

## A GREENER FUTURE

# Chemicals get the safe treatment

Once seen as fringe, products derived from nontoxic ingredients are going mainstream.

By MARLA CONE  
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### First of two parts

**A**T FIRST, the experimental shampoo looked like a putrid salad dressing. Its oil and its water just couldn't get along. They separated in the bottle and, over time, the shampoo took on an ugly brown hue.

The team at Avalon Organics, based in Petaluma, was trying to make a line of hair, skin and bath products without toxic chemicals, using ingredients derived from plants, such as lavender and coconut.

"It was a disaster," said Morris Shriftman, the company's vice president at the time. "We thought we had failed."

In any recipe, whether for cake or shower gel, swapping out one ingredient for another can result in a complete flop.

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But the chemists working for Avalon Organics refused to give up. After years of tweaking recipes, at a cost exceeding \$1 million, the company reinvented more than 150 products and came to lead a growing movement dubbed "consciousness in cosmetics."

"We accepted this stuff blindly for so long. Now we're asking questions, seeking information. The awareness that we're living in a chemical environment is finally taking hold," Shriftman said.

Innovations in designing green chemicals are emerging in nearly every U.S. industry, from plastics and pesticides to toys and nail polish. Some manufacturers of cosmetics,

household cleaners and other consumer products are leading the charge, while others are lagging behind.

For decades, many manufacturers used the most powerful weapons in their chemical arsenals, with scant attention to where they wound up or what they might have been doing to people or the planet.

Now, in a fresh take on the pre-World War II slogan, "Better Living Through Chemistry," small chemical companies and giant corporations, including BASF and Rohm and Haas, are implementing the tenets of green chemistry, creating safer substances that won't seep into our bloodstream, endanger wildlife or pollute resources.

Once viewed as part of a fringe lifestyle, rooted in the hippie movement, natural and nontoxic are going mainstream. Driven by regulations, consumer demand, an eco-friendly business philosophy and fear of future lawsuits, large corporations, retailers and manufacturers are eliminating some chemicals, pulling products off shelves and redesigning others. The names are familiar: Wal-Mart, the Walt Disney Co., Ikea, Home Depot, Nalgene, Kaiser Permanente, Baxter HealthCare, Gerber, Clorox and Origins.

Yale University chemistry professor Paul Anastas, known as the father of green chemistry, said the movement is "not simply choosing the next, less-bad thing off the shelf. It's about designing something that is genuinely good.

"Green chemistry is not a theory," he said. "It's being demonstrated by companies over and over again."

With a little ingenuity, every substance in the world "can be reinvented and made safe," said John Warner, former director of University of Massachusetts' green chemistry doctorate program and now president of a research company creating sustainable chemicals.

But the greening of chemistry is a slow shift, not a revolution. Most chemists lack basic training in understanding environmental hazards and seeking safer solutions, and many businesses resist changing familiar chemicals and manufacturing techniques.

Even companies like Avalon Organics are learning that manufacturing a shampoo or shower gel without toxic substances isn't easy. Synthetic chemicals called phthalates add fragrance, parabens kill germs, and sulfuric acid and petrochemicals create a thick lather. Such substances have long been considered key ingredients in cosmetics and bath products. But they have been linked with cancer, skewed hormones and other threats to people and the environment.

"We heard from everyone that what we were doing was risky, that it was unnecessary, that all the major cosmetics companies use these chemicals so they couldn't be dangerous," Avalon's Shriftman said. "But we decided to subscribe to the precautionary principle. We wanted to do the right thing. We rebuilt our products from scratch. It took a long time. It took a lot of experimentation. And it took a lot of money."

Though toilet bowl cleaners and body lotions may not save the planet, they are the first step toward weaning its human inhabitants from their toxic chemical dependency.

"We believe that the small act of scouring the sink," said Shaklee Corp. Chief Executive Roger Barnett, "can be part of the giant act of changing the world."

## Early exposure



**C**HEMICAL CONTAMINATION starts in the womb. Even before a baby takes a breath, her body contains chemicals passed on by her mother. Tests of umbilical cords show that a newborn's body contains nearly 300 compounds — among them mercury from fish, flame retardants from household dust, pesticides from backyards, hydrocarbons from fossil fuels.

Virtually everything we buy, breathe, drink and eat contains traces of toxic substances. The names are confusing; the list, mind-boggling: Bisphenol A in plastic baby bottles and food cans. Phthalates in vinyl toys. Polybrominated flame retardants in furniture cushions. Formaldehyde in kitchen cabinets. Radon in granite countertops. Lead in lipstick. 1,4-Dioxane in shampoo. Volatile organic compounds in hair spray.

Every day, about half a dozen chemicals are added to the estimated 83,000 already in commerce. In the United States alone, about 42 billion pounds of chemicals are produced or imported daily. Although California has no major chemical manufacturing plants, it is a large user: About 644 million pounds are sold daily in the state, according to a University of California report on green chemistry published in January.

Many chemicals are probably benign, but basic health and safety data are lacking for about 80%. Some, such as chlorine gas, are so highly poisonous that a minuscule amount can kill. Others can raise the risk of cancer and other diseases. Animal tests show that some suppress the immune system, obstruct brain development, deplete testosterone, mutate cells, turn genes on and off or alter reproductive organs.

Since the 1960s, when the pesticide DDT nearly wiped out the bald eagle, public policy has dealt with the risks on a chemical-by-chemical basis: Ban a few, restrict others and clean up the mess left behind.

Meanwhile, nearly half of

the nation's waterways are classified as impaired by pollutants, the air of most cities is shrouded with soot and smog, and the multibillion-dollar bill to clean up the Superfund list of hazardous waste sites keeps growing. Chemicals have moved pole-to-pole via oceans and winds, turning animals and humans around the globe into unwitting lab rats.

Scientists and regulators continually try to figure out whether various chemicals pose a threat, and to what degree, yet they rarely come up with definitive answers. Even when a proven hazard is banned, it can take decades, perhaps centuries, for it to dissipate. Sometimes, its replacement is just as risky.

"California's hazardous waste sites are still growing. And they're still leaking," said Maureen Gorsen, who directs the state Department of Toxic Substances Control, which is spearheading a Green Chemistry Initiative launched by Gov. Schwarzenegger. "We need a massive chemical shift. We need to move to the beginning, to the design part, what goes into the products we use rather than what comes out the end."

## A simple formula

**T**HE LABORATORY inside Shaklee's corporate headquarters in Pleasanton, Calif., looks like any other. But it's missing a lot: chlorine, formaldehyde, glycol ethers, solvents.

Wearing a white lab coat, senior scientist Arshad Malik starts with a beaker of water. He mixes in a vegetable-based thickener, then pours in a blend of coconut oil and sugar extracted from corn. Finally, he adds a drop of a preservative.

Malik is demonstrating the deceptively simple formula for Shaklee Corp.'s household cleaner, the workhorse of its "Get Clean" line.

Gone are the petrochemicals and formaldehyde. Although cheap and effective, they emit toxic vapors.

When Shaklee began searching for a green surfactant, the ingredient that dissolves dirt and grease, no chemical company seemed interested in inventing one made from vegetables. Not until Shaklee called Germany and talked to chemists at Cognis, a specialty manufacturer.

The result: a biodegradable mix of coconut oil and sugar.

Josef Koester, marketing director for Cognis' Care Chemicals North America, said his company created the coconut-and-corn surfactant by incorporating a simple concept: "Using less chemistry."

Over the past few years, this less-is-more approach has become big business for companies going green. Even Clorox, which got its name from chlorine, launched Green Works, a nontoxic line of cleaners, this year.

Two of the biggest innovators in household products are California companies: Shaklee, which is sold person-to-person, and San Francisco-based Method Products, which sells through Target, Costco and other large retailers.

"What is driving this market now is concern over bioaccumulation of chemicals in the body," said Jim Greene, Shaklee's vice president of product development.

"The public is now reading labels and they're very concerned about what they're putting not only in the environment, but onto their skin and into their bodies."

Some green chemistry products are trying to grab a market share from the big brand names by offering something beyond environmentally friendly ingredients. Method's kitchen and bathroom cleaners, which cost roughly 10% more than traditional ones, are scented with lavender and other essential oils and packaged in hip, colorful containers.

"If it needs to be ugly to be green, it won't ever be mainstream," said Adam Lowry, a Stanford University chemical engineering graduate and co-founder of Method. "We show

consumers that buying green is not only more healthful but also more pleasurable, and it's almost cost-neutral."

Sales at Method, one of the fastest-growing private companies in 2006, have reached \$77 million a year. Avalon Organics' market also soared; it was sold last year for \$120 million to Hain Celestial, known for producing organic foods.

"We've built in green chemistry from the very beginning. It was at the core of our business philosophy," Lowry said. "The companies that don't do it will become the dinosaurs."

## Formaldehyde-free

**J**OHNS MANVILLE CO. may have learned the hard way. It was bankrupted by one of the deadliest and most expensive toxic episodes in history: asbestos.

The building materials company, now under new ownership, wanted its new fiberglass insulation to be as environmentally safe as possible. So it turned to Rohm and Haas, a \$9-billion-a-year chemical company that invented a new glue with no formaldehyde, a carcinogen that has been the binder of choice for fiberglass.

Johns Manville is now the only manufacturer offering a complete line of formaldehyde-free insulation, and because its factories emit no formaldehyde, it is the only one exempt from federal hazardous air pollutant standards.

The new adhesives cost more per pound. But Mike Lawrence, Johns Manville's vice president and general manager for insulations systems, said the manufacturing process was tightened to bring costs in line. He said their products are priced in the same range as competitors' and meet the same industry standards.

"It was the right thing to do for our employees, our customers, for our shareholders," Lawrence said.

Peggy Jenkins, the California Air Resources Board's indoor air quality specialist, advises consumers to buy formal-

dehyde-free insulation to reduce their exposure to the carcinogen.

Still, such products comprise only about 20% of the insulation market. Owens Corning, the largest manufacturer, uses formaldehyde, saying there is no evidence that trace amounts pose a health threat.

Colin Gouveia, a global marketing director at Rohm and Haas, said most consumers are unaware that building materials contain formaldehyde.

"Sometimes green products," he said, "need a little kick from a regulation to overcome the barrier to change."

That is what stoked the market for another green chemistry product, an industrial paint. In 2006, the South Coast Air Quality Management District set limits on smog-causing petroleum-based solvents in industrial coatings used in the Los Angeles region.

Caltrans had to find new paint for the state's 850 steel bridges that was not only low-polluting, but could withstand the elements. Rohm and Haas' biggest challenge was the perception that a water-based paint couldn't be durable.

Barry Marcks, Caltrans' associate chemical testing engineer, said the new low-emission paint has been used for two years on the state's bridges — 86 million square feet of surface area. It's as rust-resistant as the old paints, and has an added benefit: It retains its glossy colors better, he said.

The cost per gallon is in the same range, but the state saves on disposal and cleanup. Caltrans workers like it too.

"Now the workers don't have to be around all those high-solvent-borne paints. The waterborne ones are a lot less toxic," Marcks said.

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## Making sacrifices

**E**VEN GREEN CHEMISTRY products have shades of brown.

No regulations or industry standards govern use of the words "natu-

ral" or "organic" in cleaning products, cosmetics or bath products. Many contain traces of toxic substances.

The Shaklee cleaner contains a small amount of a germ-killing biocide used as a preservative. Avalon got rid of parabens but uses glycol ethers as preservatives.

Sometimes consumers have to make sacrifices in the pursuit of green. Method and Shaklee products, for example, are not disinfectants, because antibacterial substances are toxic and not naturally derived.

The greenest products are 100% vegetable, made entirely of renewable, natural feedstocks that are not chemically modified. Less green are those that include minerals or inorganic materials.

Shaklee Corp.'s dish-washing detergent, for example, contains sodium carbonate. The least green of the products use petrochemicals or animal substances.

"You can always say, I can do this greener," said Koester, Cognis' marketing director. "But you don't want to go back to washing your hair with soap, do you? That would be the consequence of going too green."

But more and more, the world's largest chemical companies are looking for substitutes for some of the old petrochemicals that made them global powerhouses.

BASF, which has \$90 billion in annual sales, invented a plasticizer with no phthalates, which are estrogen-mimicking compounds used to make vinyl. It is marketed in China, where 80% of toys are produced.

DuPont is using cornstarch as a key building block to make polyester. Dow Chemical Co. is turning soybeans into a compound for polyurethane foam and building a plant in Brazil that will use sugar cane to make plastic for use in grocery bags and other products.

Green chemistry is "not just a niche anymore," said Neil Hawkins, Dow's vice president of sustainability.

"When you have retailers like Wal-Mart setting environ-

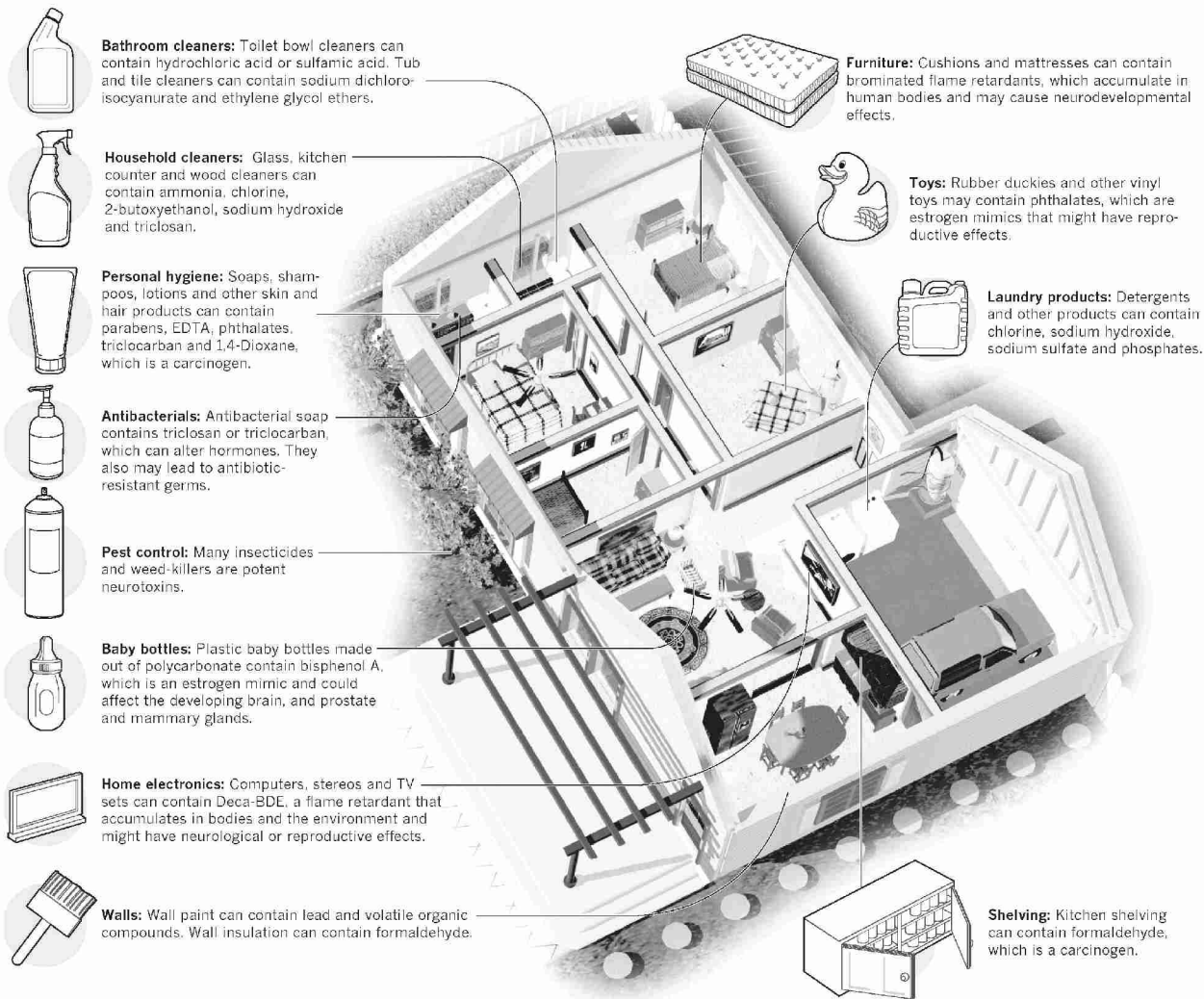
mental goals," he said, "it creates a demand and a ripple effect for new, innovative prod-

ucts. I see some real changes right now, driven by the market."

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## The toxic home

Every room of every home contains an array of toxic substances. About 83,000 chemicals are in commerce today and many of them are used in consumer products. Take a look at a typical house, room by room, to see what chemicals may be inside your own home.



Sources: National Institutes of Health Library of Medicine Household Products Database, Stakee Corp., "Squeaky Green," by Eric Ryan and Adam Lowry, the U.S. Environmental Protection Agency, Environmental Working Group, Agency for Toxic Substances and Disease Registry. Graphics reporting by **MARLA CORNE**

RAOUL RANOA Los Angeles Times

### On latimes.com It's around the house

More photos and a list of toxic substances in a typical home are at [latimes.com/chemistry](http://latimes.com/chemistry).

## Top 10 chemicals produced in the U.S.

Many of the estimated 83,000 chemicals produced in the United States are used in massive quantities exceeding 1 million tons a year. The top 10 for 2006 include several used to make fertilizers and plastics and to disinfect or treat water and waste.

CHEMICAL	VOLUME	MAJOR USES
<b>Sulfuric acid</b>	39.6 million tons, valued at \$2.24 billion	Fertilizers, producing other chemicals, dyes
<b>Nitrogen</b>	34.7 million tons, valued at \$1.67 billion	Fertilizers, production of ammonia and other chemicals, food refrigeration
<b>Polyethylene</b>	34.4 million tons, valued at \$27.8 billion	Plastics for packaging, film, trash bags, diapers, toys, wire coating, housewares
<b>Oxygen</b>	27.6 million tons, valued at \$2.36 billion	Industrial furnaces, healthcare, waste treatment, fertilizer, plastics
<b>Ethylene</b>	27.6 million tons, valued at \$27.75 billion	Plastics
<b>Lime</b>	19.8 million tons, valued at \$1.65 billion	Steelmaking, cement, sewage treatment, construction, pesticides, sugar refining
<b>Sodium carbonate (soda ash)</b>	11.9 million tons, valued at \$930 million	Glass, pulp and paper, detergents, water treatment, aluminum production, textiles
<b>Phosphoric acid</b>	11.8 million tons, valued at \$3.32 billion	Fertilizers, soaps and detergents, metal rust-proofing, pharmaceuticals
<b>Chlorine</b>	11.4 million tons, valued at \$2.38 billion	Solvents, plastics, flame retardants, water purification, food processing, pharmaceuticals
<b>Ammonia</b>	11.0 million tons, valued at \$3.38 billion	Fertilizers, nitric acid, oil refining

Sources: U.S. Bureau of Statistics, U.S. Geological Survey, American Chemistry Council.