Surfactants and Detergents—Current, future perspectives

Ted Matson
Panel Chairman

(At the 1985 AOCS annual meeting, Ted P. Matson served as organizer/chairman for a panel discussion on the surfactant and detergent industry, focusing primarily on the United States. Panelists Arno Cahn, Jane Creel, M.J. Rosen and W.J.B. Vogel each made an opening statement, followed by a question-and-answer period, and then each offered brief concluding remarks. The following article is based on that panel discussion.)

Formulation and evaluation

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Detergent formulations are not usually associated with the excitement of high technology Nonetheless, these products have shown a surprising vitality—and technology—in the changes we have seen in the last few years. I shall briefly touch on four developments I consider noteworthy.

The first is the expansion of enzymes in laundry products. Enzymes make a technical contribution to the washing process—not a major contribution in all laundry loads, but a contribution which is very much perceivable on those stains that are susceptible to degradation by enzyme action.

Proteolytic enzymes were first introduced in the late 1960s and early 1970s. They subsequently were withdrawn as the result of unfavorable publicity regarding their safety. As far as consumers were concerned, the publicity was undeserved. Such hazards as there were, were confined to persons handling enzymes during manufacture of detergent products.

Since then, improvements have been made in expanding the range of conditions under which enzymes are active and the form in which they are delivered to the formulators—mainly through a variety of coating/encapsulation techniques. In addition, amylolytic enzymes have been commercialized so that we now have mixtures of proteases and amylases in a number of detergent products—although as yet not specifically claimed as such.

The second change we are witnessing is the continuing expansion of heavy-duty laundry liquids. The expansion has been relatively steady since the mid-1960s. Various explanations have been given:

- their convenience and efficacy in pretreating stains
- the relative improvement in their detergency performance as the effectiveness of powders has declined with declining phosphate levels
- the changing composition of the wash load in the direction of less cotton and more synthetics (on which the high level of surfactants in heavy-duty liquids is more beneficial than it would be on cotton)

Historically, the expansion of this product category has taken a leap forward whenever a new brand has been introduced into the marketplace. One relatively recent introduction was Liquid Tide with an unusually high level of surfactants, a high level of a fatty acid soap and the presence of some cationic surfactants in combination with anionics and nonionics.

The third noteworthy development is the expansion of combination products which provide both detergency and softening. This is a development that is market-driven in that it provides added convenience for the user. Even the less-than-onerous task of throwing a coated sheet into the drier is now eliminated.

The combination products deliver softening that is only moderate compared to the standard rinse-cycle softeners. On the other hand, they deliver good anti-stat protection—which ties in nicely with the increasing proportion of synthetics in the laundry load.

Technically, there have been some very innovative approaches here: tying up the cationic surfactant during the wash cycle by adsorption onto certain clay types, filtering of the clay/cationic combination during the spin cycle followed by melting and distributing the quaternary by the heat of the drier. Other approaches call for special quaternary structures for use with nonionics and for clay itself as a means of conferring softening. This is a growing category: from zero a few years ago to about 10% of products at present.

The last development is improved stain removal through bleaching. Enzymes have already been mentioned for removal of certain stains. Other stains are susceptible to chemical bleaching—oxidation.

Products containing activated perborate—with TAED as the activator—are widely distributed in Europe, where high levels of perborate have been standard for many years. Activation is needed to confer effectiveness on perborate at lower wash temperatures—around 60 C in Europe these days.

In the U.S., we have now seen a new product that contains both proteolytic and amylolytic enzymes as well as activated perborate. The activator in this case contains a moderately long chain. As a result, it is claimed, the activator is adsorbed on cloth and performs its activation chore where it is most needed.

Facing the facts: changing consumers

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I have been asked to represent the consumer perspective. In these initial perspectives, let's step

back for a macroview of the consumer. I will discuss four demographic trends as well as four strategies consumers currently use for managing housework. These will provide some insights into the needs of consumers today and tomorrow.

Let's face it, as enthusiastic as you and I may be about our products, nobody really likes to scrub floors, wash clothes and clean house. These are boring, thankless and sometimes difficult tasks. They are done simply because they must be done. Coupled with the time and economic pressures created in the home as the American family evolves, these tasks are becoming even more onerous than before.

Here are four important demographic trends that can affect the acceptance and use of our products. For these demographic data I am indebted to Rena Bartos and the J. Walter Thompson Company for their analysis as well as to the conference board and the U.S. Census Bureau.

First, the impact that the movement of women into the labor force has made upon society and the home is far greater than one could possibly have imagined 30 years ago. This year (1985) women outnumber white males in the work force. In 1984, 54% of all women in the United States 16 years or over were in the work force; only 33% of all women were full-time housewives. And the number of working women continues to grow. The number of working wives has doubled during the past 20 years with the greatest growth coming from mothers with very young children—children under six years old.

Why do women work? There are a number of reasons, of course. Self-fulfillment is important. But I expect the most important reason women work today is because it is a financial necessity, which brings us to demographic trend No. 2. This trend is what I call America's shrinking middle—middle income and middle class—or what is popularly known as the development of a two-tier economy.

The conference board predicts that by 1990 (equivalent of 1982 dollars):

- 37% of all households will earn $30,000 or more a year and they will receive 71% of the income.
- 44% of all households will earn less than $20,000 a year and their share of the pie will be only 14% of all income earned.

To quote Lester Therow—it's not that we're a bimodal economy, but the center is getting squashed down. The number of people in the middle distribution is smaller, with about one-half falling down the pyramid and one-half rising up. What a different society and marketplace we may face if by the year 2000 America is without a significant middle class.

The third demographic trend is the growth of the single person household. Here again, today's demographic facts shatter myths. For example, the conventional portrait of the American family consisting of one father (bread winner), one mother (homemaker) and two-plus children now accounts for only about 7% of all households. Today, one in three households is a single person household. Five years from now in 1990, fully 45% of all households are expected to be headed by a man or a woman without a spouse (29% headed by a woman and 16% by a man).

The growth of these single person households reflects a number of changes in traditional life patterns, many of which you observe each day. It reflects marriage at later ages, an acceptance of non-marriage as an acceptable lifestyle, and an increase in those living alone between divorce and remarriage (three out of four divorces are followed by remarriage.) Additionally, this trend represents the increased longevity and vitality of older Americans.

Demographic trend No. 4 concerns the growth of single parent households. Is there a more stunning illustration of the extent to which the family has changed in nature and in social structure than in the following data:

Today, 20% of all children live in single parent homes. According to the conference board, in 1990, only five years from now, 27% (more than one in four) of American children will live in homes with only one parent. Twenty-four percent will be living with their mothers alone and 3% with their fathers.

Unfortunately, those families headed by women are also frequently poor. Black or white, this group comprises the largest membership in the bottom tier of our two-tier-income society.

What effects do these demographic changes have on consumers and our products? There are three obvious points:

- There's less time available to clean.
- Convenience becomes even more attractive.
- Along with a basic dislike for most cleaning tasks, consumers are developing different attitudes toward housecleaning, which can affect our products.

What are these changed attitudes, and what strategies do consumers use to manage household chores? I see four.

Management strategy No. 1 is to lower or change standards. "If I don't see the dirt, it doesn't bother me, so I just don't look," said one of the women interviewed in a recent newspaper article. "This 'no look' method of cleaning has become popular, because women who stay home to scour and scrub are not staying home anymore," the reporter concluded.

Or they make certain trade offs. Selling Areas Marketing Inc. (SAMI), a New York research company, indicates sales of scouring powder, mildew remover and floor waxes slipped again last year, continuing a 10-year trend. In contrast, sales of paper plates and aluminum baking pans (the kind you throw away) have blossomed.

Strategy No. 2 is negotiation—women, who for the most part still have ultimate responsibility for the smooth running of the home, attempt to negotiate with other family members (children and husbands) to share tasks. However, the success of negotiating with teenagers is not always rewarding. They do contribute to some aspects of housekeeping, but for the most part their involvement is more related to cooking and shopping than scrubbing and cleaning.

And what about husbands? Men,

it's true, are changing their attitudes toward housecleaning and sex stereotyping of household chores. Men's shifting views on housework, however, are not reflected in dramatic changes in their behavior. For example, among household cleaning chores, clothes care and kitchen cleanup are still considered by most men to be women's tasks. A 1981 study indicated only 8% of men washed clothes and only 10% washed dishes.

Although most researchers agree the gap between the amount of time spent by men and women on housework is closing, it is still impossible to quantify the amount of work men are doing at home. Importantly for the future, however, an egalitarian model is reflected in attitude and practice more often among younger men—the well-educated and the moderately affluent—and with both blue and white collar workers.

Additionally, single men—that growing number in single person households—do take on household responsibilities. As researcher Judith Langer points out, "For men living without women, the question isn't who takes out the garbage, but whether or not the garbage will be taken out." And they quickly learn both cleaning and shopping skills.

The third cleaning management strategy is "do it yourself." How do homemakers without help from the family handle the problem of housework and shrinking hours at home? According to a University of Michigan study, working women and especially working wives spend less time doing housework, but they expend more effort in the hours available. Household appliances become their best friends.

"Pay to have it done" is strategy No. 4; if all of these earlier strategies fail, there is of course the ideal solution—a maid. Right now, 8% of households earning more than $30,000 a year pay to have someone clean their houses. Most middle class families, however, probably consider maids to be luxurious, unreliable or exorbitant. For those who reject this notion but need help, a new industry is developing—housecleaning franchise operations. These companies provide a team of cleaners to visit a home on a regular basis or for a one-time overhaul.

There is increased probability that this strategy will become more popular in the near future. As more and more people have incomes substantially over $30,000, more will be able to afford outside help. Additionally, increased immigration into the United States will increase the pool of household workers.

This concludes my overview of a changing consumer market. During our question-and-answer session, we can discuss some of the laundry practices and problems that consumers tell us of today.

Current developments in surfactants

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The surfactant industry currently faces a number of challenges, including development of (a) surfactants to replace less desirable chemicals, including insecticides, herbicides and preservatives toxic to humans and beneficial animals, and flammable or otherwise hazardous organic solvents; (b) surfactants for use in household detergents and in industrial processing at room temperature; (c) surfactants for use in hard water without the use of builders or sequestrants; (d) surfactants based on biotechnology, using process wastes or municipal wastewater; (e) surfactants for efficient and effective removal of pollutants from industrial and municipal wastes; (f) surfactants for more efficient production and utilization of fossil fuels; and (g) more efficient and effective surfactants for all of these applications through use of surfactant combinations showing synergism.

Surfactants to replace less desirable chemicals. Here some creative thinking can be very useful. For example, materials do not have to be toxic to plants to act as herbicides. Surfactants that prevent water from penetrating into soil can act as herbicides by preventing water from reaching the roots of the plants. Some water repellents for soil have been developed recently, based upon the reaction of two moles of long chain fatty acid and one mole of diethylene triamine (1,2). Such materials might be used to replace toxic herbicides.

To replace pentachlorophenol and other hazardous wood preservatives, quaternary ammonium cationic surfactants can be used. Dialkyl dimethylammonium halides have been recently investigated for this purpose (3). Maximum fungitoxicity was exhibited by compounds with alkyl chains having 10–12 carbon atoms. Bromides were more effective than the corresponding chloride salts. In another investigation, combinations of dialkyl dimethylammonium chlorides and alkyl dimethylbenzylammonium chlorides were shown to exhibit marked synergism as disinfectants and fungicides (4). In fungicidal activity, mixtures of the two types of quaternaries were 10–40 times as effective as the individual materials. Aldynols, specifically (3-n-alkyn-1-ols), have also been reported recently to have antifungal properties (5).

To replace highly toxic insecticides, surfactants also can be used to produce emulsions of nontoxic insect repellents. These emulsions sprayed onto vegetation can produce a water-repellent, insect-repelling coating that will resist removal by rain.

Surfactants for use at room temperature. The use of enzymes in laundry detergents to improve wash performance has become more prevalent as lower washing temperatures have become attractive as a result of the desire to conserve energy. A number of recent investigations of enzyme performance in this application reflect this increased use. In one (6), washing performance at 70 F in the presence of proteases was shown to equal or surpass washing at 120 F in the absence of them. In another (7), lipases were shown to be suitable for the removal of oily soil at room temperature. Improved surface properties at room temperature are made possible by the recent development of commercial products

having a narrower distribution of ethoxylates than conventional ethoxylate nonionics. A number of recent investigations (8–10) have described the performance of these products, which have better solubilities in water, lower viscosities, lower gel temperatures and higher cloud poir.•s and which wet cotton better and show better detergency than the normal, broader-distribution materials. The production of these materials has been discussed in several recent patents (11).

Surfactant for use in hard water without builders or sequestrants. To improve the detergency of linear alkylbenzenesulfonates in hard water, nonionic surfactants of the alcohol ethoxylate type have been mixed with LAS (12). On both sebum-soiled permanent-press cloth and sebum-soiled cotton, mixtures of LAS and a C_{12-14} alcohol ethoxylate with 70% EO at a 4:1 weight ratio gave improved performance over formulations containing only LAS as the surfactant at Ca^{++} concentrations of 200 ppm or more. These studies also showed that the LAS/nonionic mixtures had improved tolerance to precipitation of insoluble calcium salts of LAS in hard water, with hardness tolerance increasing with increase in the EO content of the nonionic. There is evidence that the polyoxyethylene chain can complex cations such as Ca^{++}.

Surfactants based on biotechnology, using process wastes or municipal wastewater. Recent investigation in this area (13) involved the fermentation of waste carbohydrate with or without hydrocarbons or lipids to produce glycolipid surfactants. These surfactants contain a disaccharide moiety as the hydrophilic group and a long chain fatty acid residue as the hydrophobic portion. The method of preparing this type of biosurfactant has been known for some time now (14). Interest in biosurfactants has been revived by their potential use in enhanced oil recovery (15,16) or in emulsion polymerization (17).

Surfactant combinations showing synergism. There has been considerable activity in this area during the past few years on the part of investigators in both industry and academia.

A number of these investigations have been concerned with the unusual properties of surfactant mixtures containing fluorocarbon-chain surfactants. The surface properties of mixtures of the anionic and cationic fluorinated surfactants $C_9F_{19}CO\text{-}ONH_4^+$ and $C_9F_{19}CO\text{-}NH(CH_2)_3N^+(CH_3)_3I^-$ were the subject of one such investigation (18). Mixtures of these two surfactants in aqueous solution formed liquid crystal structures without the formation of a precipitate. These mixtures had lower critical micelle concentrations and reached lower surface tensions than the individual surfactants by themselves. The two surfactants were used together as components of an aqueous formulation to extinguish oil fires. The formulation showed a high rate of aqueous film formation and good resistance to re-ignition.

The surface properties of mixtures of a fluorinated anionic and a hydrocarbon-based cationic were the subject of another such investigation (19), in which it was suggested that the surface film produced might have a double-layer structure consisting of a layer of fluorinated anionic molecules riding atop a layer of the hydrocarbon-based cationic.

In my laboratories at Brooklyn College, we have been investigating the properties of mixtures of surfactants intensively for the past five years (20–26). We have been particularly interested in the relationship of the chemical structures of the surfactants to the existence of synergism in mixtures of surfactants. Our work has been successful in discovering the exact conditions under which synergism will exist in mixtures containing two different types of surfactants. From a readily determined experimental parameter that measures the degree of interaction of the two surfactants with each other and from the properties of the two individual surfactants, we can predict whether mixtures of the two surfactants will exhibit synergism in such fundamental properties as surface tension reduction, interfacial tension reduction and micelle formation We also can predict the composition of the mixture at the point of maximum synergism and the surface properties of the mixture at that point.

Our studies show that, in general, the greater the degree of interaction between two surfactants, the greater the probability that synergism will exist between them when they are mixed. Our data indicate that the degree of interaction between two surfactants in mixed monolayers or in mixed micelles increases in the following order: POE nonionics–POE nonionics < POE nonionics–betaine < betaine–cationic < POE nonionics–ionics (cationic, anionic) ≪ betaine–anionic ≪ cationic–anionic. Mixtures of anionics and cationics or of anionics and betaines, consequently, have the greatest probability of showing synergism. However, synergism also can be shown by mixtures of polyoxethylenated nonionics and ionics, although here the probability of their occurring is considerably less, and the structures of the two surfactants must be carefully selected for synergism to occur. We are currently working on synergism in wetting.

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Opening remarks—panel discussion

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Changing formulations and consumer habits have led to a demand for surfactants and surfactant combinations that work well under a variety of conditions. The surfactant industry must provide products which work in hot and cold water, in poorly built products, in liquids and powders and on various soils. Not only must they do this well, but the surfactants must be cost-effective and safe—both for humans and the environment. While others may be used with varying degrees of success, the two major surfactant intermediates, linear alkylbenzene (LAB) and detergent alcohols, will continue to be the mainstay of the surfactant industry. They are best able to meet the stringent requirements of the detergent industry. We expect this to continue into the foreseeable future for several reasons.

First, these intermediates are based on stable/economical feedstocks. Relative to synthetic surfactants and barring unforeseen events, crude oil is expected to be sufficiently available at stable prices. The outlook for natural gas is also good. As a result, the feedstock outlook for synthetic surfactants is good.

Natural feedstocks, such as coconut, palm, and tallow, continue to offer a promising future, despite their cyclical volatility. The availability of palm oil and therefore palm kernel from improved agricultural techniques and stable harvests is increasing significantly every year and might in the future resolve some of the volatility in availability and cost of natural feedstocks. Surfactant chemicals, both synthetic and natural, consume only a small part of the total respective feedstock pools. Therefore, availability of feedstocks for LAB and alcohols should be plentiful, provided the industry can continue to afford to pay competitive price levels.

Another reason we don't expect any "new" surfactants in the near term is current capacity. Sufficient capacity is already in place, both in the U.S. and worldwide, to meet LAB and detergent alcohol demand at least throughout the decade. Most of these facilities are modern, efficient plants utilizing current technology. In many cases, these plants are paid out and operate at costs that give them an advantage over new facilities. Thus, they will not be easily replaced and any new intermediates will face an uphill struggle.

A third reason derivatives of LAB and detergent alcohols continue as the "workhorse" surfactants is their established track record for safety. These materials have low toxicity and are environmentally safe and biodegradable. They are easy to handle, and further processing into final products is well established. Worldwide, these products continue to gain new markets—primarily replacing other surfactant chemicals because of their performance and environmental advantages. Thailand and India are two recent examples of countries that have switched or are switching to biodegradable detergents.

And finally, LAB and detergent alcohols do the job. For more than 20 years LAB has been the surfactant of choice for detergent products. During that time, alcohol derivatives have also moved into a major role in this industry. More importantly, LAB and detergent alcohol derivatives continue to meet the needs of tomorrow's detergent producers. Consumers will expect more out of detergent products than before, such as stain removal, softening and odor control. LAB and detergent alcohols continue to deliver the high level of general cleaning which the consumer expects, while being compatible with multifunctional additives.

These four points all confirm that today's surfactants will, in all probability, be tomorrow's surfactants. To ensure this, most surfactant intermediate suppliers are working hard to keep this industry a strong and viable one.

Questions submitted to the panel

1. **What are the long-term prospects for polyacrylates as builders in heavy-duty detergents versus NTA and tripolyphosphate?**
   Cahn: The future of polyacrylates would seem to be tied to developments in the builder area. The principal usage of polyacrylates at present is in products with low levels of phosphate—or no phosphate at all, such as in carbonate products. Polyacrylates are polyelectrolytes with an abundance of negative

charges. Their action is said to involve interference with nucleation and crystal growth of precipitates. It is understandable, therefore, that we have seed application of polyacrylates mostly in carbonate products.

2. **Since convenience and functionality seem to be the wave of the future, why don't we see a booming market for products such as Solo and Yes—"softener-detergent products"?**
Cahn: This is a marketing question—and calls for a knowledge of what turns on the totality of consumers in the U.S. Obviously, such knowledge would be highly prized but is not likely to be available in detail. The consumer market is made up of many subsets—consumers who always try something new and those who show remarkable loyalty to their current brands, consumers who buy only products that are on sale, those who buy anything that smells of lemon, those who pick up only products displayed at eye level—to name but a few of the many subsets. We will have to wait and see how large a subset will go for the detergent-softener products.

3. **What do you foresee in the development of builders?**
Cahn: The future of builders is here now—in the sense that we see a plethora of builders in use replacing the one builder of the past—sodium tripolyphosphate. Its future is uncertain at this point since there is still legislative activity in several states that could result in a spreading of phosphate bans. Replacement formulations range all the way from high sodium carbonate products to those having no builder at all but containing high levels of surfactants instead. Sodium citrate usage appears to be expanding with expanding heavy-duty liquids; Zeolite A has seen extensive application with some reduction in the past year or so. NTA—after an initial burst shortly after introduction of the first phosphate bans and subsequent withdrawal—is also in use to some extent at present. Expanded usage will probably have to await the outcome of deliberations in the state of New York. A decision is expected at the end of the summer on the use of NTA in the state. [Note: New York State subsequently did ban sale of NTA-containing products.] In addition, development can safely be assumed to be proceeding on new builders, such as the biodegradable polymers that Monsanto has patented. From the point of view of the formulator, the widest choice of permissible builders is desirable. Given such a choice, formulators can optimize their products—from the high builder/low surfactant formulations of the past to the high surfactant/no builder products of the present.

4. **What is the future for paraffin sulfonates?**
Cahn: As you know, this surfactant has found a major use in European light-duty liquid formulations. It has not made an impact in the U.S. so far. It is difficult to predict the future—not so much because of paraffin sulfonate per se but mostly because the introduction of a major new surfactant in the U.S. has proved to be generally a very tough task. Even AOS, which has been the object of significant development and commercialization effort for something like over 15 years, has not captured a major market share by a long shot. Basically, it is tough to compete with the cost-effectiveness of the current workhorse surfactants. Some special properties, such as outstanding bleach stability, may assure a surfactant a niche in the market but even this does not guarantee major volumes.

5. **Liquid Tide lists sodium laurate as builder. Any theories on its function or mechanism?**
Cahn: It is true that laurate is listed as a builder in the Liquid Tide formulation. In considering what type of builder laurate may be, it is clear that sodium laurate is neither a sequestrant nor an ion-exchanger. That leaves us with precipitation as the most likely mechanism for building. To some extent, this must be a matter of semantics since laurate not only can remove calcium by precipitation but also acts as a surfactant. Soap, after all, is the original self-building surfactant. I conclude that laurate in this formulation contributes to a detergency in a number of ways which go beyond the classical definition of a builder.
Rosen: The term "builder" is usually associated with a material that performs at least one of the following functions: (a) hardness cation sequestration, (b) deflocculation or dispersion of particulate soils, (c) alkalinity buffering, or (d) soil anti-redeposition. Sodium laurate does not seem to be capable of performing any of the last three functions. On the other hand, it does interact strongly with calcium. It is conceivable that, in the formulations used, the laurate forms soluble mixed micelles with the other surfactants present, thereby acting as a calcium sequestrant.

6. **What is the future for cationic surfactants in the detergent market?**
Cahn: I would view the future of cationics in detergent formulations as reasonably bright. We already have noted the expansion of the detergent-softener subcategory that uses cationics. In addition, there has been a fair amount of activity in the patent literature and also in publications on the benefits conferred by a cationic in a ternary surfactant system in combination with anionics and nonionics. I would expect increasing usage of cationics in this manner.

7. **What do you consider the**

driving force behind the apparent emphasis on liquid heavy-duty laundry detergent?
Cahn: As was mentioned earlier, the introduction of each new brand has historically led to an expansion of the category. It is also true that the manufacture of HDLs requires less sophisticated—and less expensive—equipment than does the manufacture of powders.

8. **What is the perspective for the development and application of cationic surfactants as detergents?**
Rosen: There appears to be little chance for future use of cationics per se as detergents. From the economic viewpoint, they are too expensive. From the theoretical viewpoint, most surfaces in nature are negatively charged and adsorption onto them of cationic surfactants would be with the positively charged head groups toward the surface and the hydrophobic groups oriented away from it. This would make the surface more hydrophobic than it originally was and consequently more difficult to wet by aqueous solutions. Soil removal, especially of oily or hydrophobic soil, would be more difficult than in the absence of the cationic. On the other hand, cationic surfactants in small quantities have been shown to improve the removal of soil by nonionics and cationic polymers are stated to improve the removal of clay soil and to act as soil anti-redeposition agents.

9. **What's currently going on in research and development of cationic and amphoteric surfactants?**
Rosen: Cationic and amphoteric surfactants are being investigated as additives for improving the surface properties of anionics. Both of these classes of compounds show synergistic interaction with anionics, producing interaction products that are more surface-active than either the anionic or the cationic (or amphoteric) by itself. It is to be expected that cationics and amphoterics will be used more and more as additives to improve the performance of anionics in various applications. For example, cationics and zwitterionics (amphoterics) have been suggested as additives in laundry detergents to improve clay soil removal and soil anti-redeposition properties.

10. **What, if any, immediate changes in laundry habits are occurring as a result of the demographic trends discussed?**
Creel: First, there has been some change in patterns as to the days of the week when people do laundry. For many years Monday remained the big wash day. Now, laundry day occurs throughout the week. According to Lever's studies, on any given day at least 20% of consumers are doing laundry. Second, because of the pressure which too-little available time brings, there is a willingness on the part of consumers to trade off top performance for modified performance if convenience is an added benefit. This is evidenced in consumer acceptance of multipurpose products such as detergents with fabric softeners.

11. **What kind of complaints and questions does Lever get from consumers?**
Creel: Lever recently began to test an 800 number on a few of our laundry products. Because we are in the early stages of this test, our information is relatively limited. However, as of today, it appears that we are following the pattern of other companies who have installed 800 numbers. We get more inquiries than complaints. Consumers have many questions on stain removal. Ink stains are a big problem as are grass stains and body oils on polyesters. Body oil stains on women's polyester blouses, especially semi-sheer weaves, are real problems. Among our most frequent complaints are those dealing with dye loss or dye transfer. This is a growing problem for consumers and stems from unstable dyes, particularly on cotton or linen-like fabrics. Many of these can be traced to fabrics produced offshore, where methods of dye application apparently are not as strictly controlled as those of U.S. producers. We receive more and more garments in which colors bleed. Interestingly, consumers still need basic laundry information. The SDA and several laundry equipment manufacturers publish excellent materials, but there remains a need to get more educational information to consumers.

12. **Are there any trends in wash water temperature selections?**
Creel: The trend away from use of hot water continues, and wash temperatures have continued to drift somewhat lower the past few years. The most dramatic drop in wash water temperature occurred between 1970–1981, however. In 1981, Lever laundry habits studies indicated 22.9% used hot water, 58.3% used warm water and 18% used cold water, respectively, for a selected load. It's important to note that these percentages represent the washing machine settings selected and not the temperature of the water entering the machine. Actual water temperatures are dependent on the temperature setting of the water heater. Recently many water heaters have been turned lower to save energy. I expect, therefore, that actual wash water temperatures are lower than the industry definition for hot (130 F and above), warm (90 F to 110 F) and cold (80).

13. **Based on the comments on lower housekeeping standards, has there been any evidence that this is occurring in washing standards?**
Creel: No, not generally; there has always been a wide range of

opinion among consumers as to what is acceptable as a "clean" wash. Some are meticulous, others less so. Oscar Neiditch of Lever described this latter group "as those who consider a clean wash as one that comes out at the end of the washing and drying process." As manufacturers, we must always target to the most demanding consumers—those who want a high level of performance as well as convenience and economy.

14. **Now that the care label role has been in place for more than a year, what is the level of compliance?**
Creel: We are seeing changes taking place toward compliance with the regulation. More information and more accurate information is given on apparel labels today. Large retailers are requiring that the apparel they purchase carry labels that comply with the regulation. Imported goods, however, are slow to reflect changes.

15. **The market for multifunctional laundry products appears to be increasing. How will this affect the single dimensional products such as fabric softeners or safety bleaches?**
Creel: There's no indication that multifunctional laundry products will depress the sales of single dimensional products such as fabric softeners. For the near future at least, I suspect that the multifunctional laundry product segment will expand the entire laundry category.

16. **With the change to lower wash temperatures by housewives, are they also changing other habits (e.g., using less/more detergent, additives, etc.)?**
Creel: There is no indication that housewives are changing their habits, i.e., increasing the amount of detergent or using other additives to accommodate for lower wash temperatures.

17. **Are you still considering a natural alcohol plant in the U.S.?**
Vogel: Vista was at one time considering a natural alcohol plant. Since that time the marketplace has changed dramatically. Considerable new natural alcohol capacity was added in the U.S. in anticipation of the replacement of other materials in the detergent market by alcohols. While there was penetration by alcohols into the detergent market, the growth has slowed and never reached the magnitude predicted earlier. In addition, some specialty applications for alcohols did not reach expected demand levels. The result? Current alcohol capacity utilization is at 65% in the U.S. and Canada. The plants now in place are efficient and have sufficient capacity to handle demand through the early 1990s. Vista Chemical is committed to the surfactants industry, and when new capacity is needed we will review the situation and determine which feedstocks, natural or synthetic, would be most competitive.

18. **Are Middle Eastern capital projects being considered and what would be their effect?**
Vogel: There are some LAB projects being considered. On the positive side, this is taking place in parts of the world where growth in demand is significantly higher than that, for example, in the United States. In most cases, however, the demand is still not sufficient to warrant new capacity. Several of the projects are being considered without sufficient respect for the supply/demand balance in their domestic markets. This results in borders closed to imports and competition, driving up domestic prices for detergent manufacturers and ultimately consumers. As these projects cannot be sold out in their home markets, the remaining capacity has to be exported in an extremely competitive foreign market. Therefore, the returns from these projects do not appear very attractive. Some of these projects are even being considered without a favorable feedstock position and are therefore very marginal and less capable of standing up against the severe world competition. While studying new LAB projects, it is most important that all considerations, such as the domestic and worldwide supply/demand balance and feedstock availability, be seriously taken into account. The correct timing of these projects is crucial.

19. **How is your current outlook compatible with your previous paper on relative cost of surfactant chemicals?**
Vogel: The conclusion drawn from our paper "Economic Cost Outlook for Surfactant Intermediates" was that LAB is a cost-competitive surfactant intermediate. We continue to support that conclusion and cannot foresee a reasonable scenario where that would not be the case. The paper tested the competitiveness of LAB under pressure of low-cost competitive feedstocks like ethylene and natural oils. Since the paper was published we have seen these circumstances realistically in place in the world market longer than we previously had anticipated. Over the same period LAB retained its competitive edge and did not lose position. We presented these facts for publication to correct the growing misconception that LAB could not withstand the competitive pressures from other surfactant chemicals. The market has now proven that the conclusions in the paper are and continue to be correct.

20. **What is the future of paraffin sulfonates in the U.S.?**
Vogel: Paraffin sulfonates have been successful in Europe for several reasons. Used almost exclusively in dishwashing liquids, paraffin sulfonates eliminate the need for hydrotropes in formulations due to their excellent solubility. Since the

cost of hydrotropes in Europe is currently very high, paraffin sulfonates are a cost-effective alternative in Europe. There is also an overcapacity of paraffins in the European market, so that the required feedstock for producing paraffin sulfonates is readily available and relatively inexpensive. The paraffin cut required for paraffin sulfonate is less efficiently produced and therefore is more costly than the paraffins generally used for producing LAB. There is not a good outlook for the same sort of success for paraffin sulfonates in the United States. Hydrotropes are relatively inexpensive here and there is no overcapacity of paraffins in the U.S. On the other hand, there is overcapacity of surfactant chemicals competitive to paraffin sulfonates (LAB and alcohol derivatives). These are formidable competitors since they already are widely accepted with a long-term, proven track record for human and environmental safety. Any new surfactant will face a long and careful scrutiny by government regulatory agencies. Also, LAB and alcohol derivatives are being produced efficiently and are much more versatile than paraffin sulfonates. Thus, an investment in "new" surfactants in the U.S. market appears at best very risky.

Closing remarks

Arno Cahn:
I believe our panel discussion has borne out my assessment that changes—improvements—in the composition of product formulations will continue to come along. For manufacturers that provide brand name products, there will be a premium on technically sophisticated products which cannot easily be preempted by competition.

Milton Rosen
As regards anticipated growth areas, in the short term look for:

- surfactants for use in hard water without builders or sequestrants. Here, mixtures of anionics and nonionics appear to be a promising approach.
- surfactants for use at room temperature in both household and industrial uses. The new, narrow-range nonionic ethoxylates may play a role here, since they have better water solubility at room temperature and higher cloud points (allowing use of lower ethoxylates, which have greater surface activity).
- surfactants for removal of pollutants from industrial and municipal wastes. Here, competition from biotechnology can be expected (e.g., microbes to remove pollutants). Cultures have been isolated that remove heterocyclic S- and N-containing material when mixed with oil and coal by oxidizing them to water-soluble materials.

In the longer term look for:

- surfactants based upon biotechnology and renewable raw materials—biosurfactants based upon cheap hydrocarbons; synthetic surfactants based on wood and polysaccharides.
- destructible surfactants—to be used in one stage of a process and then destroyed at a later stage in order to eliminate any deleterious effects due to their surface activity. In these surfactants, the hydrophilic and hydrophobic portions are linked by a bond that is easily broken under specific conditions. Examples: disulfide bond under mild reducing conditions; acetal or ketal bonds under mild acidic conditions.
- surfactants for improved production and utilization of fossil fuels—surfactants to improve fracturing of reservoir rock; wetting agents for dust elimination in coal mining; dispersing agents for production of flowable coal-water and coal-oil dispersions with high solids content.
- use of surfactants in computers—ordered multilayers of surfactants as "molecular switches" for controlling current flow in computers.
- use of surfactants in the form of vesicles for controlled release of drugs to specific targets in the body.

Jane Creel:
What the are the implications of today's demographics and consumers' changing attitudes? What are the opportunities for marketers?

Here are three for starters: First, as pointed out earlier, time is a resource in short supply and will continue to be so. Convenient and multifunctional products will be the wave of the future. Today, the significant growth of heavy-duty liquids that combine good stain removal, solubility and excellent cleaning qualities as well as consumer acceptance of combination detergent and fabric softener products indicate this trend. Busy working women may not be as concerned about whether the floor is shiny as in presenting a well-managed home.

Second, although women still do the lion's share of the work, don't overlook the fact that male attitudes are changing (albeit reluctantly). Keep an eye on younger men, who appear less sexist, more egalitarian and more realistic about the necessity of a two-income family and the problems in maintaining a functioning household. They may become important future customers.

Third, can cleaning ever be made fun? Maybe there will be new technology or more disposable items. However, in the meantime let's not overlook cleaning services. This may be a growth industry with a huge market and a need for products designed especially for this field.

These are only starters. Important new ideas and opportunities lie ahead for those who, unhampered by icons of the past, can recognize that the families and the people who use our products are diverse and

that markets are becoming more segmented. These will be the successful innovators, for they are free to see the realities of an evolving future market. They will be the people who face facts.

W.J.B. Vogel

Here's what to look for in the future:

- feedstocks. In the near future we foresee stability in feedstock costs for synthetic surfactant chemicals. Medium to longer term, there should be a return to profitability for the ethylene producers. Therefore there should be a cost pressure on surfactant chemicals derived from ethylene. And in the long term, there could possibly be increased usage of natural feedstocks for the production of surfactant chemicals. This in particular should occur when the expected increased availability of palm oil leads to a greater stability in the supply of natural feedstocks.
- capacity. More projects for surfactant chemicals will be considered in developing countries. This could lead to a continuation of the worldwide overcapacity for detergent alkylates and alcohols unless the timing of these projects is carefully related to the supply-and-demand balances in the world. Startup of some of these projects in developing countries and the resulting overcapacity might lead to protective home markets and would, therefore, disrupt world trade in surfactant chemicals.
- demand. The growth in demand worldwide for surfactant chemicals will be considerable in developing countries, due not only to improvement in technology leading to a higher standard of living, but also to a growing concern for a cleaner environment and, therefore, biodegradable products. In areas like the U.S., Europe and Japan, demand will continue for surfactant chemicals that give improved performance and are compatible with additives that lead to multifunctional detergents. The concern for margins and cost performance in detergents will continue to require surfactant chemicals that are most cost effective.
- competition. We believe that detergent alkylates and alcohols will continue to meet all of the future requirements of the detergent industry. It is hard to envision any new surfactants that might penetrate the market in a major fashion in the next decade or so. With the overall concerns for toxicity and the environment, it will be time-consuming and risky for the investor to introduce new molecules for surfactant chemicals into the marketplace.