CHAPTER 2
Inside Stuff: How Professionals Do It

Every artifact has a designer, whether amateur or self-consciously professional. Nowadays, the work of design—the intentional use of cultural and material resources to create a worthwhile artifact[1]—is where the cultural rubber hits the commercial road. Designers' backgrounds, their mode of operation, and the way they organize their work all affect what stuff ends up being. Although acutely aware of the going trends and business requisites, designers also bring their own professional values and experience to the work. In a realm where there is so much uncertainty as to what will succeed, specifics like designers' own biographies and individual tastes have opportunity to weigh in. But as with their stuff, designers occupy a niche, a spot in an ecological web of institutions, inducements, and impediments; they cannot just do what they want. In talking to many dozens of designers (at least a hundred), observing them in their offices and at their conventions and meetings,[2] I tried to learn just how their mode of operations, including the impediments they face, shapes the stuff we know and use. Almost all of "my" designers are product designers as opposed to fashion, textile, graphic, or software creators. I also slighted design engineers, a closely allied tribe whose members often work directly with my core group of product designers. Most of the designers I know work as consultants rather than (as is common in the auto industry, for example) as employees of the businesses they design for. Reflecting common language in the trade, I refer to these outside businesses as "offices" or "consultancies," to distinguish them from the "firms," "companies," and "corporations" that are their clients. Although there is no way to know the relative proportion of goods that come from these consultancies compared to in-house designers, in terms of

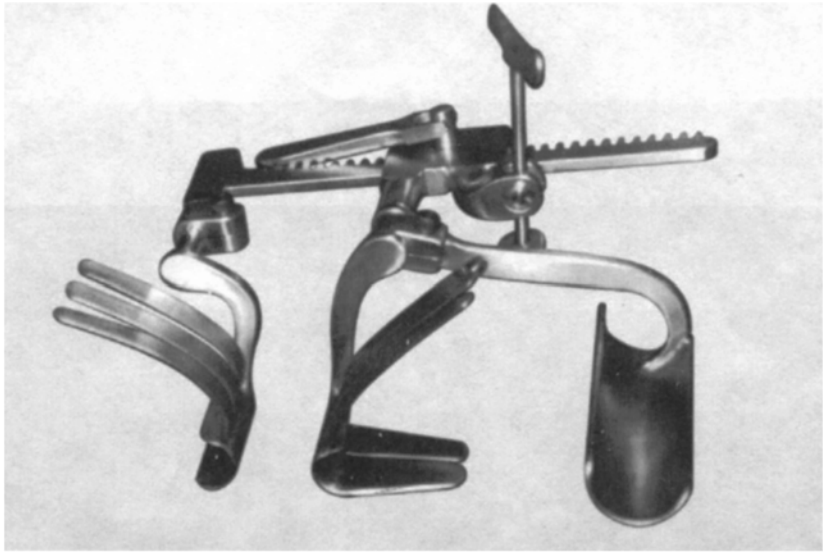
innovation, technique, and product leadership—automobiles excepted—these outside offices are where the action is.

PROFESSIONAL CHALLENGES

Intrinsic to design practice are the challenges designers face from their clients and the larger worlds in which they operate. Every profession has its "story," one needed to build image in the outside world as well as provide some motivation to do one's work, even just to get up in the morning. The story—and certainly the conditions that lead to it—affect the content of the work output. Designers hold the vision that they both increase clients' profits and are good for life. They mount this story in the face of intellectual critiques of the stuff their labors create, but also—and as a more pressing matter—the suspicion within the business world that they are not really essential in the "hard" realm of technology and money-making.

As a profession, design is a newcomer; prior to about the 1930s, producers used artists, craftspeople, engineers, and draftsmen to specify what an artifact would be. Only later did corporations, most notably Bell Telephone and Pennsylvania Railroad in the United States, hire individuals specifically to design their products. In Europe, especially at the Bauhaus in Germany and companies working directly with it, and in Italy at Olivetti, professional design work came to be built into production routine in a more thoroughgoing way. Some companies, especially in the United States, continued well after World War II to turn out goods without the benefit of professional design—some still do. It does matter. Look at the pictures on the next few pages to compare Heimstra Design's reconfiguration of a device for open-heart surgery with the first engineered version—one that also, in a sense, can do the job (although never put into clinical application). These are two different things with different consequences for product profitability and ease of use.

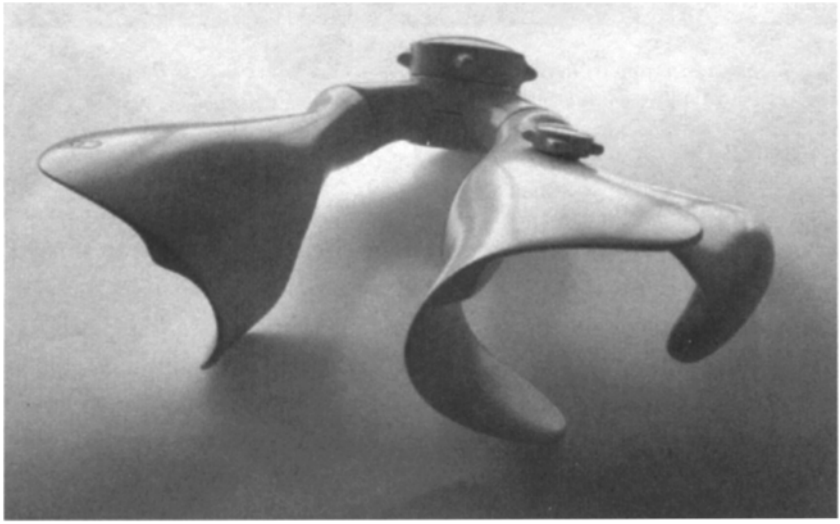
The low pay and power of designers, relative to others in the business world, provides some concrete evidence of marginal status. Average entry-level designer salaries, according to a 1996 survey, ranged from $28,000 in consulting offices to $35,000 in corporations.[3] A 1991 *Fortune* magazine survey reported typical salaries to be about $35,000, with a large corporation's design chief making $100,000—"much less," said *Fortune,*



Heart surgery appliance (before design). Minimally Invasive Coronary Bypass Device. Photograph ©Hiemstra Product Development, LLC.

"than [a] counterpart in engineering and marketing."[4] Heads of large companies rarely come from design backgrounds, but instead from finance, marketing or (at least in the past) mechanics and engineering.[5] Design consultancies are not in prestigious office buildings. In New York, for example, they will be found downtown in gentri fying areas rather than midtown; in LA, they are not in Beverly Hills— but they are also not found in slums, either.

Designers' small population size augurs weakness, at least in terms of organizational clout. There are far fewer designers than the hundreds of thousands of engineers, marketers, and advertising people who populate production systems. Of the twelve thousand or so industrial designers in the United States about a fourth were, in 1997, members of the Industrial Design Society of America (IDSA). Not an indicator of strong professional development, three-fourths of practitioners think it not worth the price of their dues to have the IDSA designation behind their names. Attendance at annual IDSA conventions runs not much more than five hundred.[6] Even within large corporations, design staffs tend to be small, perhaps 30 people. A handful— maybe six in the United States —have reached the size of several hundred. Some offices

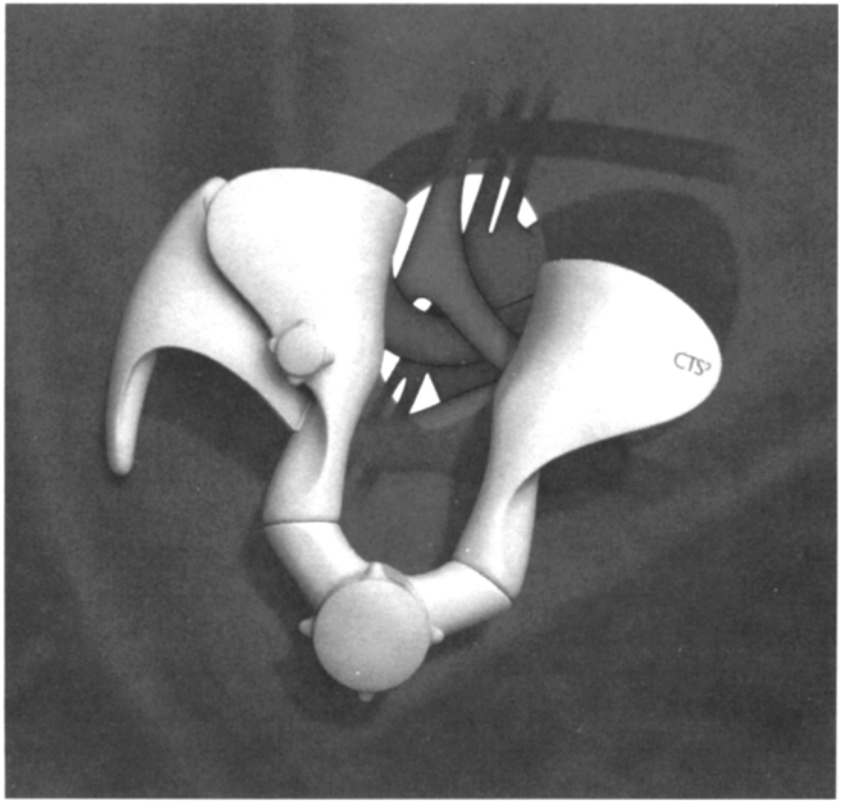


Heart surgery appliance (after design). Minimally Invasive Coronary Bypass Device. Photograph ©Hiemstra Product Development, LLC.

comprise only a single person, perhaps operating at miscellaneous jobs for marginal firms but also on occasion having one or two major clients that keep them busy. For example, when he was still a solo practitioner, California designer Richard Holbrook had Casablanca ceiling fans and Thermador kitchen appliances as his primary clients. Larger offices may also have clerical personnel, model builders, computer support specialists, and engineers.

Government—at least in the United States—does not license or otherwise provide recognition. No state or national boards certify someone as an industrial designer; neither degrees nor membership in the IDSA carries legal weight in terms of access to work or meeting any product regulatory requirements—such as for safety or recyclability. The U.S. Census established an industrial design job category (an SIC Code) only in 1995.

Evidence of inattention to design (and designers) in the United States starts with school. Children have to memorize the names of explorers, inventors, and artists but not of designers. Although sometimes included in school curricula in other countries (Australia, The Netherlands, and the United Kingdom), design is rarely acknowledged as a skill or designers as a profession in the U.S. Teachers do not give much positive notice to young people's self-motivated sketching of dresses



Simulated application, Minimally Invasive Coronary Bypass Device. Photograph ©Hiemstra Product Development, LLC.

and cars, their building of models, or their constructing of Rube-Goldberg contraptions. Art teachers admire technical precision or self-expression while so-called industrial arts emphasize technology, not its merging with art. Official school culture does not prize—indeed it more likely disdains—consumption artifacts or kids' efforts to modify them.

At the college and university level there are only about 45 design degree programs in the United States; unlike most fields, design is taught primarily at specialized schools, such as the Art Center in Pasadena, Pratt in New York, the Rhode Island School of Design, and Detroit's Cranbrook. Approximately 20 institutions provide some form of graduate training,[7] but only one, the Illinois Institute of Technology,

offers a Ph.D. Some universities run their design programs out of engineering schools, others out of art departments.

Although change is afoot, designers (including design engineers)[8]— still worry that corporate bosses and clients see them as merely "making things pretty";[9] never mind that their work is "denigrated" in the circles of real art.[10] The dual suspicions, from business and art, go back a long way. "A large number of artists," Gottfried Semper wrote in 1878, "many of them gifted, are working in steady employment for the French and English industries, in a kind of dual subservience." Making up their "degrading situation" is that "their employer thinks of them, on the one hand, as burdensome taste-makers and form-beautifiers, whom he does not consider his equals, seldom paying them well," along with "the hierarchy of the academic art world, which puts him down."[11]

They can do without the art world, but to have a livelihood, designers have to show they mean business. They have strategies. In working against stereotype they may propose that they know materials, markets, factories, and technologies, although the range of claims will vary with the size of office and audacity of its owners. To demonstrate practical competence, a designer may, without fee, take the client's product apart and reconfigure its elements to show how it can be made more cheaply and more functional, as well as be better looking.

Most tell of past success in developing profitable goods, sometimes involving vast profit. When they are given maximum responsibility and autonomy, designers argue, such outcomes are more likely. LA's Spencer Mackay takes credit for a non-invasive body thermometer (Thermo-Scan) that turned the client's $6 million investment into a company that soon after sold for $140 million. Heimstra's surgery appliance redesign (fig. 2.2) turned an initial $6 million investment into a prototype that leveraged $300 million in investment capital. Boston-based Fitch Design's transformation of the Bernoulli computer file back-up system into the Zip drive saved Iomega corporation from its demise and propelled the single largest stock market run-up for any listed company in 1994; Iomega's CEO praised Fitch's accomplishment as "reinventing a company through design."[12] These tales circulate within design media; the consultancies put them up on their walls and feature them in presentations to clients.

More than any other actors, designers are in a position, they say, to know how specific variants will influence the product's success and thus how to judge among options, including how to fabricate the artifact. From experience on varied goods for different clients, they know modes of fabrication, materials, suppliers, consultants, and markets. They may, on occasion, manipulate tooling and processes on the factory floor, developing techniques to make a specific product possible. They may also have access to prior market research from other products, including the competition's stuff, which they may have themselves previously worked on. They have the resources, in other words, to do more than many clients might suppose.

Designers have to think about patents. Coming up with something new means not just new in style and functionality, but "legally new." This requires an approach the authorities will consider authentically different from what in patent terms is called the "prior art." If not itself patentable, the designer looks for ways to make sure the new product at least does not infringe on someone else's patents—including those put in the way just to frustrate new entrants. A product's specific configuration may have to be guided by the precisely detailed conventions of just what is or is not a patentable variation of patented versions. In creating the Verse microphone, the designers wanted to avoid making royalty payments on prior versions, payments that would have exceeded the product's manufacturing cost.[13] Instead of the conventional (and patented) arrangement of circular base, pivot, and strawlike extension with a microphone bud on the end, the design firm of Fiori (of Portland, Oregon) made it as a simple base and stalk. The new microphones have a unique form that includes a bypass of existing patents.

Rather than doing one thing really well, their special asset, designers often claim, is the capacity to combine across realms. They describe themselves as "problem solvers," "facilitators," and "generalists." Using creativity guru Edward Debono's word, they often proclaim their "lateral" knowledge, derived from cross-discipline sensibilities in art and engineering.[14] They can "see" across a range of concerns: human factors—like ergonomics, readability, "interface design"—and marketability and ease of manufacture. Ambitious offices claim to provide a "comprehensive strategy"

Verse microphones gained their form from the need to escape licensing fees. Labtec ® Verse™ microphone. ©2002 Labtec. All rights reserved. Labtec, the Labtec logo and other Labtec marks are owned by Labtec and may be registered. Used with permission from Labtec.

for a consistent "visual vocabulary," tactile feel, and instrumentation (e.g., controls appear and operate the same way) across a client's line of products. They may claim the role of organizational experts, helping integrate various activities within the client firm and smooth its relations with suppliers, other designers, and retail outlets. If they lack a relevant specialty, say optical scanning, they can bring in the right consultant. Rather than being limited to a specific product category, a good office can design anything, they say.

Put more informally—which is the way they talk among themselves—they can make individual products and whole ranges of goods cool. What is "cool"? For designers, "you know it when you see it," in the same way that "anyone" can see that Heimstra's heart surgery appliance is cool compared to the prior version. Cool are products that solve as many challenges

as possible and *look* like they do. That is hitting the design sweet spot. To get to cool, designers use intuition (a trait they feel blessed to possess) honed not only in art backgrounds and design training. Their intuition comes from involvement, at least in the past, in more marginal arenas like theater, music, or free-thought movements that have expanded their thinking repertoires. Cultural currents that bypass others in the business world more often touch designers. As has been said of successful fashion designers, they have "an instinct for visualizing sharply what is perhaps nebulously and unconsciously desired."[15]

In terms of the object itself, good design involves working up good form and good function together as part of a single mind-set and practical accomplishment—"cool." I saw people designing the guts of electronic exercise gear and some basic medical equipment at one design office, part of the "total design and total engineering" the consultancy proclaims for itself. This means more than, for example, massaging a particular external form to accommodate a certain kind of apparatus inside and more than tailoring an internal mechanism to accommodate a preferred external form. When the process goes right, form and function—along with marketing and all the rest of it—are held in the mind together. This is what designers sometimes call "concurrent design" and engineers call "concurrent engineering." Even if a single person cannot keep it all in play at once, a product team can. At least at the high end of professional design, offices claim to give birth to products out of just such an interactive synthesis.

Clients may think they can second-guess designers because they commonly do have some experience with a particular task —they know a bit about toasting a piece of bread. They may not know much about art, but they know what they, and maybe even others, like. Designers express annoyance that deference goes to engineers, accountants, and "real" executives while those same experts often feel free to substitute their own judgment for that of the designer. So in addition to winning a client, designers often have to demonstrate why their views should count.

Designers typically work on a competitive basis; manufacturers may invite a number to make presentations. A standard pitch includes elaborate slide, power point, or video presentations of the office's general approach, its way of

working with clients, its repertoire of services, and examples of past work. The office tries to convince that it is good at anticipating consumer demand and that it designs things that are easily and inexpensively manufactured. The pitch is about market share and longevity, dollar volume and production efficiency, as well as past products' cool features. A product that sells in big numbers and keeps selling a long time saves clients the costs of retooling and reorganizing their marketing and bolsters the designers' reputations as effective professionals. It becomes everyone's interests to come up with, say, a Ford Taurus—dominant in the U.S. car market for a decade—or Scotch Tape or the Toastmaster IB-14 pop-up model, the country's largest seller from 1947 to 1961. A subsidiary pitch is product reliability—appealing to companies eager to avoid the costs and headaches of returns, store complaints, and burdens on technical assistance lines.

Designers use their own offices to display their craft to clients. Design premises are modern and spare—no florals, antiques, or other pretty things. Designers' dress is similarly "architectural," in solid colors and simple lines, including (among men) the collarless, priestly appearing shirts favored by affluent culture workers in the mid-1990s. Such sartorial and object details reinforce design as practical and "hard," even though the settings are otherwise diverse, ranging from a historic London mews, a redone New York loft, or a sparkling Orange County office park. A number of them radiate superhigh technology. At California's Designworks (partly owned by BMW), a full-size car pavilion revolves at the head of the conference room table. The consultancy has almost nothing in its interior, including the furniture, that it did not itself design. Some offices have turned items developed for their own use into marketable products.

Designers take some care to not overplay their aesthetic interests and backgrounds. In announcing one of its awards competitions, the IDSA called for each prospect to submit a product that "tells the world that good design is not just about aesthetics—it's about the bottom line!" (IDSA e-mail to members, March 8, 2002). Working under art-suspicious clients, designers may have to "sneak aesthetics in," according to a designer who has resorted to the practice: "If a client knows you're doing it to make it look good, they'll resist it. Sell it on function or cost savings." Veterans sometimes warn the young

and "idealistic"— or other "beret types"— to face up to practical considerations and keep their artsy leanings under control. Indeed, some designers criticize products with aesthetic goals so high that production costs price them off the market. Some designers, those who do not win prizes, use *that* fact to sell themselves, trying to leverage corporate prejudice to their benefit. A full page *I.D. Magazine* advertisement from the old-line Teague Design office ridicules the competition with the headline quote: "LISTEN, I'M AN AWARD WINNER." The text then mocks the imagined competitor: "ENTER THE PRIMA DONNA: 'IT'S BRILLIANT, IT'S THE PINNACLE… IT'S FABULOUS…' The ad ends with the tag line "AT TEAGUE WE DON'T WEAR TIARAS."[16]

Such bend-over-backwards positioning aside, virtually all designers are—to a degree—closet aesthetes, although they do not use words like "pinnacle" or "fabulous." Though all designers must be practical and some offices tend toward mechanics, the art part is what they, often uniquely, bring to the table. Some designers went to art school before design school; others were painters or sculptors. But as one told me, "I sensed my limitations as an artist." Some working professionals remain "Sunday painters." A prominent designer proclaimed in the IDSA house magazine, "we must have the courage to defend the beauty of a design, its emotional charge, its poetry."[17] In receiving a special personal recognition award from the IDSA in 1997, 90-year-old Eva Zeisel urged her colleagues to "bring back the beauty and glory of the tabernacle…warmth and beauty…like in the olden times."[18]

Most designers do believe their aesthetic judgment makes for better products and, in part for this reason, helps stuff sell. Designers believe that beauty alone, even if it means just changing an encasement—what they call the "shroud"—can pay off handsomely. Ravi Sawhney of RKS Design showed me a hand-held gaming device that, after a fresh rehousing, moved into the number one sales slot from its prior seventh position. "People do read a book by its cover," says Sawhney. "They make a first judgment based on appearance of something and then they work to back up that first judgment. They may turn away from the product when other types of evidence do not confirm their first impression, but appearance comes first."

A product design can—and many do—fail utterly. The client can pay for a design that is too complicated to produce at the

right price, inappropriate for its intended market niche, or with safety flaws that lead to expensive litigation and damaging publicity. If production goes forward on a bad product, it can destroy a company. Some products still involve vast development investment. The Gillette Mach 3 razor, introduced in 1998, took $700 million up front to make happen. A new automobile model can cost $1 billion to launch.

Clients do not gain much help from the design world in terms of figuring out just who is good or bad. There are no "Zagat" guides listing and evaluating product designers. And although they like to guffaw at the clumsy work of engineers or amateurs, designers do not often speak about their own mistakes or those of their professional colleagues. Unlike in the academic world, designers' conventions and periodicals contain no out-loud challenges of one another's work. Because designers are reluctant to acknowledge there is something a competitor can do better than they can, they seldom refer clients to other designers. Nor are there, as in show business or publishing, agents who make the match. Price competition also does not operate very well, given the uncertainties of just what one is buying or selling for a given amount.

CLIENTS

Gaining a client is both the opportunity to do a design and a source of constraint about how it can be done. Some designers gained their first clients through prior employment in design departments of manufacturers. Hauser Design, a leading design office in Southern California, arose when the principal's employer closed down. Many of the displaced manufacturing executives and engineers started their own companies, and almost all hired him, in part, says Steve Hauser, because he was the only designer any of them knew. His flow chart, made in about 1989, shows that about half his significant clients originated from the initial group of co-workers at the engineering company. The other clients were mostly in separate clusters of three to five firms or, on occasion, single firms that called him up based on magazine publicity or, in one case, his listing in the Yellow Pages.

The modes of referral—and such referrals are overwhelmingly important—affect the substance of products. In the Hauser case, the engineering orientation of his employer gave rise to a

series of clients oriented in the same way, evolving into continuous specialization in medical instrumentation and related technical devices. In effect, the referral system creates a category of design office, one that goes on—and here I speculate—to provide a kind of stamp to a large range of products that have all been designed by the same office. The client base has a certain homogeneity, which gives rise to a similarity in the types of goods an office produces.

The system is by no means rigid; there are also processes that shift consultancies toward different kinds of clients over time (Hauser slowly evolved into a wider product range). One of my informants began in furniture design. After having successfully designed chairs for a client, the same manufacturer asked him to do a wheelchair. The result was more like a piece of furniture than prior wheelchairs. While changing, to a degree, the very nature of wheelchairs, the designer was now in the growing field of medical equipment. Manufacturers in this realm, noticing the success of his wheelchairs, hired him for "other" medical equipment, and that field is now one of his firm's primary activities. So style and features of a certain sort move from furniture to medical equipment, changing the nature of the medical stuff.

Aside from referrals from existing clients, new business can come through a range of serendipitous circumstances, some quite casual. A major California office got a first boost when the designer's jogging partner connected him to the electronics company for which he did the advertising. The "weak ties"[19] that people typically have with a large but non-intimate social network provide some of the client base. In another vein, Waterpik, based in Colorado, found that its designs were creating production problems for the LA-area aluminum fabricator it had engaged to execute the product. The aluminum company recommended Spencer Mackay, a local design firm, to make adjustments that would simplify production. When Waterpik had a new product to make, it turned to Spencer Mackay because the consultancy had solved the prior difficulty. Here the LA design office, and any specific sensibility it might have, gets into Waterpik through LA's role as a fabrication locale.

Face-to-face interaction between client and design office shapes the products, which is why some designers consider their products collaborations. A California-based designer

spent 90 non-stop days with Compaq computer at its Texas location to work through a project. In another case, involving an international team, the U.S. client traveled to the U.K. designer every six weeks, and the designers went to the client approximately four times over the nine-month development period (this was in the early '90s). At various points, the designer presents recommended solutions in drawings or models or both. Visits to the designer allow clients to see and touch prototypes while simultaneously brainstorming, pointing, and manipulating. Videoconferencing, in contrast, does not allow physical contact with prototypes, or the ability to scan fleeting facial expressions and body language.

Although most designers speak of how "lucky" they are to have such "good clients," tensions arise from different priorities and status levels of the two parties. In one frequently told case (an extreme one), Chrysler's CEO, Lee Iaccoca, would walk through his company's design studios and order changes to his taste. He insisted on the boxy look and vinyl roofs that made most of his company's cars—and this seems a strong consensus[20]—the design duds (and poor sellers) of the late '80s. A more general, and subtle, complaint is that clients tend to overspec ify what they want and in this way unduly limit possibilities. Designers prefer to be told the overall goal in functional or market terms. They don't mind being asked, in crass commercial language, to capture a certain percent of market share, as long as they are not told how to do that. They would prefer being told to find a better way to keep teeth clean than to be instructed to create a brush with a rubber nib. From the client's perspective, of course, there are already vast uncertainties, and specifying some of the parameters of the envisioned product is a way of limiting them.

Designers also come with certain urges stemming from professional ideals that are at least somewhat separate from corporate notions of a good product. They have heroes they would like to emulate, visible in their books, posters, and biographical articles consecrating the great designers, like Raymond Loewy, Henry Dreyfuss, and Marcello Nizzoli. Designers like peer recognition, as they display their plaques and press notices on the walls of their offices and reception areas. They are also proud when *Business Week, I.D. Magazine,* or the IDSA's well-turned-out publication, *Innovation,* publish their work. Professional notions of

accomplishment thus also shade into what designers take to be good products. Clients may believe consumers prefer the trade-off of lower initial costs with less efficient operation and poorer durability than designers would like. Disagreements can revolve around different interpretations of consumers' aesthetic preference. One designer confided that working with a certain maker of household products caused him to seriously confront the meaning of his life, so awful was the design history of the product line. He eventually managed to "educate" the client to products that were, in his judgment, more attractive and appropriate. Some clients align more than others with the cultural framework of designers; for example, Silicon Valley firms like Apple or Hewlett-Packard are largely in synch with the tech-oriented design firms that have grown up around them. Garage tinkerers (and their creations), being unknown quantities, have less chance of finding a good designer than does a firm with more impressive bona fides. Novice clients have to be educated about what design is and why the fees only seem high. A few offices will not deal with novice clients at all.

Product success, say the designers, requires everyone to be on board; the engineers, accountants, and executives all must want the design to succeed. Without sufficient enthusiasm, too many "good reasons" will arise not to "move the envelope." Designers distrust judgments made by people who, in their view, have insufficient motivation to "make it work." Sometimes the problem is one of engineers trying to refine an existing mechanism, rather than striving for a different way to reach the goal. A former design head at Amtrak recalled a lot of problems with engineers for whom the prior version would always "do."[21] Not having the will to play, to appreciate fantasy or elegance, the employee will not expand enough sweat to engineer, source the right materials, or develop the marketing strategy.

Pricing design work can be a source of tension. What is a fair price to pay for someone to create a thing that does not yet exist and indeed that may, depending as it does on so many contingencies, never come to exist at all? Complications of all sorts can arise. Designers can misinterpret the clients' goals, can miss deadlines or delay so long that factories go quiet or a competitor moves into the breach. Clients can demand more work than agreed on, insist on unreasonable schedules, or

refuse to pay for additional work that could not be anticipated, as when an early design has to be scrapped because the market changes or the competition gets there first. The client's decision at one stage may imply a greater or lesser complexity of design work for the next. Remuneration arrangements, as with substantive design decisions, thus have to be dealt with ad hoc, as projects move along.

Different methods of design pricing exist to deal with variations in types of goods and different expectations of their sales potential. Offices can collect a flat fee or they can take a percentage of gross sales—a royalty interest. For the designers, royalties can mean big rewards if the product succeeds. On the other hand, fees mean getting paid whether it does or not. The two different payment systems help different kinds of artifacts come into being. For a product that might be risky, perhaps involving a real change but a client without much money, a royalty arrangement may lure in a designer who comes to share a belief in the product's potential. But the designer may be taking on the risk of working with clients with inadequate resources to bring the product successfully to market—if the clients were rich enough, they would just pay the fee and keep the future profits for themselves. Working with such a marginal client could end up meaning the designers worked for nothing. Sometimes the product and the firm emerge together as a joint project, with the designers retaining an ownership stake—something that New York's Smart Design did with the highly successful Oxo Good Grips kitchen tools it developed with manufacturer Sam Faber.

For some other kinds of stuff, however, having to work under royalties (or joint ownership) would hurt the designers. For example, a corporation may want a product that, although unlikely to sell well, will add prestige to the firm, perhaps indirectly boosting sales of other stuff they make—for example, the way auto companies issue "concept cars" that bring attention to their brand. In other cases, a company may be willing to produce a small number of units to test a new market that it will enter only if there is good public response to an initial model. For these types of goods, royalties would not pay.

For the more established offices, relations between client and designer may become so closely aligned that the designer no longer has to compete for projects at all—the office is simply

hired—and fees (or royalties) are established with little discussion. Over time, through repeatedly close and high-trust relationships, client and office become what business organizational experts call "quasi-firms," operating almost as a single entity. Indeed, office and corporation can become so blended that the client takes ownership stakes, as happened with Steelcase office furniture buying into the IDEO design consultancy and BMW investing in Designworks. Such efforts to more systematically conjoin centers of creativity with production activity presage a more general trend in corporate life that has big implications for the nature of future stuff (trends to be taken up in chapter 7).

DESIGN TECH AS A FORCE

Besides speeding up their development, new technologies for *doing* design affect products in more subtle ways. By the late '90s almost all offices in the United States used computer-aided design (CAD). CAD allows designers to alter their schemes rapidly; inputting change of a single dimension, for example, creates instant readjustments of all other dimensions. Electronic data interchange (EDI) permits direct linkage between designers' computers and those of clients. This means people with different roles can act on the same design scheme in tandem even at a distance, with clients responding on the work itself from afar. The great CAD dream, now only partially realized, is for electronic versions of a design to enter directly into an automated manufacturing process. The designer would ship the CAD program to the factory electronically and the finished goods would come out the other end.

Some designers, starting in about the mid-90s, turned their CAD-produced diskettes over to more specialized firms to create product prototypes. The process, called "stereolithography," results in a three-dimensional plastic model. At a more modest cost, a desk-top forming machine using ordinary potato starch can create prototypes by functioning, in effect, as a 3-D printer linked to CAD programs (year 2000 cost was about $10,000). Combining the new processes, a product like a new computer model can go from first discussions to manufactured item in six months or less.

Software may influence substance. The word processing program I use to write this book comes with a grammar check that motivates me to make some dubious "corrections" that, should others be acting similarly, will cumulatively shape writing in the English language. For the designer, the computer interface mediates in subtle ways. CAD is not a "prostheses of the mind" like the drawing hand.[22] A microsecond delay from the technology can kill a gesture. Particular CAD programs make some types of products easier to design than they otherwise would be, especially those with complexly irregular shapes (Frank Gehry's fantastical buildings like the Bilbao Guggenheim owe much to their designer's technology). Design awards now sometimes list not only the name of the client and the designer (unless prohibited by the manufacturer), but also the design software used to create the product— evidence that CAD is not just a tool but intrinsic to the outcome.[23] In actual practice, electronic media, drawing, and talk seem to reinforce one another. The "drawing is indecipherable until verbalized, and the words obscure until visualized."[24]

Three-dimensional prototypes similarly work with talk and various combinations of handwork and technology. Models and prototypes facilitate thinking through ergonomic problems and can be tried out in different situations, including wearing clothes or undressed, by those with more or less dexterity, and with different hand sizes and motor strength. Models are especially appealing to clients. "If I show you a picture of a spoon on a screen," says Jeff Smith of Palo Alto's Lunar Design, "and have one on the conference table, you'll grab the one in front of you and stop looking at the wall." Here too, the old-fashioned methods persist. Hand-built models, unlike those from stereolithography, can be made of materials tailored to the product (clay, wood, or foam) and then painted or covered in veneers to simulate almost any sort of finished surface. A designer can make adjustments to a handmade prototype with barely a moment's hesitation, changing its weight or perhaps tactile feel. Handmades also can more easily simulate details like flaps and moving parts—something that may affect a client's willingness (pro or con) to accept such elements in a finished product.

INSPIRATIONS, PERSPIRATIONS, AND SUCH

When I asked designers about the source of their ideas, which I often did, they were nice enough to provide some answers, a number of which I will repeat. But I think it was a bit forced. Products come from too many places to lend themselves to an interview sound bite. Ideas—and bits of ideas—creep in at random times and places. Many designers keep notepads at the ready—in the car for drive-by sketching, by their beds to use in the middle of the night. Designers are apt to say their solutions "just hit." But there are some patterns in their responses.

Some say they "look a lot" as they move through life. Sometimes, they look more specifically, for example at air photos for shapes and textures formed by roadways, crops, and natural demarcations. They may engage in voracious magazine and web surfing, what Tom Kelley, general design manager at IDEO, calls "idea wading."[25] The Swedish designer Charlene Schlyter says she got a successful chair design from a calligraphy course in which she became fascinated with the letter "h." No matter what kind of products they work on, designers notice the constantly changing array of shapes, colors, and textures that people wear, especially young people. They are prone to visit hip spots like LA's Melrose Avenue or New York's Soho district. An earring might inspire a car accessory or fender shape. Architectural elements, including store and window fixtures, may suggest the kind of look consumers have begun to assimilate.

Not surprisingly, many designers keep up with art, going to galleries and museums. The high art commonly in their backgrounds enters into their stuff, sometimes in direct ways as when they are consciously working an Arp-like form into a lamp base or car fender. But they do not go too far, stopping well short of involving consumers in an esoteric art history lesson. To deliver the goods, the trick usually is to downplay, if anything, the high-end cultural knowledge that may be incorporated in the object. A designer may put Monet water lilies on a sofa, but unless aiming for a very select market, shoppers should not have to know about French impressionism to get it.

However vague their sources, designers believe they need to keep the ideas coming, and this, according to both the bosses

and the line staff, requires "fun." Designers talk of how little money counts to their satisfaction, and indeed several consultancy owners say that salaries are their weakest motivator. Designers come in nights and weekends to catch up, advance new products, or develop "cool stuff" for their boat, car, or house (workplace parking lots do not empty out at five). Designers are free to come and go, rearrange things in their work setting, and wear what they want. There seem to be lots of parties and silly prizes (made possible by having in-house capacity to fabricate just about anything). Floor layouts are non-hierarchical, although the two or three top principals sometimes have conventional closed-door offices (principals are always designers). Almost all design studios have separate workrooms for model building—segregated because of the noise, odor, and dust. But all designers move freely through every space, often, for example, making their own models or working directly with those who do. People in design speak of a need to maintain a kind of creative intimacy in the studios, which may explain why, even as the profession has expanded over the years, the scale of offices has not much changed. Design works best with minimal layers of bureaucratic control, and small size means fewer layers.

Some offices try consciously to stimulate free thinking with the kinds of objects they keep around. At the Palo Alto offices of IDEO, "Tech Boxes" situated in the various work studios are filled with "neat stuff"; one had about three hundred items contributed by staff people from their various meanderings. Clients are encouraged to sift through the stuff both as a source of amusement and to loosen them up to imaginative solutions. Things and pieces of things turn colors when touched, ring in funny ways, collapse oddly, expand with gusto or quickly shrivel when exposed to body heat. In a direct product effect, IDEO's Dennis Boyle, observing this shrink-return feature, created a non-mechanical means for users to eject PC cards from their Apple PowerBook. Heat supplied by the computer battery shrinks a wire of the magic material, called Nitinol, which releases a latch that frees up a spring, and the spring shoots out the PC card. The Natinol wire immediately returns to its former shape, again ready to hold a PC card in place.

Toys are scattered all around IDEO's spaces (and several other offices I visited). Boyle speaks of toys as "congealed

ideas." Toys need to delight, surprise, and be cheap. They can be remarkably simple, with few parts, or amazingly complex but fabricated in an inexpensive way (Radio Shack's $30 Armitron toy has about three hundred interconnected moving parts). Toys are kept within reach on shelves and on the floor so "you can grab them," "make a kinetic contact," think through their process "even as your eyes were looking for something else."

Beyond their work environments, designers approach tasks by drawing on their personal experience, most particularly their own bodily needs. Many goods are, after all, an extension of the human body, improving on activities already well practiced. Eyeglasses, binoculars, and telescopes extend the eyes, telephones the ears, can openers the hands. Some products derive from physical ailments of their creators or their kin. His wife's difficulties in handling conventional kitchen tools motivated Sam Faber to create the Oxo Good Grips line with Smart Design. The original creator of the Jacuzzi tub was a man named Jacuzzi who created the whirlpool bath to alleviate a family member's arthritis. Because they are typically neither very rich nor in abject poverty, designers come up with ideas that derive from experiences common to many others as well—a true marketing advantage. Not everyone is this way. George Bush (the First) had never seen a supermarket scanner before a presidential field trip; Queen Elizabeth did not know the inside of a fast-food operation until late in the last century. In the design office there is no use for royalty of any kind. Instead, the life practices of designers are put to work in the way assignments are given out (swimmers are assigned goggles) or in the way designers come up with projects of their own. Designer Alberto Mantilla designed a baby crib for his son, Mateo, without realizing it would one day be marketed (and under the name Mateo). Another designer credited his mother-in-law, frustrated by the tipsy restaurant table they were sharing, for the challenge that led to a successful product: "make a better one; you're a designer," she said. So he came up with a table with easy-access finger-twist levelers built atop the foot of each leg.

Goods that end up with industrial applications also can emerge from ordinary life experiences. The "Menda bottle" is familiar to many people who have received an inoculation at their doctor's office. The special quality of the Menda bottle is that when the nurse presses a cotton swab down on the top,

the bottle spurts up alcohol. So the clinician can wet the swab with the use of just one hand, allowing the other hand free to inject. The bottle's inventor, an engineer named David Menkin, created it after watching his wife's difficulty in trying to get baby oil on a swab while struggling to put a fresh diaper on their infant. He saw a need for a bottle that would dispense fluid upward and allow one-handed operation. Menkin's efforts to market it as a nursery product failed. But the Menda bottle became a mainstay in other applications, first in medical offices and then in a still bigger way in factories, or wherever else soldering operations take place (workers swab surfaces with acetone using one hand while holding the metal parts, or the soldering tool, with the other).

Another influence on product detail comes from mundane physical objects already part of the designers' immediate surroundings. The person who specified the dimensions of standard floppy diskettes thought the coffee stirrer he had in his hand was about the right size. As with some other decisions where standardization is more important than the content of that standardization—like which side of the road to drive on—using the stirrer's length was as good a method as any. The design ers of Hewlett-Packard's first hand-held calculator measured the pocket of the shirt William Hewlett was wearing at the time when, taken with miniaturization possibilities inherent in semiconductors, he asked his team to come up with a calculator small enough to wear. That particular shirt ordained the dimensions of a piece of electronics.[26]

It is not all happenstance. Designers also do what they term "research." For example, they may create "style boards" (or "lifestyle boards"), assembling pictures of products, scenes, clothing, and other items used by the target group. This reveals the prevailing "design language" in play and stimulates new ways to fit a product into the tastes and needs of a given consumer group. A phone for teenage girls, for example, might be accompanied by logos of clothing they wear, CD album designs, pictures of stars, stuffed animals, and dolls that are popular with that age group. Designers want to provide the right "visual placement"—making the product right for its "design position." They may also perform a "product audit" in which they compare goods of all the competitors, packaging included. If their own product is cheaper or of lower quality

than competing models, they may try to reassure buyers by closely following convention. If they have designed a more costly item, the method is to differentiate. Another technique involves taking competitors' products apart to see how they were made ("reverse engineering") and then try to surpass them in some way—re-creating the mechanics to get a better look or altering form to enhance functional performance. Designers commonly scrutinize the way consumers change a product after buying it, like putting stickers on phones, customizing cars, disengaging smoke alarms. These aftermarket alteration "studies" provide notions of how to accommodate consumers' actual practices or solve the problems they try to solve on their own.

Especially in larger and more sophisticated offices, designers may use techniques more familiar to social scientists like ethnographic observation, time and motion studies, and focus groups. To "do teeth" (that is, create a toothbrush) a design office may bring in dentists and hygienists and toothpaste makers; they may video people brushing or flossing and break down their movements. Designers might examine the number of required reaches they can cut from a product's use, perhaps how configurations and materials will minimize fatigue or injury. Designers think through how human physicality interacts with objects in any setting and at all stages of the life course and daily round— including intimate acts and the products, like toilets and condom dispensers, that aid them.[27] Many in-house "studies" are notably informal, as IDEO's Kelley corroborates: "We have no time for detailed scientific studies at IDEO, nor does most of the rest of the business world… We usually track down several interesting people to observe and talk to…. We'll blast out a query to see if anyone knows friends who fit a certain profile or who might let us watch them using an existing product or service."[28] A person described as "part anthropologist and part seer" (with a college degree in psychology) oversees these operations at IDEO.

Contrary to suspicions that corporate research is designed to foist new things on people who do not need them, systematic market research has, in the view of some designers, a conservative bias. Jeff Smith, founder of Lunar Design (Palo Alto), sees quantitative-based research as part of the corporate system of "antibodies" deployed to make sure something that might be dangerous does not get into the system. Given that the

research is anything but exact, it can mistakenly kill excellent products, not just bad ones. The researchers "clinic the thing to death," says another major figure, Charles Pelly who designs for BMW. Market research isolates a product from the context of its purchase or use and cannot predict how it might catch on with time and exposure. Designers think they are the ones who project forward in terms of market preferences, whereas market research documents preferences in the present. But many designers welcome the research as a genuine guide for product refinement, or at least as a way to back up their intuition with "the numbers."

Ideas within a given consultancy often come from prior jobs carried out by the office. An office's dominant product type may influence the other things its people create. Although there are no crisp boundaries, consultancies tend to specialize—computers and electronics, for example, or medical equipment, or furniture, or display fixtures. Another type of divide is between design for consumers versus institutional applications (e.g., hospitals, laboratories, and factories) or retail goods as opposed to capital equipment. A consultancy that primarily designs computers might tend to turn out toys or vending machines that are computerlike, even if not otherwise technically distinctive. Clients may come to a given office because its designs have a look they are after (say, for a steam iron they want to look like a laptop) thus helping create, through the way consultancies are organized, a particular product model that might not otherwise exist.

Beyond patterns that make some sense, new stuff happens from what designers can acknowledge as "simple" dumb luck, even mistakes. Happenstance happens. The little Post-it at 3-M Corporation came out of experiments that produced an adhesive so weak it appeared useless. But a 3-M engineer and choir member named Art Fry used a piece of paper coated with the stuff as a bookmark in his hymnal.[29] After he loaned his choir book to another singer, it came back with a note written on the "bookmark," which had been placed on its cover. In this way, a new product was born. ScotTowels arrived in 1907 when the toilet paper machinery at Scott Paper company went haywire, producing the wrong consistency and shape. The result yielded a new product and set the still dominant size standard for paper towels and their holders. Of course, for mistakes to translate into products, the organizational and

personal proclivities have to be right. 3-M does not just manufacture chemicals; it makes consumer goods as well. Scott Paper had a vast marketing apparatus ready to put a new variation to the test. Luck is never totally dumb.

WHO DONE IT?

One way of answering the question of where stuff comes from is to name an office or even the human being who came up with a product, akin to the way we might say that Edison invented the lightbulb or Michaelangelo painted the Sistine Chapel ceiling. The answer to the "who done it" question is seldom clear. Who invented the Post-it? The scientists who failed to create a strong adhesive? The 3-M choir singer who stuck the thing on a page? His choirmate, who was the first to write on it? Or the 3-M boss who saw the opportunity and gave the go-ahead for mass production? Among designers, there is little ambiguity as to who should get the credit for a modern product. They should. They gave it form, and they (not marketing, engineering, or finance) typically came up with the conceptual solution that made it happen as a product. To come up with the very successful "Dustbuster" light-weight vacuum cleaner, the designer made changes in the size, controls, and appearance of an industrial shop machine. The Sony Walkman also combined elements already in existence—a tape player and headphones. The company wanted a very small, portable tape player. But because speakers were then too large to fit the specified dimensions of the product, the designers worked it up with headphones.[30] Rather than creating a compromised cassette player, they produced a new way to listen—privately and without ambient noise. If use and application are an intrinsic part of what something actually is, as most designers believe, the Walkman and Dustbuster were new inventions for which they can take the credit. Creation, in this sense, means seeing how the parts can be made to fit together; a "thing" exists only through the successful linkage across realms.

It bothers designers that when their products succeed, recognition goes to the manufacturers—who seldom even release designers' names (design consultancies, in contrast, tend to include notice of those who worked on the project). A designer working for a major corporation who had just won an IDSA "gold" told me it was "the first time in 27 years I have

received any recognition for my work." Giving public credit to individual designers would risk talent raiding; such raiding might also, one can surmise, stimulate a rise in the status and income of design professionals. Not knowing who designed their goods, people refer to products by the name of the manufacturer (a "Black and Decker drill") or the store where they bought it ("an Ikea sofa"). It is unjust, designers might say, to publicly ignore Brooks Stevens as the person who created the steam iron and its holes (no more hand sprinkling), along with stove knobs that do not burn hands. Why shouldn't Jonathan Ive, the California-Londoner who directed design of the I-Mac, have his name on the product itself just as Armani has his on clothing or Picasso has his on paintings?

Especially when the creators are dead and gone, they can sometimes be recognized. So more people now buy "an Eames chair" rather than "an easy chair" or a "Herman Miller" (its manufacturer's name). In France and Italy, where designers do receive greater recognition, the products are made distinctive by that fact, something that implies there would be product effects if the same pattern were to spread to the United States and other countries.

WHO DESIGNS AND WHY IT MATTERS

The nature of the humans doing design, including their ethnicity, race, and gender, influence what stuff can be. By IDSA figures, women make up only 11.5 percent of members; there are no data on ethnicity and race, but based on my own observations, the proportion of African-Americans, in particular, comes nowhere near reflecting their share of the U.S. population overall.[31] However apparently homogenous their own group, designers are well aware of diversity in how different types of people are built and function. They may speak, for example, of a product having size advantage when it will work for all between "the fifth percentile Asian female and the 95th percentile African-American male." Ford designers test products dressed in what they call a "third age" suit, with glasses and gloves, to simulate having the body and eyesight of a 70-year-old. Designers would all bet money (in effect, many do) that women and men have different physical capacities and logistical preferences. When Australian designers saw that more women were changing their own car oil, they developed

an oil can handle needing less strength to puncture the can and with less likelihood of producing a mess.

In terms of gender, some designers say that women not only tend to design different things—by desire or office prejudice they concentrate in textiles, graphics, and housewares—but also design the same things differently. Not all designers think this way, and some outspoken women designers say gender makes no difference. Among those who think it does, one version is that men are more "performance oriented"—that is, they want the product to run faster or more powerfully or have more features. Women, in some degree of contrast, concentrate on the interface: how the product can be approached and satisfactorily used—its "affordances," as they say in the trade.[31] An in-house appliance designer told me her bosses (all men) "explained away" women focus groups' preference for her simplified washing machine control panel Her comments were pungent, "If women did more designing, products would be simpler… I'd like to add up all the money that's been lost by white male arrogance." To heighten her male colleagues' appreciation of the importance of the human-product interface, a different woman designer says she persuaded her Japanese male clients to scrub their home bathrooms (presumably it was their first time) to show them the importance of cleaning ease for a toilet seat. All this runs counter to the critique that men design products to "ensnare" women;[32] if anything, women designers seem to think the "ensnaring" is the part men do least well.

Power tools were once designed exclusively by men and solely for men to use at work. But during World War II, women in U.S. factories started "borrowing" their tools for home projects (during the war more women had to do home carpentry and plumbing tasks as well the other domestic tasks). Power tool companies like Black and Decker, now the largest U.S. maker, noticed the trend toward home use and began producing home power tools after the war. At first the marketing aimed only at male consumers, then gradually shifted to include women. Such products now represent the bulk of Black and Decker's business with most power tools bought as gift items.[33] Changes in the domestic sphere altered the products. If there had been women at Black and Decker in the first place, perhaps the transition would have taken place sooner.

There are other plausible outcomes of designers' gender. A woman designer created a mammography device more sensitive to women's physical comfort that also, to aid the patient's calm, placed the woman physically closer to the technician. In dealing with other medical problems, like incontinence, both the physical and social predicaments of the patient are different by gender, and it may indeed save a lot of research effort if the person designing for the woman is also a woman. In design of ordinary outdoor metal furniture, a woman designer was thought to have given the product "a more delicate aesthetic" than would a man, or so I was told by a woman designer. Women may also design for smaller bodies. The La-Z-Boy recliner chair came out with women-scale models only after years of having the man-size version on the market.[36]

Still more subtly, women might take consultancies in a more "caring" direction. I notice a disproportionate number of women active in IDSA realms having to do with children's goods (hardly a surprise), but also in special sections and events having to do with ecological responsibility. They are also salient in public service projects. Australian designer Ruth McDermott won a public service award for designing a needle packet for an AIDS prevention program. Her design made it extremely difficult for a child or innocent person to access the contents, and impossible for the user to retrieve a used needle once it was returned to the case.

Given its relative invisibility, design careers may be especially vulnerable to subtle forces that guide one kind of person into the profession (or its subspecialties) and discourage others. The absence of design as subject matter in schools, the low numbers of designers walking the earth to "bump into" and the weak visibility of the field make it harder for a broad base of young people to have product design as a goal and then take the steps necessary to achieve it. Automobiles, being so central in the lives of boys, act as a draw, but even here there is no clear way to turn that boy-toy into a career line. For several male designers, their childhood dream was to design cars, "whatever that meant," as one told me. In still a different case a self-described "drawing-and-painting type of child" took a battery of school tests and was told he was well suited for work as an "industrial designer." But because he was not told what that phrase meant, he became an anthropology major, only years later finding the route to design. A knowledgeable U.S. Army

officer first encouraged one designer now working in LA after spotting him, as a child, creatively assembling stuff out of rubble in a post-war Displaced Persons camp in Germany. A number of designers are from design families, having kin in product design.

Feminist commentators note that job environments can send signals that create enough discomfort to encourage women to go elsewhere. It is not a stretch to see the physical environments of the design offices as bespeaking not feminine welcome but "manly beauty, naked and unadorned," the trait admired by Vitruvius in his praise of the Doric column.[35] "Less is more masculine," as a contemporary commen tator translates the same sentiment.[37] The major American auto companies (at least GM and Ford), were self-consciously masculine during their heydays. According to Mike Nuttal, head of the IDEO design office, General Motors engineers called designers "clay fairies"—not exactly making for an environment conducive to inclusion of women or for relaxing gender anxieties among the designing men. Women were not permitted to design car bodies for fear their presence would yield "emasculated design" or inhibit the men around them from using sexual gusto to mold their phantasmagoric body parts.[37] The exaggeratedly pointed bumpers of the late '50s (which crushed on slight impact) were called "Dagmars" at GM, a reference to a full-breasted entertainment celebrity of the day.

In the end, I do not know the full reasons for underrepresentation of minorities or segregation of women, but note that employers advertising jobs in the IDSA's *Design Perspectives* want ads make no mention of diversity goals nor encourage applications from underrepresented groups. In contrast to past practices, some male designers now say the inclusion of women is a necessity, whether for reasons of fairness or because of the belief that women bring a distinct and valuable orientation to the design process. There is also the thought that in "the new paradigm" (as designer Tucker Viemeister called it) both male clients and women clients (who also show up more frequently on designer radar) appreciate women's presence. That women are gaining a more prominent role in design is plausible enough, given design's general relation to the "outside" world—one of continuous interaction and parallel development.

Designers at any given historic moment carry forth the history, as a designer-informant put it, of "the whole stream of what has come before." Though other corporate actors are no less creatures of history, the designers have the special role, in ways their practices indicate, to connect "soft" sensibilities of art and culture with the "hard" production facts. Somebody has to do this amalgamation because otherwise there would be no goods at all.

CHAPTER 3
Form and Function

The great form versus function debate within design reflects analogous controversy in society. It raises the large issue of life's priorities: pleasure or business, expressivity or fulfilling practical need. In more concrete terms of goods production, the question is whether products ought to be made useful or beautiful. If not one or the other, then where should the "compromise," the "balance," the "line," be located? Asking which matters most or even what the balance should be, I will try to show, is fruitless. More radically, I believe that what appears to be form can alternatively be viewed as function and what is thought functional can be seen as aesthetic. But the fact that the argument takes place, and that people take positions within it, affects the goods. I want to show the way both form and function, as each is conventionally understood, enter into products. But in addition, I want to show how the debate itself, variously naïve or sophisticated, also lodges in the stuff.

For their part, designers think that both form and function matter for the creation of a good product. In their common refrain, "it's both." But they do not have a clear way to articulate just how and why both matter, something I try to remedy. To do so, I must document the less appreciated element, the "art part," as omnipresent in human projects and in ways often not realized. But I always understand art as connecting with all other aspects, technology and business included. I also declare that my "art" includes all the variants of "play, fun, display, and pleasure"[86] whether they end up as things hanging on walls, around necks, as songs to sing, or just new ways to be silly. I will try to show its presence in projects usually thought of as having little to do with such realms. As I

gather up rhetorical steam, I can then turn to the debates themselves as a force in making up the goods.

Given the stance of so many commentators who champion one or the other—form or function, art or economy—studying the two under the same lens of appreciation runs against some substantial intellectual precedents. For some who champion the *practicalities* of life, art may be a good thing, but hardly intrinsic to the production process. Some schools of anthropology (but not all) hold that art happens historically only when a people generates enough material surplus to free up time and consciousness for the non-essentials. "Men eat before they reason," Marx said—and that means well before they decorate. In a contemporary vein, Petroski argues with characteristic succinctness that the "evolution" of modern products comes from their "usefulness," by which he means utility quite apart from any aesthetic considerations. Issues of aesthetics, he says in *The Evolution of Useful Things,*

> may certainly influence, in some cases even dominate, the process whereby a designed object comes finally to look the way it does, but they are seldom the first causes of shape and form, with jewelry and objets d'art being notable exceptions. Utilitarian objects can be streamlined and in other ways made more pleasing to the eye, but such changes are more often than not cosmetic to a mature or aging artifact.

"Design games," he says with seeming pride, "are of little concern to this book."[2] Some commentators more closely connected with the design world echo the sentiment. The *New York Times* design critic Philip Nobel has urged that "utility, not vanity, should drive change in design…that's one of the things that distinguishes it from art," he says. Rather than succumb to "style traps" and "glamour" (as he thinks they were doing in the year 2000), designers should engage in "can-do make-do problem solving."[3] From deeper within the business world, creating and appreciating art has always been suspect—viewed as something done by those who take up the unessential tasks, women and effete or neurotic men. Ornamentation and emotion are regions "that Western and particularly Anglo-Saxon society has defined as feminine preoccupations."[4] The business-minded, traditionally at least,

give credit for corporate success to the virtues of competitive drive, including the capacity to exploit natural resources and labor.

Connoisseurs on the art side of the divide are equally wary. They may grant that practical resources can be necessary to physically sustain artists, but money and commercial considerations are otherwise a threat to aesthetic fulfillment. Indeed, instances of art serving business is enough to rule it out as art altogether. As Max Eastman said of artists who have "gone over" to commerce—reminiscent of Semper's nineteenth-century lament—the use of their work in advertisements is "an obituary notice of these men as artists."[5] Commercial art is thus an oxymoron. Art needs to be an autonomous antidote to the commercial, not corrupted in its service. Some go one step further to argue that art's value comes from its potential to *oppose* the economy, at least the economy under capitalism. When it is not obviously doing just this, one should be suspicious. Otherwise, preoccupation with the aesthetic, some left thinkers have argued, may deflect workers' attention from the conditions of their exploitation. That is why, it has been said, capitalism turns up the volume on high art "in periods of confusion and uncertainty"[6] so as to keep the masses humbled and distracted.

Out of this mishmash of art for art's sake, utility is all that's really needed, and the kinds of suspicions that can arise from mixing the two, how does one look for art in the goods and the process that leads to them? Some theories of art do leave a space for merchandise because they define art not in terms of how well the creation itself meets some canon, but in the way it connects to its context, however mundane. This means that ordinary things and miscellaneous experiences can be artful. Baudelaire was one who searched for an alternative "to the academic theory of a unique and absolute beauty." There may be something like intrinsic beauty for Baudelaire, but it needs an appropriate social and cultural context to come out—"the age, its fashions, its morals, its emotions." Unless the object can catch this second element of art's "double composition"—"the amusing, enticing, appetizing icing on the divine cake"—the first elements remain beyond "our powers of digestion or appreciation."[7] In other words, ordinary social currents are intrinsic to the art experience; they unlock the thrills.

I go one step further than Baudelaire and see even his "divine" base as coming out of social experience. For me, there is no limit to the excitement that even ordinary experience can generate when artfully invoked. What he and others take as divine are the large and small dramas of life juxtaposed in spectacularly particular ways: maybe its stormy nights, sexual thrill, a flowerpot, eating Rice Crispies, coming home from school, and all art one has ever seen before. Something becomes art through achieving in the viewer an intense lash-up of connotations, a congealing that gives emotional force even to details like a certain physical curve, minor indentation, or nipplelike bump. So complicated a melding clouds over the mechanism of the artist's accomplishment. Art happens when observers sense they cannot know how their response came to be. Whether it is a finial that so perfectly tops off a picture window lamp, a religious icon whose decoration and form evoke higher beings, a "magnificent" painting in some great collection, an awesome rendition of "Melancholy Baby," or a good magic trick, art represents uncanny accomplishment. One cannot easily think, "oh, I could do that" by this or that procedure. There is, as Alfred Gell put it, "the spectator's inability mentally to rehearse" how to make it happen— a "blockage" in cognition that creates "fascination" or "captivation."[8] Mystery refracts back upon the senses, in ongoing, instant-by-instant loops, intensifying the experience. To at least a degree, this is also how a good toaster works.

With home appliances, as with other media, judgments change; people come to understand the object only too well, causing the mystery to erode, the trick to become old hat, the "manipulation" to become transparent. People may come to understand there are institutional mechanisms that support, celebrate, or reinforce one object as opposed to another. An artistic thing can then be demystified for what it was all along—just a style, perhaps a result of advertisers' enticements and thus no longer experienced as authentic. As mysteries yield to clar ifications, creators produce new mysteries to be again demystified. As with choosing first names, certain people lead, being first to see through the stuff of the prior generation or that came earlier in their own lives. The old—at least the proximate old—no longer intrigues. This adds in, from the world of art, a further elaboration of the underlying mechanisms of fashion.

From their loftier and more refined positions ahead of the pack, elite critics can regard ordinary people's fascinations as wasteful kitsch, armed as they are with enough cultural capital to see the contrivance. But elites lack a sufficient awareness to demystify their own prized goods—although when they do, they chuck that stuff too. It would be a step forward to see all goods as mysterious works of art to their admirers. Then we could more fully understand how the seduction process works—just how products become powerful through the particular way they combine art and utility.

HIGH CORRELATION

That designers themselves think "it's both" is evidence in itself for art's significance. They may be somewhat self-serving in making the claim, trying to exploit their artistic capital, but they do have a lot of evidence based on business experience. They perceive a high correlation between stuff they judge as having good form and stuff they judge as highly functional—a correlation that yields market success. In the car industry, it is clear to them that the Japanese and German designers used no form-function trade-off to produce the cars that so drastically eroded the domestic Big Three. Aesthetics do not dictate car reliability or a quieter ride, but aesthetic speculation, carried out with focused enthusiasm, may offer frameworks for technologies that otherwise would not exist. Loving a look, design practice indicates, can stimulate dissatisfaction, experimentation, and reconfiguration in ways that increase technical skills and capacities.

Just as valued form and function may "naturally" align in products, people who specialize in one or the other—artists compared with, say, engineers, are less different than stereotypes imply. Every artist must, as Howard Becker has carefully observed, face the mundane.[9] There are material matters of pigments, solvents, durability, weights, scale, and interrelations among parts. There are organizational issues having to do with agents, dealers, galleries, preparators, critics, and patrons without whom the work could not successfully exist. The artistic output at the end stands as an encapsulation of the practical vicissitudes through which it has come to be—as well, of course, as the "magic" the artist brings to bear in making the combination happen. If the art is a

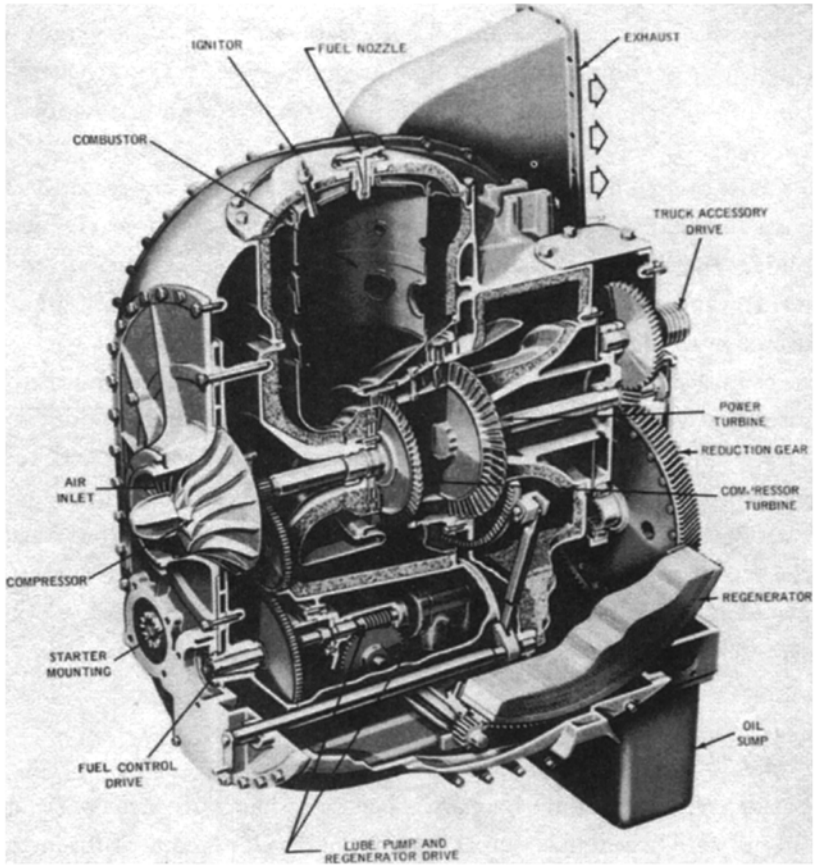
solution, it cannot occur without the problems it has come to solve and those problems are, in considerable degree, practical ones. Indeed one's signature becomes what one makes of such limits.[10]

Leonardo did top-grade weapons as well as murals, and the same talents that make his works recognizably excellent for art connoisseurs plausibly helped his products be more effective in war. His notebooks make clear the Renaissance Man never stopped, and that includes his assiduous efforts in promoting his projects to patrons—whether pitched as art, entertainment, science, or some concurrent combo. Renaissance man lives on. In Zen terms, what might be going on then as now, is "mindfulness"—the propensity to focus and, in effect, let all parts of the individual brain as well as group intelligence work through toward an effective solution.

REPRESENTATION

That stuff typically has to be represented before it can exist is so obvious it is seldom remarked upon. Da Vinci advanced the skills of drawing to advance the prospects of his production goods. The development of linear perspective, critical to any realistic representation of objects, came from the drawings of Florentine sculptor and architect Filippo Brunelleschi, who applied the technique in 1425. In the way that people can experience a coastline through a map rather than being there, they can have some image of an object or production process without direct experience of it.[11] In mass production, specificity becomes especially important because extensive investment has to be made up front before a single item comes into being. Patents require precise representations of parts, how they combine, and how they will operate. Having a representation of a prospective thing amplifies the potential for enrollments among clients who give the go-ahead, investors who are needed for the money, distributors who commit to an inventory. If the product is to go before focus groups, the model, sketch, or prototype must be right or the research will be invalid.

Drawings and models integrate across time because they provide a way for different actors to come into the process at different moments. Many of us have had a chance to see the process when watching workers combine in constructing or remodeling a house. As subcontractors comes along, each



Cutaway view of an engine. Photo courtesy of Alexander Levens Estate (From Graphics: Analysis and Conceptual Design by A.S.Levens.

checks the plans to get oriented and coordinate with those who came before and will come later in the process. Drawings (hard copy or computer-based) also integrate across space as they travel from one location to another within a factory or from one factory to another.

The precise mode of representation, the skills at hand, and the art conventions in use, affect the product outcome. Technical drawing underwent the same sequence of styles in the fifteenth through nineteenth centuries as did the other graphic arts.[12] Sophistication grew in use of multiple perspectives, shadings, and the other artistic tricks to communicate proportion and kinetic relations. It was not until

well into the twentieth century that cross-sectional or "cutaway" drawing came about, a form of non-representational art coterminous with early modernist painting and budding surrealism. Max Miller's cutaway aircraft drawings for plane manufacturers in the United Kingdom during the interwar years receive part of the credit for making the aircraft's production feasible,[13] as with engines and artifacts of all kinds. Ways of representing imagined things helps make them things in fact.

ART AS PIONEER

Besides representation, there are other ways that art comes before useful object. Things now seen as functional developed out of things not evidently functional at all, indeed precisely because, in some cases, they appeared "merely" arty. That meant they were let alone, perhaps to be later tinkered into something considered useful. No one has argued the point more boldly than the MIT metallurgist Cyril Stanley Smith, who turned from what today we call materials science (and a career that included the Manhattan Project) to larger analytic frameworks later in his life. Smith says that aesthetics, desire, and "play domains" were the engine of materials innovation. He speculates that those who first molded baked clay, circa 20,000 B.C., were making fertility figures,[14] not utilitarian objects. Artifacts from the Neander Valley in Austria, circa 35,000 years ago, show detailed chipping and coloring.[15] Flutes carved from bone go back that far. Evidently the early technologies only later became the basis for pots, cups, and vessels. Humans used copper met allurgy to make ornaments prior to creating knives and weapons.[16] This runs against the claim that, as Petroski puts it, tools are "the first artifacts of civilization."[17]

Cyril Stanley Smith sums it up: "Paradoxically man's capacity for aesthetic enjoyment may have been his most practical characteristic for it is at the root of his discovery of the world about him, and it makes him want to live."[18] Cultivating and transplanting flowers, says Smith, preceded crop agriculture, and "playing with pets probably gave the knowledge that was needed for purposeful animal husbandry." He speculates that "pleasurable interactive communal activities like singing and dancing" gave birth to language itself. This

leads him to the idea that "aesthetic curiosity has been central to both genetic and cultural evolution."[19]

From other sources, there is a suggestion that weaving fabric for decorative costuming and ceremonial events presaged the use of nets to trap animals and vessels to carry goods. "When people started to fool around with plants and plant byproducts, that opened vast new avenues of human progress," says archaeologist James Adovasio.[20] Dutch historian Johan Huizinga wrote in 1938 that "the whole mental attitude of the Renaissance was one of play."[21] These claims may be hard to prove—especially notions like singing before language or pets before animal husbandry. But the bias in our thinking is evident in the way we put the burden of proof on the idea that the art could not have come first—or even simultaneously. We naïvely take as given the primacy of utility.

Evidence from within the industrial era is more clear-cut. Smith describes a host of metallurgical discoveries in which the aesthetic presaged the mechanical. Blast lamps to make decorative beads led to the modern welding torch, forming the basis for modern steel production. Depositing metallic coatings by means of electrolytic currents owes its origins to layering gold, silver, or copper on baser substances to produce jewelry and decorative medals.[22] All copper and aluminum came to be produced through electrolytic reduction. The same process led to inexpensive production of conductors and integrated electronic microcircuits, including those used in computers and microwave equipment.[23] Across the industrial board—mining, missiles, textiles, chemicals, and plastics—the art application, at least as often as not, came first.[24] Materials and techniques that have spiritual, playful, or aesthetic value help hold a place, providing the space for improvements to develop, for the complementary elements to arrive and maybe for what is later regarded as the efficient solution to come into being.

BUILDING MARKETS

The artistic—including the subtleties of detail—creates markets. In the pleasure of feeling the texture of a doorknob, hearing the sound of a computer click, or taking in the look of a dental drill, the sensual makes people want things. Of all the realms of productive seduction, automobiles are perhaps the most noticed and, other than armaments, the most

consequential of objects. Creation of cars depended on the invention of the wheel. Exactly how that came about can only be a guess, but the one by Jane Jacobs is that people made small solid circles, perhaps out of ginger root or squash; maybe mothers entertained children by twirling the vegetable slices on sticks. Then may have come toys of more durable materials. In terms of dating the event, archaeological evidence suggests the wheel came around about five thousand years ago, with the first ones used for ritualistic and ceremonial purposes—carrying effigies of deities or important persons.[25] Apparently closely linked in time and function, wheeled vehicles came into military use as chariots and battle wagons.[26]

But the next great advance, and it came several thousand years later, was the bicycle, invented in France as an amusement for rich and agile gentlemen. Subsequent technical refinements in the United States led to the "bicycle craze" as production boomed over the 1892–1897 period, with women joining in the sport. The bicycle's subsequent "serious" use as a basic mode of transportation (in some places) came only after mass automobile production was under way in the United States. But in the meantime, the bicycle brought on important technical innovations like the pneumatic tire, breakthroughs in ball bearings, seamless steel tubes (for the bicycle's frame) and the first use of stamped sheet metal (in 1890), thus replacing the more expensive foundry method for forming parts.[27] The socially significant bicycle rid ing public created societies that lobbied governments to build better roads.

The car industry similarly was born for fun, as a plaything for the rich—not as a rational device to move people and goods. The first car, created by Benz in 1886, was ridiculed by the head of the German patent office, who declared that the internal combustion engine, which then was thought appropriate only for stationary applications, "has as little future as steam for motivating road vehicles."[28] Others referred to it as the result of Benz's "mad obsession," consumed as he was by speed at any practical cost. Chevrolet, who started one of the early companies that was to become merged into General Motors, was a racing enthusiast, as were other U.S. car builders. The races, well publicized and greeted with sensation wherever they were held, helped spark general interest in automobiles.

The look of the car became no less aestheticized. Roland Barthes not altogether approvingly recorded the "intense amorous studiousness" with which people at a 1950s Paris exhibition admired a new-model Citroen car: "the bodywork, the lines of union are touched, the upholstery palpated, the seats tried, the doors caressed, the cushions fondled." Cars, said Barthes, "are almost exactly the equivalent of the great Gothic cathedrals…conceived with passion by unknown artists, and consumed in image if not in usage by a whole population which appropriates in them a wholly magical object."[29]

The history of car production displays what goes wrong when makers think the car is merely a device for transit. Understanding the automobile as magical object was not in Henry Ford's repertoire. As Michael Schwarts and Frank Romo note, his production equipment gave no consideration to the possibility of periodic design changes. Hence "the boxy body of the Model T…was maintained long after the technology was available for a more streamlined design because the metal stamping machines that were installed in the Ford plants could not create curved panels."[30] Ford's production tools could do only one thing, albeit one thing well; half of them had to be scrapped when he finally did make the move toward "styling." Because his machines were also so close together on the shop floor, as a matter of efficiency, there was too little physical space to reconfigure them. Before retooling in the latter 1920s for its first style-oriented car, the Model A, Ford laid off massive numbers of workers and lost $18 million, providing "the most expensive art lesson in history."[31] Henry Ford's philosophy of "any color you want as long as it's black," lowered his company's market share from 55 per cent in the early '20s to less than 15 percent in 1927.[32] General Motors' cars outsold Ford's, and at higher prices. So in addition to whatever organizational smarts GM had over the competition,[33] the aesthetic was a distinct GM edge. The company brought in Harley Earl, who had earlier gained some fame customizing cars for LA movie stars. Beginning with the inaugural project for which he had full responsibility, the 1927 La Salle car, GM began its solid run of profitability. The world's first automobile styling department was GM's, and it was set up under Earl's direction.

After first innovating with color, including two-tone styling, Earl moved GM into deeper changes in body shapes. To gain a more rakish line, Earl smoothed steel over a built-in luggage compartment (today's "trunk" or "boot") to replace what had begun as, in fact, a bolted-on trunk.[34] This also became the place to put the spare tire, which could then come off the car's exterior. To mold steel into the shapes he needed, engineers created dye casts to follow the desired forms, including the "sporty" GM hardtop arrangement. GM developed simultaneously a special steel that was "flexible enough and strong enough to endure the tremendous strain" of the molding processes.[35] The streamline look, with a rolled steel body, enhanced the car's aerodynamic efficiency, decreased the number of its parts, lowered labor costs, increased security against theft, and quieted the ride. Analogous taste and engineering changes moved through appliances and other transportation equipment. One of the more famous was Raymond Loewy's first streamlined locomotives for Pennsylvania Railroad, eliminating rivets he thought made the train look "unfinished and clumsy."[36] The new design saved millions in fabricating costs.

By the '50s, the U.S. car companies moved into what Edson Armi (one of the few art historians to take cars seriously) calls "more irregularly sculpted cars (that) have more in common with the automatism of postwar expressionist painters and their biomorphic fantasies…"[37] with, in the case of the flagship 1957 Cadillac, "Duchamp, Gropius and Marinetti all commingled in the tail fin."[38] Despite the great appeal these products first had, things again changed—in terms of popular taste as well as the engineering and sales performance of the U.S. vehicles. The Big Three lost out to foreign producers who eschewed Detroit's chrome bucket reruns. Designers often disagree on aesthetic issues, but nowhere have I found a designer praise U.S. autos of the late 1970s and 1980s. *Fortune* magazine, in a 1988 review of "five products U.S. companies design badly," listed cars, making an exception for the Ford Taurus.[39] Cars from Germany, Italy, and most triumphantly Japan have been more highly regarded for their styling, fuel efficiency, and—with the exception of Italy—reliability. The combination of failings in the U.S. product devastated Midwest economies and eroded billions in corporate worth. All this, I would argue because, at least in significant

degree, U.S. makers were unable to find the right art when they needed it.

FULFILLING BASIC NEEDS

At every instant in the history of social life, as Braudel summarizes, "man feeds himself, lives and dresses…but he could feed, live and dress differently."[40] Even as people fulfill what might seem fundamental material needs, the psychological and cultural realities they attach to their goods become as firm and incorrigible as any physical compulsion. The proof of this pudding is that, at the extreme, people will indeed die rather than eat the aesthetically wrong thing or, as in the case of anorexia, go without food altogether rather than risk appearing unattractive. With death somewhat less certain, they will drive recklessly, drink excessively, or smoke tobacco. Cigarettes may be a health menace ("coffin nails") but they also imply the romance of Bogey and Bacall, mysterious travels, or living on the defiant edge. These are involuntary associations; like lost loves, we can't get them out of our minds. In Richard Klein's strong statement, "cigarettes are sublime."[41] Pleasure comes not just through biologic addiction, but through social and symbolic appeal, including the flirtation with death itself. "To be on the wire is life; the rest is waiting," the acrobat Karl Wallenda explained in returning to his act after a member of his troupe met death in a Detroit fall.[42]

Such inclinations influence products, the economy more generally, and all the institutions in which the economy is embedded. Culinary preferences among some fifteenth-century Europeans (along with people's desire for glitter) stimulated the great treks and voyages over the earth, forever changing all that came after. Starting at least as far back as Roman trade in the time of Alexander and Chinese traders at the time of Marco Polo's journeys, sponsors were involved in a pleasure business —a kind of entertainment economy—rather than a utilitarian search to increase caloric intake.[43] European elite taste for sugar led to slave plantations of the New World, among other social and economic consequences.[44] Taste for coffee and tea, also filling no nutritional needs, brought analogous transformations in domestic production systems and population displacements, including the transformation of Latin American peoples into virtual coffee slaves.[45] Every such

food preference carries with it a distinctive goods regimen. Asian diets of small cut-up pieces work with chopsticks; U.S. steak eaters need sharp knives; dope smokers need bongs. A world of culinary products (pots, pans, blenders, serving plates) rises and falls depending on what is being imbibed and how it is prepared and served.

Like food, bodies need a place to rest—but given the changes across time and place in how this is done, the rest is sensual history. The bed is anthropologically odd; most people slept on the floor, shared large platforms, or used hammocks. Chairs are also unusual among world peoples, most of whom squat, or sit cross-legged or flat on the ground. Islamic peoples traditionally do without furniture, making both home and public life on elaborate rugs. From the archaeological evidence, chairs existed as early as the Neolithic Age, but as an expression of authority rather than for relief from standing.[46] Pervasive among the Greek and Roman citizens, slaves did not use them nor did those in the conquered territories. In depicting the diners as sitting, Da Vinci upgrades Jesus and his group, who were too lowly for chairs; they would have been on the floor that night just as on other nights. The chair disappeared even in the West during the medieval period for purposes other than to signal status. It is a misunderstanding to think of today's furniture reproductions of "period" pieces as simulating prior ways of life without realizing they were used by only a small segment of the population at the time—and for different purposes than they are now put.

With the eventual triumph of chairs, at least in Europe and North America, came what we might think of as the "chair style of life" involving related sentiments and artifacts, including the commode and tables of an appropriate height. Higher seating altered the placement of windows and increased the liabilities of low ceilings. Chairs have become part of the methodology of respect and rectitude.[47] Victorians, perhaps emulating medieval clerics, identified sitting up straight with moral virtue. For this reason, it was more important to sit up straight at home compared to the less morally charged environment of the office, where slouching was more acceptable—something of a reversal of the contemporary norm.[48]

The chair's danger to posture, bone development, and healthy defecation is evidence that something other than inherent functionality lies behind it. Use of chairs is actively

enforced, starting with the hard work of training children to sit. As architecture professor Galen Cranz testifies from woeful personal experience, the naturalization of the chair becomes evident to those who might otherwise ease their back pain by lying on the floor to conduct business or enjoy themselves at dinner parties.[49] To do so would breach normal social life. The chair's symbolic value and the physical necessity now reinforce one another. Europeans and North Americans have lost the technique and muscle power to squat. The chair's durability is locked in because it has lashed up with so much else, indeed invading and snatching our bodies.

Clothing is another necessity we could often do without. People exaggerate its health benefits and other practical gains. So a furry lining supposedly helps ward off a cold even though bacteria and viruses—not a failure to stay warm—cause disease. But clothing does incubate and help spread vermin and dangerous microbes, especially when adequate laundering is not feasible. Ankle support was thought to be a health necessity at the turn of the century, thus creating high-top shoes for women, whose ankles in fact were made weak. As with chairs, shoes do little for the body; even purportedly comfortable ones would probably be best left off under many circumstances.

Use of clothing at all is sometimes a fashion "extra." This is obvi ous enough in the tropics where most people today wear full-on dress despite its functional superfluousness. But even peoples whom we might think required garments because of harsh climates could exist through their own skin. Indigenous peoples of Australia and Tierra del Fuego apparently kept warm through diet and exercise.[50] Alternatively, no sensible person should ever wear clothes in a New York summer, but millions swelter in them on the city's sidewalks and require air-conditioned interiors to offset the burden. Of course what is involved is an aversion to social stigma, something that even minor errors can attract. Wearing the wrong blouse when visiting relatives can mark a betrayal of "sartorial conscience," even risking effrontery.[51] More radically, a person who walks downtown wearing only underwear (or forgetting a sock) undercuts a whole life of competent living. As the U.S. cross-dresser Ru-Paul says, we are each born naked and all the rest is drag. Analogous to the ways "precision consumption"[52] works in other goods areas, working the drag—among those

who produce and those who buy—makes up the stuff. This art of dressing is as important, personally and economically, as utility.

LEAPS AND VISIONS

Getting to a new thing, even if only by small and incremental steps, requires leaps. Art helps leaps, something that engineers and scientists often acknowledge—at least in their memoirs. Necessity is not, Cyril Stanley Smith emphasizes, the mother of invention: "A man desperately in search of a weapon or food is in no mood for discovery; he can only exploit what is already known to exist. Discovery requires aesthetically motivated curiosity, not logic, for new things can acquire validity only by interaction in an environment that has yet to be."[53]

Children, Baudelaire explains, are always "drunk" with inspiration, always "in a state of newness," and ready to take on the world unburdened by practicalities or conventions. This is the element that even in adulthood makes the creative difference; "genius," says Baudelaire, "is nothing more nor less than childhood recovered at will."[54] Or as I heard a designer quote somebody wise, "get out of the day and into the play."

How does this inspiration work? Images "just hit," as the designers say. These are not the full-on solutions, but rather insights that then stimulate more precise working out just how an imagined solution will take shape. Such "preanalytic visions"[55] offer a glimpse of the ultimate solution, the form it might take, and for the creator, the thrill that goads the tedium that may lay ahead. The imagined and idealized outcome becomes a template, a basis for judging alternatives, that leads one solution to replace another. "There is no doubt," says one reviewer of the history of inventiveness, "that nonscientific, even nonverbal, thought plays a crucial role in all invention, including that of engineers."[149] The art testimonials pour in from the famed. "It is more important to have beauty in one's equations than to have them fit experiment," writes physicist P.A.M.Dirac.[57] Andrew Strominger, the contemporary string-theory physicist, is guided by "a sense of aesthetics, of what would be the most satisfying possible answer to the problem. I would say: Gosh, wouldn't it be nice? And then try to prove it."[58] Einstein, the genius himself, followed the same version of scientific method.[59]

We all think in pictures, and those pictures have objects, and those objects have affective connotations. Experiments show it is harder to learn logical propositions when expressed formally ("If a, then b") compared to expressions that incorporate "real" objects ("If Socrates is a man…").[60] Similarly, it is easier to solve analytic problems based on assumptions of speed, time, and distance by attaching a scenario of trains leaving stations than trying to hold it all as mathematical symbols. By utilizing known cultural objects, including spatial and geographic phenomena, people can more easily manipulate dynamic scenarios. That is a principle of the desktop metaphor in Macintosh and Windows. "In order to remember a long sequence of ideas," a cognitive scientist explains, "one associates the ideas, in order, with a set of landmarks in the physical environment."[61] Coming from the other direction, geographer Yi-Fu Tuan says "transient feelings and thoughts gain permanence and objectivity through things," which then become repositories of meaning.[62] Objects and landmarks do their "thought jobs" because they are affectively redolent. This dual nature of objects as both material and emotion is consistent with emerging notions about how people manage to think at all. Affect makes objects into utilities of mind.

It is doubtful, as held in the common stereotype, that art and prac ticality reside as separate realms lodged in different parts of the brain, left versus right. More advanced cognitive science presents a different picture. At a very basic level of brain functioning, art and utility not only operate in conjunction, but presuppose one another. People who have had accidents that leave them with lesions in a certain part of their brains (the ventromedial frontal segment) show both severe loss of affect along with diminished capacity to reason their way through ordinary life problems. Experiments with such individuals show, writes cognitive scientist Antonio Damasio, that "the powers of reason and the experience of emotions decline together," even when some other skills like memory for facts and language remain strong. Feelings, based on emotional sensations, act as "somatic markers" that help establish priorities of what to think about and in what order. They are, as Damasio puts it, "boosters to maintain and optimize working memory and…scenarios of the future. In short, you cannot formulate and use adequate 'theories' for your mind

and for the mind of others if something like the somatic marker fails you."[63]

Emotional traces give objects and the thoughts they carry differential salience. This makes them hierarchically available for complex combinations over time.

This supports the idea that whether as designer or consumer of an object, people do not recognize form and function as separate elements to be weighed as more or less valuable compared to one another. The solutions come as a single gestalt or "blend"[64] rather than as separable "additives." This clarifies why people often have trouble explaining just why they like something and why designers have trouble specifying how they gain ideas. It misleads to think of people, groups, or brain parts as hyper-specialized to one kind of capacity or orientation as opposed to another. Seeing a chair, one may take in the fact of a certain durability or rest for a weary body, all merged with the thrill of red velvet upholstery like that upon which Marilyn Monroe once reclined or John Wayne shot up. The practical and the sensual merge as one: seeing durability may bring pride in having acted soundly in acquiring (or designing) such a chair; anticipating a resting place invokes past rests, a good book, or nice dreams. When apprehending an object, aesthetics and practicality combine as the very nature of the thing.

I do suspect there is one way that the aesthetic must be the more basic, and that is in motivating people to do all this combining. Life is a job, including the moment-to-moment cognitive work involved in doing all this unceasing blending. If there is a master force out there, it can be identified—and here I overlap with the spiritualists of the world, particularly those who write song lyrics—"it's still the same old story, a fight for love and glory." That is why, once again, we see so much "irrational behavior" whether in the world of goods or any other realm of human activity. Products are not merely a matter of function or thrill, but both in a single case and across all the stuff that comes our way.

FINE ART

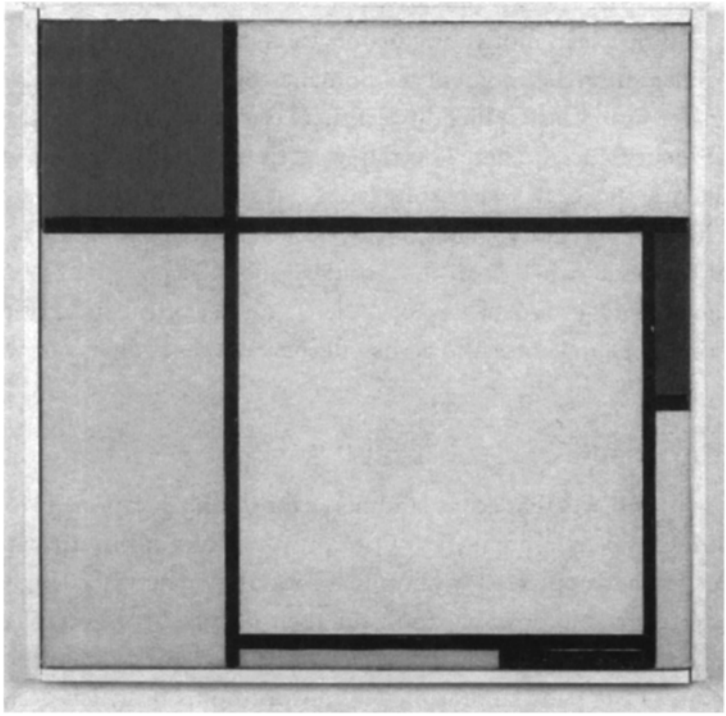
Among the objects that act as landmarks for thinking, especially for certain kinds of people, are works of fine art. The links of fine art with the production and appreciation of ordinary goods were more evident before art institutions so

strongly took on their "beyond-the-goods" elitist stance. In the early part of the last century, New York's Metropolitan Museum of Art had "laboratories" and workrooms in which designers mimicked items in the collections to create lighting fixtures, inexpensive jewelry, soap wrappers, toothpaste containers, and lampshades.[65] The Brooklyn Museum had similar operations; the Museum of Natural History offered lectures for retailers on the art of the Mayans, American Indians, and other groups.[66] In Britain, the Victoria and Albert was consciously created for its commercial applications.

Some of the evidence left behind is obvious, especially in the realms of clothing and textiles. Recognized avant-garde artists like Sonia Delaunay and Natalia Goncharova ended up in Parisian couture in the 1920s. Artists like Leger, Dufy, Dali, Schlemmer, and those associated with movements like the Wiener Werkstatte, Bauhuas, futurism, and constructivism designed clothing. Because people change their wardrobes so fast, compared for example to their bathtubs, each moment in art history has a chance to quickly register. Chanel, responding to modernism, created dresses and suits with rectilinear lines, celebrated for "the working beauty of the garment in wear."[67] In the mid-1960s Yves Saint-Laurent turned Mondrian directly into a cocktail dress—a concept later knocked off in dresses and, among many other products, in cigarette lighters.

The theater—and then later the movies—is a halfway point for images on their way from art to goods. Besides their work as set designers, modern artists created stage curtains and character costumes—people like Matisse, Leger, Chagall, Picasso, Miro, Depero, and, in the present day, David Hockney. The neo-Greek costumes worn by dancer Isadora Duncan helped launch the Hellenistic dress styles that we associate with the post-World War I years.[68] This style later became the "flapper look" as it drifted further from the Greek prototype.

Art visions can also translate into new means for war. Besides innovations in painting, literature, song, poems, and theatricals to encourage fighting and sacrifice, the First World War marked the coming of a different mode of battle dress and choreography. Overhead bombing, new at the time (from long-range artillery and then planes) turned visibility from an advantage into a liability. Intimidation through displays of fierce regalia or redcoat power dressing was over. It was a time



Piet Mondrian. Composition, *1929. Photograph by David Heald ©The Solomon R.Guggenheim Foundation, New York.*

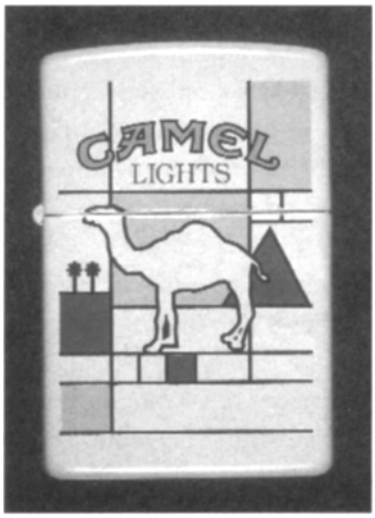
for camouflage, which came to the French Army via cubism, a form of painting that eschews literal representation but relies on precise placement of line and color. The developer of the technique, Guirand de Scevola, was explicit: "In order to totally deform objects, I employed the means Cubists used to represent them—later this permitted me, without giving reasons, to hire in my (army) section some painters, who, because of their very special vision, had an aptitude for denaturing any kind of form whatsoever."[69] By the end of the war, three thousand artists were working as camoufleurs. Avant-garde colleagues in architecture were more or less simultaneously responsible for some of the fortifications along the Maginot line, developed out of fanciful pre-war experiments in sculpture and bent-steel concrete forming along with interrelated engineering discoveries.[70] The twin technologies of camouflage and Maginot line probably prolonged the war to end all wars by enhancing defense; otherwise artillery and

Yves Saint-Laurent Cocktail Dress, Autumn-Winter, 1965. Victoria & Albert Museum; ©V&A Picture Library.

tanks would have wiped out bright armies less secure than those surrounded by molded concrete. We had a durable system of death and misery with art and mechanics combined in destructive standoff. Bad stuff.

Along with the military museums, fine arts institutions like the Met feature armor and hold special shows on historic military gear. According to the Smith and Wesson handgun product manager Herb Belin, "A firearm is no different from any other product.... Its design is based on engineering and aesthetic needs."[71] Perhaps it is easier to use a handsomely designed U.S. M16 or German G3 rifle than a clumsy Soviet-styled submachine gun such as the Kalashnikov AK47.[72] Military parades, gun shows, and battle reenactments testify to public fascination.

As with the usual pattern of interactions, war goods go back into the art they came from, affecting the goods of peacetime. The futuristic bombs and bomber planes used in World War I inspired, in one famous genre, the Italian futurists, whose forms —in still another iteration—turn up a generation later in U.S.



Mondrian to a cigarette lighter. Photograph by Jon Ritter.

car styles as tail lights, bumpers, and "rocket" insignia (the Oldsmobile icon, even before Sputnik) and rifle sights (Chrysler Imperial tail lights, circa late 1958).

Given the art-merchandise linkage, idealistic movements have consciously tried to mobilize art to inspire goods that would be socially beneficial In the late ninteenth-century British Arts and Crafts school, William Morris and his associates created home products with natural motifs (flowers, trees, leaves, acorns) modeled after paintings of the day, including the romantic idyllic landscapes of Gwynn-Jones and Lord Leighton. Such furniture, wallpaper, dishware, fabrics, and bedding, based on nature, would ennoble their users. There were variants across Europe and North America of explicit match-ups between art currents, merchandise, and a social vision—De Stijl in the Netherlands, Mackintosh in Scotland, secessionism in Vienna, art nouveau in France, Craftsman in the United States.

It was the creators at Bauhaus who most explicitly and consequentially advocated linkage of art, merchandise, and social vision. Almost in reverse of the Arts and Crafts groups, Bauhaus celebrated the potential of machine-made goods to provide a more honorable aesthetic and egalitarian social order. Funded by the German government and active between the

world wars until closed down by the Nazis, the school housed painters and sculptors, architects, and the type of people later to be called industrial designers. To see the fine art in a Bauhaus chair, compare the painting of Piet Mondrian with Marcel Breuer's "Wassily" chair (on the next page)—which takes its name from Breuer's painter friend and the chair's inspiration, Wassily Kandinsky. Entire institutions and vast public facilities (corporate headquarters, airports, restaurants, dormitories) continue to be outfitted with Bauhaus models. Although many of the Bauhaus "classics" had sales success, the still greater economic consequence comes from the imitations and their stylistic influence on other wares. First through Braun home appliances and then to the other German makers, the Bauhaus idiom influenced virtually all producers.[73]

Of course, fine art offers vision from afar as well as through proximate contact. Operating more or less independently in the United States, Harry Bertoia, himself a lifelong artist, attributed his classic steel-rod or "diamond" chairs to Marcel Duchamp. "I wanted my chair to rotate, change with movement, like the body in Duchamp's 'Nude Descending a Staircase'" Bertoia said.[74] This chair has been vastly imitated, with the wire back appearing in kitchen dinette sets, folding card table sets, and a large run of garden furniture.[75] (The next two pages exhibit the line of descent.)

Matisse and Kandinsky can end up in a tub. To stand out from the competition, the bathroom fixture maker American Standard hired the British designer Robin Levien to create a bathtub that would anchor its other products in the affluent segment of the market. Plumbing products are often sold as ensembles, so if you lose the tub sale, you may lose the sink and toilet as well. Especially if a firm like Jacuzzi—the "hot" maker of expensive tubs—were to buy up a sink/toilet producer they would then have a complete range to threaten the more traditional brands like American Standard. In a 37-page booklet the designer documented his borrowing from Matisse and Kandinsky to create the "single geometric alphabet" of circular arc, large wave, small wave, and straight line that went into the tub's "playful balance." The "Wave" series, produced in a variety of models, was never intended for mass sales but consciously used high art to establish the

"Wassily" chair by Marcel Breuer, 1925. Photograph by Jon Ritter.

clients' presence in a particular niche. Sales were sufficient to meet the product's goals, augmented by an unanticipated boost from markets in the Middle East.

The Wave bathtub broke with prior tubs. Ordinary tubs are symmetrical with hot and cold controls on either side of the tap at the tub's foot. In the Wave case, the tap is on the side about where an outstretched hand could reach the flow, and the temperature controls are also on the side, but in easy reach of the hand. This tub can trade on asymmetric images put in circulation by certain modern artists and the emerging deconstruction architects. It is a break with classicism and Victorian aesthetic conventions. The tub is also safer and more comfortable than conventional tubs, but much pricier—as much as ten-fold the cost of base models. The same art "groundwork," I would argue, helped the success of the more basic Ford Taurus by allowing dashboard controls to be clustered around the driver. This was a reversal from prior dashboards using an aesthetic of rectilinear symmetry. The

Marcel Duchamp. "Nude Descending a Staircase No. 2," *1912. ©The Philadelphia Museum of Art: The Louise and Walter Arensberg Collection; ©Artists Rights Society (ARS), New York/ADAGP, Paris/Estate of Marcel Duchamp.*

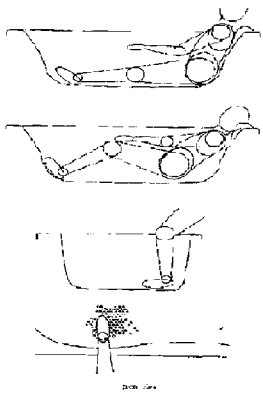
Harry Bertoia, Diamond chair, 1952. Photograph courtesy of Knoll.

Wire garden furniture knockoff, circa 1980. Photograph by author.

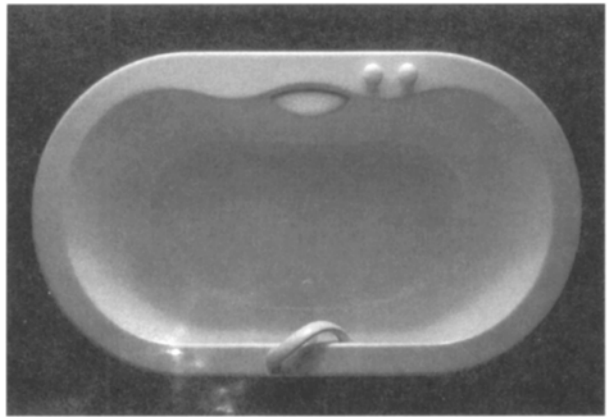
new design helped make cars safer by lessening the stretch of short-armed drivers trying to reach for radio dials.

Even seldom seen infrastructure is affected by art. Pipelines, in homes and factories can tend toward formal rectilinear symmetry, as for example when a fuel supply must make connection to two different valves. Compare this kind of installation with one that allows an asymmetrical linkage through a shallow-angled branching as shown in the drawings on page 81. The symmetrical version may look neater, but the right angles raise energy pumping costs. The alternative version works better, makes less noise, and is more eco-friendly.[76] It has been resisted because so many involved in the process, including professional engineers, defer to classical neatness. As with other art-to-product routes, the path is not so self-conscious as the Wave designers' record of Matisse-to-tub. Art just merges with life and work experiences, available as part of the blend that makes things thinkable.

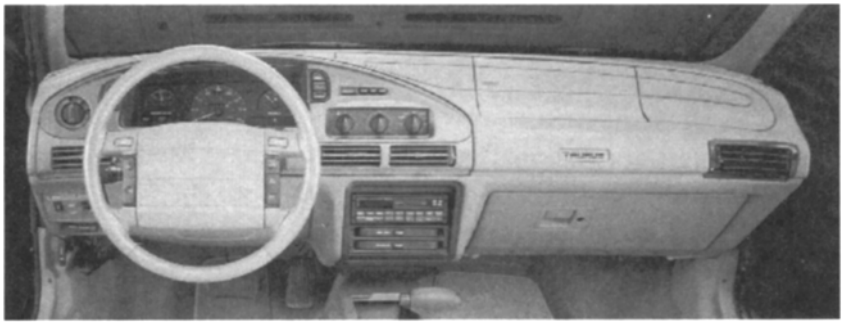
Tub study, inspired by Matisse. ©Studio Levien.



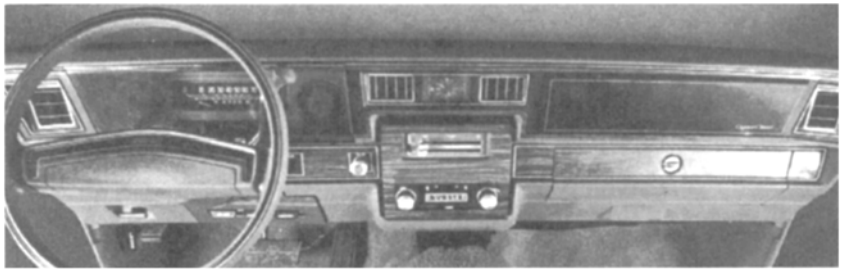
Tub study—ergonomic exercise. ©Studio Levien.



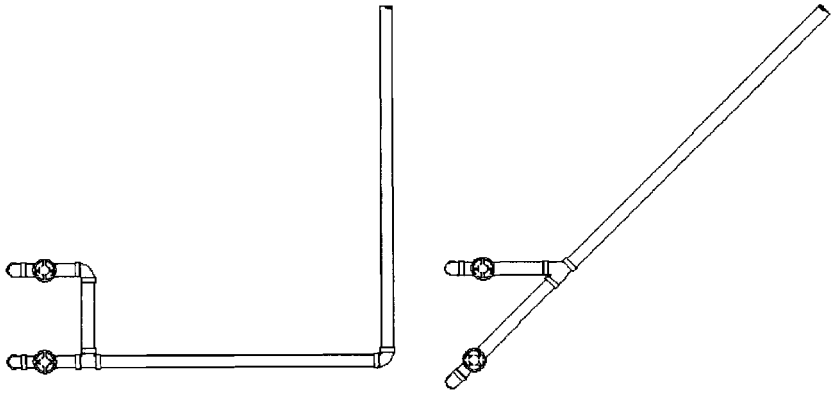
"Wave" bathtub as marketed. ©Studio Levien.



Ford Taurus dashboard. ©Ford Motor Company.



Geometric symmetry, Pontiac car dashboard. Photograph by author.



Symmetrical and right-angle pipes vs. asymmetrical. Drawings by David Paul Collett.

THE SEMIOTIC HANDLE

Whatever its original inspiration, the management of aesthetic detail helps determine the specific ways a product will be useful and durable. The polka dots or a favorite Disney motif on a child's bedding is more likely to secure a comfortable night's sleep (for both child and parent) than putatively more "functional" hospital whites.[77] When decoration is a "technology of enchantment,"[78] it is as efficacious as any other form of technology. The enchantment details have to be just right, appropriate to the users gender, age, and so forth. Individuals can be attracted to an object but "wrongly" attracted, for example. Form may excite a pull on the wrong lever, or in the wrong order, with an unsuitable grip, or for an inappropriate application. If the push-down lever of a pop-up toaster beckoned not just a single finger, but the whole hand, the force could damage the mechanism. Scholars now understand that all objects tell a story, have a semiotics that people "read." Every material object thus works through its *semiotic handle* and that kind of handle, as much as any other type, affects what something can be by making it attractive in the first place and specifically useful in practice.

I am not making the more familiar argument that objects should be shaped to make them more useful in a conventional sense of utility. In his influential book *The Design of Everyday Things* Donald Norman condemns design that puts aesthetics ahead of functionality. Instead, he thinks, products should be

shaped to provide affordances, their very form should instruct the proper use. He praises, for example, faucet handles on some airplane washbasins that invite a downward pressure by having concave indentations that cradle the finger. I like the faucets he likes and hate the VCRs, with their long booklets of instruction, that he condemns. And everyone should worry about nuclear power plant control panels set up as a uniform array to give them a "modern" look, if that means plant operators will be confused in approaching them.[79] But in opposing aesthetics, Norman does not seem to realize that aesthetics are the basis of his affordances. Faucet handles do not simply have indentations; there are indentations and there are indentations. The ones praised by Norman invoke surrealist forms of sculptor Jean Arp—an imagery that many jet-era customers can find, literally and pre cisely, attractive. Just exactly how a physical element will act as a "come-on" depends upon the designers' ability to catch the cultural sensualities of the moment and the group, and mobilize them for the push-down goal. The "before" version of the open-heart surgery device (fig. 2.2), ugly to most contemporary eyes, would likely have been intuitively friendly for a mind shaped by ninteenth-century mechanics. But given the art-historical and consumer goods moment of the late twentieth-century, the molded shapes of handles and forms of the "after" invite the more healthy usage.

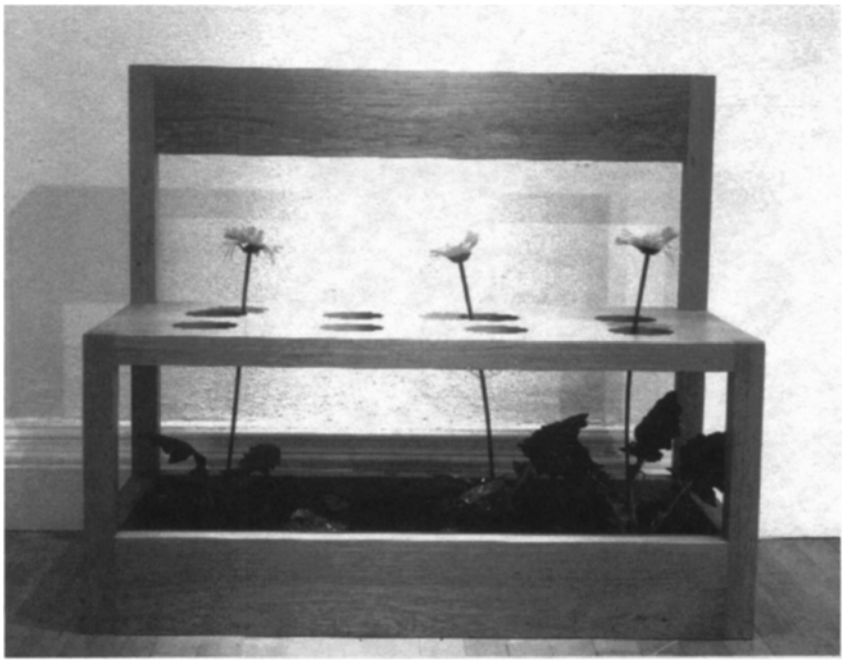
Getting the right semiotic handle affects utility in capital goods, both in the sense of helping them sell as well as enabling production through their use. In awarding a prize to Uvex Designers for Genesis protective eyewear (worn in industrial applications), the jurors praised the lenses as "successful because they make you want to put them on.... And once you've got them on, they're so comfortable you're in no hurry to take them off."[80] The aesthetics of forklift trucks also seem to matter, whether because it helps workers do a better job or just because factory owners like to buy stuff that looks good—or both. Crown Equipment Corporation's decision to break the U.S. industry mold by hiring a design consultant in the early 1960s resulted in crisp Bauhaus lines on their forklift trucks. The product won the IDSA "gold" (shared that year with the Ford Mustang), and launched the company toward market dominance (with annual sales of $600 million by 1995). The founder and CEO, Thomas Bidwell, says that

although he is "from an industry that bends heavy metal…we used design to build our company.… Design was our edge."[81] He recalls that people think his customers "are the tough guys who chew cigars." But "I never did buy that.… This guy buys suits. He doesn't turn his senses off when he goes to work."

The right semiotics will be of one sort for an airplane sink, another for a skateboard, and still different again for a chair that certain people will find worth sitting in. In some cases—for example, products for young "techies"—it may be important for the product to look hard to use, or may be hard to use in fact. If not, people will avoid it, and it will have no use at all.

After generations of being focused on exterior decoration of people's pots and baskets, archaeologists increasingly now recognize that what they called "style" goes beyond what is on the surface. Even just in physical terms, style is not merely a surface add-on, but involves proportion and shape, the thickness of the rim or lip of a vessel, the flanging of a bronze ax.[82] Vessels must hold things that people can, given human physiology, manage to carry, but they otherwise can be vastly different— archaeologists call this potential for variations in the way the same thing can be accomplished "isochrestic" variation.[83] Style is not something opposed to function but contains it. So form and function, rather than bespeaking opposition, are the conjoining mechanism through which a particular people at a particular moment get something done. This settles a false dichotomy and provides a way to understand why in looking at contemporary product realms, "it's both" keeps coming up.

One way to see how the process works is to examine instances when things, either by accident or through deliberate calculation, go "off"— when the tension between apparent form and apparent function gets manipulated in a way that notice must be taken of form-function as a *problem*. Duchamp could generate outrage with his 1917 urinal because it juxtaposed what was then "simply" a functional item with a setting in which its function could *not* possibly be fulfilled. The subsequent practice of sticking other ordinary utilitarian objects into a setting in which they cannot function raised eyebrows until this latest twist in modern art—using "found objects" alone or in assemblage—itself became routine. The magic went out because people, just by seeing it repeated and maybe practicing it some on their own, learned just how the

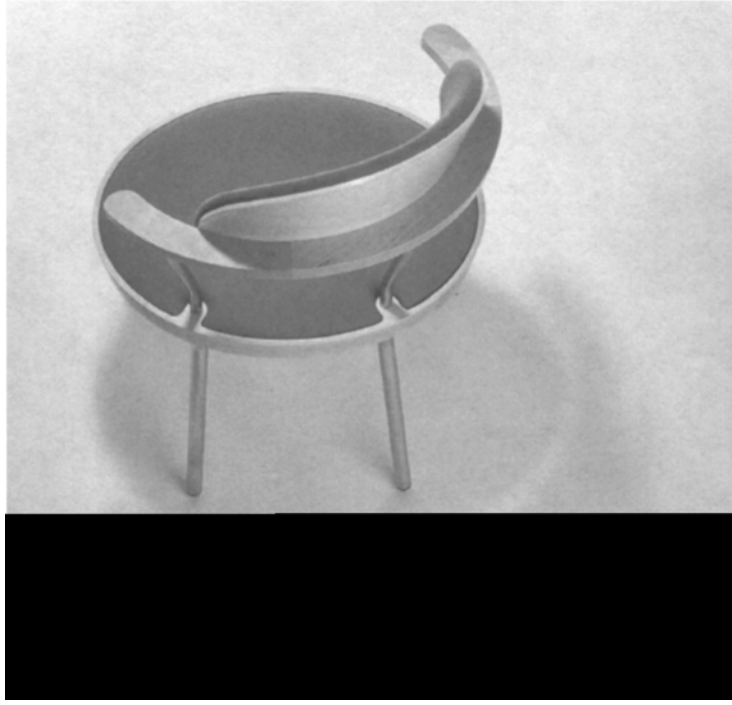


Garden bench art piece. "Reserved: Seating to be Shared with Flowers." ©Michael Anastassiades, Anthony Dunne, and Fiona Raby.

shock was generated. Just as I imagine the very first "real" urinals to have been a rush that dissipated over time, so it was that the first art gallery urinals lost their effectiveness.

Artists repeatedly try to intrigue with form-function confusions. It was used in a garden bench entitled "Reserved: Seating to be shared with flowers." As shown in the picture that follows, a human-scale garden bench has large holes across the seat with artificial flower heads poking through. There is just barely enough space to partially sit between them —is it "really" a bench? "Only" an artwork? By putting the piece at the edge of this presumed boundary, the artists thwart the normal habit of classification, thus stopping some traffic and producing some wonder.

Closer into the product realm, some useful artifacts carry an artful tingle of uselessness as part of their appeal. In her line of home furniture, Maya Lin (creator of the Vietnam Memorial) has side chairs that put the body slightly off-center— deliberately awkward for those whose sense of comfort means



Chair by Maya Lin, The Earth is (not) Flat. Photograph courtesy of Knoll.

having symmetrical access left and right. Her chairs require a certain twist in the sitter. As she explains it, "It's almost a subconscious way of making people pay attention to their surroundings."[84] In this "making people pay attention," the chair operates as a piece of art, continuously intervening in the body's movements and the sitter's experience. As with any such effort, the issue is not whether the chair is fundamentally dysfunctional, although keeping the body moving is thought by many experts to be physiologically best. But it wouldn't matter if it were ergonomically awful. If people so much enjoy "a Maya Lin" that they buy it and use it, then it has the right affordance to make it a success all around. Her chair is radical because it pushes against understandings and customs of what is the ideal form-function mix, the type-form convention, for a chair.

MAKING LOVE

Productive projects require coordination among diverse actors; there must be a way to "get it together"—to enlist enthusiasm as well as create a common understanding as to what a shared enthusiasm should serve. Art, not just in regard to representations in plans and prototypes but also narratives and song, coordinates diverse individuals and groups by tacitly providing shared understanding of "what this is all about." We know the details involved in even a single life project are always too numerous to explicitly state, that no list of rules can incorporate all that needs to be known and done.[85] Whether making a movie or a line of dishware, some alternative mechanism is required to seduce diverse agencies and actors into a coherent effort and to give them "the feel" for the desired outcome. It is "art"—sometimes a painting (like a Matisse bather), a metaphor (like "the tabernacle"), or a fantastic aspiration (Steve Jobs's drive for products "insanely great")—that radiates visions that span across actors and industrial segments. Art brings enrollment.

Before Edison could have his lightbulb, a lot of different actors had to sign on. Edison overtook his competitors (like Swan in England) not just by coming upon a good gizmo, but by organizing other aspects of the industry into being—investors, power sources, and government cooperation to stage street lighting exhibitions.[86] This coordination was no doubt part of the "perspiration" he said was crucial to his success. As reported in firsthand accounts, seeing streets lit by electricity filled hearts with rapture, helping overcome not only organizational impediments but also fears of so inexplicable and dangerous a technology (gas lighting also gained its early acceptance through uses "for effect and display as much as for utility").[87] Colored glass followed, evolving into Tiffany lampshades to add further glory to displace the dark. A bandwagon builds as people find it easier to love something others also love—something we see at performances when people joyfully join with one another in offering a "rousing" applause.[88] A crowd of affections becomes a virtuous mob as aesthetic contagion spreads. Impresario of it all, Edison prevailed.

We can look, using the same ideas, at why a big contemporary project can fail. Over 24 years of planning and

prototype efforts, the sponsors of an ambitious automated French railway project called Aramis spent large sums and extended great energies before finally giving up. In the end the project could no longer hold together; the diverse participants—politicians, bureaucrats, financiers, technologists, media, and public groups—no longer operated in common orientation toward it as something worthwhile. In his detailed account,[89] Bruno Latour chronicles how so many pieces needed to be kept together more or less at once and over an extended period—something that only "love" could do. When segments of the coalition fell out of love, the prospect of a lash-up for Aramis came to an end. Latour found "love" in his study of French transit in the same way Cyril Stanley Smith found it in the toys—as well as art—that he perceived to be the core of technological change. "All big things grow from little things," Smith writes, "but new little things will be destroyed by their environment unless they are cherished for reasons more like love than purpose."[90] Or, from a different context and put another way by jazz maestro Duke Ellington, "it don't mean a thing if it ain't got that swing."

CHICKENS AND EGGS

I have tried to clarify why "it's both." For any product, form and function are always bound up. Partisans can choose to praise one over the other. Historians can notice that the "art" came before the utility or vice versa. Consumers can explain they love it because it works or because its so pretty. But within the mind, biography, and history, form and function interact as they mutually determine what something turns out to be. We are, with form and function, with art and economy, at home not just with chicken and egg, but chicken in egg and egg in chicken. There are no independent variables in this henhouse.

I think the root of confusion is the common assumption that instrumental rationality is the core of human activity, an idea rein-forced not only by academic fields like formal logic and economics but by almost everyone's retrospective accounts of their own behavior. Whether in science articles, history books, or even therapy sessions, folks "clean up" their messes to provide an orderly story.[91] In part this is because it is nearly impossible to recapture the complex textures that make up human activity and in part because we are expected to have

performed in a way sufficiently "rational" to make a tidy accounting possible. We are supposed to mesh our accounts "with the juridical, ethical or grammatical legalism" in which we each find ourselves.[92] Indeed, to try and make conscious the artful mechanisms through which practice occurs undermines the very capacity to succeed at that practice— like trying to ride a bike by thinking through how it can happen.

To speculate ever more widely, I surmise that people do sometimes recognize, as evidenced especially in their poetry, religion, and song, that life's ends are artistic. But even if they reach these "heights" of spir ituality, folks understand the means for reaching such ends as—at least in the United States and Europe—practical strategies. At each moment individuals tend to exaggerate the role of the utilitarian. The artful pleasure always beckons on the horizon—pie in the sky, by and by—or when nostalgic moments recall the meaningful moments of a spent life. Whatever wisdom this implies for enriching our existence, the relevance here is that the underplay of art, both as an end and as a means to reach that end, inhibits understanding of how new things happen.

The right form-function combination makes for a successful product, but the durability of that success depends on the type of artifact, its market niche, and the cultural moment. We now examine why some things—like stripes on underpants—change a lot, while things like diamond rings seem to go on forever.