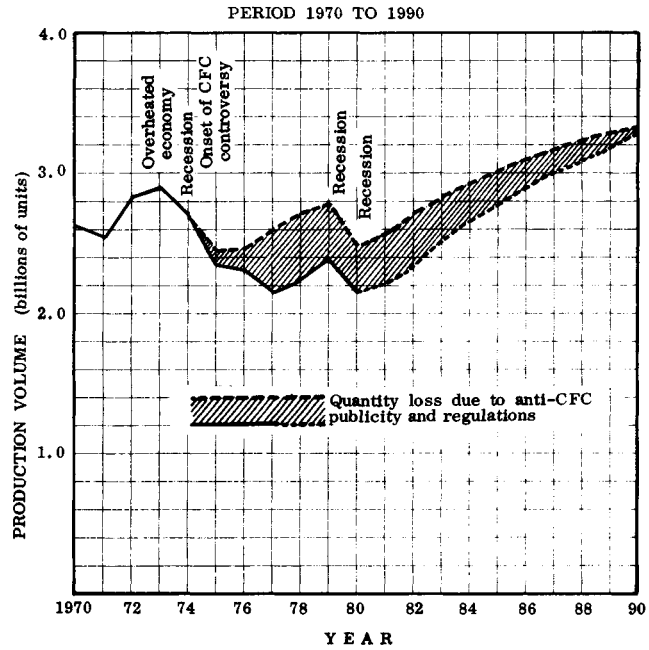


Figure 9. Difference between Demand in the Absence of CFC Regulation and Demand with Regulation

TABLE XXIII.

Worldwide Consumption of Aerosols in 1979

Market	Million Units Sold	Units Per Capita
U.S.A.	2,398	10.20
England	498	8.90
The Netherlands	175	9.97
Australia	135	8.98
France	429	7.73
West Germany	462	7.34
Switzerland	47	6.94
Canada	134	5.74
Austria	39	4.92
New Zealand	13	4.18
Italy	252	3.65
Greece	28	3.21
Norway	10	2.96
Finland	18	2.94
Argentina	94	2.89
Republic of South Africa	72	2.88
Japan	311	2.62
Mexico	71	2.19
Sweden	11	1.45
Brazil	101	0.96
Other Latin Amer.Countries	145	
Other African Countries	136	0.07

TABLE XXIV.

Production and Uses of Chlorofluorocarbons P-11 and P-12; During 1958 to 1980

Year	World Production (Billion Pounds)	Western Nation Production (Billion Pounds)	U.S.A. Production (Billion Pounds)	U.S.A. Sales (Billions of $)	U.S.A. CFC Aerosol (Billion Units)
1958	0.23	0.22			
1959	0.28	0.27			
1960	0.33	0.32			0.11
1961	0.36	0.35			
1962	0.44	0.43			
1963	0.52	0.50			
1964	0.61	0.58			
1965	0.68	0.64			0.32
1966	0.79	0.74			
1967	0.87	0.81			
1968	0.99	0.93			
1969	1.13	1.07			
1970	1.23	1.16			1.36
1971	1.34	1.27			1.30
1972	1.52	1.44			1.47
1973**	1.73	1.65			1.67
1974***	1.86	1.791	0.90	0.40	1.41
1975	1.58	1.65	0.80	0.37	1.13
1976	1.70	1.64			0.92
1977	1.62	1.54			0.55
1978	1.53	1.45	0.86	0.41	0.21
1979	1.48	1.40	0.90	0.44	0.03
1980			0.93*	0.50*	0.02

*Estimated. **Base year for many calculations. ***Peak year.

TABLE XXV.

Propellent Selection for Aerosols Filled in 1979 (%)

Country	Fluorocarbon	Hydrocarbon	D.M.E.	$CO_2/N_2O/N_2$*
U.S.A.	1	90	0	9
England	68	30	0	2
France	70	25	0	5
West Germany	67	23	0	10
Italy	60	30	0	10
Denmark	55	40	0	5
Belgium	50	28	18	4
The Netherlands	20	62	15	3
Canada	11	82	0	7
Mexico	47	51	0	2

*In the approximate ratio of 85:14:1.

The graph suggests a loss of about 4.33 billion units up to 1990, after which it is assumed the controversy should have no further impact on aerosol usage, even it it has not been resolved scientifically by that time. Using the *CSMA* figure of 2.165 billion units for 1980, this loss of business adds up to two full years of production. Actually the analysis shown in Figure 9 is extremely conservative; other econometric studies point to losses of two to five times this amount.

The U.S.A. position against chlorofluorocarbon gases has been the subject of endless debate. Aerosols were the first target of the EPA and FDA. The effect of their regulations, plus the international activities of the EPA in trying to achieve wider bans on chlorofluorocarbons, is shown in the following Table XXIV, from which it is apparent that sales diminished after 1974 on a worldwide basis.

Despite the increasingly obvious defects and shortcomings of the Rowland-Molina theory, where these researchers tried to explain three-dimensional atmospheric phenomena using a one-dimensional computer study, the EPA strove vigorously to export the U.S.A. position on banning CFC aerosols to a variety of other nations. They received mixed reactions, more generally on the negative side. About 1979 Canada agreed to a partial ban on fluorocarbon propellents, where they were used as true propellents for hair sprays, personal

TABLE XXVI.

Aerosol Productions During 1979

Product	U.S.A.	Canada	England	Japan	Switzerland
Insecticides (Non-pet)	131	10.5	60.5	89.1	0.6
Air Freshener (& D/D)	122	8.0	30.0	8.4	1.5
Waxes & Polishes	140	10.5	43.5	6.9	0.4
Oven Cleaners	38	2.6	5.0	3.3	0.9
Laundry Aids, as starch	117	3.5	13.0	20.5	0.9
Other Household Products	235	11.0	10.0	26.9	6.4
Hair Sprays	238	13.0	103.5	57.2	11.9
Cologne/Perfumes	32	7.5	64.5	1.2	5.2
Antiperspirants & Pers Deod.	268	20.5	52.5	19.1	7.2
Shaving Creams	137	8.0	18.5	5.6	1.6
Other Personal Products	97	3.5	8.0	7.4	4.6
Medicinals	26	6.6	34.0	9.1	1.1
Foods	141	3.5	2.0	1.2	0.1
Paints and Coatings	271	17.0	28.5	38.2	3.1
Automotives	166	5.5	31.5	14.3	1.8
Industrials (Other than Paints)	134	1.5	13.0	27.1	0.9
Animal Products	16	1.0	2.0	1.6	0.2
Other Miscellaneous Products	88	0.3	2.0	3.1	1.6
Total Household Products*	784	46.1	162.0	156.7	10.7
Total Personal Products	772	52.5	247.0	90.5	30.5
Total Miscellaneous Products*	842	35.4	113.0	94.6	8.8
Total Aerosols (Excluding the butane cigarette lighters)	2,398	134.0	522.0	341.8	50.0
Butane Cigarette Lighters	275	N.A.	26.3	23.0	N.A.

*These categories are patterned from the English (BAMA) figures, not the U.S.A. (CSMA).

deodorants, antiperspirants and colognes. In 1980 Sweden effected a ban, followed by one in Norway, and Western Europe generally agreed to try to limit utilization of CFCs to 70% of their former levels, over a three-year period. the cumulative effect of bans, planned reductions, recessions, marketer indecision, adverse consumer reaction, consumerist positions and other factors has been that the 1980 sales of P-11 and P-12 are now about 36% below the level which would have been predicted in the absence of the Rowland-Molina theory, the bad press and all the socio-economic problems which followed. The loss is estimated as about 880 million pounds (400 Kilotonnes or 400 Gg). During the 1973-1977 five year period, U.S.A. consumption of CFC dropped about 67%, and U.S.A. aerosol production fell from about 50% of world aerosol production to about 33%. The 1979 situation for aerosols filled in various countries is shown in Table XXV:

In 1977 worldwide manufacture of aerosols accounted for 48% of all P-11 and P-12 production. By 1978 this had dwindled to 43%, with refrigeration and air conditioning uses remaining in second place with 31%. Japan appears to be the fastest growing CFC producer, manufacturing 141 million pounds (64 Kilotonnes, or 64 Gg) during 1980.

Approximate figures for aerosol production in several countries during 1979 are given in Table XXVI.

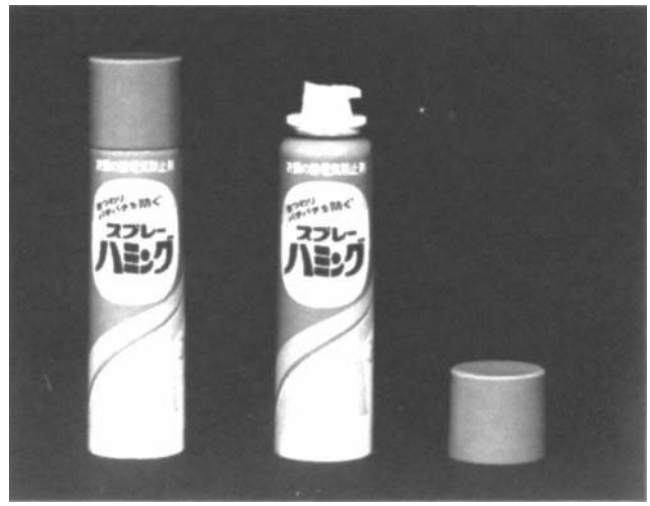


Figure 11. Japanese Anti-Static Products for Garments
The Japanese dispenser is smaller and the product is more distinctly perfumed than U.S.A. counterparts. A special actuator covers the valve cup.

The use of data on aerosol productions can be very misleading. For example, the production of insecticides in England rose from 42 million in 1975 to 85 million in 1978. What might seem to be a dynamic market was actually one where domestic consumption was at the saturation point of about 19 million units, with all the rest being exported. Another statistical tool that is badly overrated is aerosol market share, as shown in Table XXVII.

Figure 10. Aluminum Tubes for Personal Protection Products.

The containers are ¾" (22mm) diameter tubes. Both have 20 mm ferrule-type valves and special actuating heads.

TABLE XXVII.

Market Share of Selected Aerosol Products

Product	U.S.A. 1980 Market Share
Insecticides	74*
Insect Repellents	70
Spray Disinfectant/Deodorants	71
Bathroom Cleaners	11**
Starch Sprays	68***
Sizing Sprays	18***
Oven Cleaner Sprays	86
Upholstery Cleaner Sprays	98.4
Window Cleaner Sprays	9
Shave Creams	94
Hair Sprays	62
Antiperspirant/Deodorants	39
Colognes/Perfumes	5
Sun Care (Sun Screen) Aerosols	7.7
Refrigerated Toppings	11
Caulking Compound	1

*Of the aerosol plus pump-spray market.

**Of the all-purpose cleaners category.

***Of the dry, liquid and aerosol starch, plus sizings market.

Aerosols with small market shares in their category might appear destined for growth, but this is not usually the case. Conversely, aerosols with a lion's share of their overall category can experience growth, simply by expansion of the category itself, as in upholstery cleaners, during 1980 and 1981 to date.

Marketers customarily evaluate the sales performance (both volume and pricing) of products during immediately preceding years before deciding to make introductions. In many cases products in the U.S.A. were first launched in Europe, such as the feminine hygiene spray, and the reverse is also true. On the other hand some aerosol products doing quite well in Europe do not seem to have interested U.S.A. marketers. Examples are foam shampoos and anti-dandruff sprays. Frypan lubricants are very successful in the U.S.A. and Australia, but are rarely seen anywhere else.

TABLE XXVIII.

Aerosol Production of Larger Volume Countries

Country	Production (Million Units) 1975	1978	1979	1980	1981
U.S.A.	2355	2231	2398	2163	2198
England	440	563	522	498	490
West Germany	457	450	467	462	
France	480	412	419	429	
Japan	245	301	342	311	
Italy	176	207	230	252	
U.S.S.R.	139	198	235	292	
Netherlands	65	139	159	175	
Canada	137	135	131	130	134*
Spain	109	130	156	151	
Australia	115	128	125	135	
Brazil	85	111	125	101	
Poland	61	97	105	112	
Argentina	105	71	92	94	
Venezuela	32	72	80	84	
Belgium/Lux.	45	51	61	72	
Switzerland	48	44	50	47	
Mexico	45	50	56	71	93
Czechoslavakia	33	47	50	55	

Country	Production (Million Units) 1978	1979	1980
Austria	37	36	39
Yugoslavia	30	33	
East Germany	28	33	
South Africa	61	58	
Greece	30	29*	28*
Formosa (Taiwan)	21	25	
Hungary	23	25	
Rumania	25	25	
Nigeria	22	26	
Portugal	24	30	27
Finland	14	18	18
Iran	14	20	
Israel	15	16	
New Zealand	13	13	13
Norway	15	12	9
China	12	12	14
Sweden	12	12	11
India	9	10	12
Indonesia	8	10	
Egypt	13	15	
Denmark	9	10*	13*

*Estimated
Note: Imports and exports change consumption figures significantly from production figures.

A listing of countries producing more than ten million aerosols per year is given in Table XXVIII.

In most of these countries the rate of aerosol productions has been essentially static over the past several years, indicating saturation. In several, the chlorofluorocarbon/ozone controversy has caused sharp reductions in volume, such as 26% in Canada, 30% in the U.S.A. and 38% in Scandinavia, measured from the onset of the problem to the non-recession base year of 1979. The greatest increases in volume are now taking place in the developing countries. Mexico increased its aerosol production by 30% from 1978 to 1979. This trend continues into 1980 and 1981, and should be sustained by an economy made more robust by increasing petroleum exports. In Africa, virtually every nation except the Republic of South Africa (which is saturated) is growing fast in aerosol consumption. Omitting South Africa, the continent showed a production increase from 46.4 million in 1978 to 80.5 million in 1979, an advance of 73%. During 1980 this increase continued, although figures are not available at this writing, and large numbers of aerosols were imported from the Netherlands, England and other countries against the time when additional local filling facilities could be constructed. In 1980, Nigeria imported more aerosols than were filled locally, and several smaller African economies did the same.

Other important growth areas include the whole of Central and South America, where production rose 22.8% in 1979, and Asia, where aerosols increased by 14.9% in 1979. (Nothing is known of Siberian aerosol production; it may be included in the U.S.S.R. contribution of 210 million units to the European total.) When the growth, static and declining areas are considered, recent worldwide production is suggested as 5.89 billion for 1978, 6.40 billion for 1979 and about 6.52 billion for the recession year of 1980.

Production figures for key countries are given for the period 1970 through 1979 in Table XXIX. Those for 1961 through 1970 are provided in the first edition of *The Aerosol Handbook* and are not repeated here.

During the period 1970 to 1980 U.S.A. aerosol production dwindled from 55 to 35% of world figures. This has been laid to the chlorofluorocarbon/ozone issue, with resultant marketer confusion, bad press, lack of aerosol advertising and consumerist activities, as well as the ban on CFCs starting in 1978, but there were other factors as well. Even before the ozone controversy, by 1973, the zenith of U.S.A. production years, the industry produced only 50% of the world total. This was due to saturation. Later on such things as inflation/recession (stagflation) and relatively high prices for aerosols began taking their toll. Marketers turned increasingly to less costly alternates. A comparison of U.S.A. and world aerosol production figures is shown in Figure 12.

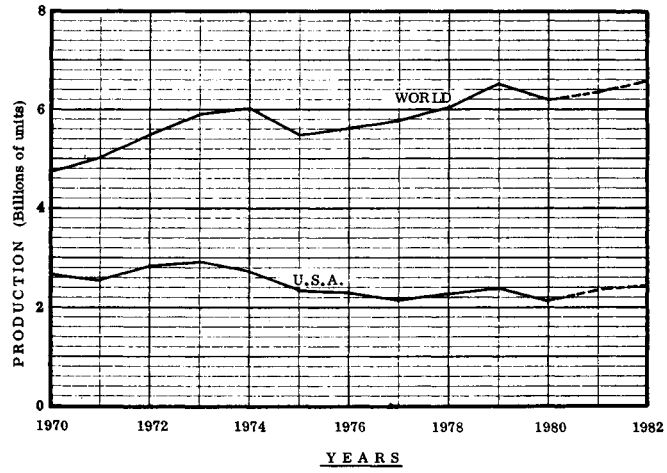


Figure 12. World and U.S.A. Aerosol Production

TABLE XXIX

World Production of Aerosols - 1970 - 1980

(Millions of Units)

Country	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
West Germany	401	401	412	389	418	425	457	454	450	467	462
England (U.K.)	304	349	361	438	478	441	495	532	563	522	498
France	254	304	359	394	450	383	454	466	412	419	429
Italy	136	158	173	194	203	173	253	192	207	227	252
Switzerland	51	57	60	58	59	47	50	53	44	50	47
The Netherlands	90	119	120	136	155	147	145	143	139	159	175
Sweden	23	27	20	24	24	19	18	13	12	12	11
Spain	34	48	68	99	112	109	120	146	130	156	151
Belgium	39	45	45	49	46	46	51	54	52	61	72
Austria	20	28	29	31	31	33	35	38	37	38	39
Finland	20	21	27	29	29	22	21	15	14	18	18
Denmark	13	13	14	14	14	14	13	11	9	10	13
Norway	13	16	18	17	15	13	14	13	15	12	9
Ireland (Eire)	6	12	13	22	15	5	5	5	5	6	3
Portugal	4	6	7	8	9	12	20	30	32	30	27
Greece	7	14	17	20	23	22	26	28	30	29	28
Turkey	2	2	(3)	(3)	(4)	(5)	(5)	6	7	7	7
Iceland/Malta/Cypress	1	1	(1)	(1)	(1)	(2)	(2)	2	2	3	3
U.S.S.R. & Satellites	137	134	(175)	(225)	(270)	(320)	(385)	429	408	489	528
Total Europe	1555	1766	(1899)	(2159)	(2353)	(2237)	(2566)	2633	2557	2709	2771
U.S.A.	2623	2554	2823	2902	2722	2354	2295	2150	2231	2398	2165
Canada	140	152	163	168	182	148	149	144	135	135	130
Japan	194	217	237	264	252	220	272	269	301	342	311
Australia	72	83	88	105	126	115	124	121	128	120	135
New Zealand	13	17	18	22	26	15	13	14	13	13	13
Brazil	33	35	39	58	67	85	108	100	111	130	101
Argentina	43	53	61	64	101	105	92	70	71	92	94
Other Latin Amer.	15	17	17	18	20	50	71	93	104	132	145
Mexico	19	23	32	36	44	65	54	48	50	65	71
Africa	40	50	55	73	91	80	84	132	147	191	208
World Total	4775	5013	5465	5910	6009	5477	5804	5773	6027	6551	6144

Note: Figures in parentheses represent best available estimates.

TABLE XXX

Ten Year Variations in U.S.A. Aerosol Categories

Category	Per Cent of the Total Market 1970	1975	1979	1980
Insect Sprays	4.0	4.3	5.8	6.9
Coatings and Finishes	8.8	11.8	12.8	14.3
Household Products	23.8	24.1	28.0	26.8
Personal Products	52.6	45.6	33.1	29.4
Animal Products	0.4	0.6	0.8	0.7
Industrial Products	1.7	3.2	5.7	7.9
Food Products	3.4	6.4	6.0	6.5
Automotive Products	2.2	3.3	7.1	6.0
Miscellaneous	3.0	0.6	0.6	1.4

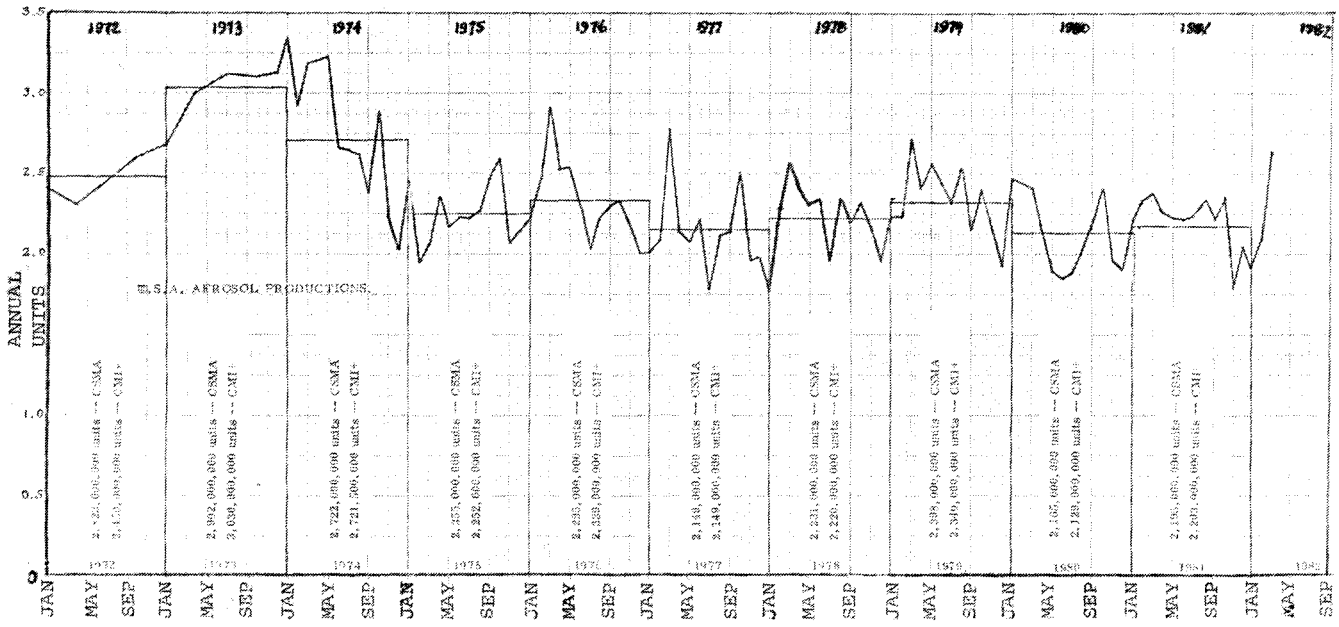
During 1980, worldwide use of aerosols was about 1.4 units per capita. If we assume conservatively a population growth of 2% per year and an increase in usage rate to 1.6 by 1990, world consumption then becomes 8.8 billions, up 42% from the 1980 figure. By referring to Figure 6, where the U.S.A. production is projected to 3.25 billion by 1990, it follows that the domestic contribution will remain about the same, at some 37% of the total.

The U.S.A. market has often been considered a trendsetter for markets in other countries. This is only a qualitative thing at best, since production of various products in other lands will inevitably be a composite of climate, regulations, timeliness, public perceptions, backgrounds and other factors. But in general, many countries begin with heavy emphasis on insecticides, then air fresheners and shaving creams, then other personal products plus paints, and finally a strong growth in the automotive and industrial products. It is interesting to look at the U.S.A. aerosol market to see how the aerosol categories have changed during the 1970s, as shown in Table XXX.

Strong expansion in the automotive and industrial product categories might suggest these areas for new product introductions. Insecticides are also believed to be a late bloomer. According to *Packaged Facts, Inc.* 1980 retail sales will be about $324 million and should rise to $660 million retail by 1985. This is due to an alarming rise in insect population, strong advertising, heavy trade promotion and new product introductions. If this is true, insecticides could account for more than 10% of the total U.S.A. aerosol market; something they have not done for over twenty years.

The Can Maker's Institute provides their members with monthly survey figures on the number of cans

Figure 13. U.S.A. Aerosol Production 1972-1981



made and shipped by participating companies. Unfortunately, some of the firms that make aluminum containers exclusively have not contributed their figures, as a result the CMI surveys are consistently about 7.2% lower than actual. When this non-reported quantity is figured in, and the total adjusted to include the small percentage of the industry volume marketed in glass and plastic aerosols, a rather accurate assessment of total U.S.A. aerosol volume emerges. The monthly survey data becomes available about 75 days after the reported month. Allowing a month for shipment to the filler, warehousing of empties by the filler, actual filling, further warehousing and shipment to the marketer or distribution center, it is reasonable to suggest a 45 day time lag in relation to either production of the aerosol or its availability to the marketplace for sale.

For a number of years the aerosol business has displayed an interesting cyclical pattern. The peak can-making period is in March, followed by one in October. Very slow months include July and December, probably due to vacation spending and Christimas gift spending as alternates to the purchase of aerosols. The effects of recessions can be clearly seen when these monthly data are graphed. Then in mid-1974 the devastating effects of the chlorofluorocarbon/ozone controversy can be observed, with production tumbling about 35% to a bottoming point in "black February" of 1976. These data are shown in Figure 13.

The Marketplace

Most aerosols are sold in supermarkets and mass merchandiser outlets. The rest are sold in drugstores, grocery stores, hardware stores and a variety of other retail establishments. The larger stores constantly monitor sales per linear foot of shelf space as well as profitability. It takes an average 27% markup just to operate a supermarket, and these stores will tolerate lower markups only for nationally advertised brands where the customer expects to find them available. The loss leaders are national brand laundry detergents, where the markup is only 10%. Because of the low profit, supermarkets have pushed private label counterparts from less than 1% in 1970 to about an 11% market share in 1981.

Supermarkets characterize their products about as follows:

a. National brands.

b. Private label (PL) products.

   i. Store name products — such as "Stop & Shop".

   ii. Franchise brands — such as A&P's "Sail", promoted and advertised by the chains much like a national brand.

   iii. Buying Co-Ops which jointly buy PL products — such as "Topco", now offered by over twenty chains.

   iv. Generics

c. Regional or local brands.

In contrast to most nationally branded products, PL products can generate significant profits for the store. They usually sell for 20 to 30% below the nationals, with generics an additional 10% below that. Store name brands are more or less on a par with the quality of the national brands. They can thus generate consumer loyalty which can grow to overall store loyalty.

Private label fillers include Chase Products Co., Georgia-Pacific, Inc., and several others. It is a capital and space intensive business due to inventory requirements. Also, these manufacturers are expected to show supermarkets how to improve their PL sales. The products need a highly visible position, an adequate price spread and regular advertising support and promotions, such as couponing. The package must have a strong selling message.

The generic products were initiated in France, where they now hold over 30% of the big laundry detergent market and several others. They were introduced into the U.S.A. by Jewel Home Shopping Service, Inc.,

Figure 14. Packaging of Gillette Products in England.

Cans are placed in trays then shrink-wrapped in polyethylene. Much of the European aerosol production is shipped in this form. The material for two 211 × 413 can six-packs weighs 20 grams, while an empty 12-pack corrugate (175# burst) case weighs 220 grams, — eleven times as much.

and now hold a 22% share of certain categories. They are increasing fast. Aside from a large 24 Av. oz. aerosol shaving cream product we have not seen any aerosol generics during 1981; however, the aerosol market is not immune from this type of merchandising.

Packaging Considerations

Good formulations rarely sell themselves. They require expert packaging with careful attention to marketing (and legal) requirements. Fewer than 10% of new products, packages, sizes and so forth are accepted by supermarkets these days. When a buyer or retailer looks at an aerosol, he sees merely another consumer packaged goods item to be evaluated. He wants to hear selling facts. Specifically he wants to see:

a. Proof of potential sales volume.
b. Profitability.
c. Evidence of consumer demand.
d. A new and uncomplicated item, free of problems.

Proof of potential sales and valid evidence of consumer demand are generally provided to him in terms of test market results. Market studies often show that aerosols have superior sales and profit power, but not always. In terms of such aspects as:

a. Total dollar sales.
b. Dollar margin.
c. Total unit sales.
d. Dollar sales per item stocked.
e. Average profit per item stocked.
f. Unit sales per item stocked.
g. Dollar sales per linear foot of shelf space.
h. Dollar margin per linear foot of shelf space.

Aerosols often outsell non-aerosols, and for this reason have a much improved chance of securing the retailer's valuable shelf space and inventory investment dollar.

In matters of package design the average or smaller marketer will work in conjunction with a large advertising agency or specialty house. In a few cases the contract filler will make a major contribution to container and label development. Package design and display are considered the major purchasing inducement for over 25% of customers, and it follows that elaborate plans are developed to show off the package in its best possible form. A check list is often compiled and used to rationalize and organize efforts toward this goal.

Marketer's Packaging Check List

Product Review

a. Is the product new or demonstrably better than others?
b. Has an analysis been made of its relative qualities competitively?
c. Are the advantages identified over competition?
d. Does the packaging choice consider—
    i. Which package will reach desired markets most effectively?
    ii. Improved properties that permit shelf life; better distribution?
    iii. Are additional forms possible to enhance sales?

Market Review

a. Has the ultimate consumer been determined? (Age — income — sex — race — life habits — interests)
b. Has the distribution plan been determined? What channels?
    (Independents — chains — self-service — mail order — house-to-house)

Display Program

a. Have retailer buying habits been checked for—
    i. Unit of purchase?
    ii. Storage prior to sale?
    iii. Display on shelf, counter, window, etc.? Mass display?
    iv. Will package be viewed at, above or below eye level?
    v. Which panel of display box, shadow box, etc. will be visible?
    vi. Will there be a point-of-sale display?

Size Considerations

a. Is size of package adapted to distribution methods, consumer habits and needs?
b. Would a change in size affect consumer convenience of quality of purchase?

Competition

a. Has product been compared to competition, if any?
b. Has packaging been compared, as to materials, size, shape, colors and designs?

c. Is packaging to be distinctive, or should it resemble that of brand leaders?

Graphics Review

a. Is identity clearly established by—
   i. Necessary features, properly positioned and emphasized?
   ii. Printing brand name in unmistakable position, clarity and style?
   iii. Is product name featured for instant identification by consumer?
   iv. Is name of manufacturer presented with adequate prominence?
   v. Possible link-up with family name, if any?

b. Does the packaging indicate—
   i. Any outstanding qualities of the product?
   ii. The manufacturer's integrity, sense of responsibility or warranty?
   iii. Tie-in with advertising programs or slogans?
   iv. Possibility of useful television promotion?

c. Is information presented on—
   i. Instructions for use?
   ii. Instructions for secondary uses?
   iii. Precautionary statements?
   iv. Formula of product; for economic poisons, drugs, foods, some cosmetics, paints, etc.?
   v. Illustration panels?
   vi. Suggested retail pricing?
   vii. Code marking?
   viii. All items covered under Federal and local Acts and Regulations?

d. Is overall impression good at point of sale?
   i. Are colors and designs in good taste and appropriate for product?
   ii. Does package look good from a distance, from close up, on the shelf, in the home, next to competition?
   iii. Does it carry a self-selling story?
   iv. Is it adequately visible and appetizing?
   v. Is recall value high?

Distribution Review

a. Is package size and shape convenient for wholesaler and retailer?

b. Is packaging convenient for storage, stacking, display, sales handling, price marking, checkout and delivery to home?

c. Is package designed to expedite self-selection, self-service, quick turnover?

d. Does package help solve pilferage problems, soilage, breakage, seasonal and holiday loads and dealer problems with regard to tie-ins and promotions?

e. Are contents damaged by freezing or overheating?

Use Factors

a. Is the size unit the best possible?

b. Is pre-sale inspection desired or possible?

c. Can package be easily opened and reclosed; cap, actuator dome, child-resistant closure?

d. Is label resistant to water damage?

e. Can consumer measure out desired amount with reasonable assurance?

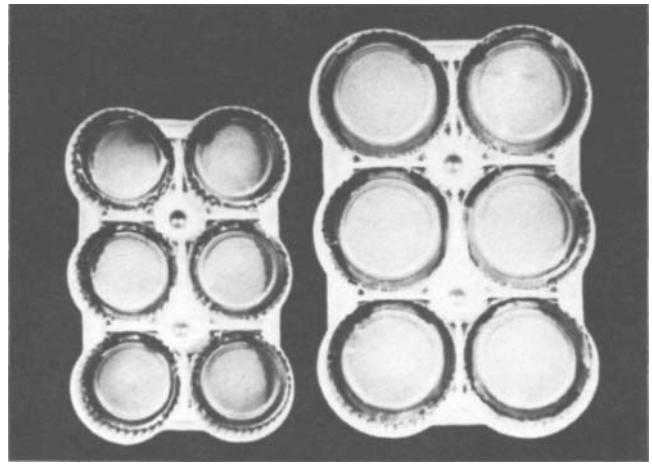
f. Will package perform under all reasonably forseeable use conditions?

g. Is size convenient for consumer storage units?

To illustrate the importance of advertising, package design and displays, it has been shown that these attributes were instrumental in influencing 67% of all brand switchers to buy a product that they would normally not have purchased.

Figure 15. Translucent 6-Pack Trays Made in England

Six-pack 211-diameter and 202-diameter translucent, thin plastic trays used to hold aerosol cans made in Europe and shrink-wrapped with polyethylene film. This cost-saving packaging mode has not yet been approved by the U.S. Department of Transportation.



It must be remembered that the most effective packages are functional, they get attention at a distance and close by, they excel in recognition power and they must have lasting power beyond the duration of the advertising campaign. Package designers strive to achieve these goals by increasing the apparent size of the unit, giving it high visibility (many shoppers forget their glasses), distinctive design, message organization, color dominance and mass impact, where one plus one should equal more than two.

Even such seemingly trivial things as package gloss must be considered. High gloss finishes are preferred by 25 to 1. Gloss conveys such impressions as "the cared-for look" (like a fine car), a safer product (smoothness connotes safety; less suspicion of contamination), the wet look (perceived as recently cleaned and still wet), good complexion (attractive), strength (strong and durable), easy visibility. A glossy surface is also sometimes interpreted as flashy, cheap and utilitarian, so the more expensive products indulge in gloss only on a limited scale; usually for lettering, metallic designs and so forth. Where softness is desired, such as in certain boudoir products, gloss is totally avoided.

Colors are immensely important to product success. The most dominant color is puce (color of dried blood), but this has unpleasant overtones, so yellow is more often selected. Generally, yellow is used in moderation because of its brilliance. It is used for "cents-off" bursts and other special applications. Yellow is also applied to specific products, such as sun bathing products. Yellow suggests the sun, blue symbolizes the sea, and bronzes indicate a healthy suntan. Subliminal psychological motivations are a major selling force in this and other markets.

Yellows, green-yellows and orange colors are being used often, as aerosol marketers strive for high visibility. These colors are associated with the trend toward lemons, limes, citrus fragrances and so forth, which appear to connote the ultimate in cleanliness. Products designed for the teen-age market often include red, purple on yellow, royal blue on orange, and so forth, because of the younger set's proven affinity for hot colors. White has a clinical appeal, but gold and white combines efficacy with elegance and this combination is used for several high priced, perfumed, after-bath talcum powder sprays. Men's colors include glossy blacks, browns and tans, often embellished with touches of vivid orange and red for style. It should be remembered, however, that women still do much of the buying for men, and are the dominant buyers of men's toiletries.

In countries other than the U.S.A., the response to colors may be quite different. For instance, in Japan red is perceived as a brave and manly color, while white signifies craftiness and cunning.

Once the finished label design is arrived at, it must be scrutinized carefully by a number of experts, such as the Technical Director (for verification of claims, formulas and use directions), the VP-Sales, Group Product Director and Product Manager (for appeal, position, visibility and so forth) the Packaging Development Director (for technical reproduction, etc.) and the Legal Department (for compliance with myriad Federal Regulations). After this, the design is submitted to the can company, the glassmaker or the paper label manufacturer for conversion into final form. Preliminary copy, such as canmaker's "black-and-white" proofs, is nearly always sent to the marketer for final review before the production process commences.

Cost Considerations in Aerosol Production

At the production level the cost of a finished aerosol is made up of three components:

a. Concentrate and propellent
b. Packaging elements
c. Services.

Each of these must be developed separately. For the first two categories the net supplier costs are used for the quantity levels required. Reasonable overages are added to compensate for anticipated factory losses. Freight costs must also be figured in where applicable. In the services category are included the cost of direct labor, manufacturing burden, SG&A (Selling, General & Administrative Expenses) and profit. In unusual situations, additional costs may be incurred, such as the need to purchase special equipment, or to inventory finished stock against established minimums. On the other hand, discounts are often provided for cash-with-order or immediate payment of invoices for produced or shipped merchandise.

An example can be provided in the case of a 1 lb. hair spray formulation, filled in lots of 100,000 cans per order.

a. Cost of concentrate and propellent.

   Fill weight target is 464.9 g per can (1.025 lb./can)

Alcohol (anhydrous)	$195.19/M. cans (with 3% loss factor)
AMP	5.29/M. cans (with 5% loss factor)
Amphomer 28-4910	79.89/M. cans (with 5% loss factor)
Isopropyl myristate	1.51/M. cans (with 5% loss factor)
Methlyene chloride	46.01/M. cans (with 6% loss factor)
Perfume oil	11.69/M. cans (with 5% loss factor)
Propellent A-70	85.35/M. cans (with 12% loss factor)
	$424.93/M. cans.

b. Cost of packaging elements.

Can (211 × 713) lithographed	$319.65/M. cans (with 1.5% loss factor)
Valve with actuator	44.83M. cans (with 1.5% loss factor)
Cap - one-inch - white	8.74M. cans (with 1.0% loss factor)
Case - 12 pack	14.17/M. cans (with 1.0% loss factor)
Glue & miscellaneous	1.03/M. cans
	$388.42/M. cans.

c. Services.

Direct labor	$16.00/M. cans
Manufacturing burden	32.00/M. cans
SG&A	4.00/M. cans
Desired profit	variable
	$52.00/M. cans, plus desired profit

The Factory Cost is thus: $861.35/M. cans, and The Sales Price is thus: $865.35/M. cans, plus desired profit.

This cost development system is fairly standard for the U.S.A. In Europe and certain other areas the method of calculation is quite different, and more complicated.

In the above example, if the marketer purchases the 100,000 hair spray units for $930.00/M. including freight to his distribution centers, he will then charge his distributors from about $1000.00/M. (lots of 1000

TABLE XXXI.

Advantages of the Aerosol Dispensing System

1. Product cannot evaporate.
2. Product cannot become contaminated with bacteria, dust and so forth.
3. Product cannot spill if package is overturned.
4. Highly colored, alkaline or chemically active products can be delivered without contacting the body.
5. Product is ready for instant use at any time. No heating or thawing, no screw-caps to undo, no mixing, blending or measuring.
6. Product can be applied to surfaces cleanly and evenly.
7. No extra items are needed, such as a paintbrush, bucket, rags, cleaner and so forth in the case of paint products.
8. Products have very long shelf lives — 3 to 30 years.
9. Dispensers are portable, easily stored.
10. Metering spray valves give automatic portioning or dosages if desired.
11. Very small amounts can be dispensed — down to about 50 mg.
12. Extremely fine mists can be produced, for instance, to make insecticides much more active.
13. Product characteristics will not change under extended storage.
14. Sprays can be used to penetrate cracks and crevices — to lubricate, undercoat, kill insects hiding between walls, and so forth.
15. Provides a unique and desired dispensing method, as in hair sprays or foams.
16. Can safely contain and dispense noxious chemicals, such as "Mace".
17. Can dispense powders, liquids, gases, gels, foams, dispersions, pastes and other product forms with equal facility.
18. Sealed system prevents oxidation of delicate chemicals, such as some perfumes.
19. No skills or tools are required to operate.
20. Dispenser will not break or shatter if dropped.
21. Can perform unusual feats — such as killing wasps and hornets in their nests at distances of fifteen feet (5 m) or more.
22. Automatically stops dispensing when valve is released.
23. Are eminently safe when used as directed and have a good safety record.
24. Are often less expensive than competitive products.

TABLE XXXII.

Disadvantages of the Aerosol Dispensing System

1. Users may inhale aerosol mists, sometimes irritating, as in the case of antiperspirants.
2. Package may overpressurize and rupture if heated to about 155° to 220°F (60°C to 105°C), depending upon formula and dispenser.
3. Some aerosols are flammable — could cause hazards if used contrary to label directions.
4. Some persons object to insecticidal odors, as dispensed by some aerosol insecticides.
5. Directionality of the spray may be a problem for some actuators.
6. Clogging or sustained streaming may occur for paints, coatings, starch sprays and so forth, especially if label directions are not followed.
7. In rare instances (less than one can per thousand) aerosols may depressurize as a result of slow propellent leakage and become inoperative.
8. Relatively high expense as a packaging system.
9. The term "aerosol" is limiting, reminding users of bad press on the chloroflurocarbon/ozone controversy and consumerist issues.
10. Disposal of aerosols is perceived as a possible problem.
11. Higher than average energy consumption is needed to produce the can — especially aluminum cans — and hydrocarbon propellents represent an energy source that could be used for heating or other applications.
12. With minor exceptions all containers are cylindrical in shape.
13. Aerosols may dispense gaseous and/or liquid hydrocarbon products into the air (estimated at 15,000 pounds, or 7,000 kg, per day in the Greater Los Angeles Metropolitan area, for example) and thus come under strong criticism from the "Clean Air" advocates in areas sensitive to smog problems.
14. Can be used to produce psychodelic highs and to generate graffiti, as is the case with a number of other products as well.

cases) to $1300.00/M. (lots of 11 cases or less). The distributor will then establish a salon or wholesale store cost of about $1.80/can, and after that the markup to retail will normally* be at least 30%, or $2.34/can.

The Aerosol Advantage

Despite the relatively high cost in some instances, the aerosol dispensing form has a large number of advantages, and no marketing survey would be complete without considering them. A listing is given as Table XXXI. It is not represented as complete, and the advantages do not apply to every aerosol. Nevertheless, it remains as a useful guideline.

On balance, it is only fair to comment that there are several disadvantages to the aerosol dispensing system, and a number of these are described in Table XXXII.

It is interesting to note that the industry has long considered explosions and flammability to be the major hazards of the aerosol system. However, the consumer discounts these and worries mostly about inhalation and possible toxicological sequellae. His rationale? He can control and eliminate flammability and bursting with reasonable care, but he cannot escape inhaling, eventually, those aerosols sprayed in the house.

In this chapter we have provided many of the essential considerations of the marketing process; an immensely complex route from product concept to the emergence of the finished aerosol in over 100,000 retail outlets throughout the country. Corporate profits, in some cases even corporate existence, often hang on marketing decisions made with never enough data, but with gaps filled in by experts using educated guesswork born of experience.