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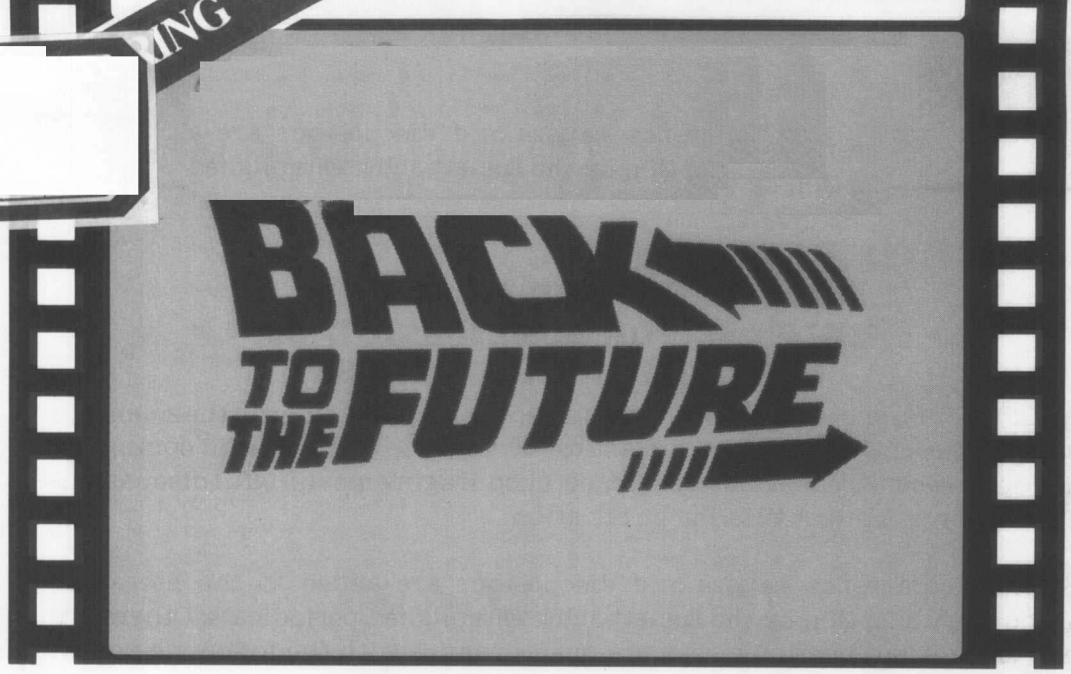

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Plastics: 1942–1992—A Personal Overview of the Past Half Century

A. G. WINFIELD
A. G. Winfield Inc.
International Plastics Consultants
P.O. Box 1296
Santa Fe, NM 87504-1296, U.S.A.

INTRODUCTION

The year is 1942. I had been involved with plastics for three years. My mentor was an energetic Professor of Geology at Franklin & Marshall College who, at 84, needed a student assistant. In 1939, I had been awarded a two-year undergraduate teaching fellowship and the post of Assistant Curator of the College Museum. Dr. H. Justin Roddy introduced me to many things including Synthetic Latices. He also sent me out to learn new methods of preservation of specimens and in this respect I learned about Acrylics which had been invented in Germany in 1936 and which E. I. du Pont de Nemours & Company, Inc. had just acquired a license to produce under the trade name "Lucite." I first saw amethystine crystals suspended in this clear glass-like plastics material and began to learn about it. To embed in those days was slow and costly but I knew that there had to be a cost effective answer. The more I learned, the more I became enamoured with plastics and eventually gave up museum work in favor of them.

That we are now celebrating the 50th Anniversary of the Society of Plastics Engineers, Inc. (SPE) is an important milestone in the history of American Plastics. This paper is my personal overview of these years. I say "personal" as I was involved with many of the developments that occurred. Always in the research and development of the field, I have had many privileged opportunities to learn about new products and processes often long before they reached the public. I have also known many of the men who have helped grow our industry—and I have worked worldwide as a consultant.

This paper contains only a smattering of what has occurred during these past fifty formative years. Because so many new materials, inventions and products were being introduced in SPE's early years, I will cover the first four decades on a yearly basis, then group the last years together.

At the beginning of each year—or group of years—I will relate my participation, where appropriate. Many of these data have not previously been made public. Following will be the important developments of the year by materials introduced, inventions or processes, products—and finally, what SPE accomplished of significance.

Hopefully, in time, all of these data—and many more—can be expanded into a more complete document, possibly in book form.

1942: In 1942, the beginning of this 50-year overview, a small group of men led by the late Fred O. Conley was busy in Detroit forming a society called the Society of Plastics Sales Engineers, later shortened to Society of Plastics Engineers. Like many, I knew nothing of this. I was busy in the war effort.

In 1942, Unsaturated Polyesters were introduced—but not immediately to the public. The Army came first. Many times in combat, soldiers had to deactivate unexploded bombs. Sometimes they were lucky; other times not. Polyesters were soon used as they could be poured catalyzed around a bomb's fuse mechanism and, when cured, would lock the triggers rendering them harmless. A friend in the Manhattan Project described a post-war automobile made of reinforced Polyester so strong that if, at 70 mph, it would hit a tree, the occupants would probably be killed—we did not have seat belts or air bags in those days—the tree would be demolished but the car would bounce off with little or no real damage.

* The information used in this paper was obtained from the following sources: the personal archives of the author and George M. Beylerian (Beylerian Ltd.), Harold Koeln (Ritepoint, Inc.), Wesley S. Larson (DeBell & Richardson, Inc.); information supplied by SPE, SPI and SAMPE; books and articles by the author and Scott Bader, C. Jackson Craven, City of St. Louis, John M. DeBell, J. Harry DuBois, *Display World Magazine*, Robert Freidel, Dan J. Forrestal, Walter E. Gloor, William C. Goggin, M. Kaufman, George Lubin, Raymond W. Meyer, *Modern Plastics Magazine and Encyclopedia*, Thelma R. Newman, *Plastics Design and Forum Magazine*, D. V. Rosato, SPE, Smithsonian Institution and the USIA.

A complete and detailed Bibliography can be furnished on request.

American Cyanamid Company, E. I. du Pont de Nemours & Company, Inc. (DuPont), Plaskon, Marco Resin Division of Celanese Plastics and Libby-Owens-Ford began to produce Unsaturated Polyesters and Pittsburgh Plate Glass Company also produced them as CR-38 and CR-39 to which glass was added for the wartime production of aircraft, boats and trucks.

Low Density Polyethylenes were also introduced. Although developed in Germany, they were pioneered in the U.S. by Daniel E. Strain of DuPont.

The Printed Circuit was born when Dr. A. Ellet and Henry Diamond, Ordnance Division, National Bureau of Standards, reported their two-dimensional printing of electronic parts for the Army's V.T. Fuse. *Plastics World Magazine* was founded by C. William Cleworth. SPI's Plastics Pioneers Association was born.

SPE's first publication, *The Commentator*, was initiated and published by its President Fred O. Conley.

1943: I was drafted into the Army-Infantry and learned that my outfit needed simulated wounds to make soldiers accustomed to gruesome battle conditions. I made "wounds" which could be applied to body parts using Synthetic Latices which I dyed bloody red or gangrenous greens and grays for realism. Many soldiers believed them to be real and sickened when exposed to them. After a training injury, I was transferred to the Dental Corps where I learned that the Army was already using Acrylics to make plates and bridges.

In 1943, Silicones were introduced, pioneered by Eugene G. Rochow and Charles Reed of General Electric Company. Fluorocarbons were also introduced after their discovery by Roy Joseph Plunkett of DuPont. Other introductions were "Saran": Polyvinylidene Chloride. It had actually been invented in 1939 but John Reilly and Ralph Wiley of The Dow Chemical Company completed the work. Saran Monofilaments were also extruded for the first time.

Hercules Powder Company supplied Cellulose Acetate for the first plastics toothpaste tubes. Plax Corp. took the license to injection blow mold items under the W. H. Kopitke patent. Moxness Company developed mold sets used in quick-change die sets for transfer molding. Stock bases for molds were introduced by D-M-E.

Elmer E. Mills Company produced injection molded Cellulose Acetate Bugles for the Army. Early Radome prototypes for M.I.T. were produced by Plax Corp. Swedlow produced the first free blown Acrylics aircraft canopies. The P-51 Aircraft had 88 parts made of Formica Melamine laminates and Wright Air Development Center approved structural sections on aircraft made of glass reinforced Polyester laminates over various core materials.

DeBell & Richardson, Inc. (D&R) was founded in Springfield, MA by John A. DeBell and Henry M. Richardson as the first American company totally devoted to research, development and consulting in plastics. They outlined the ethics of this field and gave it stature and credibility. It was moved to Hazardville, CT several years later where it became a model to the industry.

SPE held its first Regional Technical Conference (RETEC) in Chicago and more than 300 persons attended to hear six papers on Dielectric Heating. The first Annual Technical Conference (ANTEC) was held in Detroit and 59 exhibitors and 1,775 attendees saw and heard what was new. President Franklin Delano Roosevelt had asked for our best effort and the plastics industry responded. It was a great year!

1944: My Army career was short lived. An emergency operation which did not heal properly caused my release and I began to seriously experiment with the Acrylics.

1944 introduced the commercialization of Sodium Carboxymethyl-cellulose (soluable cellulose gum) and Cumene Peroxide was first produced by Hercules Powder Company.

The in-line automatic plunger transfer molding process was patented by Novotnoy. George Lubin and H. Greenberg of Bassons, Inc. filament wound reinforced plastics hoops. The Finn-Magnus all-Polystyrene Harmonica appeared. Lawrence Wittman of Republic Aviation developed the first low pressure thermoset prepregs. The B-15 Aircraft with a reinforced Polyester sandwich fuselage made a successful flight.

Dr. Leo Hendrick Baekeland, Belgium born American inventor of Phenolics in 1909, died at the age of 80. He was among the greatest inventors of all time and his contributions to the plastics field are among the most important.

No SPE meetings were held due to wartime restrictions on travel.

1945: In early 1945, I perfected my mass-producible Acrylics embedding process and applied for patents. Winfield Fine Art in Jewelry was formed in New York City where lines of embedded jewelry and other accessories were produced and sold.

Cellulose Propionate was introduced.

Dielectric heating was introduced by Virgil E. Meharg of Bakelite and Consultant Paul D. Zottu. W. Brandt Goldsworthy molded the first all fiberglass reinforced Polyester (FRP) automobile-airplane for Consolidated Aircraft at his Industrial Plastics Company. Four were made. The first molded hinged closure bottle was created by Wayne F. Robb for the Shaw Insulator Company. Ritepoint, Inc. initiated a line of injection molded Acrylics advertising "heads" for their new ball point pen lines. The frangible bullet for Frankfort Arsenal was developed by transfer molding a lead filled Phenolics compound.

The Polymer Institute at Brooklyn (NY) Polytechnic Institute was founded by Dr. Herman Mark and the Plastics Program at Princeton University was initiated by Dr. Louis F. Rahm. General Georges F. Doriot, U.S. Quartermaster Corps, sent a team of American observers to defeated Germany to investigate technical plastics developments that might prove beneficial to the U.S. during their push to defeat Japan. Headed by John M. DeBell, it included Walter E. Gloor of Hercules Powder Company and William C. Goggin of Dow Chemical Company. Results were a healthy boost to U.S. plastics. George Lubin reported the first FRP boat produced by Bassons, Inc.

No SPE meetings were held in 1945 due to wartime travel restrictions but the *SPE News Bulletin* was initiated as a quarterly publication.

1946: We were still at war – with Japan. The Office of War Information (OWI) asked me to embed the Walkie-Talkie to render it unbreakable in combat. This work was the precursor to electronics encapsulations – in which I was also later involved. We also did pioneering work with biological and historical specimens for a number of leading American institutions.

Important developments for 1946 included the merger of American Viscose and Sylvania Corp. – and the output of Rayon passed the billion lb market. Jim Hendry built a two oz screw injection molding machine. Van Dorn introduced a commercial hand powered injection molder. Wayne F. Robb of Shaw Insulator Company designed a fully automatic transfer mold. A filament winding process was designed by R. E. Young and M. W. Kellogg, on which they produced rocket cases and pipes.

Chrysler Motors introduced Acrylics molded tail lights. Earl S. Tupper produced a 7 oz Polyethylene tumbler which he claimed was made of "Poly-T." Waldes Kohinoor introduced the Nylon zipper. H. D. Justi sold a line of Acrylics dentures. Horsman Dolls introduced them made of Vinyl Plastisols which provided a new realism. Polystyrene wall tiles made their appearance as ceramic substitutes. Polystyrene radio cabinets superceded Phenolics in production. The U.S. Navy received its first FRP boat. The first FRP Radomes were made by H. W. Rahmlow. Ritepoint, Inc. initiated a line of cigarette lighters with clear injection molded Acrylics reservoirs.

The *SPE News Bulletin* became a printed magazine and shortened its name to *SPE News*.

1947: Due to overwork and fatigue, I was forced to close Winfield Fine Art in Jewelry and moved to St. Louis, MO where I had family.

Epoxy was introduced in 1947. Dow Chemical Company launched its "Styron" brand of Polystyrenes for plastics housewares.

The first practical work on etched copper laminated plastics circuitry was accomplished by Donald Mackay, C. Edison and Otis D. Black at the Radio Corporation of America. Synthane Corp. made the circuitry. Grayhill Moldtronics Inc. hired George A. Scharry to develop the first fully automatic transfer molding press to be used for high quantity production. Hyjector by the Rockford Machine Tool Company was the first fully automatic transfer molding machine to use electric preheat. Plax Corp. demonstrated blown tubing. Badge Plastics Company extruded Phenolics clarinet bodies. Anahist used the first custom blow molded package. Relief maps made by vacuum forming was developed by E. Bowman Stratton, Jr. for the Army Map Service. Dow Chemical established a Plastics Technical Service Center for its customers.

R. R. Dreisback of The Dow Chemical Company along with Dr. John J. Grebe received the Hyatt Award for the production of pure Polystyrene and its polymerization.

1948: While attending Washington University Graduate School in St. Louis under the G.I. Bill, I was invited to assist doctors at their School of Medicine in developing a formfitting collar with a clear Acrylics window for patients being radiation treated for cervical cancer. The window would allow the beam to focus on the tumor – an early use of plastics in medical applications. Later that year, one of my own embedments – a Buckwheat Necklace – was purchased by the Museum of Modern Art in New York for its permanent collection.

In 1948, Impact Polystyrenes were jointly developed by Robert R. Dreisbach and J. Lawrence Amos of The Dow Chemical Company and released as Acrylonitrile-Butadiene-Styrene (ABS). Polystyrene monofilaments and oriented Polystyrenes followed.

Watson Stillman and French Oil Mill Machinery Company both developed and marketed self-contained, auxiliary plunger, transfer molding machines. Extrusion coating of paper with Polyethylene was developed by Charles Fields of DuPont. Admiral Radio produced a 35 lb TV cabinet of molded walnut and mahogany Phenolics. Air-inflated structures and buildings made of Nylon and Polyvinyl Chloride (PVC) made their appearance by the Bird Company under their trade name "Birdair."

1949: The early post-war era brought its share of new developments. Elmer E. Mills developed a process to extrude tubes, index them on a rotary table, clamp them, then insert needles through which to pass air for inflation to produce bottles. Screw plastification with automatic transfer molding was developed by Marlin and Clyde Keaton using a non-reciprocating screw, the quantity of feed being regulated by a screw-revolution count control. It was produced by Watson Stillman as the Keaton Plungermatic.

The Nash automobile used three large Polystyrene instrument panel overlays. Cubic blow molded bottles were developed by Shaw Insulator Company for the U.S. Medical Corps. The first Radome made of FRP was installed at Saulte Ste. Marie, MI for the U.S. Weather Bureau.

Dr. George T. Felbeck of Carbide and Carbon Chemicals Company received the Hyatt Award for his engineering developments contributing to the large scale manufacture of Polyethylene.

SPE News changed its name to *SPE Journal*.

1950: While no new plastics materials would be invented until 1954, other developments were taking place. R. W. Canfield developed the BNR Injection Blow Molder for Plax Corp. Celluloid ceased to be an important plastic while Rayon and Cellulose Acetate took precedence. Phenolics as resin binders began to seriously replace shellac for paper, wood and fiber laminates. Ritepoint, Inc. introduced a line of new ball point pens which were extruded Cellulosics and Acrylics, swagged to shape. PVC coated milk cartons were introduced by Sealrite Company. The English began to use PVC to facade buildings and as window frames, gutters and downspouts, flooring, piping and ducting as well as wall coverings. I.C.I. introduced Acrylics in England as fenestration.

1951: In 1951, I became Advertising Manager of Seymour Wallas & Company in St. Louis, a pioneer in flexible PVC products. Silk screened in many designs and colors and sewn, they produced household accessories, inflated and inflatable toys.

In 1951, plastics tube containers with removable caps were developed in Switzerland by Andre Strahm and were licensed to Plax Corp. Wheaton Plastics Company developed a proprietary machine for high volume injection blow molding of bottles working under Swiss inventor Alfred Borer's patents. C. C. Coates of Royal Manufacturing Company developed the rotary blow molding process on a vertical axis. The patent for the first pultrusion machine was issued to A. M. Howard and L. S. Meyer.

Len Glazer of Revell, Inc. began to produce injection molded hobby aircraft kits to replace those of balsa wood. R. L. Swiggert formed Photocircuits Corp. to produce etched circuitry. Kalwall Corp. introduced a series of FRP sandwich panels without cores – attached to either side of aluminum block sized extrusions. The Cellulose Acetate Butyrate heel for ladies shoes was now accepted universally.

The Ohio Gallery of Fine Arts in Columbus produced an exhibition entitled, "Design in PLASTICS" to demonstrate what these new materials offered. Among those exhibiting in plastics were Donald Desky, Charles Eames, Raymond Loewy, George S. Nalle, Jr. and George Nelson.

1952: I was appointed New Plastics Products Engineer at Ritepoint, Inc. and developed a method for injection molding embedments. They never pursued this invention but did use my work on interior plating and mirrorizing pen barrels, curved hot stamping techniques for pen barrel exteriors and decorative aspects of the cigarette lighter lines.

In 1952, DeBell & Richardson, Inc. (D&R) developed the production of Di-Allyl Phthalate molding compounds and Polyfluoren (mono-chloro-tri-fluoroethylene) for Acme Resins. William H. Willert of Egan Machinery Company invented an in-line reciprocating plasticating injection molder. The patent was not issued until 1956. BFGoodrich developed impact rigid PVC which became the precursor material for plastics pipes. Rex Brandt developed fiberglass reinforced Polystyrene, then marketed it through a new company: Fiberfil Corp. Plastigels made their appearance and were a boon to the toy industry.

PVC liners for swimming pools were first demonstrated by Bilnor Corp. and by U.S. Fiber and Plastics. Edgar Kaiser of the Kaiser-Frazer Corp. announced plans for an experimental plastics body sports car designed by Howard Darrin. Printed circuits were first used in commercial production. The Molded Fiberglass Tray Company molded 400,000 FRP trays for Wonder Bread showing mass production possibilities for FRP. The Marco Method was introduced by the Marco Resin Division of Celanese as a viable method for molding FRP. Dry fiber glass was placed in a closed mold and catalyzed resins were drawn by vacuum through the mold. For the production of small and very large parts, it was the precursor to resin injection molding and to R.T.M.

1953: In 1953, Reed Prentice built the first 600 ton clamp injection molding machine using a reciprocating screw press based on W. H. Willert's invention (see 1952). Fluidized bed and electronic spray coating was originated by Knapsack Griesheim AG of Germany. Polymer Process Inc. acquired the license under the U.S. patent and introduced it in the U.S. as the Whirlclad Coating System.

Chevrolet began production of its new Corvette which used 41 FRP parts, 17 of which were major assembly components – and a weight saving of 190 lbs. over steel. Its FRP body design was far advanced with soft lines and curves not possible in steel. Kaiser-Frazer also offered the Kaiser-Darrin K-161 with an all FRP body. The Boeing B-57 Aircraft introduced Phenolics fiberglass ducting.

40,000 lbs of powder exploded in Houston, TX creating the worst blast in the City's history. While glass, ceramics and metal structures were broken or twisted beyond repair, FRP roof panels produced by the Corrolux Division of Libby-Owens-Ford survived intact, proving their potential as viable plastics building materials.

President Dwight D. Eisenhower announced the Atoms-for-Peace Program (see 1957). Dr. Howard L. Bender of Bakelite Corp. received the Hyatt Award for his lifetime research and development in the field of Phenolic resin molecular structures. Hermann Staudinger, father of modern polymer chemistry, received the Nobel Prize in Chemistry.

1954: In 1954, I spent a year working at Universal Match Corp. and learned to use Polyester resins. On a U.S. Navy project, however, they needed molded rust-proof caps for unfused shells. I solved this by replacing a percentage of the plasticizers in flexible PVC with rust inhibitors, then had the material injection molded into threaded caps to fit the shells – thus precluding rusting on shipboard.

In 1954, Styrene-Acrylonitrile (SAN) was introduced. Polyurethanes were introduced in Germany. Guilio Natta polymerized Polypropylene at the Polytechnic Institute in Milan, Italy.

The Kriedel flame treating process allowed Polyethylene to be printed or silk screened. Ford's new Thunderbird convertible had an FRP hardtop as an accessory. M-G-M, NBC and CBS began to use vacuum formed impact Polystyrenes and FRP for movie and TV sets and properties. D&R developed a machine for the continuous casting of Polyester buttons for the Patent Button Company. Eastern Plastics Magazine was initiated by Frederic M. Rea, owner of Western Business Publications.

1955: I left Universal Match Corp. to be appointed Research Director of the newly formed Hanley Plastics Division of Wallace Pencil Company. In my first year I developed an FRP baseball bat over a balsa core which hit balls 20% farther than wood. The project for Rawlings, Inc. was abandoned because Major League parks were too small to accommodate the extra distance. Later that year, I cast the first large piece of sculpture to date in water-white Polyester resin, unsupported and made to resemble Murano Glass. The 37″ tall angel weighed 75 lbs. That year we developed embedments using water-white Polyesters.

In 1955, I became a member of SPE, St. Louis Section. I also sponsored my Assistant, Joseph Swafford as probably the first Black Member of SPE.

In 1955, Allyl plastics were introduced by Food Machinery Corp. (FMC). Polyurethanes were introduced in the U.S. by Mobay Chemical Company.

Unette Corp. initiated plastics tubes with sealed-off ends and "tear-off" openers. D&R developed extruded patterned pen barrel stock for Easterbrook and improved plastics wall tiles for Sunbeam. Lined plastics bottles were blow molded at Plax Corp., the development of Jules Pinsky and Alvin Nielsen. The Chevrolet Corvette body was produced at the Molded Fiber Glass Body Company set up for that purpose. *Plastics Technology Magazine* was born.

SPE printed its Technical Papers in bound form at the 11th ANTEC in Atlantic City, NJ as Volume 1. Fifty-three papers were included.

1956: As Research Director of Hanley Plastics Company, I was able to lead some interesting work for our clients: for Olin Industries, solid rocket fuel development with thermoset binders to withstand high heat; for Scott Air Force Base, unsupported, free standing, clear, textured and partially embedded (with glitter) Epoxy panels for their Officers Club; for Missouri Research Company, burglar proofing panels consisting of 3′ × 6′ sheets of veil reinforced Polyester into which was embedded ulta-fine copper wire screening, the total of which became so frangible that any tampering would activate the alarm system; and finally, the development and prototyping of the first FRP household furniture trailer which we did for the Croft Trailer Hitch Company. I was also appointed to the Engineering Faculty of Washington University.

In 1956, Acetal was introduced.

William H. Willert's invention which revolutionized injection molding (see 1952) received its patent. It was the first major development in injection molding technology since the torpedo. D&R developed synthetic mica sheets for Wright Air Development Center. An FRP Bull in natural colors made for the Kansas City (MO) Stock Yards and mounted on a high concrete pylon, represented an early use of FRP as outdoor sculpture or advertising applications. It is still standing in good condition after over three decades.

1957: Hanley Plastics Company was sold and I left to become a Plastics Consulting Engineer at DeBell & Richardson, Inc. John M. DeBell was to become my mentor, friend and severest critic who helped me mold my professional career as a consultant. I was assigned with Hans E. Hafner and E. Wayne Turner under Wesley S. Larson to work on a Quartermaster Corps project under the Atoms-for-Peace Program (see 1953) concerned with the Packaging Irradiation of Food. With it for three years, we tested some 300 plastics films and film combinations.

In 1957, three new plastics were introduced: H. Schnell of Germany reported the introduction of Polycarbonate resin. High Density Polyethylene and Polypropylene were also brought to the marketplace.

Monsanto's plastics "House of the Future" opened at Disneyland. The brainchild of Monsanto's Ralph Hansen, it was designed by Marvin E. Goody. M.I.T.'s Dr. Albert G. H. Dietz was structural engineer assisted by Drs. Frederick J. McGarry and Frank J. Heger, Jr. It became the most widely publicized and visited plastics house in history. During its ten-year existence, over 25 million persons visited it.

1958: Corfam, a Polyester reinforced Polyurethane was developed and introduced by DuPont as a poremeric synthetic leather substitute. In France, Jean Pierre Fisholle invented a building panel made of Polyester and called, "Crystopal." Cycloaliphatic Epoxy resin was patented and issued to CIBA Corp. Graphite fibers were commercially produced for the first time from Rayon.

Rotational Molding (or slush molding) was introduced as finely divided micropulverized Low Density Polyethylene became available. The McNeil Akron Division became the prime producer of machinery for this process. D&R developed the Fourdrinier screen with a Nylon filament warp for Cheney-Bigelow and an undersea cable repeater housing assembly for Simplex. Monsanto blow molded an experimental Coca Cola bottle from Acrylonitrile but it was legislated out of the marketplace. The first refrasil-Phenolics ablative reentry nose cone was used on an ICBN Missile. *House and Home Magazine* sponsored a Symposium: "Plastics in Home Building" and noted over 80 applications of plastics in this context. The U.S. Pavillion at the Brussels Worlds Fair used a circular roof made of brightly colored Kalwall FRP panels. The National Association of Home Builders introduced foamed Polystyrene boards as cores between plywood and gypsum boards as safe and viable home building insulation.

1959: I was a Director on the Board of SPE's Western New England Section and became founding Editor of the *Western New England SPEctator*—the only magazine in SPE history initiated by a Section to be considered as competition to the *SPE Journal*. The Editor and the Section were eventually censured by SPE National but allowed to complete its one and only year of publication as advertising commitments had to be honored.

In 1959, Chlorinated Polyether was introduced. DuPont began its commercial production of Acetal Homopolymer. Bayer started marketing Polycarbonates in Germany. Texaco experimented with high strength Boron fibers in reinforced composites indicating stiffness and high strength not possible with glass fibers.

The First Intercultural Exchange between the U.S. and the U.S.S.R. took place with the Soviets sending their exhibition to the New York Colisseum. The U.S. sent a giant Geodesic Dome made of steel struts and formed Acrylics panels to Moscow along with a series of heroic sized FRP sculptures resembling giant umbrellas. Designed by George Nelson, engineered at M.I.T. and constructed by Lunn Laminates, these umbrellas were pretested for wind loads using propeller aircraft. After their appearance in Moscow where they caused a sensation, the Soviets moved them to Yalta where they still stand. Attending the American National Exhibition were President Richard M. Nixon, Soviet Chairman Nikita Khruschev, John M. DeBell and George Lubin.

Matell, Inc. introduced the plastics Barbie Doll. Foster Grant converted the Schick Shaver from ivory Urea to Nylon. The Lily Chair designed by Erwine and Estelle Laverne was made entirely of Acrylics except for the cushion. Dynamit Nobel erected the Troisdorf Kunststoffe Haus in Troisdorf, Germany to demonstrate as many plastics as possible in this experimental dwelling.

SPE published Volume II of *Processing of Thermoplastic Material*. It also established the first Plastics in Automotive Group.

1960: SPE published my book, *Plastics for Architects, Artists and Interior Designers*. Yale University invited me to teach for one year; the subject was "Plastics as Art Media."

1960, the new decade, held many surprises. Celanese Plastics introduced Acetal Copolymer developed by Frank Brown and Frank Bernardinelli. Penton, a Chlorinated Polyether, was developed by Hercules Inc.

Polyester decorative overlays were introduced by both Burwood and Syrocco. An exterior paint called "Luco-Tex" was introduced by John Lucas & Company. An exterior paint made of Acrylics Emulsions, it was colorful and easier to use and cleaner than paints made with mineral spirits. The use of high impact Polystyrene furniture legs started a new trend. Borg-Warner built the Formacar prototype of ABS. Dow Smith began production of filament wound pressure pipes. Master Unit Die Products Inc. (M-U-D) introduced the standard quick-change mold components. Consoweld Corp. installed the first of the world's large laminating presses capable of producing 180,000 ft² of laminates daily. It was 28′ high and weighed 300 tons. The Boeing 727 Aircraft had 5,000 lbs of FRP parts which were less expensive than metal and lowered cost by 33%. The Douglas DC-8 also used 2,000 lbs of FRP. Leo Windecker's composite aircraft was first to receive FAA approval. St. Peter's Basilica at the Vatican replaced all exposed electric wiring by burying them in PVC pipes under floors and behind statuary.

SPI was requested by the United States Information Agency (U.S.I.A.) to assist with the Second Intercultural Exchange Exhibition to the U.S.S.R.: "Plastics–U.S.A." SPI invited industry specialists to form an advisory committee: Mason Gould, Owens-Corning Fiberglas; Pearl Hagens, Modern Packaging; Vera Hahn, Fairchild Publications; George Lubin, Grumman Aircraft Corp.; Hiram McCann, Modern Plastics; Tino Perutz, Omni Products; Harriet Raymond, Celanese Plastics; and Armand G. Winfield, DeBell & Richardson, Inc.

SPE held its 16th ANTEC in Chicago with 84 technical papers presented and an attendance of 2,484 persons. Staff written articles appeared for the first time in the *SPE Journal*. The society also held six Regional Technical Conferences (RETECs) and "Blow Molding Comes of Age"–sponsored by the Newark Section drew a record crowd of 679 persons.

1961: 1961 was a great year for me. I had been busy for several years in the planning and preparation of "Plastics–A New Dimension in Building" which was sponsored by SPE as its first–and only–traveling exhibition. I had conceived the idea and with the blessing of my employer D&R, had spent much company time and money on my participation. The inaugural presentation was at the Springfield (MA) Art Museum and the Western New England Section held a RETEC at its opening. The exhibition then traveled for the next two years to be shown at museums across the U.S. and a printed souvenir book accompanied the tour.

My work for the U.S.I.A. consisted of first assembling a collection of American Art made of plastics; then training the American Staff in plastics technology; and finally, writing the souvenir book to go with the exhibition: *Plastics–U.S.A.* was eventually co-authored by me and Henry M. Richardson, with an Introduction by President John F. Kennedy. It was translated into Russian and 350,000 copies were printed in color for distribution behind the Iron Curtain. The book credits SPE and SPI along with contributors to the exhibition. I was then invited to travel with the exhibition as Chief Plastics Consultant. Exhibited in Kiev, Moscow and Tblisi, I was an invited lecturer at many Academies and Institutes in these cities and in Leningrad during the four-month tour. George Lubin joined us for one month in Moscow. Later, 45 of my photographs taken in the U.S.S.R. were purchased by The Metropolitan Museum of Art in New York for their Archives.

In 1961, the Plastics Institute of America was chartered. Founded by Jules Lindau, III, who then became its first Chair, it was to grow to be one of our industry's important organizations. Plastics Design and Processing Magazine was founded by Lake Publishing Corp. The first Filament Winding Symposium was sponsored by the Society for the Advancement of Materials and Process Engineering (SAMPE).

A. Shindo experimentally produced the first high modulus Graphite from Polyacrylonitrile. Continuous Graphite filament was commercially produced for the first time. All molded Acrylics piano keys were now replaced by those made of SAN. The Plasticsmesse in Copenhagen, Denmark pointed up new and interesting uses of European plastics–especially thermosets and oversized rotationally molded tanks.

SPE launched its newest publication, *SPE Transactions*. Eleven RETECs were held drawing 3,101 persons. The newly founded Technical Program Committee had a great start by planning the technical program for the 18th ANTEC.

1962: Phenoxy was introduced. Polyvinylidene Fluoride was introduced by Penwalt as "Kynar."

Alfred Duca of M.I.T. invented the "Lost Styrofoam" process for metal casting. Professor Felix Drury of Yale University built experimental free-form houses of Polyurethane foam sprayed over formed screens and netting. Cavrock Company introduced FRP sheets simulating brick and stone walls. Johanna Lawrence took the U.S. license to produce "Crystopal." Raymond Loewy designed Studebaker's Avanti automobile with an FRP body.

SPE was responsible for seven RETECs. A most significant SPE project was a joint meeting between the Presidents and Executive Secretaries of the five major societies involved with plastics. This meeting opened the doors to plastics standards. Dr. Herman Mark of the Brooklyn Polytechnic Institute received the new SPE International Award in Plastics Science and Engineering.

1963: In 1963, I took a one year leave of absence from D&R to become Executive Vice President of the Newly formed Crystopal, Ltd., manufacturer of architectural and decorative plastics. I also became President of SPE's Western New England Section.

I was involved in a number of major projects for the New York Worlds Fair: For General Electric, I embedded large (up to 4′ × 8′) sheets of colored Lexan Polycarbonates in water-white Polyesters as back lighted panels in elevator cabs and as wall surrounds in their V.I.P. Executive Suite in their Pavilion.

I developed and produced the American Express outdoor Map of the World which was 15′ high and 25′ wide made of 15 5′ × 5′ panels mounted in a steel framework, capped and backlighted. Using Acrylics, Polyesters and Silicones, unusual effects were developed simulating stained glass and oceans.

My most ambitious assignment, however, was the building of special properties for Leon Leonidof's "Wonder World." Designed by Donald L. Shirley, Jr., with costumes by Erté and using the facilities of Zaria Displays in New York City, I directed the engineering and building of a Space Capsule capable of holding several actors in a waterproof environment; a giant Sea Serpent which would rise out of the water; a 16′ Idol which would collapse and burn four times daily—five on weekends; Lily Pads for a Water Ballet; and a form-fitting Mermaid Suit buoyant enough to keep a swimmer afloat. All of these properties were made of FRP except for the Mermaid Suit which was of Synthetic Latex and Foamed Rubber scales. A full stage background was also developed using the new Rowland lenticular Polycarbonate called "Rowlux," which, when appropriately lighted, assumed the appearance of sunrise—or sunset.

For many others, 1963 was an equally good year. F. J. Stokes introduced the Injectorset, a 50 ton fully automatic transfer molder with a reciprocating screw. Richard G. Angell, Jr. invented the Union Carbide process for low pressure structural foam processing. Frank H. Lambert developed a process for molding expanded Polystyrene foam products: the expandable bead molding system. The use of electroless plating of metal on ABS placed Marbon in direct competition with die-casting. The equations which allowed the calculations of screw extrusion flow problems were summarized by H. R. Jacobi.

At the New York Worlds Fair, the Bell Telephone Pavillion was facaded with FRP panels up to 60′ in length. Other structures made of FRP included the 7-Up Pavillion, the West Virginia Pavillion, outside telephone booths, marina floats and docks and miscellaneous architectural details. Steel street lighting luminaires were made with rotationally cast globes of Cellulose Acetate Butyrate—or of fabricated Acrylics. Many buildings were constructed with air-inflated domes on their tops which were illuminated at night. Fountains were also constructed of a variety of plastics materials. Many of the exhibits in a multiplicity of pavillions were interiorally constructed or decorated with various plastics—as were many of the new products introduced to the public.

SPE produced nine RETECs in 1963 attracting some 2,018 persons. Dr. Guilio Natta received the SPE International Award.

1964: I resigned from D&R and established my own consulting firm: Armand G. Winfield, Plastics Consultant—later, Armand G. Winfield Inc. I was also appointed to the faculty of Pratt Institute in Brooklyn as Plastics Consultant to the Industrial Design Department—where I consulted and taught on a part-time basis until 1970, set up a Plastics Laboratory and established an SPE Student Section.

In 1964, DuPont introduced Ethylene-Vinyl-Acetate (EVA), Surlin Ionomer resin and Polyimides.

The first book on filament winding, *Filament Winding: Its Development, Manufacture and Design* by D. V. Rosato and C. S. Grove, Jr. was published by John Wiley & Sons, Inc. Graphite fibers became available to the trade for reinforced Polyester and Epoxy research and development. A conical filament wound S-glass motor case was developed for the Sprint two-stage Missile. D&R developed a process for the manufacture of thermoformed milk containers for Mobil.

Dr. Guilio Natta, recipient of the SPE International Award in Plastics Science and Engineering in 1963, and who first polymerized Polypropylene, received the Nobel Prize in Chemistry.

SPE initiated Educational Seminars with limited registrations to be held at ANTECs. Thirteen RETECs were held attracting 3,970 attendees. A second symposium on plastics was presented at the Metals Congress of the American Society for Metals (ASM) and exemplified the effectiveness of SPE intersociety relations.

1965: Polysulphone was introduced, developed by Alfred Farnham and Robert Johnson of Union Carbide. Parylene was also introduced, developed by William Gorham and Dale Pollart also of Union Carbide Corp. DuPont's Corfam (see 1958) went into volume production. DuPont also introduced Aldyl, a Polyethylene pipe designed for gas distribution. Dr. Carl S. Marvel at the University of Arizona developed Polymenzimidazoles which provided previously unavailable high temperature adhesives.

Owens-Corning Fiberglas Company introduced the shipable forming package of glass (Type 30) for filament winding, pultrusion and weaving. Glass reinforced SAN appeared as part of the instrument panel on the Cadillac Calais. Boron filaments became available to the trade for production usage. Owens-Corning Fiberglas Company began construction of underground gasoline tanks made of FRP. The National Sanitation Foundation Standard 14 was adopted by the industry as that for plastics pipes, opening major markets for widespread use. D&R developed materials and a process for exact copying of archaeological artifacts for Wennegren Company.

The SPE ANTEC became International with six papers offered in French with simultaneous English translations. 128 papers were presented. Ten RETECs were held attracting 3,651 persons. The Palisades Section's "Injection and Blow Molding of Polyvinyl Chloride" attracted 888 attendees—the largest RETEC on record. Dr. Turner Alfey, Jr. received the SPE International Award.

1966: Two new plastics materials were introduced—both produced by General Electric Plastics: Noryl and Polyphenylene Oxide (PPO).

The first Uniloy machine for the production of High Density Polyethylene blow molded milk bottles, invented by Sam Rupert of Hoover International, was installed at the Heatherwood Dairy. Studies at the Bell Telephone Laboratories made

the first direct observation of links between crystals in a polymer.

Pontiac used Nylon for its fender extensions. High Density Polyethylene fuel tanks were blow molded by Phillips Products Company which held 20 gallons and weighed 9.5 lbs. Bell Helicopter began to use exterior surface PVC laminated to interior surface ABS on its Jet Ranger. Gruman Aircraft developed the first full scale ballast tank for the PX-15 Submersible. Raymond Loewy's Chair was made of PVC, walnut and cast aluminum. Beylerian Ltd. imported the Italian Columbo Lamp and Columbina Mirror in Acrylics for the American markets.

SPE decided to choose ANTEC site selections seven years in advance. The concept of Continuing Education was recognized as a primary responsibility of SPE to its members. It was to include training courses and special programs for plastics engineers. The Plastics Institute of America was presented with an $8,000 grant for fellowships and educational grants-in-aid. Eleven RETECs were held with a total attendance of 3,949. Consultant J. Harry DuBois received the SPE International Award in Plastics Science and Engineering.

1967: I conceived and Chaired the New York Section's RETEC, "Plastics in the Medical Sciences." A "first" of its subject, many famous doctors were speakers.

In 1967, F. E. Brown invented the third process for forming plastics tubes. The Aragon Front-End Extruder appeared which had the screw protruding into the hopper to allow volatiles to escape as it pumped material to the die. The Dow Chemical Company's "Black Box" became commercially available. It fed proportional amounts of chopped fiberglass and resin into an injection molder where a screw provided mixing and blending.

Verplex Company introduced a line of plastics globes for residential lighting appliqued with cast Polyesters and Acrylics paints in dimensional designs by Barbara LaBarge Winfield. The U.S. Navy began research on uses of FRP on their minesweepers. Beylerian Ltd. imported the German and Italian FRP chairs by Kartell – the first high style all-plastics chairs in the American markets.

At EXPO '67 in Canada, the U.S. Pavillion was a giant Geodesic Dome 187′ in diameter made of a steel frame to which 2,400 formed gray translucent Acrylics panels were attached. The all-reinforced plastics bathroom – designed as a modular drop-in unit – was introduced by the Crane Company.

1967 was SPE's Silver Anniversary. The ANTEC celebrating SPE's 25th Year achieved the largest registration in SPE history with 3,502 in attendance. A subcommittee was formed to organize National Technical Conferences (NATECs). RETECs in 1967 numbered 10 with attendance at 4,118. Dr. Paul J. Flory received the SPE International Award in Plastics Science and Engineering.

1968: I was invited to spend a year at the College of the City of New York as Visiting Critic in Architecture and taught students the use of plastics in building and architecture. 1968 was also the year we celebrated the 100th Anniversary of American Plastics – the centennial of John Wesley Hyatt's invention of Celluloid (Cellulose Nitrate). The New York SPE Section was in charge of this ANTEC and I was selected to write the Souvenir book which was to be presented to ANTEC attendees. Entitled, *100 Years Young* and illustrated by Brian D. Gilliam, 7,500 copies were printed by SPE – with a Carbide UCAR cover. Over 3,000 were given at the ANTEC and the balance was eventually distributed to schools, colleges and libraries. I received my first UNIDO Grant in 1968 to survey the uses of plastics as viable building materials for developing countries.

1968 was the year of the Moon Landing by our Astronauts and several items and components made of plastics did land with them. In 1968, Nathaniel Wyeth successfully produced a biaxially oriented stretch-blow molded Polyethylene Terephthalate (PET) carbonated beverage bottle using this new plastics material developed by Eastman Chemical Company.

The Transfermix Extruder was introduced by Sterling Extruder Corp. Filon developed a continuous sheet making machine to produce laminated Polyester/glass sheets: flat or corrugated; smooth or textured.

Oldsmobile selected Polypropylene – which was chrome plated – as the radiator grill on their Toronado – a good metal substitute. General Motors used Polyurethane Elastomer bumpers on both the Pontiac GTO and the Chevrolet Camero. Sheet Molding Compounds (SMC) made their debut as air deflectors on Chrysler Station Wagons. The Ford Shelby GT used some FRP panels on its body. Boeing's SST – Supersonic Aircraft – design included the projected use of over 6,000 lbs of reinforced plastics and an equal amount of unreinforced materials. General Dynamics Company installed Boron/Epoxy rudders experimentally on the F-4 Aircraft. Author D. V. Rosato estimated that the U.S. aircraft industry was using over 50 million lbs of plastics in 1968, over half of which was reinforced.

SPE sponsored nine RETECs drawing a total of 2,092. One RETEC was sponsored by the new Japan Section: "Recent Advance of Plastics Processing Techniques in Japan." Nine Educational Seminars were given on such subjects as Injection Molding, Thermoforming, Extrusion, Polymer Science and Product Design. The establishment of 16 Professional Activities Groups or PAGs were announced as in operation. Dr. Raymond F. Boyer received the SPE International Award.

1969: Armand G. Winfield Inc. built the first portable, air inflated stage set for Buddah Records' "The Element's Memory" rock band. Made of flexible PVC dielectrically sealed and hand painted, the set of jungle animals, trees, plants and clouds for a full Broadway stage could be used, then deflated, packed and moved in a small van.

The Construction Specification Institute added plastics as viable building materials. Hooker Chemical Corp. sponsored an exhibition in New York City at the Museum of Contemporary Crafts, entitled, "PLASTIC as plastic." Beylerian Ltd. was awarded the U.S. license to produce ABS injection molded chairs and tables designed by Kartell of Italy.

SPE held its first NATEC in Dallas, subject, "Plastics in Packaging." Thirteen RETECs were held with a total attendance of 4,331. Dr. Richard S. Stein received the SPE International Award.

1970: I became a Fellow in the Plastics Institute (U.K.), now known as the Plastics and Rubber Institute—the fourth American to be so honored.

In 1970, Thermoplastics Polyesters were introduced. Cold-molded Plastics with Melamine additives to improve arc-quenching properties were produced by Garfield Manufacturing Company. Cold-molded, glass bonded mica was used by Mykroy Ceramics to produce absolute flatness and 25 year stability for Bell System's electronic switching systems.

The structural foam molding press was invented by Richard G. Angell, Jr. Two piece containers were made by thermoforming and spin-welding on a new machine produced by the Brown Machine Division of Koehring Company.

Thermoformed ABS was used on an experimental car designed by Borg-Warner. The automotive industry used over 300 million lbs of reinforced plastics in a multiplicity of applications in 1970. Richard W. Seabury, a pioneer plastics molder with Boonton Rubber Company, died.

SPE's 2nd NATEC, "Plastics in Furniture," was held in St. Louis and 684 persons attended. Eight RETECs were held attracting 1,911 persons. SPE and SPI jointly initiated the Plastics Education Foundation. Dr. Arthur V. Tobolsky received the SPE International Award in Plastics Science and Engineering.

1971: Our company completed the research, development and prototyping of the World's First Soft Bathroom environment and patented it for our client. Designed for the sick, injured, infirm and incapacitated, it was impossible to get hurt in this unit. I was also the featured invited speaker at the 2nd Australian Symposium on Reinforced Plastics and Composites in Sydney in May. Later that year I was invited by UNIDO to attend an Expert Group Meeting on the Use of Plastics in the Building Industry in Vienna and to give an updated version of the survey I completed on this subject in 1968.

The first commercially available Aramid fibers: Kevlar was introduced by DuPont. Celanese Plastics ended its production of Cellulose Acetate. DuPont closed out its Corfam. Foster Grant developed and introduced Myriad, a high density foamed Polystyrene building board.

Chrome plated ABS grills were used on Chevrolet's Caprice. Vittorio H. Moratelli of Sabemo Pty. Ltd. architected a 22 story office building in Sydney, the exterior of which was clad in bright orange FRP panels and a sister building in Perth was bright blue. Disney World opened in Orlando, FL and its theme Cinderella's Castle and many other buildings were constructed with colorful FRP facades and architectural details. St. Louis' new Botannical Building was a large Geodesic Dome made of formed Acrylics panels on a metal frame.

SPE held 10 RETECs with 2,284 in attendance. Dr. Albert G. H. Dietz of M.I.T. received the SPE International Award.

1972: My wife and business partner Barbara and I completed the research, development, prototyping and testing of the C.A.R.E. House for Bangladesh in 16 weeks due to the urgency of the need. Tested by jet aircraft at Grumman Aerospace, the jute reinforced Polyester structure showed a maximum deflection of 2.3" over 10'. Dr. Albert G. H. Dietz, who evaluated the work for C.A.R.E. called it the first major breakthrough in truly low cost housing.

Later in 1972, we designed and built TES: Temporary Emergency Structure, made of PVC extrusions supplied by George Meyers. SPE sponsored its showing at the NATEC: "Plastics in Building Construction: Realities and Challenges" in Pittsburgh.

Martin Industries received a patent on its cam-actuated grabber, a high speed automated part remover for injection molding, thus opening the door to Robotics.

The Canadians introduced foamed Polystyrene molds for concrete buildings where, after the concrete had set, the foam was left for insulation. The International Development Consortium Ltd. introduced a new building method where sandwich components were assembled and cured on site using portable dielectric heating units.

The Plastics Hall of Fame was established primarily through the efforts of the late Sidney Gross, then Editor of *Modern Plastics*.

SPE published a Division oriented Speakers List. Eight RETECs were held with 1,210 attendees.

1973: Our Company completed the second C.A.R.E. prototype House for Bangladesh and patented it, assigned to C.A.R.E. It had even better physicals and cost under $US 300.

Polyphenylene Sulphide (PPS) was introduced and commercialized by Phillips Petroleum Company. Polybutylene was also introduced.

Nathaniel Wyeth invented the PET beverage bottle (see 1968) and assigned the patents to DuPont. Owens-Corning Fiberglass Company mass-produced the all-FRP bathrooms. Energy absorbing microcellular Polyurethane foam was pretested on New York City taxis, then used in Chevrolet's Chevelle Laguna.

A Symposium: "Plastics Industries in a Developing World" was cosponsored by the Plastics and Rubber Institute, the British Plastics Federation and UNIDO in London. The Gordon Research Conference featured "Research Materials for Building" in New Hampshire and The American Chemical Society's Symposium in Chicago was entitled, "Fillers and Reinforcements for Plastics."

SPE changed the name of the *SPE Journal* to *Plastics Engineering*. Nine RETECs were held with a total attendance of 1,788.

1974: Barbara and I were retained by the Metropolitan Opera Association in New York to assist on the refurbishing of opera sets. We taught them non-flame supporting FRP techniques and the results were spectacular including lightweight simulated stone towers 32' high for "Othello."

Polyethersulphone was introduced.

McDonnel-Douglas began to use carbon fiber reinforced Epoxy to make the upper rudders on their DC-10's. Acrylics panels stiffened by FRP were formed as body panels for the Bricklin automobile. The first RIM facia was used on the Pontiac. Norfield Corp./Don Beasley introduced NorCore, a semi-