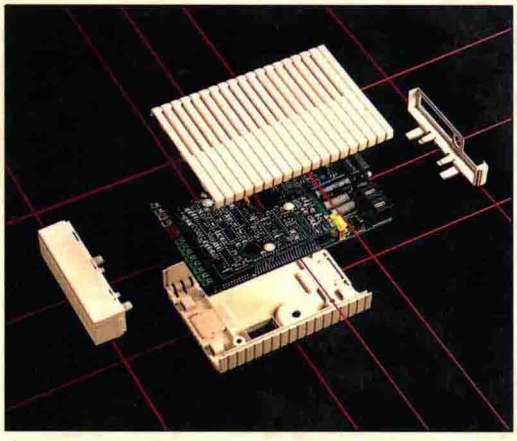
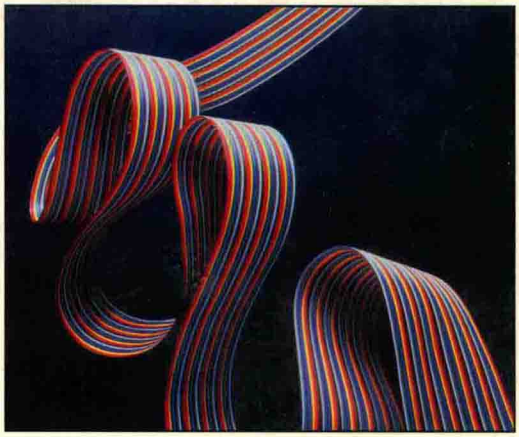
DESIGN in PLASTICS





Successful Product Design In Plastics

Douglas Cleminshaw

DESIGN IN PLASTICS

Rockport Publishers

A publication of Rockport Publishers
5 Smith St.
Rockport, MA 01966
(508) 546-9590

Book Layout & Production:
Blount & Company
12 Station Rd.
Cranbury, NJ 08512
(609) 655-5785

Jacket Design, Type Specifications, Essays & Chapters Openers:
Cleminshaw Design

Printed in Japan by Dai Nippon

ISBN: 0-935603-11-5

Distributed to the book trade and art trade in the U.S. and Canada by:
North Light, an imprint of F&W Publications
1507 Dana Ave.
Cincinnati, OH 45207
(800) 543-4644; Ohio: (800) 551-0884

Distributed to the book trade and art trade throughout the rest of the world by:
Hearst Books International
105 Madison Ave.
New York, NY 10016
(212) 481-0355

Other distribution by:
Rockport Publishers
5 Smith St.
Rockport, MA 01966
(508) 546-9590
Telex: 5106019284
Fax: (508) 546-7141

DESIGN IN PLASTICS

Deepest thanks are due to my design partner and wife Linda Cleminshaw, who spent countless hours collecting, selecting, following up and organizing the materials for this work, as well as in shepherding me through it. Without her the book would not have been possible; it has been truly a joint effort. My special thanks go also to authors of the included essays: Arthur Pulos, Kenji Ekuan, Gianfranco Zaccai and Dan Gilead. Many other friends assisted in the work in ways known only to them; I am grateful to you all. Special thanks, too, go to publishers Stan Patey and Don Traynor, whose faith in the work never wavered.

—Doug Cleminshaw
Tully, New York
December 1988

DESIGN IN PLASTICS

Rockport Publishers

A publication of Rockport Publishers
5 Smith St.
Rockport, MA 01966
(508) 546-9590

Book Layout & Production:
Blount & Company
12 Station Rd.
Cranbury, NJ 08512
(609) 655-5785

Jacket Design, Type Specifications, Essays & Chapters Openers:
Cleminshaw Design

Printed in Japan by Dai Nippon

ISBN: 0-935603-11-5

Distributed to the book trade and art trade in the U.S. and Canada by:
North Light, an imprint of F&W Publications
1507 Dana Ave.
Cincinnati, OH 45207
(800) 543-4644; Ohio: (800) 551-0884

Distributed to the book trade and art trade throughout the rest of the world by:
Hearst Books International
105 Madison Ave.
New York, NY 10016
(212) 481-0355

Other distribution by:
Rockport Publishers
5 Smith St.
Rockport, MA 01966
(508) 546-9590
Telex: 5106019284
Fax: (508) 546-7141

INTRODUCTION

"Benjamin."
"Yes, Mr. Robinson?"
"Benjamin, I just want to say one word to you."
"Yes, Mr. Robinson?"
"Plastics."
—The Graduate, *Mike Nichols 1966*

Novelists have often been prescient in analyzing where society and technology are headed. "Natural" materials (which is to say traditional non-polymer materials) were very much the standard of excellence when Mike Nichols wrote *The Graduate* in 1966. Plastics had entered the language, but as a euphemism for ersatz. Fake. Teakwood, slate and tile were the real thing. Plastics were not.

But Mr. Robinson was right. Today, plastics are the watchword of our everyday environment—from the carpet that cushions the floor of your automobile to the "jellies" your teenage niece wears on her feet.

Other plastics are hidden, their presence unnoticed, but their performance well-known: Plastic adhesives, plastic coatings for wood and metal, laminates for furniture, the shine on your no-wax floor.

Why shouldn't plastics be everywhere? Plastics are the fourth great class of materials after natural fibers, ceramics and metals.

Half a century ago plastics engineering was relatively simple: Choose from a relatively narrow selection (Bakelite and few also-rans) and try to make it look like a natural material. Just a quarter-century ago an interested novice could learn the basic characteristics of most known plastics with relative ease. Today, the welter of trade names alone would make a lexicographer dizzy: from Acetal to Kevlar and Lexan and on down the alphabet to Zytel. Plastics engineering and design are complex specialties.

Plastics have gained in applications and in acceptance. But they still lack something the fibers, metals, woods and ceramics have long enjoyed: a tradition of design. Each of us has notions of how something made of wood should look. We recognize ancient traditional designs in metal when we see them. We simply haven't had enough experience with plastics to know how we should feel about a piece of plastic. A vague sense that there's something tacky about plastic lingers. We have to examine designs in plastic on a one by one basis, questioning the merits of each piece.

That's why this book is in your hands.

In its most basic sense, design means an arrangement; it is the result of a deliberate act on the part of the designer. It is also an act of communication about how the elements that caused it to come into being—the function of the object, the selection of materials and process—have been resolved. Good design fits the application to the task at hand.

In a truly good—total—design, everything works, both with itself and with the rest of the world. The best designs have a harmony so total that if any element of their makeup is disturbed, the result suffers. Good design is unexpected; we recognize something creative, a new contribution to the tradition.

When we see good design, it makes us feel good. When a result makes eminent good sense to all of our senses, we feel pleasure. We recognize its excellence without having to fully or consciously understand what it is about the thing that makes us feel that way.

Particularly from the vantage point of the designer, plastics are truly a medium of the post-industrial age. No design in plastics can result from a single intellect engaged alone in a creative act. A design in plastic is the result of many forces. Some are technological—someone had to design the resin and the process for shaping it. Some are economic—capital investment and marketing considerations. Some, including environmental and safety regulations and fashion, are purely social. All of these influences bear on the designer at his drafting board or—increasingly—CAD terminal. Good design in plastics results from excellence in a wide array of disciplines.

These materials are so easily shaped, they earned the name *plastic*, meaning formable. Plastics are amenable to a variety of processes: injection molding, casting, sheet molding, drawing filaments, hand layup. Ironically, in only a few of these are the tools used to shape plastics themselves made of plastics. Design in plastics is heavily influenced by what can be readily cut in metal. Achievements in metal technology dictates what can be achieved in plastics. On the other hand, the extreme malleability of plastics creates a demand for more creativity in shaping metals to work the plastic with.

However fascinating the processes, this book is not about technology. It's about how our lives are profoundly different and better because designers have this delightful new medium to create in.

There are tens of thousands of things made of plastic. It's difficult to find a place where you cannot see something made of plastic, even if it's only on the tips of your shoelaces (assuming you still wear leather shoes, of course). So this book has not been drawn from all the things that are made of plastic, but from a selection of pieces that are both current and typical; especially

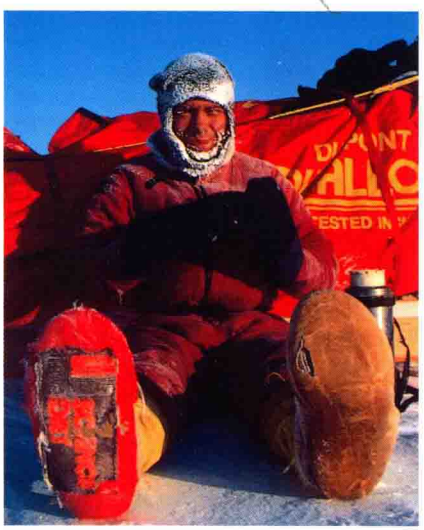
from those categories where no product would exist if there were no plastics.

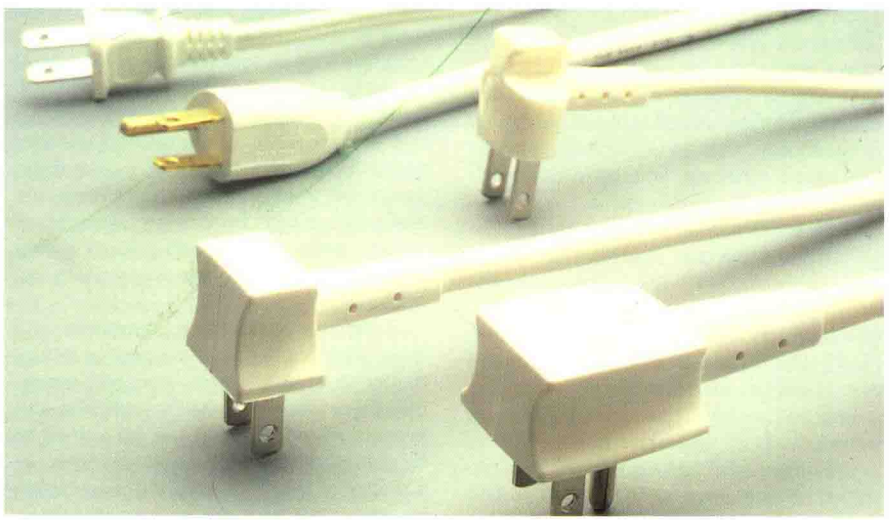
Some of these products have won design competitions. Others are here by reason of publicity about some aspect of their design. Still others were chosen by consensus of their excellence.

There is a bias here in favor of form and visual design. A variety of intellectually-stimulating products have been neglected. Their beauty is no less real, but it is not as easy to discern in an illustration. When the choice has been between pleasing physical lines and an intellectually elegant product, the choice has been in favor of those which please the eye.

A really good product "has stardust on it," to steal a line from another movie, one of Woody Allen's. Good products raise the human spirit. This book is a paean to the intellect and all its resources, to the material wealth we share, to aesthetic design solutions to the complex problems of executing products in this wonderful new class of materials we know as plastics. Because plastics are so new and because we are on the lower part of the learning curve, the entries in this book show only a beginning. But it is a beginning filled with promise.

—Doug Cleminshaw
Tully, New York
September 1989





FOREWORD

by Arthur J. Pulos

There are children today who may believe that nylon sheep graze in Lexan fields under polyethylene clouds hard by the Dacron woods. There are also women, one may suppose, who insist that nylon is better for stockings than plastic. And there must be men who are convinced that the best leather comes from nauga cattle. Yet, while such old expressions as "clear as a crystal" and "light as a feather" are familiar to everyone, few people would question that there are materials in existence today that could challenge the superiority claimed by natural materials. Acrylics are known to be clearer than crystal and that Styrofoam can be made that is lighter than feathers.

The fact is that these materials have become so familiar in their own right that it is difficult to remember that they are man-made polymers—plastics—that until relatively recently carried pejorative connotations derived from their original development as cheap substitutes for valued natural materials such as tortoise shell and ivory. At the same time it may not be normally realized that the so-called natural materials are not as natural as conventional wisdom would have it. A living thing, a tree, is cut down and transformed by brute force into useful pieces. High furnace temperatures are used to transform sand into glass. And electricity is turned on to shock aluminum out of bauxite.

Over the past century chemists and other scientists have learned how to reduce matter to its simplest elements and recombine them into new materials endowed with predetermined properties to be trained to be compliant servants to human wishes. As a matter of fact, inventors and manufacturers have been hard put to keep these new materials from becoming generic in the public mind. When this happens, the material is legally endowed with a life of its own, rather than continuing to be the exclusive property of its owner or patentee. Early on, the DuPont company dropped its claim of ownership to its invented product, nylon, when it realized that the material had rushed into the public consciousness to fast to be contained. As far as the public was concerned this only meant that the coined word Nylon had dropped its capital N to become nylon, a common substance that anyone could manufacture. The DuPont Company, however, is still holding doggedly onto Dacron, as is Owens Corning with Fiberglas (one s) and General Electric with Lexan.

Until the Depression of the 1930s synthetic materials were tolerated, but not particularly respected by the broader public even though enthusiasts of the Art Moderne style had endorsed them as materials of the moment. Celluloid and Bakelite had been around since the last century however the flammability of the former and brittleness of the latter had limited their acceptance by the public. It was only after the General Mills company hit upon the idea of promoting its new cereal by giving away a bright blue Skippy bowl with each purchase of two boxes of its Wheaties that plastics become a familiar material. Skippy was the name of an orphan character who appeared with actor Wallace Beery in the 1930s film, *The Champ*, and was taken to heart by the public as a symbol of the pathos of the times. The free bowl was made of a formidable and even unsanitary-sounding material, urea formaldehyde that proved in use, however, to be hygienic and virtually unbreakable. Over five million bowls were distributed followed quickly by other plastic premiums that were all welcomed by the impoverished public of the times. The head of one company that benefitted from this experience was to comment later that, "This mass sampling of a relatively unknown material helped to introduce the entire emerging plastics field to the American consumer market."

Before the end of the decade the public had become familiar with a number of new plastics that were to compete with and, in some cases, displace original natural materials. Acrylics under the names Lucite by DuPont and Plexiglas by Rohm and Haas appeared in the marketplace in 1935 in the form of crystalline giftware that caught and held the attention of the public. The optical clarity and toughness of the new material also proved to be indispensable to the Air Forces during World War II in the form of transparent bubbles for gunners and bombardiers. On the side, airmen found another, albeit surreptitious, use for the gleaming acrylic rods that were snaked through the wings of a B 24 bomber transmitting light to the cockpit that enabled the pilot to see if his wingtip lights were working. Aircraft mechanics managed to liberate pieces of the rods to be made into bracelets, rings and earrings for the girls they left behind.

In 1939, the DuPont Company, exploring potential applications for a new synthetic, linear super-polymer plastic put women's stockings made of the material on sale in a test market in Wilmington. Public response to a product that would cost half as much as the increasingly scarce silk stockings,

wear ten times as long, and look even better on a woman's legs than silk was so impressive that DuPont decided to expand its production of nylon to meet anticipated national demand. Accordingly, it licensed some fifty companies to manufacture stockings aimed at national distribution to be launched the following year. In May 1940 when four million pairs of stockings were put on sale the entire supply was virtually exhausted within four days. With nylons, described as a miracle protein-like material made out of coal, air and water, paving the way plastics could no longer be thought of as a substitute for the real thing.

During the war, a new thermoplastic, polyethylene, appeared and was immediately pressed into war service as an insulating material. However, a chemist, Earl S. Tupper, believed that polyethylene had great potential for post-war applications and by reformulating it in 1945 was able to successfully manufacture his first product, an ordinary tumbler. Before this time the value and durability of kitchen wares were associated in the public mind with rigidity, weight and expense—ceramics, glass and iron. With Tupper's new product just the opposite philosophy prevailed. By its very nature the material was at its best in simple modern shapes that were flexible, durable and eminently adaptable for refrigeration, storage and table use. And perhaps, above all, the products were inexpensive. He originally called his material Poly-T to help dissipate lingering public doubts about plastics being too cheap to be useful. Later, the products, now known as Tupperware, found their way around the resistance of marketing outlets (apparently because there was not enough of a profit there to please merchants), directly into people's homes by means of a unique system of Tupperware Parties that entertained a gathering of neighbors as well as demonstrated the value of the products. It is now generally recognized that flexibility, lightness and translucency can be assets rather than faults in container design—today a great variety of food products are marketed in plastic contain that find a new life in the home.

In 1947 *House Beautiful* magazine commended the form of Tupperware products as being art objects, and compared their material to alabaster and jade. Other similar recognition came from their selection by the Museum of Modern Art for its Good Design Exhibitions in the 1950s. These honors were accepted by the public as being justly deserved recognition that precious materials and uniqueness were not the only criteria upon which esthetic value should be based and that even the humblest products could also have eternal cultural value.

Even though melamine, a formaldehyde-based thermosetting compound, had been known for more than one hundred years to be a tough, yet light material that was scratch-resistant, as well as odorless and tasteless it was not until the wartime demand for tough helmet liners for the Army and light shipboard dinner trays for the Navy that manufacturers turned to this material for their answer. This successful use of melamine to meet military needs helped pave the way to its acceptance at the public level.

At war's end the American Cyanamid Company was convinced that melamine had a future in dinnerware for other institutional markets as well for the home if fresher and lighter colors could be made available. Moreover, the company believed that melamine's resistance to scratching could overcome the whispering campaign, encouraged by the ceramics industry, that there were dangerous bacteria lurking in the most miniscule scratch on a dinner plate.

Accordingly, the company decided in 1945 to test public acceptance by commissioning Russel Wright to develop a special line of melamine dinnerware to be tested first in restaurants. The commission came to Russel Wright because the wife of the president of American Cyanamid was an ardent admirer of his successful ceramic American Modern dinnerware line. Wright had convinced her that materials for daily living should be modest rather than exotic. Thus, his elevation of humbler materials to domestic respectability—aluminum and stainless steel for silver, maple rather than mahogany, and now melamine for ceramic wares—complemented rather than displaced other materials that were considered more appropriate for formal and ceremonial occasions.

The company subsequently equipped several restaurants with sample sets of Wright's design that were modern and attractive in form with a surface judged to be comparable to glazed china. Within a year after its spectacularly successful field test the line, now named Meladur, was made available to the general public. More than a dozen other plastic molders also began production of their own melamine dinnerware that, with designs by Joan Luntz and Belle Kogan, brought in a feminine sense of form. And, when colorful melamine inlays became possible, a fresh approach to decoration that was appropriate for a more casual style of living became fashionable.

Thus, while the American porcelain dinnerware industry has virtually disappeared because it has not been able to grow beyond traditional styles, designers have demonstrated that they could conceive new forms in new materials that the general public would welcome for everyday living. And, to give weight to this conviction, while some merchants are reluctant to display such products alongside their fine china, silver, and glasswares, melamine, and other modest materials have found a convenient and profitable place in the modern living sections of department stores and specialty shops that cater to a younger generation.

Other interesting manifestations of the impact of plastic materials include their virtual displacement of glass containers for products ranging from beverages to cleaning compounds. It is evident that, apart from the savings that result and the elimination of glass breakage there has been a substantial reduction in shipping weight. One interesting result of lighter weight is the fact that the replacement of glass with plastic in the small bottles of alcoholic beverages aboard passenger airliners has resulted in weight savings that enable the airline to add, on the average, two more fare-paying seats to each flight.

These these have been only a few examples of the interplay between polymers and people. Others could have been added from the areas of architecture, business and domestic furnishings, appliances, transportation, and recreation to illustrate the degree to which plastics have been serving and, in the opinion of some, may be threatening the quality of life. In view of some evidence that plastics should be held accountable for a substantial percentage of the waste that is now going into landfills it has been proposed that their production should be curtailed and that research programs should be supported for the development of biodegradable replacements.

In closing it may be interesting to note that polymers may be more comparable to the human species than one might imagine. They, too, are of biological origin—even if several times removed. Living things follow cycles of conception, birth, service, death and renewal. So do polymers. They, too, are consumed by use and like other products of nature are destined, or should be designed, to disappear and be renewed without encumbering living spaces on this planet.

COMMENTARY

by Kenji Ekuan

Nyoi is an oriental word. Nyoi means to have things come out in exactly (nyo) the way one wishes (i). In order to attain a state of nyoi, one must first obtain will power and direction (vector). When volition is added to a wish, things undergo alteration. For the Japanese, whose culture has always taken as its theme the development of materials, plastic presented a new challenge. Plastic became a material that satisfied the desire to have things come out as wished.

First, coloring was provided for everyday life. Its high chromaticity had a strong impact. In the context of the traditional Japanese lifestyle, almost everything used to be made of wood, bamboo, paper, clay and straw. Glass was used for only a very small number of items. Thus, the only things that lent color to daily life were textiles, pottery and lacquerware, with most of their colors being of the subdued variety. Plastic added a great deal of brightness and color with utensils with a high chromaticity.

The next phenomenon to appear was the making of imitations with plastic. Since it had superior flexibility, it was made to imitate a broad variety of materials—wood, to imitate bamboo in the making of baskets, to imitate pottery, glass and metal. One of the greatest accomplishments in plastic was the imitation of the great traditional Japanese crafts of lacquerware that had been developed through the use of natural resin.

So what is the true essence of this material which can convert itself into so many differing textures? One result of this flexible superior student material was its role in pointing out the true value of the original materials which it was made to imitate. The self-sacrifice of one material clarified the existential significance of another. From the midst of this imitation game, the consciousness of the worth of natural materials was raised.

While on the one hand the Japanese people appear to be cheerfully absorbed in the making of imitations with plastic, on the other hand, they have continued to have feelings of distrust and dissatisfaction toward it.

The reason for this distrust is found in their view of the transience of time. Everything is in a constant state of change. The Japanese find joy in discovering these changes in all things, and utilizing their discoveries to deepen their philosophy of life. And it is through such delicate changes that they confirm the health of their own sensitivities and find satisfaction.

The waxing and waning of the moon, the blooming and falling of blossoms, the seasonal burgeoning and disappearance of the voices of insects. These are the indications that announce the instant-by-instant passing of time on the faceless clock of nature. And this is the basis upon which the culture of Japan has constructed its precisely accurate natural calendar.

But the major premise of plastic is immutability. It denies wear and termination. Plastic never dies.

The Japanese people have so entirely based their sensitivities upon the transience of time that they even include their own deaths in their natural calendar, and they keep transience in mind in everything they do. Thus they feel not only uncomfortable with, but they even hold a horror of this thing called plastic that denies death; that even when death of use/function finally comes does not show its death in a change of shape, that never undergoes any change. A culture which places the highest value upon change feels as though it is being violated by a material that takes immutability as its major premise. The resultant strong resistance is always behind the Japanese attitude toward plastic, which reveals itself on the foreground as a devising of new ways to make plastic imitate other materials.

What was the reason for this phenomenon? Perhaps it was due to an inveterate distrust of this new material in the hearts of the Japanese.

The Japanese were too taken with their view of natural materials as honest and therefore correct. Perhaps this is what kept them from taking as straightforward and guileless an approach to plastic as Americans. The Japanese can't quite bring themselves to truly believe in plastic. They cannot see its true value. They don't know where this material was born. They know it to be a superior student that can accomplish anything it sets its hand to, but they feel that something is missing. It is this sort of suspicion under which plastic has suffered in Japan.

In the process of skillful handling of imitations made of this new material called plastic, the Japanese seem to have begun to acknowledge it anew in accordance with their own sensibilities. Now it appears that a new way of understanding and acknowledging plastic is beginning.

Japan's industrial strength has extended its greatly varied capabilities. What is to be manufactured with the productive power it has thus gained? The consummation of an industrialized society is the starting point for creation of an informationalized society. And it is here that plastic is establishing itself as an information media material. Have we not just gone through a quarter-century of testing the extent to which this material that possesses the ability to become anything at all can endure as the three-dimensional alphabet of information?

Nyoi is an expression of will, and the way in which nyoi is expressed indicates the breadth of a person's desires. In this context, Japanese people have pinned the way they wish things to be upon materials and tested their cultural adaptability for themselves.

So what is the reason behind the acknowledgement that the information society may be the place where plastic can be utilized to realize the way they wish things to be? I believe that it was the traditions of Japanese culture that made the Japanese people come to think in this manner.

Actually, Japan has two anticipatory material cultures that have amalgamated the original meaning of the word plastic with the immutability that symbolizes its inherent character. One is the world of pottery which was a world of form developed through what we refer to today as ceramics. The other is the world of lacquerware developed through natural resin.

Products made from clay and lacquer were utilized more as carriers of information than as functional items. They have always served as carriers of information concerning the areas where they are produced and the craftsmen who made them.

With these two materials as its base, the possibilities of form and expression were pioneered as an important subject of Japan's culture of form. The act of giving concrete form to the way one wishes things to be unexpectedly questions human nature. It was the pottery and lacquerware craftsmen of Japan who made the brave attempt to answer this severe question by challenging the state of the way they wished things to be.

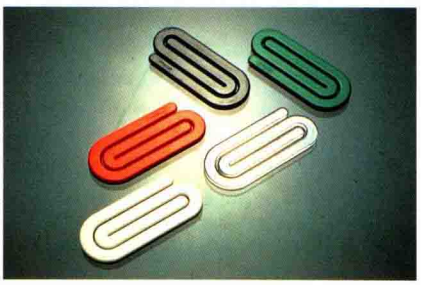
It has been said that the home where the raw materials were born and nurtured can be seen in such conventional materials as wood, paper, textiles and pottery. If their home can be seen, people can find the piling up of of the hypotheses that indicate their origins, even if their nature has been slightly twisted or if they have gone off the beaten track, and it is here that we can discover the key to their understanding and acknowledgement.

"Plastic does not reveal its home of origin, and for this reason, its behavior cannot be accepted." This attitude is no longer acceptable in Japan since the experiencing of the post-War period of high economic growth. The raw material of plastic is petroleum. Since petroleum is one of the resources produced by nature, it is a natural element.

Kenji Imanishi, an animal behaviorist has said that, taken back to their origins, all living things—and even minerals—are nothing but natural forms of our earth.

For human beings, the creation of a material for the making of man-made objects is the same as creating a new life form. This is the way Japanese people view plastic, and I believe it is the reason that it is correct to say plastic has succeeded in gaining a life in Japan.

Kenji Ekuan is president of GK Industrial Design Associates, headquartered in Tokyo, Japan. He is also the past president of the International Council of Societies of Industrial Design and a philosopher of design well known around the world.



SPORTS & RECREATION

Sports, games, outdoor pastimes, and entertainment are expanding everywhere. One reason for this is increased consciousness about the possibilities for use of leisure time through modern communications. But the major reason is that the economies of mass production have made equipment for sports and active leisure pastimes affordable for millions more than could have ever afforded the old-fashioned toys for the rich.

Modern sports have their cultural roots in the classical materials—wood or brass-head golf clubs with wooden shafts, wood-framed rackets strung with the intestines of cats, bamboo fishing poles with silk lines attached, leather-covered balls stuffed with bird feathers, gutta-percha balls, wooden skis with leather bindings, cotton sails for wooden boats and so on. But these "classical" materials will not do for modern sports. In every field, of course, there are purists who relish the old forms and old-fashioned ways of doing things, simply for the sake of preserving the past in unchanged form. But ask a modern contact sports player about, say, protective headgear. A suggestion to return to the leather model used by generations before will be greeted with raw incredulity.

Not long ago skis for downhill racing were made of wood with steel edges attached by screws. Today's very sophisticated carefully engineered intricate composite skis would be utterly impossible without plastic resins. And the performance achieved on skis would be impossible. Plastics are both the physical and conceptual adhesive that holds it all together; that makes it happen.

The changes in sports are everywhere. Consider the effect of Astroturf, the grass-like plastic carpeting that has made possible totally enclosed climate-controlled year round indoor playing fields. The costs of maintaining natural living grass turf in heavily-used indoor entertainment arenas is prohibitive. Hence Astroturf. There follows next subtle changes in the equipment used and the way sports are played on this new plastic surface.

Boating is sport for millions of people because of the cost economies of Fiberglas reinforced polyester resin.

Pole vaulting records are in a range inconceivable without the remarkable energy-storing capabilities of today's equipment. The gladiators of American football are clad in plastic armor. The familiar Frisbee flying saucer started life as a metal pie tin, but is quintessentially a plastic sports plaything.

When we include rubber as a plastic material, there is no question that modern sports depend on plastics. Rubber a plastic? Of course it is, synthetic or not. Plastics are the class of viscoelastic materials. Rubber from tree juice is a natural elastomer unquestionably belonging to this group and no other. Interestingly, the remarkable stretchy and springy properties of rubber were unknown in the West until the dawn of the age of plastics. The unfamiliar qualities of elastomers and viscoelastics came on Western culture all at once. We are still very much in the process of discovering what forms and designs fit well with the new and culturally unfamiliar properties of the members of the group. The new materials have been used many times in old forms, old designs, familiar old shapes, always inappropriately and with disastrous results. No wonder plastic has been used as such a derogatory adjective.

The viscoelastics—plastics—are characterized by very long molecular chains with lots of bends in them. At various points in the long organic molecule there are double-bonded oxygen atoms. These make for very flexible springy joints in the plastic molecule. This characteristic arrangement of atoms is the basic molecular fact that makes plastics—including rubber—a class unto themselves, one quite different from the other three fundamental classes of materials.

What would sports and games be like without the plastics known as rubber? Children the world over toss rosy air-filled bouncing balls at walls and paving, inventing games as they go. Young girls everywhere play a game of picking up things (called "jacks" in the United States) with a little sponge rubber ball, usually red. Tennis would be a very different game without an inflated rubber ball.

The traditional game of tennis has been changed through plastics not only because the equipment has been greatly improved, but because the very weather conditions under which it can be played have changed.

Would there be any table tennis without the strong, lightweight, resilient properties of cellulose nitrate to suggest creation of the little ball, and thus the game?

As for newer games, the sport of sailing on surfboards—boardsailing or windsurfing—would probably never have been invented without plastics. These light, agile, durable craft are nearly exclusively plastic. Hull, mast, sail, battens, fins, flotation, all are sophisticated composite plastics.

The sport of kayaking has changed along with the kayak. Its popularity increased as kayaks evolved from wood-framed structures covered with animal skins into assemblies of Fiberglas or aramid-reinforced thing structures into today's nearly indestructible one-piece rotomoldings. Much of the appeal of modern kayaking comes from the ability of plastic boats to bounce harmlessly off rocks in turbulent whitewater rivers. This is quite a different end use than open water transportation in the Arctic, though we still call them kayaks.

In sports, winning counts. Superior performance is valued more than tradition. Good plastics design abounds. The different and new capabilities of plastics can be freely used in honest expression of their own unique abilities. In sports plastics are never used as substitute or ersatz anything; they are only used when superior to other materials in the use at hand. Sports applications demand careful design, careful choice of plastic resin, careful

engineering and processing to get the optimum blend of properties that will result in superior performance—the winning advantage, the "edge."

We indulge in sports and pastimes for fun. Whatever seems like more fun will be the direction in which sports evolve. The fact that plastics as a class of materials offer capabilities we may have never known before means that many, many new sports and active leisure pastimes will be invented, all of them using plastics.

Outstanding performance means the truly optimum blend of properties available at the time of design. Because sports are so performance oriented, plastics—and design in plastics—will always be an arena in which they excel.