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Guest Editors: Zsuzsanna Böröcz, Robert Loader, Silvia Naldini

MODERN PLASTIC HERITAGE

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Uta Pottgiesser & Wido Quist

Editors-in-chief

APPROACHES TO PLASTIC HERITAGE

The Docomomo Journal looks back to a long history and has started as a 'newsletter' in in August 1989 to facilitate the communication among the young docomomo community. Since then, the responsibility for the journal has moved with the headquarters and each generation of the journal has developed its own characteristic and focus. Since 1993 the 'newsletter' evolved into a thematic journal, reflecting the archival and on-site research on Modern Movement materials, technologies and typologies executed by individual members and Specialist Committees. The journals 9-26 shed light on the conceptual and technological particularities of Modern Movement buildings and sites. During the 'Paris Period' the journals 27-41 created a unique overview about the diversity of Modern Movement around the world. Finally, when moving the headquarters to Barcelona and subsequently Lisbon the journal entered into a phase of broader theoretical reflection about the principles and foundations of Modern Movement displayed in the issues 41-65.

Settling the docomomo headquarters at TU Delft in the Netherlands in January 2022, we are entering a new cycle of our journal expressed on the one hand by turning the journal fully open access and on the other hand by introducing a strict peer-review process, that allows for further scientific indexation of the journal. Still, we wish and aim to maintain the strong attachment of the journal to both, the academic AND professional community. At the same time, the journal wants to tackle the challenges and dimensions related to preservation and conservation of the very different modern heritage in a world that is challenged by climate change, scarcity of global resources and social inequalities. To do so, the Docomomo Journal will maintain its two basic areas of research, discussion and stewardship: documentation and conservation. But it explicitly wants to foster the links between both often separated disciplines and create holistic and practical contributions to deal with the pressing demands to preserve on the one hand and to improve and renew our built environment on the other hand, in majority built in the second half of the 20th century.

This Docomomo Journal 66 on plastic is the result of collaboration between the Docomomo International Specialist Committees of Technology (ISC/T) and that of Interior Design (ISC/ID) bridging the disciplines from product to interior design and to architecture. It is an expression of the broadened dialogue within Docomomo International. Combining methodologies and knowledge of a wide range of disciplines has become a prime goal within Docomomo International encouraging and facilitating the exchange between the International Specialist Committees (ISCs) and the national and regional Working Parties. The present publication is the first manifestation of this new effort and combines the spirit of the multi-facetted technology dossiers into a fully-fledged journal bridging documentation and conservation.

We would like to thank and acknowledge the commitment of Robert Loader, Zsuzsanna Böröcz and Silvia Naldini who acted as guest editors of this "Plastic" issue. Thanks to their never-ending patience and persistence allied with the contributions and commitment of the professionals, scholars and researchers who generously collaborated with their knowledge, it is with great pleasure that we are launching this issue of the Docomomo Journal. A journal that – from now on – will be published both in print and online via OJS (www.docomomojournal.com), redesigned and provided with figures in color.

With special issues and open calls, the Docomomo Journal will be open to relevant contributions and facilitate academic and professional exchange. It will further include and elaborate the current docomomo themes of digitization, education and sustainability and offer a platform for the diverse approaches to and interpretations of the multiple modernities across the continents.

INTRODUCTION

Zsuzsanna Böröcz, Robert Loader & Silvia Naldini

OUR PLASTIC HERITAGE: WHERE ARE WE NOW?

This Docomomo Journal on plastics is the result of collaboration between two Docomomo International Specialist Committees[1] (ISCs): the Committee for Technology (ISC/T) and the recently formed Committee for Interior Design (ISC/ID). The two ISCs hosted, together with the Dutch and Belgium Working parties, successive specialist events in October 2017 (TU Delft) and March 2018 (University of Antwerp) which served as a platform for networking, discussion and, subsequently, for dissemination of knowledge on plastics in Modern Movement architecture and design with in-person visits to relevant buildings, institutions and companies.

The ISC/T is a large and dynamic expert group which boasts a long and fruitful history within Docomomo International. Since 1997 it has issued 14 successive Technology Dossiers that examined the conservation of modern materials and components such as concrete, glass and curtain walls that have assisted in addressing the preservation of important modern buildings. In October 2017 it hosted the seminar, entitled *Plastics in Modern Movement Buildings. Conservation and (Re-)design of Synthetic Building Components* at the TU Delft Faculty of Architecture and the Built Environment in the Netherlands. It focused on the exterior applications of synthetic building materials with contributions from conservation architects, scientific researchers and fabricators and included excursions to Polyproducts (Werkendam), the bus station in Hoofdorp by NIO architects and the extension of the Stedelijk Museum in Amsterdam by BenthemCrouwel Architects. The concern for 'historic' plastics is still, for many, a surprising concept, and it is clear that a difficult situation is developing for many plastic buildings and objects of the twentieth century. In addition, the study of historic polymers must now progress to encompass the multitude of necessary hidden, essential tasks in building physics and construction.

Inaugurated at the 14th Docomomo Council Meeting in Lisbon in 2016 the ISC/ID expressed the wish to expand and deepen the study, discussion and dissemination of interior design[2] in the Modern Movement, and this joint publication is the result of the first public action of the new committee. The small starting team of the young ISC/ID, which later grew into a substantial and global expert group, inscribed itself in the tradition of the ISCs by organizing the international seminar on *Plastics in Modern Movement Interiors. Conservation and (re-)design of plastic Finishes, Furniture and Products* which

1 Registers, Technology, Urbanism+Landscape, Education+Training, Interior Design, Publications. https://docomomo.com/iscs/

2 The term 'interior design' was chosen amongst others mainly for two reasons. Firstly, and most importantly, to avoid the binary or supplementary position of the interior in relation to architecture, and secondly to stress the emphasis on the design attitude, which is of primary concern in understanding the modern interior, especially from the perspective of the heritage professional. Moreover, the modern movement architect's demands for a new aesthetics in response to new technology and for a total work (of art) that embraces all expressions into a unitary (and also utopian) environment for humanity also seems to validate the term 'interior design'.
See also Els De Vos and Inge Somers, 'With the Other, Beyond Confusion. A Critical Analysis of the Anglo-Saxon Academic Discourses Concerning Identity and Position of the Interior Discipline', in International journal of Interior Architecture + Spatial Design, eds., Meg Jackson and Jonathon Anderson, vol 1: autonomous identities, 2013, pp. 22 – 32.

01 Antwerp Plastic Seminar participants Excursion to Brussels.
© Michel Corthaut, 2018

took place at the University of Antwerp Faculty of Design Sciences in March 2018, and received participants from Belgium, the Netherlands, Germany and Spain. It was dedicated to the field of polymers as one of the hot topics of (mainly) the post-WWII period. The seminars were followed by a day of visits starting with the Brussels Design Museum with director Arnaud Bozzini, the headquarters of the Centre Démocrate Humaniste (the first Belgian building with a reinforced polyester façade: archs. René Aerts and Paul Ramon, 1964-66) and to ROTOR in Anderlecht who practice the deconstruction of buildings where elements are sorted, stored and re-used in new constructions. It is clear that the 'polymer era' has left a heritage, for good and for worse, that deserves consideration and care. The conference, excursion and workshops, therefore, aimed to raise the sensibility of young researchers, designers and restoration and heritage professionals towards the use, conservation and recycling of polymers in the context of circular economy approaches.

The ISC/ID wishes to create a discourse that transcends traditional boundaries and develops multiple perspectives with different approaches – e.g. thematic, chronologic, geographic – and their synergies. Increasing interest in interior design from all parts of the world shows that interiors relate to a wide range of disciplines and touch upon aspects such as comfort, privacy, beauty, effectiveness and many more. The identity of the modern interior is not only the result of the integrated approach toward architecture, furniture, design, decorative arts, utilitarian objects, equipment, textiles and light, but it also derives from the social commitment to improve the quality of (everyday) life starting from the (material and immaterial) needs of every human being.

The seminar programs provided a theoretical, historical and practical contribution to an interdisciplinary field which was important for three reasons: in bringing together expert networks from different disciplines, in combining different methodological approaches and in disclosing the results in a single publication. This was not only new within Docomomo International, but it underlined the plural perspective essential to every scientific discipline. This Docomomo Journal addresses the concerns of historical evaluation in the past decennia and the immediate and pressing challenges of the conservation of plastics in architecture. Articles have therefore been selected for their relevance from topics originating in both seminars and from further afield.

Carola Hein introduces the positive and exciting image of plastics as clean, functional and fun, which spread in the post-war years, but then developed into an uncontrolled and negatively perceived mass-produced plastic world. She also describes the fully plastic house that embodied the dream of the early plastic period when this material was used by architects for design products.

The negative campaign against plastics that followed the first period of enthusiasm is addressed by Zsuzsanna Böröcz to explain why the recognition of plastics as heritage objects only started in the 1990s. Until then, plastic objects were not considered suitable for museum collections. The effects of that situation are still seen in the lack of experience in conservation, restoration and preservation of plastic objects, and illustrate the importance of the Brussels Design Museum (founded in 2015), which hosts a large collection of plastics and develops important conservation policies.

The study carried out by Nina Serulus concerns the history of the plastic furniture manufactured from 1958 to 1980 by the Belgian company, Meurop which exemplified a belief in the utility of plastics for everyday life. Established on the principle of good design at affordable prices, Meurop can, in many ways, be considered an exemplary company. The format was a huge success domestically and in the emerging European market. The manufacturer boasted an in-house design studio and plastics department, working primarily with high-impact polystyrene. The production came to an end due to the impact of the oil crisis and rising ecological concerns.

Based on the examination of two specialized Belgian journals, Nick Serneels presents an overview of synthetic materials (plastics) and finishes dating from the 1960s that were used in the interior of office buildings. The inspection of selected buildings, in which the original presence of plastics could be established, shows that the plastic elements of listed monuments have often been removed and do not receive a similar level of protection to other materials. Plastic materials used in buildings should be assigned an equal status and treated with the necessary care and respect.

Five of the eleven articles in this publication are dedicated to *Futuro* houses – a set of buildings that were produced within a limited time period and to a similar design with only small variations in specification. They are now found around the world under different ownerships and with different histories. For these reasons the global collection of *Futuro* houses forms compelling comparative case studies.

Pamela Voigt has made extensive contributions to the history and conservation of plastics buildings. Her paper describes the detailed survey work that illustrates the gaps between the built reality and the design literature for the licensed American version of the *Futuro* house.

The *Futuro* house that is described by Wayne Donaldson constitutes an architect's personal investment in many years of rescue and resurrection of a neglected *Futuro* that had been unwanted except for its eventual sale value.

The travels and interventions of another *Futuro* in private ownership is documented by Stamatopoulou, Karoglou and Bakolas. This *Futuro* experienced the very different environments of Belgium, France and Greece with repair by boat specialists in both France and Greece. As problems with the building continue to be unresolved, the authors are now undertaking scientific analyses of the environmental conditions and physical deterioration.

Lydia Beerkens's paper describes the careful research and decision-making that informed the conservation of the *Futuro* that is now owned by the Museum Boijmans van Beuningen in Rotterdam. This building also has extensive periods

02 Detail of the plastic collection at Design Museum Brussels.
© Michel Corthaut, 2018

of unknown history and the inevitable and typical damage common to other *Futuros* that have travelled. However, as a museum object and also, importantly, as the prototype of all *Futuros,* rather than a production model, this particular example has a unique status that has led it only to be exhibited indoors.

Pulling all the studies on the Futuros together is the paper by Tyurkay and Pottgiesser, which synthesizes the many approaches towards conservation of plastic buildings. It highlights the importance of understanding the life-cycle of polymers in order to inform Conservation Management Plans, maintenance and monitoring.

The article by Robert Loader deals with architecturally applied, large-scale external elements, which both enclose and characterize a building. The examples treated are from the UK, with a focus on GRP. The construction methods applied for architectural plastics during the 1960s-70s vary greatly, which reflects the experimental and innovative nature of this technology. This type of heritage will be at risk in the UK until a comprehensive catalogue of relevant buildings is completed, and more awareness and expertise are developed as a basis for their conservation.

Christina Malathouni deals with the recent history of the Preston Bus Station in Lancashire, built in 1969 by the Building Design Partnership (BDP) and in recent years threatened with demolition. It is an extraordinary example of almost lost Brutalist heritage that won the World Monuments Fund/Knoll Prize in 2021 thanks to thoughtful refurbishment. The key to understanding the overall character of the architecture is the conscious decision to design and build with two main materials – concrete and glass reinforced polyester (GRP). Even though little has survived of the plastics used in the project, the 'integrated design' ethos of BDP and the suitability of GRP for building applications remain convincing and now underpin a new life-cycle.

Zsuzsanna Böröcz *is an art and architecture historian (Ph.D. KU Leuven 2004). She is guest professor at the KU Leuven Faculty of Architecture and affiliated to both the KU Leuven Department of Architecture A2I research group Architecture Interiority Inhabitation and the University of Antwerp Faculty of Design Sciences Henry van de Velde Research Group. She is also President of Docomomo Belgium and co-chair, together with Bárbara Coutinho, of the Docomomo International Scientific Committee on Interior Design.*

Silvia Naldini *is senior researcher and lecturer at the Faculty of Architecture of Delft University of Technology and has been active in the field of Conservation and Maintenance of Monuments for more than thirty years. She works in (EU) international and national research projects and transfers scientific knowledge into practice (Monumentenwacht). Recent research concerns Professionalism in Monuments Conservation and Integral Transformation of Museums. She is editor of the Rondeltappe book series on Conservation and Transformation and of the DOCOMOMO International journal.*

Robert Loader *is an architect based in London with extensive experience in repairing and upgrading historic buildings and neighbourhoods. Current research focuses on the materials and conservation of building facade components developed in the twentieth century. He is Secretary of Docomomo UK and Chair of the Docomomo International Specialist Committee on Technology.*

THE GLOBAL PETROLEUMSCAPE AND ITS IMPACT ON DESIGN PRACTICE

Carola Hein

ABSTRACT: Over the last century the petroleum industry's rapid growth has been accompanied by a steady flow of aggressively promoted petroleum-based products. The petroleumscape's spatial expansion and visual representation achieved widespread citizen buy-in. Following World War II the use of plastic materials in the building industry significantly increased through efforts from architects and industry leaders. The House of the Future, built by MIT architects, the Monsanto Chemical Company, and Disneyland exemplified a modern lifestyle: clean, functional, and fun. The architectural and technocratic dream of a mass-produced, fully plastic house that seemed possible in the post-war years did not survive the subsequent commercialisation of the plastics industry in the 1960s and 70s.

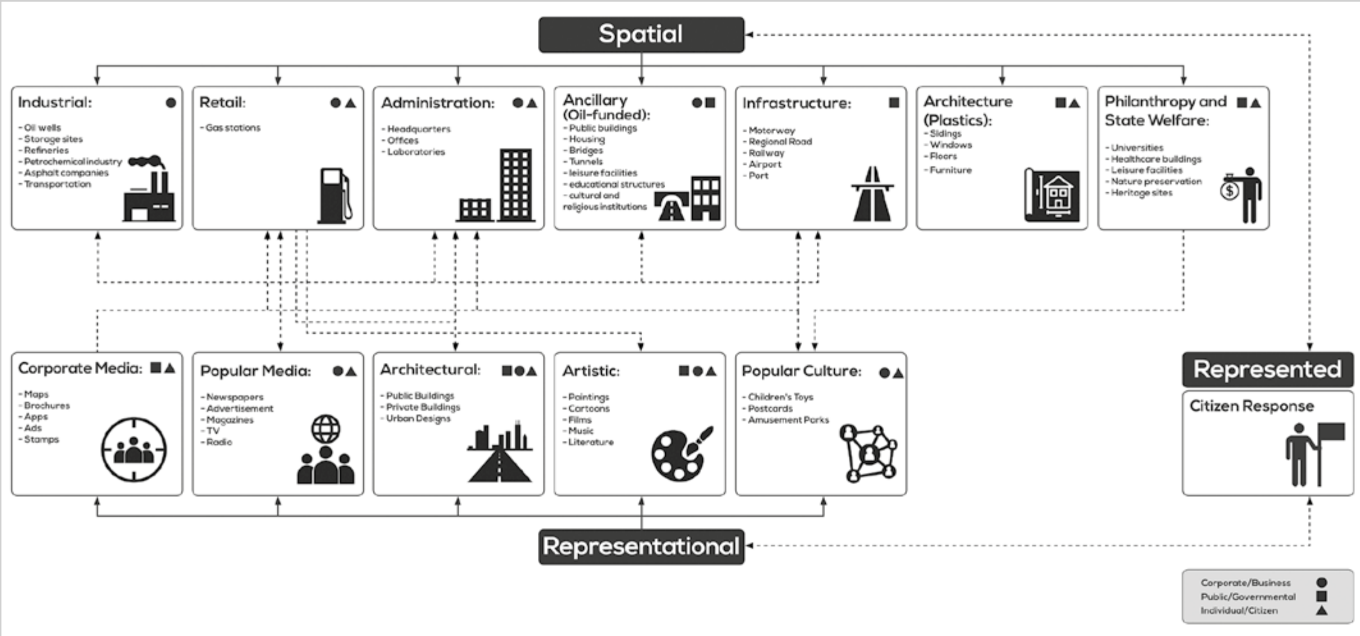
KEYWORDS: petroleum; synthetic materials; industry; architecture; plastics

INTRODUCTION: The expansive growth of the petroleum industry and its multitude of products - from lighting oil to fuel and plastics - has relied on the growth of a large consumer base. Citizens of different classes, races, cultures, genders, and ages around the world have embraced a multitude of petroleum products. They have benefitted from cheap energy for travel and heating, and they have taken advantage of easy-to-use plastic-based building materials. Extraction, production, transformation, transportation and consumption of petroleum have created a multifaceted spatial layer, a petroleumscape, that includes refineries and storage sites, office and research buildings, transportation infrastructure and gas stations.[1] All of these spaces are connected through their relation to a single commodity - petroleum - and its group of industrial players.

The petroleumscape emerged along with narratives and imagery that encouraged the use of petroleum products. Constant promotion helped reinforce widespread citizen buy-in, creating an energy culture that reinforces the spatial presence of the industry and further increases consumption in everyday life. Among the diverse industrial, administrative, retail and ancillary spaces, plastics in architecture play a particular role: plastic components related to building have a particularly wide range of applications and customers. They can be small in scale - from light switches to furniture - or part of architectural design and construction practice - from windows to walls. They can be marketed to professionals and builders as well as the everyday consumer.

This contribution provides an introduction to the early history of plastics, and explores how the vision of a plastic house developed after World War II, followed by the promotion of plastic materials in the building industry [FIGURE 01].

Petroleum naturally bubbles up from the ground, and humans used it for specialized purposes for millennia in ways that foreshadow our uses today. Incendiary weapons such as "Greek fire" anticipated our current use of oil for warfare, lighting, and warming. Bitumen, once used to make watertight pools and basins in Mesopotamia and to mummify bodies in Egypt, today appears in asphalt street surfaces, roofing materials, and waterproofing. And the historic use of petroleum as a medicine precedes more recent pharmaceutical and cosmetic uses; for some 150 years people have been applying Vaseline petroleum jelly to dry skin and minor wounds. Throughout the 18th century, inventors, businessmen, and chemists worked to create an efficient petroleum-fueled lamp to replace those that used more expensive natural oils[2]. By finding ways of transforming crude petroleum into useful products the oil



01 The Global Petroleumscape. © Author

industry was able to adapt to changing societal conditions and also to transform environments and lifestyles.

Industrial petroleum drilling started in 1859 and over the decades that followed, petroleum products became increasingly ubiquitous in industrial and daily use. In the early decades, petroleum was refined mostly into lighting fuel and grease. Engineers rapidly developed new uses for other petroleum products. Notably, the refining of crude oil to make kerosene also created gasoline. Long considered a waste product, gasoline's explosive qualities led Karl Benz (1844-1929) to use it in 1886 in the first practical internal combustion engine. Since the mid 19th century, chemists also began devising uses for petroleum that did not involve burning it. These uses include the production of new materials such as vinyl for paints, floors, or wall-covers; or petroleum-based fibres such as nylon, acrylic, polyester, and spandex, as well as microplastics, including the microbeads in some body scrubs and toothpastes.[3]

Plastic materials can be natural products, but it was only with the development of synthetic plastics that plastic could become so commonly used. Natural products such as rubber latex - made from plants - and shellac - made from the secretions of a beetle - are limited in amount. The synthetic production of easily mouldable products provided a broad range of new possibilities for different users. New plastic materials emerged in the mid-19th century, and were shown, for example at the 1862 International Exhibition, where Parkesine by Alexander Parkes (1812-1890) received a bronze medal. In the history of modern plastics Bakelite takes an important role. A lightweight and durable plastic, nonconductive of electricity and heat resistant, it served the emerging automotive and electrical industries at the turn of the 19th and 20th century. New products were made, including telephones, radios and electric sockets, but it was also used to replace existing products, such as toilet seats, ash trays, and jewellery. Plastic materials allowed for new organic or curved forms - in line with the predominant taste of the time - which were coveted by designers.[4]

Beginning in the 1920s, the American engineer Buckminster Fuller (1895-1983) imagined lightweight, prefabricated single-family houses that would allow for autonomous living and which showcased various uses of plastic products. There were many advantages to this structure, including the ability to prefabricate components in factories to be shipped and assembled, and adapted to local environments. Aluminum was Fuller's preferred material, which he combined with plastics, for example in the 4D Tower of 1928 and in a waterless toilet. In 1940 Fuller applied for a patent for a bathroom made of moulded plastic. Fuller would further develop these pre-war designs in his Wichita House of 1944, which used plastic windows. He then continued to further develop his building with the geodesic dome, a 1953 version of which was covered with DuPont's Mylar polyester film, creating a thin, clear, and very tough skin.[5]

Synthetic materials replaced limited natural ones and promised cheaper goods for a large group of new consumers among whom women played an important role. In the 1930s, the chemical company Du Pont invented two new products: nylon and neoprene. Nylon rapidly became a household item as it replaced the hairs of wild boar in toothbrushes. It was celebrated as it made stockings available for women at a much lower price than silk.[6] The development of synthetic plastics for insulators facilitated new amenities in the house and notably the electric kitchen. Heavily promoted by General Electric, the new kitchen -presented at the 1933 World's Fair with the "House of Magic" exhibit - featured an electric laundry, an iron, and a sewing machine, including numerous

02 General Electric's House of Magic, General Electric Range Advertisement. © Better Homes and Gardens June 1948, retrieved from https://www.flickr.com/photos/91591049@N00/15825470231

plastic components.[7] General Electric (and other companies) praised the advantages of plastic products for use in homes and marketed the innovative technologies and materials as part of a modern lifestyle - clean, functional, and fun. The presumed spaces of women - the kitchen - and their activities - cleaning, cooking, tending to the children - were of particular interest to the new industry [FIGURE 02].

Plastic materials were of great importance for the war effort, as the rapidly growing airplane and chemical industry needed lightweight composite materials and high strength plastics and plywood. Nylon replaced silk in parachutes,vinyl was used for tents and boots, and polyethylene was used for radar cables. The production of plastics during the war stimulated the creation of a new industry, which needed customers after the war ended. Plastic architecture appeared not just to be a way of using military technology in peace-time, but a way of solving the housing problem. As Beatriz Colomina points out, "The wartime accomplishments of the plastic industry were presented to the public in popular magazines as the great hope to ensure the financial future of an expanding, post-World War II economy."[8] The chemical company Monsanto was a key player in transitioning plastics from war to peace-time use. Monsanto worked closely with MIT in Boston. MIT's wide-ranging research foci at the time included "the fields of lighting, solar energy for house heating, plastics, zoning regulations as they affect the cost of residential building, the perceptual form of cities, and community costs and revenues involved in new industrial developments."[9]

MIT had contracts with several players from the chemical and plastic industry. Professor Albert Dietz (1908-1998), who was working on lightweight construction materials, was also the chair of the Society of the Plastics Industry (SPI) Committee on Plastics Education, which heavily promoted plastics. In 1950 he led the Plastics Materials Manufacturers' Association program which issued a "A Program for Plastics Education in Science and Engineering."[10] Dietz published multiple articles on plastics in 1954-1955 including a report funded by Monsanto.[11] MIT received various grants from Monsanto including one in 1955 for plastics in city planning.[12] By 1955 MIT developed studios with support from Monsanto along with "architectural evaluations of some of the typical building products that are either wholly or partially

03 The (all-white, all-male) participants of the Plastics in Building conference in 1955. © Building Research Institute, Plastics in Building, Washington, D.C.: National Academy of Sciences, National Research Council, 1955, p. 6

composed of plastics, and illustrations of present trends and future possibilities in the use of these materials." The goal was to "forecast possibilities that can be achieved when, in the future, we may take maximum advantage of the inherent properties of plastics as applied to house fabrication." A year later, MIT announced that:

> *The Division of Building Engineering and Construction, together with the Department of Architecture, is designing and constructing a plastics "House of Tomorrow" under the sponsorship of the Monsanto Chemical Company. Structural shape and architectural design have gone hand in hand, and a great deal of pioneering in structural design has been made necessary by the relatively new and untried structural properties of the materials.*[13]

In the 1950s, for the professors at MIT, the goal of the collaboration was to develop an integrated, structural approach to plastics in construction.

The collaboration among industry, research and design grew as documented in a two-day workshop at the Chamber of Commerce in Washington in 1955. There, industry representatives, researchers, and architects studied the properties, uses, standards, codes, and future of plastic in building. Albert Dietz from MIT described the main characteristics of plastic as a building material. Following a number of presentations on the diverse uses of plastics in building, the structural engineer Johan A. Bjorksten (1907-1995) pointed out that "in looking to the future of building I believe that we should envision the use of plastics in primary structures" rather than as decorative or secondary building elements.[14] Robert K. Mueller, of the Plastics Division of Monsanto Chemical Company, pointed to the extreme increase of plastics over the last decades before 1955. He wrote:

> *the output of plastic materials has been expanding at an average rate of about 20 per cent per year since 1918. […] From 23 million pounds of plastics at the time of World War I output has jumped to three billion pounds estimated for this year. Output has doubled since 1949 and increased ten-fold over the amount of 1939. […]*

We estimate total consumption of plastics in the building trades for 1954 will be over 400 million pounds.[15]

He further summarized the diverse possibilities of plastic materials in architecture and design: "the future of plastics in building is limited only by our imaginations and the public acceptance of new concepts in living".[16] [FIGURE 03]

Architects were eager to claim the new material for design purposes. In the roundtable of the 1955 event, the architect Robert Fitch Smith (1894-1964) from Miami presented a guest cottage that he had designed in Deerfield Beach, Florida, with 30% recycled plastics for Russell Reinforced Plastics Corporation. The building included 350 square feet of translucent fiberglass so that all spaces of the building could receive light at any time. Smith recognized both the opportunities and potential dangers of the plastic industry as they engaged the building sector:

Architects have always dreamed of a building material which is free from maintenance, termites, rust, discoloration, disintegration. Now, with the help of new mechanical engineers and industrialists, we may be well on the way to the development of this new material. We may even be on the way toward a new period of American architecture, a bright, new conception for the closed in spaces where people live—no dark corners, but a happy, sunny material clothed by a good structure. We may even be on the way to the golden age of American architecture. Only our misuse or our lack of appreciation of this glorious new material can slow our progress.[17]

And he warned presciently that architects needed detailed information from the plastics industry to make good buildings rather than let contractors and building owners choose from a broad range of plastic components: "To the architect, this detail is good and valuable information as to the parts of future buildings." [18]

Fitch-Smith continued:

These viewpoints must form a harmonious unit and must be so designed architecturally; therefore, a design background becomes necessary in the industrial phase of the work. If your materials, fine as they are, are misused, they will become of less value and will stop progress in its very path. I plead with you to hold to an architecturally-designed product as your goal, instead of a back-yard, do-it-yourself product. [19]

An important addition to the petroleumscape occurred in 1957 when MIT architects, Monsanto, and Disneyland formed a powerful collaboration with key players in design, research and education to show an integrated design approach towards the plastic building of the future. The "House of the Future" had to be modular and flexible in line with Fuller's designs, and offered a view of future living in a plastic-walled structure with new technologies including ultrasonic wave dishwashers, picture phones and atomic food preservation. The designers introduced new forms and technologies and, together with Monsanto and Disneyland, marketed it to millions of visitors as part of a modern lifestyle: clean, functional, and fun. The attraction imagined a possible mass-produced home of the future, but despite the inclusion of key collaborators, architect-designed houses in plastics did not become a trend. Soon after the House of the Future closed in 1967, the Finnish architect, Matti Suuronen (1933-2013) would design and build prefabricated single-family homes made of plastics, the Futuro (1968) and the Venturo (1971) [FIGURE 04].

By the mid-1960s, the opportunity for close collaboration between plastic and building industry seems to have passed. A 1965 conference in London entitled "Plastic in Building Structures" indicated the shift.[20] Architects pointed to the particularities of their profession. R. D. Gay wrote provocatively: "The architects are prevented by the established protocols and statutes of professionalism from developing their ideas on commercial lines. In spite of their ability to analyse and co-ordinate, the majority of architects shield themselves behind the facade of a dilettante club." And he continued: "The housing band-wagon is in motion and about 400 builders have already jumped on, each with his industrialized building system; 95 per cent of these systems are ill-conceived, unsuitable, based on ignorance of basic research and national requirement, and generally ugly."[21] The author still held out hope for collaboration between the building and plastic industries in view of post-war housing needs:

There exist major difficulties of communicating with the building industry. Whatever the problem, and its order of magnitude, it must be realized by both industries that there will be, in a few years, the absolute necessity for new materials, used in new ways. A large proportion of these must emanate from the organic-chemical industry, used alone or in conjunction with contemporary developments in the steel, aluminium and, perhaps, other industries." [22]

04 Some 20 million visitors saw the House of the Future, set in the year 1986, at Disneyland Anaheim, between 1957 and 1967. © Linda Peach Warner Collection. Acc#2014-57, Orange County Archives, retrieved from https://commons.wikimedia.org/wiki/File:Monsanto_Plastics_Home_of_the_Future,_Disneyland,_1958_(15364290924).jpg

He regretted that the "completely built plastic home seems to have disappeared." [23] He criticized a lack in leadership from MIT: "There are no 'codes of practice'; no text books are available for the design of building structures - for a decade we have been awaiting one from Dr. Dietz and his colleagues at the Massachusetts Institute of Technology." Dietz did not pick up this call, by 1979 a Plastic Design Structural Manual was still in the making.[24]

Some architects created unique structures with plastics materials. Kisho Kurokawa's (1934-2007) Nagakin building (1972) in Tokyo, which included a prefabricated plastic bathroom, offers an example. Plastic bathroom elements have since become a key feature in many Japanese houses, as they fit both the humid climate and the shower and bathing habits. The upheaval in the global petroleumscape in the 1970s meant that plastics could no longer be used by architects to create cheap, bespoke components. Instead of following comprehensive architect-led design for entire prefabricated and repeatable structures, the petrochemical and building industries collectively developed new materials and building elements including plastic bathroom units, insulation, windows, furniture, Lego toys, and doll houses. They turned towards the contracting sector and consumers instead of architects.

Professional magazines became one of the tools of the plastic industry to engage with the building sector. Numerous publications addressed themes such as "Plastics in Building" or "The Styron Story" and a journal titled "Plastics in Building Construction" (1975-) in the 1960s-1970s promoted the use of plastic building elements.[25] Advertisements for companies producing plastic building components spoke directly to consumers, cleverly connecting everyday objects with building materials. Women and young children were carefully targeted as consumers. Tupperware parties made plastics an integral part of a woman's experience, possibly reinforcing her preference for vinyl cladding or plastic windows. Girls encountered plastic Barbie dolls using plastic wardrobes, bathtubs or doll houses. Together with their brothers they may also have played with Legos or other plastic blocks.[26] The advertisement for Formica, "Too bad Dad," featured the Formica vanity, a must-have for women and girls, with a counter space around the wash bowl and drawers for towels, laundry and medicine.[27] Advertisements by Lamilux - a firm that produced components for ready-to-mount timber structures and grew to include fibre-reinforced composites - for corrugated sheathing and roof windows also aimed at engaging a new group of consumers, appealing notably to women apt to be in charge of the household.[28] The Styron advertisement for plastic wall tiles claimed a close collaboration with designers, but primarily addressed the client.[29] [FIGURE 05].

05 Publicity Too Bad Dad. © Unknown, retrieved from https://retrorenovation.com/wp-content/uploads/2008/03/1952-formica-lav343.jpg

Since the 1960s, plastic has been entering all parts of the home in a piecemeal fashion. Consumers have been buying plastic for everyday uses. Architects and builders have used the multitude of plastic products that have been developed for the construction industry. Much plastic building material regularly ends up in landfill sites. The current crisis of plastic waste seems to have brought the building industry back into the view of plastic producers and architects. Some recent projects feature buildings made of recycled plastics, such as the Plastic Bottle Village by Robert Bezeau (°1949) in Panama, built from a million plastic bottles, or Swansea-based Affresol's recycled plastic houses, composed of eight tons of trash each, and intended to solve housing and recycling problems simultaneously.[30]

DISCUSSION

By tracing the history of oil's impact on the built environment and its representations through the lens of plastic in architecture, the extent to which oil flows have affected society's physical spaces and ways of living from the smallest to the largest scale can be observed. The extent to which the consumer in general is now effectively part of the system is evident, and the critical need to comprehensively explore the relationship between architecture and plastic is clear.

CONCLUSION

The architectural and technocratic dream of a mass-produced, fully plastic house that seemed possible in the post-war years did not survive the subsequent commercialisation of the plastics industry in the 1960s and 70s. Designers lost any possible leadership role when technical design knowledge was concentrated in manufacturing and marketing corporations, rather than in the professions or academia. Over the same period, the early image of plastic as clean, functional and fun was to be tainted by the realisation that the cheap exploitation of plastics was beyond the control of Western economies, and later, that the consumption of mass-produced plastic would create intractable environmental consequences.

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COLLECTING PLASTICS IS COLLECTING DESIGN HISTORY

Conservation Practices in Museums

Zsuzsanna Böröcz

ABSTRACT: From the 1950's onward, the myriad qualities of all plastic objects were praised without a second thought. This enthusiasm significantly delayed the awareness of their enormous impact and it took almost half a century to consider these objects a part of post-war culture. This essay aims to sketch the history of the appreciation of the relevance of plastics in the museum world, specifically as a part of design heritage, seen from the viewpoint of the collector and the conservator-restorer. The case of the Design Museum Brussels, established in 2015, shows how a collaborative and interdisciplinary approach on conservation can be developed to the benefit of our plastics heritage.

KEYWORDS: Design museum; plastic design collections; conservation practices; plastic heritage; Brussels

INTRODUCTION: We welcome each renewed design museum or new collection of post-war plastic design furniture. We admire the creativity and optimism of the Space Age shapes with their typical colour outbursts, while we are simultaneously standing on the barricades to protest the use of plastics in everything, from disposables to cosmetics, because we can no longer ignore the damage plastics cause to the environment. For decades our everyday life was marked by the widespread use of petroleum-based polymers, and until very recently this was also the case in arts and culture. From the 1950's onward, the myriad qualities of plastics – from the Greek word 'plastikos', meaning capable of being shaped or moulded – were praised, and so were all sorts of objects, from ordinary kitchen utensils to design objects and furniture, from the disposable items in our daily lives to art. So much so that after half a century we came to regard these objects as part of our heritage – our architectural heritage, interior design heritage, the broad heritage of design cultures and the heritage of consumer culture. The awareness of the enormous impact these materials have had, and are still having on our lifestyle and environment has grown slowly, as well as the knowledge of their inferior durability compared to traditional materials. This time-lapse makes the desire (and one could add, the moral obligation) to conserve this heritage still more challenging.

This paper aims to sketch the history of the awareness of plastics in the museum world, specifically as part of the design heritage seen from the viewpoint of the collector and the conservator-restorer. In this regard it is worth noting that the post-war rise of design itself triggered a reorganisation of the museums of applied arts. This has paved the way for the establishment of design museums and more recently *plastics* design museums. The fact that these recent museums are smaller and operate with limited staff and modest facilities in terms of stock area and restoration laboratories, is in harsh contrast with the fragility of the materials in their collection. This fragility is underestimated. A number of initiatives indicate that scientific research on preventive and restoration practices is now finding its way to museums, stimulated by a collaborative attitude. Dedicated partnerships in a multidisciplinary context produce an exchange of knowledge among the museum stakeholders: the conservator-restorers, the curators, the (free-lance) conservation scientists, the artists, the art historians, the managers[1], the visitors and finally the authorities. To illustrate this, we will zoom in on the Design Museum Brussels[2], established in 2015 to host the private collection bought by the Atomium containing some 2500 plastic objects, and which ever since, has been working on a successful restoration policy [FIGURE 01].

01 The Plastic Design Collection of the Design Museum Brussels. © C. Licoppe 2018, DesignMuseumBrusselsLiophotography

DRAWING ATTENTION

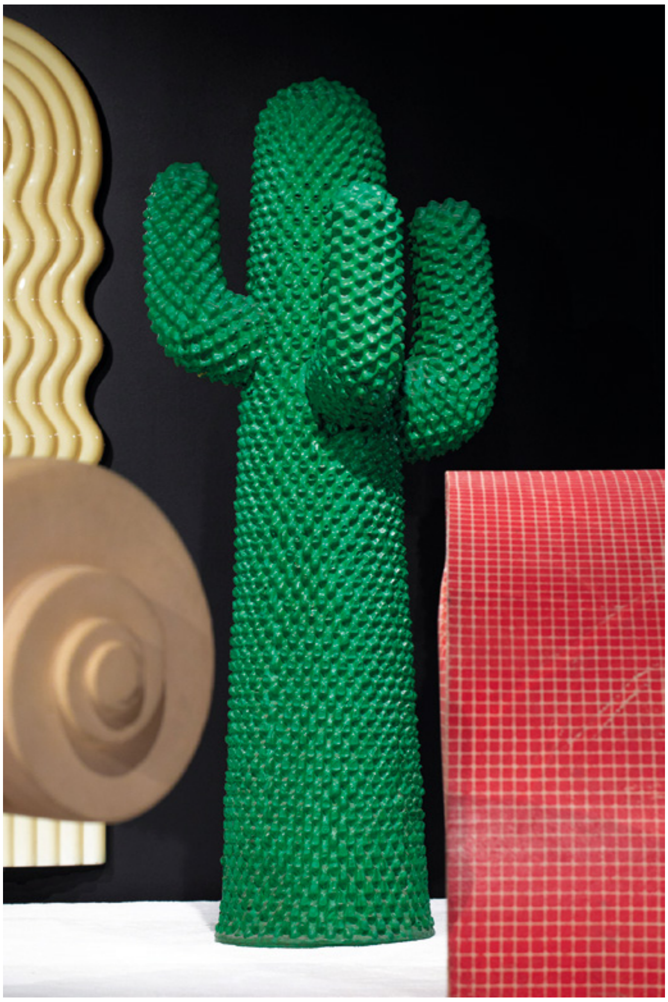
In its Strategic Plan for 1992-1997, the London Victoria & Albert Museum expressed for the first time in its history the necessity of a care program for plastics. A few years later, in 1994, it appointed Brenda Keneghan, a conservation scientist at the museum, as its first polymer conservator[3]. During her surveys in the 1990's, Keneghan called the situation she encountered 'a plastics denial syndrome'[4]. People in charge of collections didn't have the faintest idea about the quantity and diversity of plastics in their collection, which resulted in a complete lack of expertise on polymers. This 'denial' was rooted in the misconception that the use of plastics had begun in the period of modern life post WWII. Instead, the use of semi-synthetics such as cellulose-nitrate dates back to the 1880s, and the use of so-called 'natural plastics' even further. Thus, when dealing with a comprehensive collection of decorative arts, one ought to take into account the possible presence of synthetic components in objects from as early as the mid-19th century. Addressing the synthetic materials in urgent need of attention, Keneghan specifies 'dry and brittle' rubber, 'unstable and degrading Celluloid™ with formation of acidic vapours causing disintegration of neighbouring objects', 'visible loss of plasticiser and darkening in colour' in PVC, and toys and cushioning of polyurethane foam which 'fall apart as a result of simple oxidation'[5].

Keneghan's first brief and factual articles on the topic, written for the museum field, suggest six focus areas which are still relevant. These are recognition (awareness), identification, storage, survey, accurate fact sheets and monitoring[6]. Although we are dealing with these issues in a more sophisticated way, her visionary statement of almost 25 years ago still counts: 'It is not all doom and gloom, however, as by the implementation of preventive conservation measures, the lifetimes of these materials may be extended significantly, but not indefinitely'[7].

THE RISE OF DESIGN MUSEUMS AND PLASTICS-ONLY COLLECTIONS

The identity of design objects is often described in relation to a set of categories: craftsmanship, uniqueness, serially produced artefacts, or the applied sciences. The start of the use of the umbrella term 'design' for these identities marked the emergence of the design museum[8]. In the 1990's, the awareness of the shifts in production and consumption connected with post-war modern life initiated the process of musealizing design. This development was accompanied by a shift in perspective from the decorative arts to design, which implied a broader view on how design is embedded in history and society. This conceptual change encouraged a great number of museums of applied arts to change their name to 'Design Museum'[9] [FIGURE 01].

Historically, museums of applied arts distinguished themselves from art museums and natural history museums in a way which was influenced by a multitude of continuously changing factors[10]. The crisis of functionalist design was followed by the post-war success of 'good design', which in turn brought about post-modern design, which playfully experimented with a new mindset towards materials, the notion of craft, high art and uniqueness. As a consequence, the traditional conceptions of applied arts shifted to the consideration of design as a genuine form of art. From the early 1980's this was gradually reflected in the acquisition policy of museums, which started to focus on more recent periods, of which plastic objects were



02 Guido Drocco and Franco Mello, Cactus, 1971 in the Design Museum Brussels. © C. Licoppe 2020, DesignMuseumBrusselsLiophotography

03 Plastic chairs in the Design Museum Brussels. © C. Licoppe 2020, DesignMuseumBrusselsLiophotography

unavoidable representations[11]. As the concept and cultural validation of design broadened, culminating in the expansive turn-of-the-century definition by John Heskett[12], design research could not disregard the importance of plastics for the discipline. This offered museums new avenues to theorise and present their plastics collection as a clear subgroup within the wider collection.

Only in the 1980s did plastic objects become valid and valuable collection items, even though the first examples had already been purchased in the 19th century. This transition raised a twofold shift regarding plastic objects in museum collections, namely awareness and interdisciplinarity. By the start of the 21st century the awareness had spread, and specialists were called for collaboration between the diverse fields. Today it is only common sense to ground the decision-making process on interdisciplinary dialogue. The consciousness that 20th and 21th-century acquisitions quite probably contain polymers, and thus may have a shorter life expectancy than traditional materials[13], has caused no measurable decline in acquisitions.

At this point, a third shift can be noted. While in the past, museums rarely collected objects on account of the materials they were made of[14], with the exception of certain precious materials, entire collections have recently been assembled exclusively of plastic items, and some have even generated – at least for a short period of time - independent museums. An example of this evolution in the UK is the Museum of Design in Plastics Bournemouth. Founded in 1988, it changed its name to the Museum of Design in Plastics (or MoDiP) in 2007 and became the UK's first and only fully accredited plastics museum a year later. MoDiP is now acknowledged as the UK's leading centre for the study of design in plastics focusing mainly on utility objects with either a compelling form or function or a historic documentary value[15]. In The Netherlands, the PolyPlasticum Steenwijk was first established in 2003, moved to Zwolle in 2010 and in 2013 it became the country's single online museum on polymers. In New York City a pop-up educational Museum of Plastic was set up in 2019 in the SoHo neighbourhood. More recently in the UK, the online Museum of Plastic 2121 was launched, which focusses on the history of activism related to plastics. It is a hub of the British Council's 'Climate Connection. Be Inspired' initiative.[16] In the following we will consider another example, this time in Belgium: the Design Museum Brussels, established in December 2015, which, besides presenting the history of design, boasts an impressive permanent collection of iconic plastic design objects from the 1960's onwards [FIGURE 02, FIGURE 03]. But first, let us dive into the topic of conserving collections of plastic objects.

PROGRESS IN CONSERVING PLASTICS COLLECTIONS

Plastics in art and design has known a long history and a rather slow development[17]. Though plastics already started to appear in the 1960's on a large scale in both artworks and utility products, and the material attracted attention from art-historians and conservator-restorers[18], the apparent simplicity and ubiquity of the material has long deceived academic research. For a couple of decades most art and culture historians discarded plastic utensils and furniture along with the mass culture they belonged to. When this opinion was revised in the late 1980's to early 90's, the interdisciplinary nature of the subject gradually dawned.

Admittedly, conservator-restorers and (design) museum directors had this change of view with a certain delay, often triggered by stumbling upon examples of spectacular degradation in some collection pieces. When they did, the alarm quickly sounded for a broad and integrated restoration policy. This raised a number of hurdles. First, museum directors, most of whom were trained as art historians, lacked the knowledge of organic chemistry and materials science of conservator-restorers and on the other hand conservator-restorers lacked a background in humanities – specifically in design cultures – necessary to grasp the extent of the subject matter[19]. Also, the museum sector as a whole was just then going through a transformation period. In 1984, the profession of conservator-restorer, developed by the International Council of Museums (ICOM, established in 1946) and its Committee of Conservation (CC), received its current definition, which emphasizes the understanding of the objects' material properties and documentary quality[20] and deems interdisciplinary co-operation of 'paramount importance' and teamwork a 'must'[21].

Most museums of a certain scale and importance have by now developed a comprehensive preservation policy for their collection, including the special needs of plastics[22]. In many cases the conservator-restorer of organic materials is made responsible for the preservation of polymers, which often requires the specific knowledge of a specialist. Thus, even renowned institutions find themselves in need of external assistance, prompting the distinguished Getty Conservation Institute, for instance, to coordinate its approach with other specialist institutions. Thus, the Getty's Preservation of Plastics Project is integrated in the Modern and Contemporary Art Research Initiative, and collaborates with various partners from Europe, notably The Netherlands and Germany[23]. The ICOM's Committee for Conservation established a working group dedicated to modern materials, aiming to attract attention to the subject[24], e.g. with the 1991 conference *Saving the Twentieth Century. The Conservation of Modern Materials*, held in Ottawa[25], and other initiatives such as *Modern Art: Who Cares?*, a symposium organized in Amsterdam[26].

Most design museums, however, are small in scale and modest in infrastructure. Curating collections that follow the history of plastics applications from the 19th century, they obtain a huge quantity of objects of which the assessment (meaning, value and condition), conservation (preventive and remedial) and use (storage and presentation) form a real challenge[27]. The new phenomenon of 'plastics-only' collections also belong to this fragile group. Yet collecting plastics requires knowledge of the material. Without experts competent to deal with its possible degradation, threats and needs, the risk of losing part of the collection is real. In this context, and notwithstanding advances in research and numerous initiatives, at the end of the 2000s design museums still lacked an overall, viable vision on the conservation of modern materials, and plastics in particular. To remediate this, the Conservation Department of the Neue Sammlung Design Museum in Munich decided to open a platform to encourage discussions and knowledge transfer in the field, and in 2009 started the conference format FUTURE TALKS for interdisciplinary discussions and experience exchange on the conservation of modern materials. Important issues were the interdisciplinary dialogue between conservators, conservation scientists, engineers, designers and producers, and the practicability of conservation treatments[28]. Significantly, in its first edition, almost all lectures dealt with issues related to plastics[29]. The edition of 2019 testifies to a deepening of the subject and focussing on specialist topics. The proposition of the 2019 Future Talks was 'Modern Surfaces', called the 'ultimate challenge'[30] for the modern heritage conservator[31]. Experiments and research by museums presented in the Future Talks subsequently formed the basis for the Plastic Identification Tool or PIT[32] created by the Cultural Heritage Agency of The Netherlands, which in 2017 led to 'Project Plastics'. This project aimed to help museums identify the polymers in their collection pieces. The tool called PIT-kit, which promised optimal results, was developed as a DIY method for museum staff. It includes a questionnaire and a sample case for comparison[33], and shows that identifying plastics need not always be expensive[34].

FROM EXHIBITION TO MUSEUM: PLASTICS IN BELGIAN MUSEUM COLLECTIONS

Belgium started to develop a consciousness of plastic items in museum collections in the first decade of the 21st century. FARO, since 2008 the Flemish fulcrum for cultural heritage[35], recognized the necessity of urgent support for museums in the conservation of plastics. In 2013, its periodical, the *FARO Journal on Cultural Heritage* (*FARO tijdschrift voor cultureel erfgoed*), spread the word on the major topics regarding collecting and conserving plastics, such as storage conditions, depot facilities, identification and conservation[36]. By writing about the history and existing collections, initiatives at S.M.A.K Ghent (City Museum for Contemporary Art), FOMU (Photo Museum) in Antwerp as well as major museums such as Die Neue Sammlung, FARO paved the way for greater consciousness and expertise on the issue[37].

The Belgian region of Flanders has its own Design Museum in Ghent, with a comprehensive collection of applied art and design objects, some of which are partially or entirely made from plastics. Although plastics do not form the focus of the museum, its plastic objects collection - dating from the late 19th century to the present - does require specific conservation know how and strategies. That is why the museum actively takes part in a project dedicated to the identification and care of plastics in museum collections called Save the Plastics![38]. It is a joint-venture between the Design Museum Gent and S.M.A.K., supported by the Flemish regional government, to make an inventory of the plastics in their collections. The two museums jointly own about 4,000 items containing plastic.

The Design Museum Brussels on the other hand, was launched at a time when the position of plastic objects in design history was already established [FIGURE 02, FIGURE 03]. That one man's obsession with and collector's urge for plastic objects can turn into a fully-fledged design museum in the capital of Europe is proof of the steady development of both the cultural perception of plastics and the design museums' efforts to broaden and professionalise in sync with the evolutions in the design field. Originally developed around a private collection of some 2,500 plastic items, the museum opened its doors in December 2015, seven years after the MoDiP in Bournemouth and just two years after the FARO Journal's special issue on plastics [FIGURE 04].

The project for a design museum in Brussels featuring a large plastics collection was developed by the Atomium organisation. The Atomium, a 102 m-high scale model of an iron atom, built for Expo 58 (the first world exposition held after WWII), is a major landmark and tourist attraction in Brussels[39]. After its restoration in 2006 and the celebration of its 50th anniversary two years later, the organisation looked to expand its programme around the core themes of modernity and progress[40]. The seed was sown by a unique private collection of plastic objects, including the Golden Sixties, Philippe Decelle's 'Plasticarium', to which the Atomium dedicated an exhibition entitled "Orange dreams. Le plastique c'est fantastique"[41]. The project prompted the Atomium to acquire the collection with the intention of exhibiting it at a new location nearby. This eventually gave rise to the plan to establish a museum of design in Brussels.

The development became possible thanks to a coincidence of opportunities. First, Decelle wished to sell his collection. The Atomium organisation saw this as an opportunity to save a local collection from being auctioned off, and to provide the proper conditions for its conservation and public presentation in the city where it was created. Moreover, it was an opportunity to strengthen the touristic attractiveness of the Atomium area, located on the edge of the city centre, and even to give the capital a design museum worthy of its status. Around the same time, the nearby former Brussels International Trade Mark (BITM) building, a late-modernist project from 1975 designed by John Portman, was in need of a new tenant. This offered a unique chance to display the collection in something else than a series of temporary "cabinets of curiosities", but

04 Front of the Design Museum Brussels. © C. Licoppe 2020, DesignMuseumBrusselsLiophotography

instead to create a fully-fledged design museum around a solid permanent collection of cult design objects, which reflected the optimism of the 1958 Expo. The BITM building was adapted for re-use by the Brussels architectural firm Lhoas & Lhoas[42], based on principles such as making use of the available qualities, organising functions around existing structures, creating a simple and adaptable exhibition system and integrating stock in the building. To provide a specific entrance to the museum, independent from the BITM building, an eye-catching exterior staircase designed by Jean Nouvel was added [FIGURE 04]. The collection was completed with loans from international public collections, galleries and private collectors to form a comprehensive history of plastics[43]. The result is an inventory in excess of 2500 objects, consisting of landmark design pieces, prototypes, consumer objects and artworks.

Rather than presenting objects in chronological, thematic or chromatic order, a more relevant conceptual, social and even philosophical organisation was defined. It bases the scenography both on relevant questions and on connections with other disciplines[44]. In scholarly and museal terms, the main role of the museum is to showcase the importance of plastics in design and to contribute to the academic discussion on the theme. Design Museum Brussels also developed an educational area called the 'Plasticotek'[45]. Organized in a separate space, it offers the opportunity to discover various plastics types and their technical properties [FIGURE 05]. It is of course related to the collection and it contributes to the varied exhibition program of the museum.

At the time of the establishment of the museum it executed a preventive conservation study of the Decelle collection items and found the collection generally in good shape. But this was temporary. Aware of the fragility of such a collection, the museum immediately started working on problems with PVC-p and natural latex in individual objects[46]. For the fashion section of the collection a preservation plan was worked out for the 2017-2018 period, consisting of a chemical degradation study and various conservation interventions, ranging from the creation of a transport box to a discreet and resistant exhibition stand, including performing tests and formulating the limitations of the intervention. From 2019 onward the museum follows a three-year plan for the preservation of the entire collection. For this program they joined the above mentioned PIT Project initiated in The Netherlands and recently adopted by the Design Museum of Ghent with a cleaning research action for the year 2021[47]. This means that, despite the museum's small scale and limited staff, Design Museum Brussels accomplishes its own preventive and curative conservation plan. As a small organisation, and thereby different from larger state or privately owned institutions equipped with conservation departments, some of

05 Radical Design Section of the Design Museum Brussels. © C. Licoppe 2020, DesignMuseumBrusselsLiophotography

them even part of ICOM, such as the Getty Conservation Institute or The Netherlands Cultural Heritage Agency[48], Design Museum Brussels depends on partnerships with central initiatives and laboratories for the necessary expertise. This typical problem for museums lacking a laboratory, was addressed in the 2017 Future Talks edition on the possibilities of the so called Plastic Project 1, which identifies preventive measures for large parts of plastic collections[49]. This initiative can be considered the inspiration for the Save the Plastics! project in Flanders and Brussels. It allows monitoring to be done by in-house personnel, but conservation of objects is entrusted to external specialists. The most important of these is KIK-IRPA, the Brussels based Royal Institute for Cultural Heritage, which carries out interdisciplinary research on materials and techniques used in artworks and cultural artefacts and on the materials and methods used in conservation and restoration[50]. Furthermore, in the academic year of 2020-2021 a project was started in collaboration with two Brussels universities, the ENSAV-La Cambre (conservation-restauration section) and the Haute Ecole Lucia de Brouckère (chemical and bio-chemical engineers section), to conduct research on the identification of adhesives. The project includes research on the cleaning challenges for this specific museum collection. Thanks to these initiatives, the specific plastics conservation assignments of the Design Museum Brussels could be entrusted to a network of external professionals.

As the novel avenues of post-war every-day life and domesticity became the subject matter of hundreds of studies in numerous fields, the importance of plastics in specific disciplines, ranging from art, architecture and design to chemistry, history, sociology and museology, was laid bare. As design museums developed expertise, they became conscious of hitherto unknown problems in the preservation of plastic objects. While there are plenty of students interested in restoration studies of traditional materials, the restoration of plastics is a niche specialisation for which the interest is not on par with the sheer amount of material present in collections, which are still growing in size and number.

Thanks to the consciousness of its importance, one afficionado's personal plastics collection became the core of a museum dedicated to the history of Belgian design. This was only possible thanks to substantial investments in an inspiring but decaying material, once adored for expressing progress and optimism, now damned for polluting the environment.

CONCLUSION

The conservation policy of the Design Museum Brussels and the evolution of its collection, which started as a private collection of design objects and furniture, is a good case study to show how an open, collaborative and interdisciplinary approach can be developed in a short timespan and even in a small organisation. Such an approach is essential to make progress in the knowledge of plastics, their deterioration processes and conservation methods and materials. Our brief analysis also reveals that it is necessary to give plastics conservation a more explicit place in higher education courses across related fields. This would benefit the collection, conservation and presentation of our common plastics heritage, which is an irrevocable part of modern cultural history.

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PLASTIC FURNITURE IN POST-WAR BELGIUM

The Case of Meurop (1958-1980)

Katarina Serulus

ABSTRACT: This paper discusses the production of plastic furniture in post-war Belgium. Plastics were commonly used to imitate wood in order to mass-produce traditional furniture in popular styles. This provoked strong reactions from the traditional furniture industry protecting their trade, and from modernists, who rejected the "dishonest" use of materials. The Meurop company was established in 1958 with a policy to offer good design at affordable prices. Targeting the new European market, Meurop developed its own distribution system of shops that covered Belgium, Luxembourg, The Netherlands, France, and Germany. In 1960, it was the first Belgian furniture company to open its own plastics department, designing and fabricating modern designs created by its own art director, and later, by its in-house design studio. Later, as a result of the 1973 oil crisis and a different attitude to plastics, Meurop's plastic dream ended and the company had to close its doors in 1980.

KEYWORDS: plastic furniture; Meurop; post-war Belgium; mass production; plastic heritage

INTRODUCTION: Plastic furniture made its entrance in the Belgian interior after WW II. International brands like Knoll and Herman Miller conquered the high-end Belgian market with modernist furniture made of plastic materials that were soon endorsed by progressive intellectual circles.[1] In the 1960s, Italian plastics also found their way into the Belgian markets.[2] When, in 1968, the renowned Biennale Interieur in Kortrijk opened its doors, it was particularly the new Italian design – with its experimental application of plastics enabling vivid colours, slick shiny surfaces, and sloping shapes – that made the hearts of Belgian middle-class consumers beat faster [FIGURE 01]. "*Blow*" – the first inflatable armchair produced in large numbers – could even seduce the Belgian Prince Albert to test it at the inauguration of the first edition of Biennale Interieur in 1968 [FIGURE 02].

Meanwhile, the Belgian production of plastics for interiors started off slowly. The very first furniture company in Belgium to set up a large-scale production of plastics was

01 View of the first edition of the Biennale Interieur, Kortrijk, 1968. © Collection Biennale Interieur Kortrijk

02 Price Albert inspecting together with Lut Schots-Devroe the Italian Blow of Zanotta, the first inflatable armchair produced in large numbers, at the first edition of the Biennale Interieur, Kortrijk, 1968. © Collection Biennale Interieur Kortrijk

Meurop.[3] It originated from the Belgian enterprise Trefac, a wire pulling factory in Rijmenam that was established in 1946. From 1956 onwards, Trefac started to produce small pieces of furniture. In view of the new European market and the export opportunities, the directors of Trefac decided in 1958 to create a new and much larger furniture firm: Meurop [FIGURE 03]. The policy of the new company was to offer good design at affordable prices through mass-production: a Belgian Ikea *avant la lettre*.[4]

In contrast with the international brands mentioned earlier, Meurop did not aim for high-end production of plastic furniture for culturally progressive circles, but targeted the mass market with affordable home products and ready-to-assemble furniture. Specifically, it targeted the new European Common Market that had come into effect that same year. Indeed, its name gives away these commercial ambitions: "Meurop" is a contraction of the French word *meubles*, meaning furniture, and *Europe*. The European future was exciting for Belgian industrialists, since it represented a new post-war economic reality and the chance to access much larger markets.[5] Moreover, Belgium was one of the driving forces behind European unification with Brussels taking on the role of Europe's unofficial capital, culminating in the 1958 Brussels World's Fair.

To be able to act directly in this new extended European market, Meurop developed its own distribution network with shops in Belgium (1958), The Netherlands (1959), France (1961), Luxemburg (1963), and Germany (1964).[6] With the slogan "from factory to the home," Meurop opened more than 60 shops in Western Europe and expanded its mail-order sales business through the distribution of advertising brochures.[7] The brochures had a wide circulation with a print run of 780,000 copies in 1959; by 1970, this number had increased to three million. The head office and factory were located in Bonheiden-Rijmenam, a small village close to Mechelen. The factory was responsible for the production for the whole of Western Europe and incorporated various workshops: woodwork, metal, sewing, matresses and a print department for the many advertisement brochures that were distributed by mail. At its height in the 1960s, more than 1000 people were employed at Meurop.

The international ambitions of Meurop were also reflected in its artistic choices. The company employed the renowned French designer, Pierre Guariche (1926-1995) as its art director.[8] Guariche was a respected designer who worked with important furniture producers like Steiner and Airborne in France.[9] For Meurop, he designed a homogeneous modern collection of modular elements and functional furniture. In 1968, Guariche was succeeded by an in-house design studio headed by

03 Walter Bresseleers, Meurop's head offices and shop at the Paleizenstraat 65-67 in Schaerbeek, 1957. © Private archive Walter Bresseleers

Guy Bernard. The in-house design studio developed new furniture ranges, working together with Belgian and international modernist designers such as Robert Heritage, Jean-Paul Emonds-Alt, Isidore Zielonka, Willy van der Meeren, Claude Blondel, George Vanrijk, Frank Smout, Guy Gerard, Philippe Neerman and T. Zanko.[10] In the 1970s, the range was expanded with more traditional furniture in semi-historical styles.

THE SIREN CALL OF PLASTIC

In 1960, Meurop made the substantial investment to open its own plastics department. It was equipped with the latest machinery,[11] and employed around 40 people, working in three shifts. It was the first company in the Belgian furniture industry that ventured into the domain of plastics mass-production. Until then, manufacturers would have sub-contracted production of plastic furniture to the petro-chemical industry.[12] In this regard the Belgian petro-chemical industry was strongly influenced by recent developments in the United States[13] through the inflow of American products, business models, and know-how stimulated by the Marshall Plan.[14] Following the American example the Belgian petro-chemical industry moved into the market of plastic products for interiors.

The petro-chemical industry had promoted the presence of plastics in the Belgian home, but usually in the guise of traditional materials, such as wood.[15] The formal possibilities of plastics were mobilized to mass-produce traditional furniture in popular styles such as Louis XV that

04 Advertisement for Synfina. © Belgian Plastics, 9, VII-1970, p. 95, collection KU Leuven Bibliotheken 2 Bergen Campus Arenberg

dominated Belgian interiors [FIGURE 04]. Wood veneer could be replaced by decorative plastic film, and molding and injection techniques enabled the manufacture of structural elements and even entire furniture pieces in plastic. The distinctive, shiny, slick surfaces of these new materials were most acceptable in the places of the house where utility is key: the kitchen and the bathroom. For example, the Ghent-based firm Vynckier, known as a producer of switchgear cabinets, developed a new collection of plastic bathroom furniture named Vyncolux.[16] Embracing the advertised hygienic character of plastic, the elements were made from formaldehyde resin in an iron mold under high pressure and temperature. Some Belgian firms from the new plastic industry also produced modernist furniture but mostly as sub-contractors. For example, Didak in Grobbendonk produced plastic furniture for Asko, and Synfina fabricated the plastic table 877 designed by Pierre Paulin for Artifort.[17]

The arguments of the chemical companies to favor plastics over traditional materials were many.[18] It was argued that the material was hygienic, low maintenance (no need to repaint or maintain the different kinds of woods), moisture-proof and that the formal and aesthetic qualities of plastics were high.[19] Advertising boasted that differences between wood and plastic could not be detected with the naked eye. The biggest advantage, however, was the price. Plastic was very cheap; that is, until the oil crisis broke out. An important addition to these advantages was that, in contrast to the traditional furniture industry, a furniture piece with very complicated shapes and many details was no more expensive in production than one with very simple shapes. In that way, the price of production could be lowered, which – according to the petro-chemical companies – implied a democratizing of the traditional furniture market.

Using plastic as a substitute for wood provoked strong reactions from the traditional furniture industry, which was still characterized by family businesses using traditional production methods. The arguments they put forward were mainly colored by anti-American sentiment – the presence of the petro-chemical industry in the furniture trade was even dubbed by some as the "the invasion of barbarians."[20] They argued that the American furniture market – where plastics had already made its entry – was not comparable to the European furniture market, since they claimed that European tastes and lifestyles differed strongly from those of Americans.[21]

Modernists also rejected the "dishonest" use of plastic imitating other materials, but from another perspective. In line with the modernist thinking, they promoted the "genuine" and "rational" application of plastics.[22] The Belgian modernist architect Renaat Braem, for example, was convinced that plastics could entail an important liberation within the field of architecture and even make Belgium more beautiful.[23] However, he alerted people to a possible "plastic inferno" when the material was not used "correctly" and bad taste was at play.[24] The Belgian design critic K.N. Elno promoted similar attitudes.[25] He was convinced about the many possibilities plastic offered in the realm of design, but detected two notable problems. The first problem was the prevailing "*plasticomanie*": there was the tendency to produce *everything* in plastic. The second problem was the inability to find an authentic form for plastic goods. He criticized the childish desires of the industry towards imitation and falsification and warned that this would cause distrust among the public and stimulate the impression of plastic as an inferior material.

The new plastics industry worried about its public image, and realized that the association of plastic with "unauthentic" and "dishonest" qualities was a commercial threat. Synfina, the largest plastic processor in Belgium, started an intense advertising campaign to change this negative perception.[26] It underlined that plastic, like other materials, had ancient antecedants as illustrated in an advertisement in *Meubel Echo* that showed natural plastic used in Egypt at the time of Tutankhamun.[27]

PLASTIC AMBITIONS AND PRODUCTION

Meurop was, from a very early date, convinced about the positive possibilities that plastic could offer to interiors. The company initially began production of furniture in metal and plywood but soon entered into the world of plastics.[28] The sales brochures of 1958 show that many furniture pieces on offer were finished with synthetic materials such as nylon, foam rubber, and imitation leather [FIGURE 05]. These materials were not produced in-house, but bought from other producers.[29]

It is unclear how Meurop gathered the knowledge to start in-house plastic production, which was usually held within the chemical industry. In 1960 the board of directors, chaired by the businessman Franz Pottiez appointed an American, Mr P. Molla as an administrator.[30] One can only speculate on the reasons for his involvement, but he may have brought technical knowledge of plastic production in the US. The head of the plastic department, Gaston Van Hove, explained in an interview that most of the workers did not have a specialized education,[31] so after they finished school at the age of 14, they started in the factory and learned by experience. All the machines had to be manually adjusted, and this was mostly a process of trial and error.

The first synthetic product made by Meurop was PVC cord which was wrapped around a metal frame to create a chair. Meurop had this chair patented in Belgium;[32] and its invention was a radical improvement over rattan, as cords of PVC were cheap, of endless length, elastic and could be colored.

The shell chair *Plastico* was announced in the March 1960 issue as "the first plastics chair" and described as "a plastic shell adapted to the shape of the body, in attractive and modern colors, without maintenance and no need to ever be repainted."[33] Next to this promotional slogan, we see a picture of three housewives sitting on this chair, cheerfully throwing their arms into the air, exclaiming, "the plastic chair has arrived!!!" It is not clear whether Meurop produced this chair itself, but it appears to be an important turning point in the company's endorsement of plastics because, soon after this, Meurop announced its "new plastics department," and expanded its range.[34] Polypropylene was the main manufacturing material, while the brochures kept using the generic term "plastic",

05 Seating units upholstered with imitation leader and nylon upholstering, Meurop brochure, no. 29, 1962. © Collection of the Flanders Architecture Institute – Collection of the Flemish Community

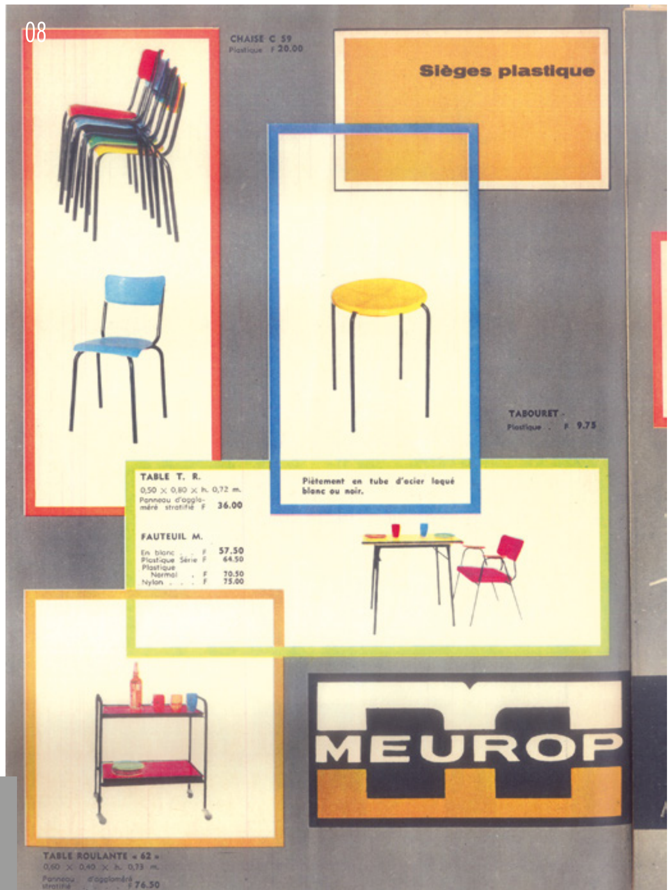
and repeated the advantages of the fabulous material, such as practicality in use, low maintenance, colorfulness, and cheerfulness [FIGURE 06 - 08]. The arrival of the new collection designed by Pierre Guariche in 1961 also included a polypropylene shell chair called "*Sea shell*." At this point the brochures no longer only expressed practical and useful properties, but also carried more qualitative and normative designations. The chair, for example, was advertised as decorative and elegant.[35]

In 1964, a new synthetic material was introduced in Meurop's collection: wall panels with PVC laminate that imitated different sorts of wood.[36] It was probably not made in Meurop's factory since it was sold under its trade name *Renolit*. The new material changed the look and the feel of its home goods completely. All the furniture – from desks, kitchen cupboards to beds that were previously laminated with wood veneer – were now only available with a PVC finish. Meurop's initial modernist approach

06 Meurop brochure announcing 'New articles from the department plastics', no. 11, 1960. © Keerbergen, Personal collection of former employee Claude Pire

07 'Color and at home by plastic', Meurop brochure, no. 12, 1960. © Keerbergen, Personal collection of former employee Claude Pire

08 Plastic chairs promoted in Meurop brochure, no. 13, 1963. © Keerbergen, Personal collection of former employee Claude Pire



had been overtaken by trends for imitation promoted by the chemical industry in the traditional furniture industry.

A number of plastics were introduced in 1967 that generated new possibilities in design: notably high-impact polystyrene and rigid polyurethane. The first was used for the futuristic range of chairs called *Starlook-ultralight* designed by Pierre Guariche.[37] Their illustrious names were: *Mars*, *Polaris*, *Jupiter* and *Luna*. This series of organic and soft chairs were meant for the living room where they would "embrace" the user "in all [their] softness" – as the advertisement goes. Vacuum-formed polystyrene was mainly used for storage objects to be hung on the wall, mirror frames, and parts of cupboards or chairs [FIGURE 09 - 11]. The shiny surface and the bright colors made these polystyrene objects very attractive, and they are often seen illustrated in a teenager's or child's room.

Meurop's ambitions in the domain of plastics reached further still. The company aimed to create a plastic shelf to be comparable with its chipboard counterpart, in both weight and cost.[38] It developed a new concept based on square tubes: hollow elements made by extrusion. These tubes could be cut to any length and also welded together. Other factories had experimented with plastic shelves at the beginning of the 1960s, but could only achieve a maximum width of only 20 centimeters, whereas Meurop succeeded in producing shelves up to 60 centimeters wide.[39] This production technique was clearly of value as the managing director, Franz Pottiez, patented it in ten different countries: Belgium, Germany, Luxembourg, Sweden, America, Great Britain, Switzerland, The Netherlands, France and Canada.[40] This development led to a whole new range of easy-to-assemble products from 1967 onwards: cupboards, office furniture, bathroom furniture and more, all completely made from plastic.

The plastic euphoria did not last long. At the end of the 1960s, plastics suffered increasingly from a poor image when people became aware of the negative consequences for the environment. Issues such as recycling and the "throw away mentality" gave plastics a bad reputation. This was connected to the new ecological mindset

09 Bed room furniture in high-impact polystyrene, Cover Meurop brochure no. 101, 1970. © Rijksarchief Antwerpen-Beveren, bedrijfsarchief Philippe Neerman

10 Seating elements in high-impact polystyrene and polystyrene foam, Cover Meurop brochure no. 140, 1972. © Rijksarchief Antwerpen-Beveren, bedrijfsarchief Philippe Neerman

11 Furniture in high-impact polystyrene, Meurop brochure, no. 5, 1971. © Collection of the Flanders Architecture Institute

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that emerged in the 1970s.[41] In 1972, the Club of Rome, founded as a think tank by scientists in 1968, published its widely read report "Limits to Growth." The report warned about the exhaustion of natural resources on Earth, particularly oil. Its message was reinforced when the oil crisis hit the following year and car-free Sundays were organized. That same year, designer Victor Papanek published his controversial and well known book on design: *Design for the Real World: Human Ecology and Social Change*.[42] He presented an activist agenda that particularly appealed to young design students: "As socially and morally involved designers, we must address ourselves to the needs of a world with its back to the wall while the hands on the clock point perpetually to one minute before twelve."[43] These publications were early indications of a growing aversion toward the modern consumer society, of which plastic was to became a negative symbol [FIGURE 12].

For Meurop, the oil crisis and the new ecological concerns were disastrous. It became expensive to make synthetic products and the negative associations with plastics curbed sales. The price of polystyrene had risen by 65%, and repeated financial reports noted that the plastics department, once very successful, had become a weak section of the company.[44] This also meant that investments into plastic shelving and the associated licenses were no longer profitable, and, furthermore, Belgium became burdened by high inflation. In 1980 Meurop's plastic dream ended and the company had to close its doors.[45]

The history of plastic design in Belgium remains a largely unexplored field for scholars. Little literature is available on the production, mediation, and consumption of plastics. While plastics played an important role in shaping the everyday material environment in post-war Belgium, plastic goods by Meurop had difficulties in finding their

12 Meurop furniture selected for the exhibition In echt plastiek / En plastique véritable by the Brussels Design Centre in 1970. All the selected pieces were made of high-impact polystyrene, except of the chair that is made of polyurethane foam. © Collection of the City Archive Gent, VDBP_P6.1

way to the design canon. However, as the case of Meurop illustrates, this area of design is nevertheless an important part of Belgium's design history as it reflects the enormous appeal and potential of the European mass market, and the hopes and dreams connected with plastic as the material for the modern world.

CONCLUSION

The experience of Meurop describes the post-war experience of growing affluence and availability of new plastic products to broad sectors of society. Over a period of about fifteen years the production of popular consumer goods evolved from aspirational, design-led products to more popular styles with wider appeal. Eventually, increased public awareness about the environmental impact of mass-produced plastic was followed by the economic impact of the oil crisis which made plastic products far less economically viable.

ENDNOTES

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The local history club 'Heemkring Het Hoefyser' organised in 1994 a small exhibition and published a booklet 'N.V. Trefac - N.V. Meurop. 1946-1980' on the history of the company. Meurop is also shortly mentioned in: Javier Gimeno-Martínez, "Redefining Social Design in 1970s Belgium: Affordable Design Vs. Elite Design," *Interiors*, 2, 2011, 149-167; Monique Bucqoye, Lieven Daenens and Mil De Kooning, *Forms from Flanders. From Henry van de Velde to. Maarten van Severen 1900-2000,* Gent/Amsterdam, Ludion, 2001; Lise Coirier, *Design en Belgique/in Belgium/ in België 1945-2000*, Brussels, Racine, 2004; Philippe Decelle, Diane Hennebert and Pierre Loze, *L'utopie du tout plastique: 1960-1973*, Brussels, Fondation pour l'architecture, 1994.

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5 See Katarina Serulus, *Design and Politics. The Public Promotion of Industrial Design in Post-war Belgium (1950-1986)*, Leuven, Leuven University Press, 2018, 101-130.

6 Katarina Serulus, "Meurop in Holland 1959-1960. The Mediation of Popular Design" (dissertation, VU University Amsterdam, 2011); Katarina Serulus, "Het Plastic Meubel in België (1954-1973)" (dissertation Katholieke Universiteit Leuven, 2010); Javier Gimeno-Martínez, "Redefining Social Design in 1970s Belgium: Affordable Design Vs. Elite Design," *Interiors*, 2, 2011, 149-167.

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Katarina Serulus *studied art history and design cultures at the KU Leuven and the VU Amsterdam. In 2016, she defended her PhD thesis at the University of Antwerp. Since 2017, Serulus has worked as a project manager at the Flanders Architecture Institute (VAI). Serulus also curated several design exhibitions. She was (among others) the curator of Panorama: A History of Modern Design in Belgium (2016-2017) at ADAM Brussels Design Museum and co-curator of Night Fever. Designing Club Culture 1960 – Today (2018), a coproduction between the Vitra Design Museum and the ADAM Brussels Design Museum.*

PLASTIC FINISHES IN 1960s BELGIAN OFFICE BUILDINGS

Nick Serneels, Philippe Lemineur, Marieke Jaenen

ABSTRACT: This paper focusses on the presence of visible synthetic materials (plastics) and finishes from the 1960s in the interior of office buildings. Although the ongoing research on synthetic materials as art pieces is well developed, building components from the interior and exterior of Belgian patrimony have not yet been studied, and remain undervalued as integral components of heritage buildings. The research presented in this paper tackles this issue by examining two specialized Belgian journals, namely *La Technique des Travaux* and *La Maison*. A selection of case studies from these two journals was examined in-depth to assess general tendencies and obtain a thorough evaluation and validation of the visible plastic materials and finishes in the case studies: the floor, wall and ceiling finishes. The plastic elements of listed monuments have often been removed, and do not receive a similar level of protection to other materials. Plastic heritage is not valued and protected as a relevant part of recent historic architecture. This part of the built patrimony needs to be recognized with equal status and therefore conserved.

KEYWORDS: plastics; synthetic materials; interiors; finishes; Belgium

INTRODUCTION: The 1960s is often characterized as an optimistic decade with a booming economy. Life became more vibrant and color was an important element in building interiors, which could be expressed in the new synthetic material, plastic. The use of industrially manufactured plastic for the building market grew from original uses in military equipment.

The flexibility of plastic fabrication enables specific characteristics to be incorporated into a particular component. Therefore, many interior floors, ceilings and walls of office buildings from the 1960s are finished with synthetic materials and finishes, such as the moveable partition walls of the Belgian Radio and Television (BRT) Center building, the wall and ceiling elements used in the Solvay research center and the moveable partition walls found in the Glaverbel Headquarters. These are all finished or manufactured from polyvinyl chloride (PVC). The value attached to synthetic materials has changed in the course of time[1].

The synthetic materials and finishes in the interior of buildings are commonly seen as 'secondary', that is, they are used to reduce the cost of the construction and serve as 'cheap' alternatives to traditional materials. However, they have a high historic value.

This paper aims to investigate the plastic heritage found in the interiors of office buildings in Brussels by collating case studies based on Belgian publications and particularly from Belgian architectural journals. The cases were listed and analysed as an inventory, and an in-depth investigation of selected examples were carried out. Three levels consisting of a literature study, archival research and an in-situ investigation were explored. The reasoning behind the design of plastic elements was examined in both a theoretical and practical manner and validated in practice. [2]

Case studies have been selected from 1933 as that year marks the introduction of several well-known plastics on the commercial market e.g. polyvinyl chloride (PVC), polyethylene (PE) and melamine formaldehyde resin (MF) which forms the basis for Formica. The synthetics composed before 1933 benefited from the properties of natural resins that would function as the matrix for the end product. *Plastics Now*, an American publication is one of the leading pieces of literature used in this research to construct a critical analysis of the materials throughout their history. Investigating the general tendencies and the global evolution of plastics shows that Belgium did not play a leading role in the development of today's plastic industry. [3] This lack of development is also reflected in an absence of knowledge about the fabricated components in buildings. The elements that are discussed in this paper have both an aesthetic and functional purpose in comparison with the better-known plastic 'heritage', namely art pieces or furniture. Several research groups have already investigated and questioned methods for the conservation of art pieces in museums, with a loss of function as a necessary consequence. The degradation of the synthetic fabric may reach an irreversible degree, or the degradation may be stabilized. The object becomes a museum object without a defined function to be preserved for future generations[4]. As part of buildings the materials and finishes described in this paper cannot be stripped of their function, and therefore other conservation strategies should be used to conserve them. Research on plastic heritage has not focused on materials used for finishing floors, walls and ceilings, which results in a lack of conservation methods when dealing with this specific challenge.

INVENTORY

First an inventory[5] was collated in order to obtain examples of visible, plastic interior elements. The book *Renaat Braem 1910-2001* provided 15% of the cases and 70% came from two journals, *La Technique des travaux* and *La Maison*. The remaining 15% were found in other literature such as *Brussels Hoofdstedelijk Gewest,* or verbally from specialists. Overal this literature study does not provide sufficient examples to reach an adequate conclusion, however the numerical results will be presented at this phase of the research.

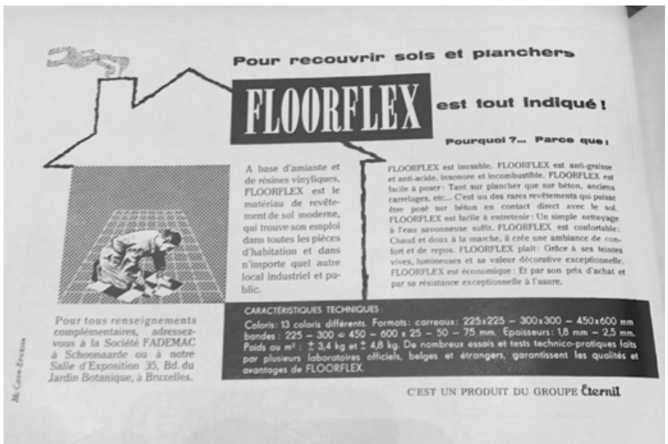
ARCHITECTURAL JOURNALS

The two journals, *La Technique des Travaux* and *La Maison*, were scanned for reference projects, over the whole period of publication of the journals (1925-1977). The first journal *La Maison* focuses on the interior of buildings and was published during the period 1945-1970 in Brussels. The journal sketches the future way of living and how rooms should be designed. The materialization of the entire room/project, going from furniture to fixed elements, is the main focus of the different articles present in the journal. It was the first of the Belgian architectural journals to be published after WWII. The focus lies on the construction, decoration and equipment of residential buildings. *La Maison* aimed to contribute to social and technical innovation without compromising the spiritual dimension of culture. The overall perspective was to introduce tendencies, and to point at the necessity of the architect as designer of the home. The head director P. L. Flouquet visited the salons frequently and reported on his observations of the new developments in the construction industry, domestic installations and way of living. [6]

The second journal is *La Technique des Travaux* which is a technical journal and focuses on the constructional aspects of the projects. The journal was published in Liege between 1925-1977. The case studies are contemporary buildings chosen for their exceptional or innovative construction. Descriptions of the finishes are briefly provided in the main text or as a caption accompanying photographs. The high rate of development within the construction industry was the main reason for publishing the journal.

Both journals aimed to reach a wide range of readers: engineers, architects, building contractors and designers. They should be seen as a combination of descriptive literature, photographic material and technical drawings. They also aimed to contribute to the debate concerning modern architecture in Belgium, with the editions published after WWII focusing on the global developments of concrete architecture.[7] The different approaches of both journals complement each other in such a way that both the technical and aesthetic aspect and quality of the material were addressed. The two journals have provided interesting and different approaches of looking at the applied materials.

Apart from the case studies found in the journals themselves, the advertisements of new synthetic materials for interior finishes were an important secondary source. Typical examples are Clartex, Solclip or Floorflex respectively produced by the companies Plastic-Benelux, a subsidiary of Eternit, and Rohm & Haas Gmbh, a German company. The products were distributed in Belgium by the company Camille Honhon and Fademac. Clartex is a polyester based product with a corrugated profile, available as tiles or rolls, and used as a finish for walls and ceilings. Solclip and Floorflex are both PVC floor tiles [FIGURE 01]. The possibility of finding more advertisements in order to analyze the manufacturers was also investigated, but with insufficient results.



01 Advertisement for Floorflex. © La Technique des Travaux, January-February 1955

The inventoried examples are selected on the basis of three different criteria:

1. The presence of one or more types of plastics.
2. The plastics need to be visible in the interior, which will exclude, for example, insulation.
3. The project should be part of the Belgian patrimony.

The criteria resulted in 41 projects included in the inventory. *La Technique des Travaux* provided 20 projects and *La Maison* added another 8. The other 13 cases studies are extracted from other sources. These projects are then analyzed on different levels: their geographic location, construction date, typology and most importantly: the types of plastic that were used.

THE EXAMPLES IN NUMBERS

Most of the examples of plastics that were mentioned in sources were located in Brussels (over 60%) and over a quarter were in Antwerp. Over 40% of examples were in office buildings, and about a quarter in residential buildings, and nearly 70% date from the 1960s. The contents of the inventory show that PVC and its derivatives were the most commonly recorded form of plastic, and were particularly found as floor, wall and ceiling coverings [FIGURE 02].

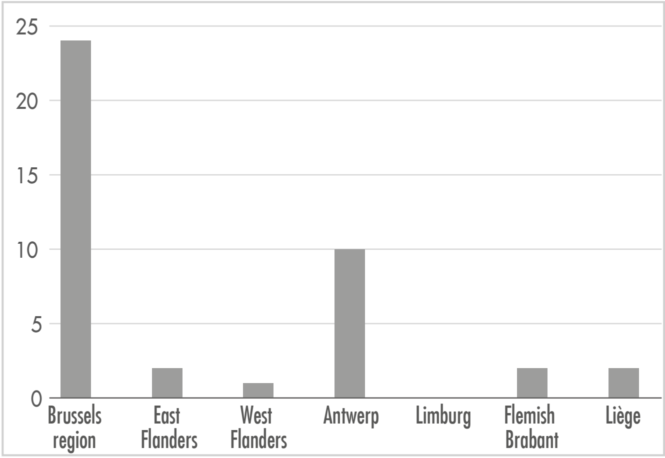
The booming phenomenon of emerging administrative companies in Brussels resulted in specialized manufacturers of plastic elements[8]. The urban evolution of Brussels is thoroughly explained and gathered in *Het Brussels Hoofdstedelijk gewest.*[9] Other literary works like *Brussel: Geplande geschiedenis, stedenbouw in de 19de en 20ste eeuw* and *Architectuur sinds de Tweede Wereldoorlog* provide an in-depth investigation of the urban fabric and tendencies[10] [FIGURE 03].

The development of administrative buildings in Brussels has been a trigger for the integration of plastics to the interiors of buildings in general. This is also the leading typology throughout the cases of which all but two are in Brussels. The focus on one typology should also be seen from of the commercial perspective as a specialization of the plastic industry. The elements produced by mass production are integrated mostly in more flexible buildings [FIGURE 04].

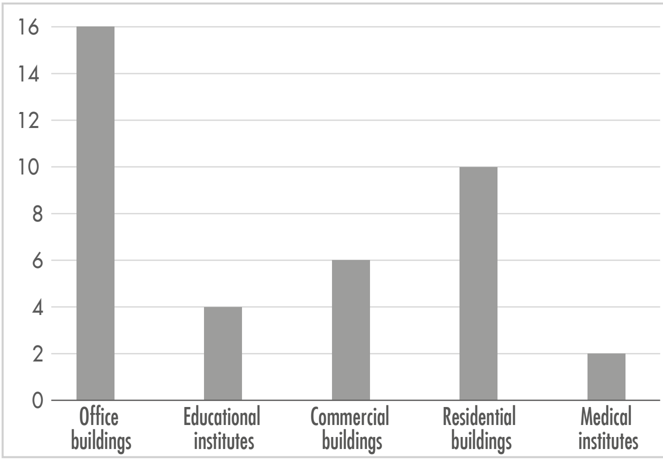
The construction dates of the different cases are concentrated around 1960-1969, when a great number of office buildings emerged in Brussels compared to the rest of Belgium. Overall distributions and specifically those in Brussels both show a similar evolution with a sudden drop in the 1970s, which is also reflected in the journals.

TWO FOCUS CASES

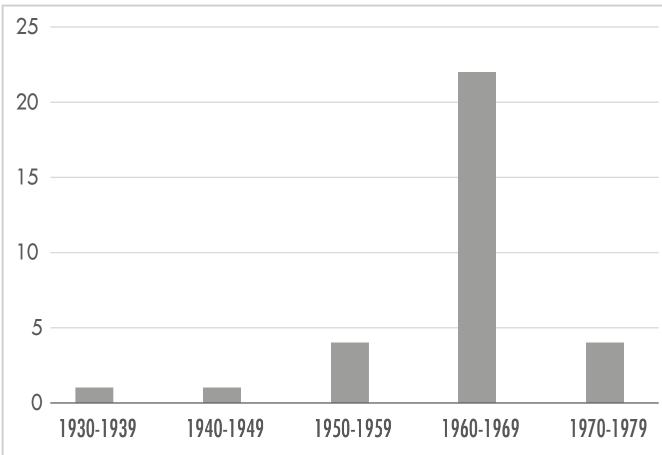
On the basis of the numerical categories above, studies[11] were selected from the 41 examples included in the inventory. The Belgian Radio-Television (BRT) center in Brussels will serve to illustrate the in-depth research



02 Geographical distribution of cases in Belgium.



03 Typological distribution of cases in Belgium.



04 Chronological distribution of cases in relation to the construction date.

The case studies are investigated on three different levels:

1. Literature study: journals and other written sources were used to obtain a first level of information of the materials chosen to make certain components of the building.
2. Archival research: the archival research focusses on the documentation available in public archives. The research aimed to confirm the results of the literature study.
3. In-situ visit: the two previous levels of research are to be verified by an in-situ visit. This third and final level serves to indicate broader practices: e.g. how are plastic elements treated when it comes to a renovation or rehabilitation of the original building?

The first two levels are examined to understand the initial concept behind the design of the building, and determine the different materials used within the building. An in-situ investigation of the cases will provide insight about the materials still available in the building.

05 View of the BRT Center. © N. Serneels

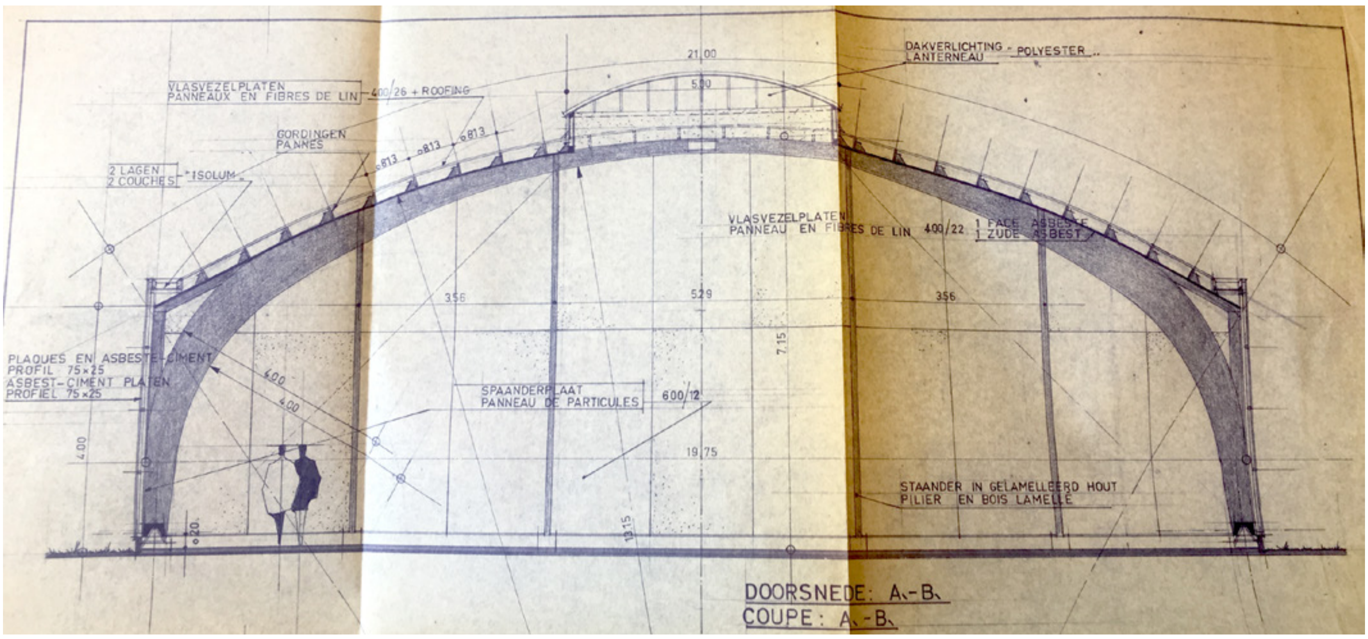
THE BELGIAN RADIO-TELEVISION (BRT) CENTER IN BRUSSELS

This case study is a multi-functional site in Brussels that includes office buildings, a daycare center, a sports center and a park. The site is best known for the iconic telecommunication tower. The construction of the adjacent office buildings started in 1964 to the design of Paul Ramon, a significant figure in the construction of office buildings in Brussels. The construction of the whole site would take 17 years to finish and would accommodate the Flemish and Walloon Radio and Television company in a symmetrically designed building complex. The northern part for the Flemish and the southern part for the Walloon company and connecting these two complexes is the common circulation area. The facades of the buildings are furnished with a repetitive polyester frame around the window openings [FIGURE 05].

The journal *Technique des Travaux* identifies moveable partitions with a vinyl finish for 200 offices in the building. These elements provided a high degree of flexibility to the building.

The literature study is not supported by the archival research. The moveable partitions are not mentioned in the archival documents consulted at the archive of Schaerbeek, although plastic interior elements in other buildings on the site are mentioned.

The daycare nursery on the site was initially executed with PVC floor tiles. The most impressive structure from the original project is the sports hall. According to the plans, this hall is a polyester balloon structure constructed in 1979. The archival research showed that the inflatable was replaced by a permanent construction with a



06 The presence of polyester in the second sports hall, 1976 at BRT-Center. © Communal archive Schaerbeek, 52/B.R.T. Art 47 - Sporthal bouwen, 1975

synthetic roof covering. The archival documents also mention Plexiglass glazing [FIGURE 06].

IN-SITU VISIT

The in-situ visit provides a new dimension to the research above as most of the elements found in the archival literature study no longer exist in the BRT buildings. The main buildings show very few elements made from synthetic materials. A few remaining doors and window sills are rare examples of the large amount of plastics that would have been found in the original buildings [FIGURE 07]. The moveable partition elements that are discussed in the literature have been reconstructed as timber panels.

The in-situ situation suggests that more plastic elements were present originally than have been found in the trade journals, and that these were removed during the renovation of the buildings. The Belgian Radio-Television (BRT) Center building can be seen as an example of how heritage built in the second part of the 20th century has been the subject of change. Although the building is listed and described in the inventory of Brussels patrimony, the original interior plastic elements are not mentioned, which implies that the Agentschap Onroerend Erfgoed did not consider these elements to be valuable.[12]

Also the Library of Scholten was renovated with respect for the original appearance and materialization.

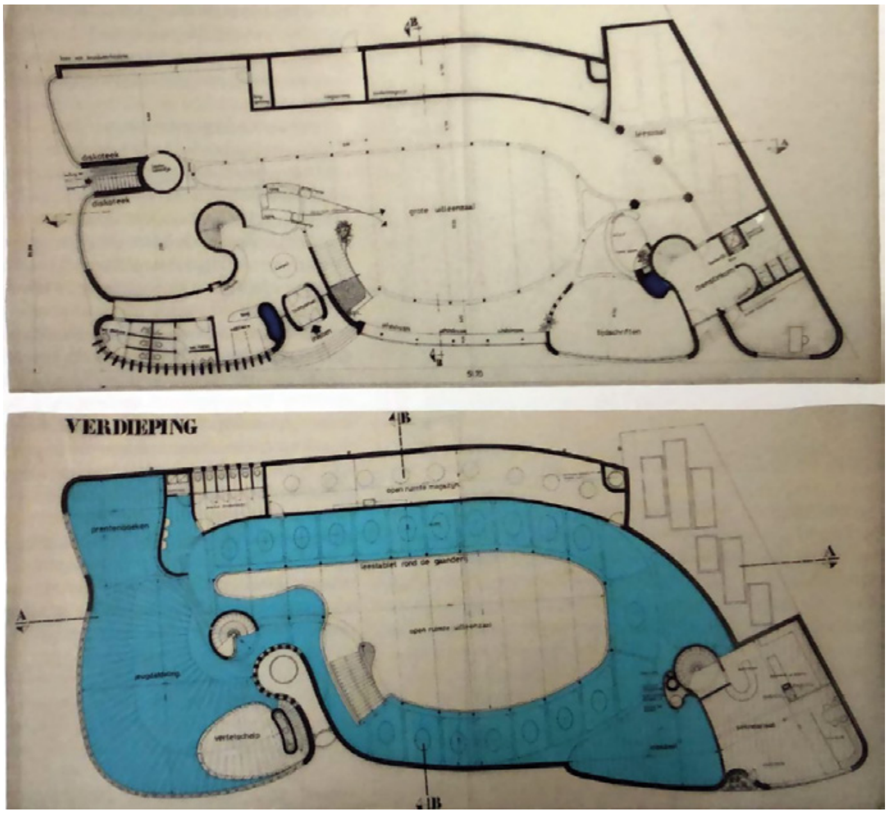
THE LIBRARY OF SCHOTEN

The Library of Schoten is a project designed by Renaat Braem and Piet Janssens, and has been given the status of monument in 1998. The building is situated next to the St Cordula Church built in Neo-gothic style, and therefore needed to exhibit an architectural presence in comparison with the monumental church. The library has an organic morphology and a distinct spatial positioning in the urban fabric

The library needed to become a cultural hub where different generations could meet and experience the collections of literature, knowledge and music in one building. According to Braem the building needed to be a functional sculpture, and therefore the need for art pieces integrated in the building would be unnecessary. The program of this project is conceptualized through an organic promenade where the morphology of the building is inspired by seashells. The building exhibits three materials: masonry and concrete for the structure and glass. The building has an open plan as shown in [FIGURE 08] which is conceived by a structure consisting of reinforced concrete beams supported by the masonry walls. The construction materials are a subtle reference to the church adjacent to the library [FIGURE 09].

The project and more specifically the shell have been explained thoroughly in the design and the choice of

07 Door finished with synthetic fabric at the BRT Center. One of the few remaining witnesses of the initial presence of synthetic materials in the building. © N. Serneels



08 Organic floor plan of the library. © Braecken et al. 2010

09 Exterior of the library of Schoten is a project of Renaat Braem completed in 1974. © N. Serneels

materials, with the impact of the construction being the primary reason for Braem's explanation. This project illustrates that architectural importance and grandeur are more significant motivators than the materialization of the shell, but this project is not a representative case that have been included in the inventory since it is the conception of an object and not so much the finishing of wall, floor or ceiling [FIGURE 10]. It shows that to accomplish the specific designed shape, the innovative material was chosen for the characteristics it is able to present [FIGURE 11].

In the period 2012-2017, the building and shell have been subject of a restoration/renovation campaign which provided both the fresh aesthetic appearance shown today, which also reflects the original, authentic architectural expression in both materialistic and aesthetic level.[13]

10 Polyester shell in library of Schoten. It is fully made out of polyester and serves as reading corner for children in a library. ©Van de Voorde et al., 2015

11 Polyester shell after restoration. © T. Vereenooghe, retrieved from https://flic.kr/p/VgDtS6

HERITAGE PERSPECTIVE: THE VALUE OF OUR PLASTIC PATRIMONY

The introduction of plastics to the building market initially had a strategic purpose to shift the market from war production to modern, civil society. Nonetheless, it has a higher than imagined impact in expressing the post-war mentality. The optimism that is materialized in plastic elements should therefore be seen as a primary heritage value of plastic.

A strong point of plastic is its flexibility. Within the limits of science, the material has been used for the set of parameters that is needed. The material can be manipulated and crafted as the producer wishes. Therefore, the strength of the material lies in its characteristics, and perhaps not in the fabricated objects.

This should not be seen as a reason to downgrade the value of plastic elements from the 1960s. The evaluation and preservation of a building that is subject to renovation or even restoration should be done in the same manner for all materials. When a restoration project includes authentic elements made from synthetic materials that need to be replaced, the question arises whether the elements meant for substitution also need to be made of a synthetic material. Clear heritage conservation principles should also be developed for plastics in architecture.

CONCLUSION

Plastic heritage is not valued and protected as a relevant part of recent historic architecture. This is in contrast with the importance assigned to plastics in illustrated contemporaneous journals. This part of the built patrimony needs to be recognized with equal status and therefore conserved.

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1 Faircloth, Bill, *Plastics now, on architecture's relationship to a continuously emerging material*, New York, Routledge, 2015.

2 For example: SERULUS, Katarina, *Design & Politics: The Public Promotion of Industrial Design in Postwar Belgium (1950-1986)*. PhD, University of Antwerp, 2016.

3 Ibid.: p. xiv-xv.

4 SHASHOUA, Yvonne, *Conservation of Plastics: Material Science, Degradation and Preservation*. 2nd edition. Slovenia, Taylor & Francis Ltd. 2009.
WILLIAMSON, Colin, 'Plastic fantastic'. Faro tijdschrift over cultureel erfgoed, n°6 (december 2013): 24-29.

5 The research explained in *Plastic Finishes in Interiors* will serve as a strong bases for the second chapter of this article since it is still valid. (SERNEELS, Nick, *Plastic Finishes in Interiors*, Plastic Seminar University of Antwerp, Antwerp, 5th of March 2018.)

6 VAN LOO, Anne (red), *Repertorium van de Architectuur in België*, van 1830 tot heden, Antwerp 2003, p. 413.

7 VAN LOO, Anne (red), *Repertorium van de Architectuur in België, van 1830 tot heden*, Antwerp 2003, p. 536.

8 SERULUS, Katarina, *Design & Politics: the Public Promotion of Industrial Design in Postwar Belgium (1950-1986)*, Phd, University of Antwerp, 2016.

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11 The buildings selected already served half a century and all have been the subject of some kind of renovation. Therefore the initial materiality should have been evaluated of which the conclusion is of great importance in this last level.

12 Irismonument, Schaarbeek Auguste Reyerslaan 52, http://www.irismonument.be/nl.Schaarbeek.Auguste_Reyerslaan.52.html, last consulted on 27th of May 2019.

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THE FUTURO

History, Design and Construction in Finland and the USA

Pamela Voigt

ABSTRACT: The Futuro by Matti Suuronen reflects the confidence in the possibilities of plastics as a new building material of post-war times. A number of the 70 to 100 Futuros that were built worldwide still exist and, generally, they are now being preserved. A comparison of four restoration approaches of Futuro Houses, dating from 2007 to 2018, has given insights into the specific constructive features, modifications and the challenge of their complex materiality and innovative design. This explains the complexity of the conservation process.

KEYWORDS: Futuro House; Matti Suuronen; Polykem Oy; FUTURO Corporation; sandwich construction

INTRODUCTION: Suuronen's Futuro houses reflect the confidence in the possibilities of new building materials like plastics. Building envelopes made of fibre-reinforced plastics characterised the prosperous post-war decades of economic strength within architecture and design.

The aim of the paper is to explain the Futuro houses in terms of construction history based on design principles within Europe and the USA. The preservation of architecture presupposes an understanding of the materials, the structure and the technical details. In analysing their design, construction and engineering structure, Futuros and other plastic buildings can professionally be conserved for future generations.

THE FUTURO HOUSE

The Futuro, made in 1968 of fibre-reinforced plastics, reflects the optimism of the era of space exploration when people believed technology could solve all problems for

01 House of the Future, USA, 1957. © IBK Archive, 2004

02 Wilp-Futuro, Munich, GER. © BAKU, P. Voigt, 2017

the human race. In the post-war years building professionals and manufacturers were dreaming of low-cost prefabricated housing, of mobile housing, and housing built using the latest technologies and materials. Durable plastic furniture, dishware and hardware made life easier and colourful. Monsanto´s House of the Future, displayed at Disney´s Tomorrowland (1957-64), Matti Suuronen's Futuro house (1968) and Kurokawa´s Habitat-Capsule, presented at Expo70 in Osaka, Japan (1970) all embody the feelings of their age as the 'the look' due to their pure geometric design, colours and new materials. [FIGURE 01, FIGURE 02] (Lesley,1998).

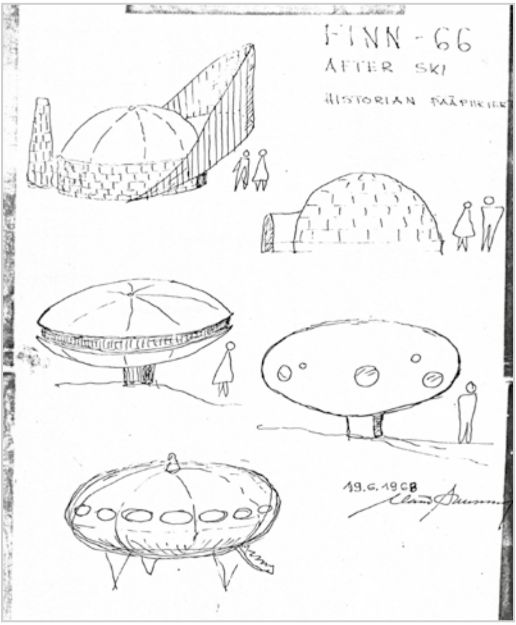
"The house (Futuro) represents very well its contemporary way of thinking and living with a strong confidence in the future – 'futuro'. In the same era in 1969 people saw on the blurry TV-screen as Neil Armstrong stepped onto the moon as a first human being. A Russian cosmonaut had already been flying in the orbit in 1961. The space seemed to offer an enormous potential for becoming a new playground for the human nation" (Kuitunen, 2010, p.3). The spaceship-like, capsule Futuro became a popular icon (Home, 2002, p. 48) and the photographer and advertising guru Charles Wilp (1932-2005), who was actively inspired by space throughout his life (and therefore called himself an "ARTronaut", Cleworth Archive), had one erected on the roof of his house in Düsseldorf in the 1970s. He received guests such as Andy Warhol and Christo, who apparently planned to wrap the Futuro during one of his art actions (Cobbers, 2010).

> *In their Manifesto of Futurist Architecture (1914), the founders of futurism—the architect Antonio Sant'Elia and the poet Filippo Marinetti—declared that the buildings of the future would be dynamic and mobile, and throughout the 1960s, the architectural group Archigram developed those ideas further. But whereas Archigram's designs existed only on paper, the Futuro is an intriguing physical example of space-age utopian architecture. (Stratford, 2012, p. 1)*

The peak phase of international building with fibre-reinforced plastics extended from the 1960s until 1973, when the first oil embargo by OPEC resulted in an international economic recession (Voigt, 2007). In addition, the growing awareness of nature, discredited plastics, and with them the striking, but only sporadically realized, plastic buildings. It was not possible to fulfil the hopes placed in them for inexpensive, technologically modern living spaces (Voigt, 2007). In the 1980s they fell into oblivion, but in due course the Futuro was the first plastic house to receive renewed attention. Futuro No. 000 was rediscovered in 1996 as part of the Skop exhibition of the Vienna Secession in Austria[1] (Home and Tamila, 2002, Suuronen, 1983). In 1997 the Utrecht Centraal Museum in the Netherlands bought this prototype as an art object and since 2007 it has been a collection object of the Boijmans van Beuningen Museum in Rotterdam. With the exhibitions of the renovated Futuro No. 001 in the Exhibition Centre WeeGee, Espoo, Finland since 2012 and the public presentation of the renovated Wilp-Futuro at the Pinakothek der Moderne (New Collection - The Design Museum) in Munich since 2017, the building has regained the awareness of experts and a wider public. Museums of Applied Art as well as design and architecture museums are increasingly interested in the now rare plastic buildings of the pioneering period (1942-1980) (Voigt, 2007).

THE ORIGIN OF THE PLASTIC CONSTRUCTION FUTURO

The history of Futuro is inextricably linked with Matti Suuronen (1933-2013), a Finnish architect. He studied at the University of Technology in Tampere from 1958-1961, but he had already worked in various architectural offices since 1955, so founded his own architectural office 'Casa Finlandia' in Espoo in 1961. His project portfolio, published in 1983, provides information about his professional career and the broad spectrum of his work (Suuronen, 1983). During an interview in 2004, however, he refers to a special project: the silo roofing of Seinäjoki from 1963 and he mentions a 4-day workshop on glass fibre reinforced plastics (GRP) shortly before finishing his studies (Voigt and Genzel, 2004). When, in 1965, a school friend asked for a ski lodge in rough terrain, he benefited from this experience and his contacts with the manufacturing company, Polykem Oy. His first idea of a dome with a diameter of 8 m was not sufficient for Suuronen as a complete design [FIGURE 03]. The hut as a ball on supports, which can be located on steep slopes or over water, satisfied him more in terms of design. The free-standing sphere was for him a man-made cave, a nest to have a warm and safe retreat in the wilderness of Finland. In several design steps, Suuronen moved away from the full sphere, as it creates too much volume, as well as from two spherical domes placed next to each other, i.e. flat spherical sections, as they again left too little space. In the end he found an ellipsoid a good compromise. Its volume was optimized, the statics defined and the formwork could be produced, because an ellipsoid is a mathematically defined shape [FIGURE 04]. Suuronen said about his design process: "The key factor is pi. It is pure mathematics. Since it is pure mathematics, it was easy to make the first wooden mould. We just followed mathematical guidelines. There were no alternatives. The measurements came from math" (Genzel and Voigt,



03 Drawing: Futuro-Sketches, 1966. © Archive Matti Suuronen, 2004

04 Drawing: sketches designing a ski-hut by Matti Suuronen, 2004. © Archive FOMEKK, BU Weimar, 2004

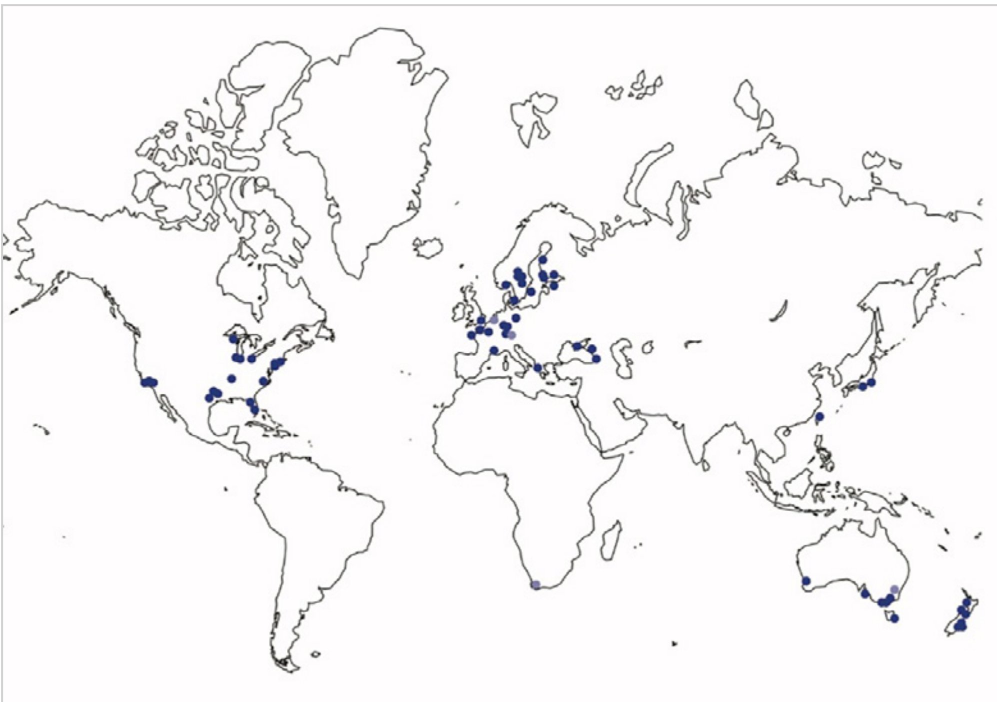
2005, 134). In designing and realizing the ski cabin Suuronen worked as the chief architect of a R&D team with Polykem Oy, that also included the structural engineer Yrjö Ronkka, technicians C.J. Olander and Heikki Tikkanen, Suuronens´s assistant Hannu Laitinen, project supervisor Peter Stude and production engineer Sven Lindfors (Mome and Tamila, 2002, p.17).

The designed ellipsoid with elliptical openings standing on a ring with filigree supports satisfied Suuronen's high design standards. Even the flap door becomes part of the outer shell, thus part of the ellipsoid. The feasibility of this unprecedented structure was assured for Suuronen and his team due to the same dimensions as the silo roofing and the mathematical derivation of the overall geometry and thus its static determinability.

This coherent, unmistakable final design, combined with the association of a UFO, hit the nerve of the time and was a prerequisite for financing the series production, international presentation and professional sales. This is also the basis for the name: Futuro. The House no. 002, advertised as a holiday home, was promoted at the Finnfocus export fair in London in October 1968, seven months after the presentation of no. 000 at Polykem Oy's premises.

As a result, 70 to 100 Futuro were produced worldwide in the 1970s. As the production was exported by means of licenced sales to the USA, Australia/New Zealand and Asia, no exact figures are available [FIGURE 05].

The oil embargo of the OPEC in 1973, the oil price increase in 1979 and the accompanying general increase in wage and production costs in the entire economic market put a temporary end to the dream of utopian plastic architecture. The industrial firms of the 1980s turned to other visions, materials and constructions. Plastic buildings



05 Visualisation of Futuro locations worldwide based on a research done by the authors showing a focus in Central Europe, the United States and in Australia and New Zealand. © Lola Kleindouwel, TU Delft, 2019

were frowned upon, considered outdated, ecologically questionable or too visionary. A phase of decay or destruction followed for most Futuros, although some – often unnoticed by the public – continued to be used.

According to Marko Home, there are 65 and a half Futuros left worldwide today. The half Futuro, split vertically, is part of Jugendhaus Frankfurt-Nied, Germany. [2]The main chronicler of the whereabouts and histories of individual Futuros can be accessed online (Futuro house). Some of the Futuros have been relocated, some dismantled, but only a few have been restored. In this article a comparison of four restorations dating from 2007 to 2018, gives insights into the specific construction, modifications and the challenges of the materials. Comparisons are made between the collection and exhibition objects, meeting the high conservation requirements of the museums on the one side, and buildings in use, whose usability must be ensured, yet still considering conservation principles and needs. This is all the more interesting because the durability of the structural restoration had to be developed with regard to the future usability of the specific interiors. Three of the four cases presented are kept outdoors, in line with the original intention of the architect, only one – the prototype no. 000 – is reserved for inside exhibition.

PRODUCTION AND CONSTRUCTION: LICENCES, VARIANTS, IMPLEMENTATIONS AND EXECUTION

From 1968 to 1978 the production of 20 Futuros in Finland is documented (Suuronen, 1983). These were delivered within Finland, to Sweden, Russia, Japan and one to Argentina for the UIA congress (Union Internationale des Architectes). The existence of a separate production site in the Federal Republic of Germany (FRG) could not be proven despite corresponding information in the publications of the 1960/70s (Bayer AG, 1969). Only the certificates of approval for the building permits were issued by licensees such as the office of Steffens & Nölle AG Stadthagen, FRG (Futuro-Haus, 1969). However, the Futuros themselves were manufactured by Polykem Oy, even if they are not mentioned on Matti Suuronen's archive list. There are also other licensed buildings, e.g. in Great Britain, Australia/New Zealand, USA and Japan. The Futuro was tested for earthquake and typhoon resistance by the University of Yokahama for the licensing to Japan (Genzel and Voigt, 2005).

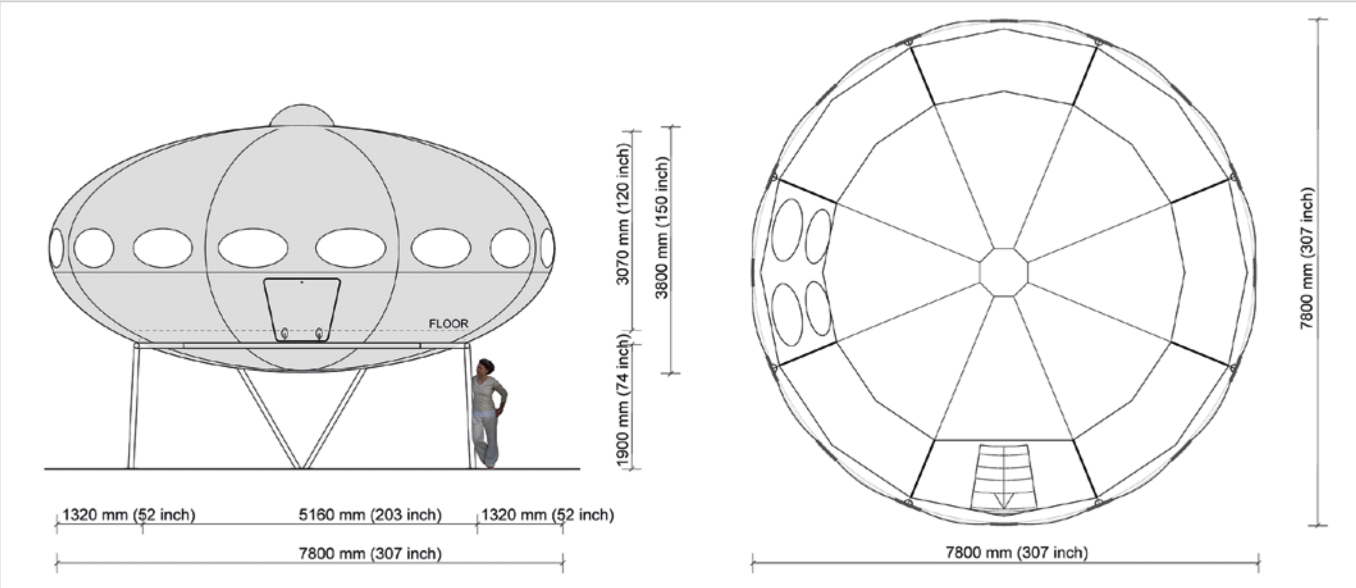
There are striking differences in structural design and construction between the Finnish and American Futuros. Accordingly, the granting of a licence to the USA included the authorisation of modifications, which will be discussed in more detail below. FUTURO Corporation is indicated as the licensee in the USA on original planning documents. Charles Cleworth's archive, which is accessible online (Cleworth Archive), testifies to his licensing, design modifications and manufacture as the FUTURO Corporation, Denver, Colorado. Since all Futuros in the USA have this construction design, it is reasonable to conclude that they were all produced and distributed by FUTURO Corporation. Confusingly for the historical research the original construction drawings of the US Futuros do not match the constructed buildings. A more comprehensive investigation of this Futuro history is therefore desirable.

The research basis for the following case studies was provided by the listed publications and the working plans made accessible to the author: Futuro Nr. 013, Berlin, 1969 (Archive BAKU, Voigt), Futuro Idylwill, California von M. Wayne Donaldson, 2004 (Archive Donaldson), Futuro Colorado, 1970 (Archive thefuturohouse), Futuro Austin, 1970 (Archive thefuturohouse). Furthermore, the author carried out building surveys and measurements during the Wilp-Futuro project (Archive BAKU, Voigt).

The production of a durable and efficient building made of plastics requires an appropriate design for the material, the individual parts and their connections, and the choice of hard-wearing plastics for a construction which will also provide a comfortable place to inhabit. Sandwich constructions made of glass fibre-reinforced polyester resins with a polyurethane foam core as thermal insulation were already commonly made in the mid-1960s. The glass fibres, which are protected by the thermoset resin matrix and permanently held in the desired form, provide–the structural capacity. Additives such as UV stabilizers, fire retardants and paint particles are added to the resin. The fibre mats, scrims or fabrics are impregnated with the resin mixture with an added hardener. The manufacturing process was known as hand lay-up or laminating. To achieve the desired form, exact negative formwork is produced to be reused several times. The sandwich construction elements, which are screwed together to form the building envelope, and whose joints are sealed with elastic seals, should be identical in order to keep production costs as low as possible. Transport sizes and the manageability of the individual parts during assembly are important factors in the design of plastic components and, ultimately, the complete plastic structure [FIGURE 06].

Matti Suuronen developed a holiday home for rough terrain. This meant that the components which were prefabricated in the factory had to be stackable on a transporter to save space and be quickly assembled without the need for lifting equipment. The famous transport of a Futuro by freight helicopter was only meant for advertising purposes.

Due to these material-specific manufacturing techniques and design parameters, the Finish Futuro consists of eight identical, double-curved, shell-shaped building sections in



06 Drawing: Wilp-Futuro: Elevation and top view. © P. Voigt, 2016

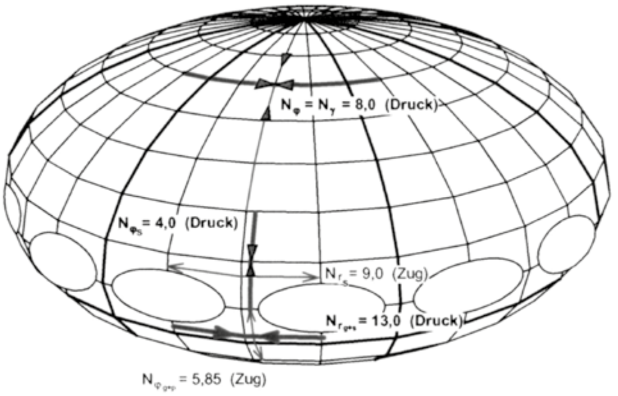
the top and bottom halves of the building – 16 sections in total. An upper section of shell weighs approx. 150 kg, a lower one approx. 300 kg. These composite shells are bolted together via their edge flanges, which also serve as stabilising ribs. The overall dimensions of the ellipsoid are 3.8 m x 7.8 m. The floor is 59 cm above the lower edge of the ellipsoid and therefore has a usable area of approx. 24 m². The room height is approximately 3 m at the zenith.

The Futuro sits approx. 50 cm deep in a steel ring (overall diameter 5.0 m made from 85 mm circular hollow section (CHS) steel). Under each structural joint there are metal lugs (10 x 10 cm) to support the ellipsoid on the ring, to which the sandwich panels are bolted and secured in position. The height of the ring is in the original design approx. 1.90 m above the ground. Four V-supports are welded to the steel ring, each with a 30 x 30 cm base plate at the foot to bolt down to individual foundations. The height results from the position of the V-supports, but could be changed as desired. For transport the ring is divided into 4 equal parts, each with a pair of V-supports.

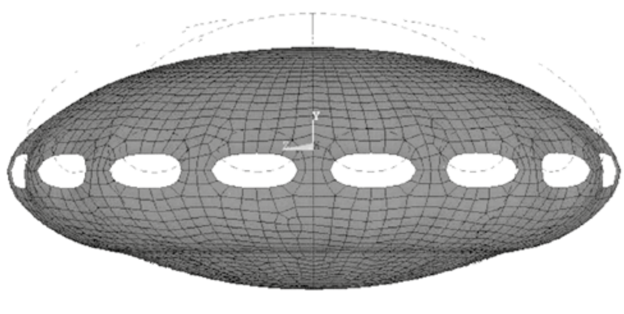
The real weight of the Futuro is about 4 tons, contrary to the original publications which indicated 3 tons. The total weight including the metal base and the complete interior is about 6 tons.

SUPPORT STRUCTURE, COMPONENTS AND FURNISHING

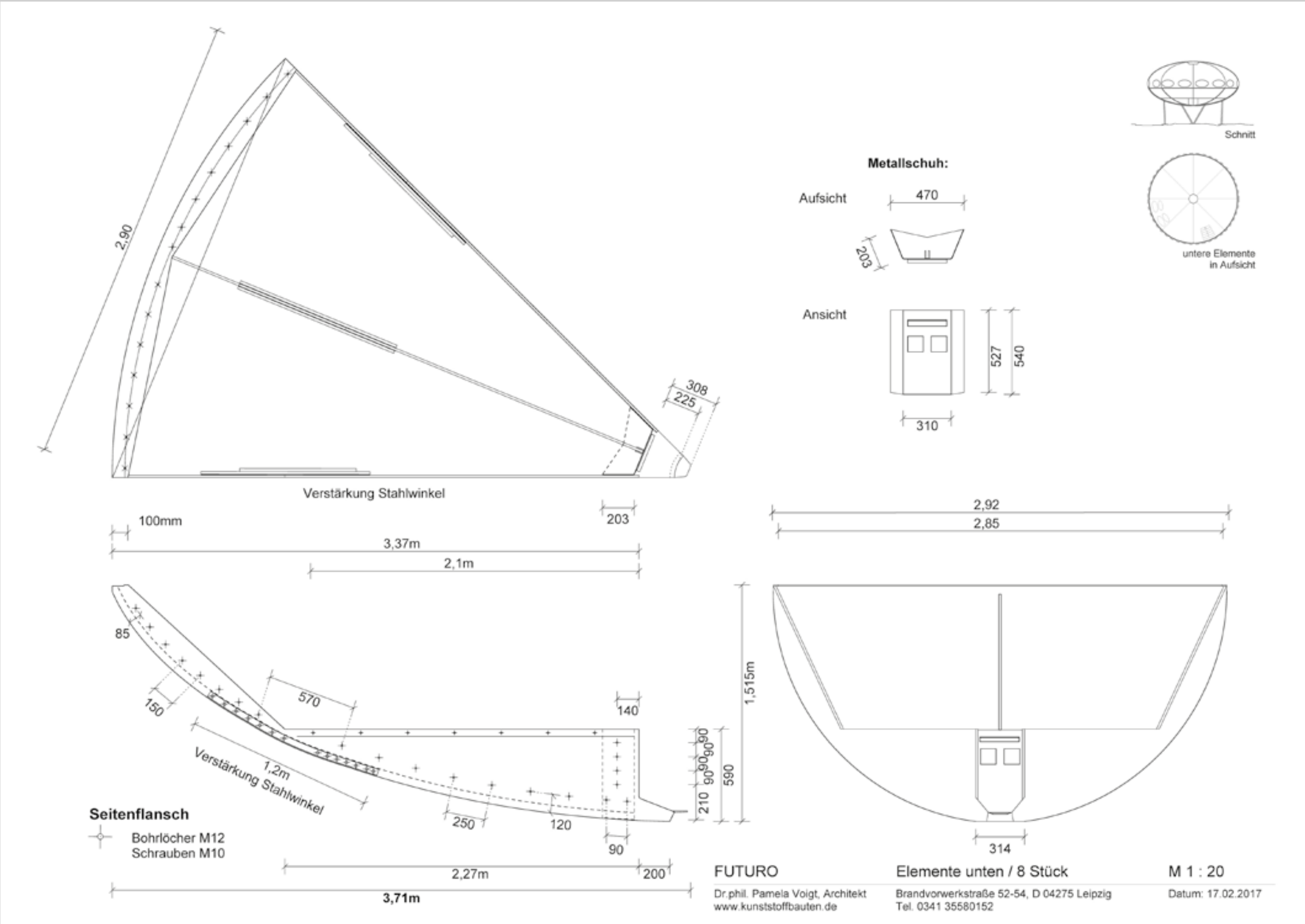
Support Structure: The Futuro has a beautiful and controlled bowl shape. The openings in the support structure are located in structurally logical positions, with the exception of the fold-out stairs. This is a major impairment of the shell's load-bearing capacity, which is why ribs have been inserted to stiffen it. Elke Genzel carried out a comparative structural analysis by both manual calculation and also by Finite Element Method (FEM) calculation with the software ANSYS (Genzel and Voigt, 2005). The manual calculation led to the same results as the digital FEM calculation. It checked the critical points: at the zenith, because at this point the curvature is the smallest and the compressive stress is the greatest, and at the equator because the material surface of the ellipsoid (position of the windows) is the smallest [FIGURE 07]. The displayed deformation pattern under dead load and snow clearly shows the calculated deformations [FIGURE 08].



07 Representation of the occurring stresses from dead load, support load, snow and traffic. © BAKU, Elke Genzel, 2005



08 Under snow the Futuro virtually sags together and hangs over the ring. © BAKU, Elke Genzel, 2005



09 Cutting and orientation of the PUR insulation in the sandwich visible in sidelight. © P. Voigt, 2016

Components: The Futuro is a sandwich construction. In a sandwich, the individual layers of material are bonded to each other, and therefore perform better as a whole than the sum of the individual layers. The structure is 3 mm GRP externally, 45 mm PUR foam and 2 mm GRP internally. In the construction file of Futuro No. 013, the use of the polyester resin Leguval (Bayer AG) is specified. The flanges of the upper Futuro shell have a height of 4.5-5 cm with a material thickness of only 5 mm, but in the case of the Wilp-Futuro, for example, they taper to 2 mm due to manufacturing inaccuracies. The lower flanges have a height of 5-56 cm with a material thickness of 15 mm [FIGURE 09].

Although the GRP sandwich is structurally adequate, only the outer building envelope is executed as such. In contrast, the side flanges and additional centre ribs of the lower shells were manufactured as GRP cross laminated plywood sandwiches (1.5 mm GRP, 12 mm cross laminated timber, 1.5 mm GRP) which were screwed to a 2 mm formed metal shoe. In addition, two metal angles (40 x 20 mm, t = 3 mm) were laminated into the sandwich adjacent to the steel ring. These are firmly connected to the plywood in the side flanges by means of screws. All side flanges and ribs of the Futuro are located inside the building. The individual components are joined at the flanges with M10 bolts and washers. In order to avoid possible cracks from structurally unfavourable stress peaks in the thin material, it was observed that screws were spaced at approx. 15 cm centres on the upper shells and 25 cm centres on the lower shells [FIGURE 11, 12, 13].

The insulation is commercial PUR foam (hardmoltoprene from Bayer AG), in the form of double-curved smaller panels or strips [FIGURE 13], which were placed on the wet laminate during production and should therefore be firmly attached to it. The insulation thickness results from Suuronen´s desire for high thermal insulation to ensure that the ski hut heats up quickly. The U-value of 0.6 W/m²K was indeed a very good value until the 1990s.

The elliptical windows are designed as double glazing made of double-curved PMMA (acrylic glass of the Macrolon brand). 16 windows with 1.25 x 0.62 m and 4 windows arranged in a lower element. Two of them are the same size as the surrounding ones, two with 1.05 x 0.43 m. These four serve as an escape route in case of fire. No windows can be opened, as Suuronen assumed that the ski cabin would be used mainly in winter and probably also in Scandinavian summers. Fresh air was supplied via the floor inlet and exhaust air removed via the ceiling opening. The floor is a wood-based panel resting on the flanges and centre ribs. For this purpose, additional squared timbers (20 x 45 mm) were screwed on. The joints of the upper elements visible in the living area are covered by a bead, also made of GRP.

10 Wilp-Futuro before disassembling. © P. Voigt, 2016

11 Wilp-Futuro element Cu wile restoration. © P. Voigt, 2016

12 Wilp-Futuro. © P. Voigt, 2017

The eye-catcher of the Futuro is the fold-out entrance staircase, which is copied from aircraft construction. It is part of the outer shell and therefore also manufactured as a GRP sandwich with five curved steps. The elevator mechanism worked via a steel cable connected to a manually operated winch in the entrance area.

The FUTURO Corporation, as the American licensee, adapted the Futuro to make additional space as a response to the needs of their customers. In the correspondence from 1970 there was even talk of a larger overall diameter, but this was not implemented [Cleworth Archive]. However, they achieved a larger usable area by raising the level of the floor by about 19 cm higher than in the original Futuro. This results in an area of approximately 29 m² instead of the 24 m². Because of this there are only two lower windows that are used for escape routes.

The FUTURO Corporation also expanded the dimensions of the prefabricated Futuro components, so that half shells were delivered. The support ring, which was also halved, was re-located within the building envelope and firmly connected to the sandwich panels. Only the steel legs penetrate the outer skin. This made assembly considerably easier, but required the use of a hoist crane.

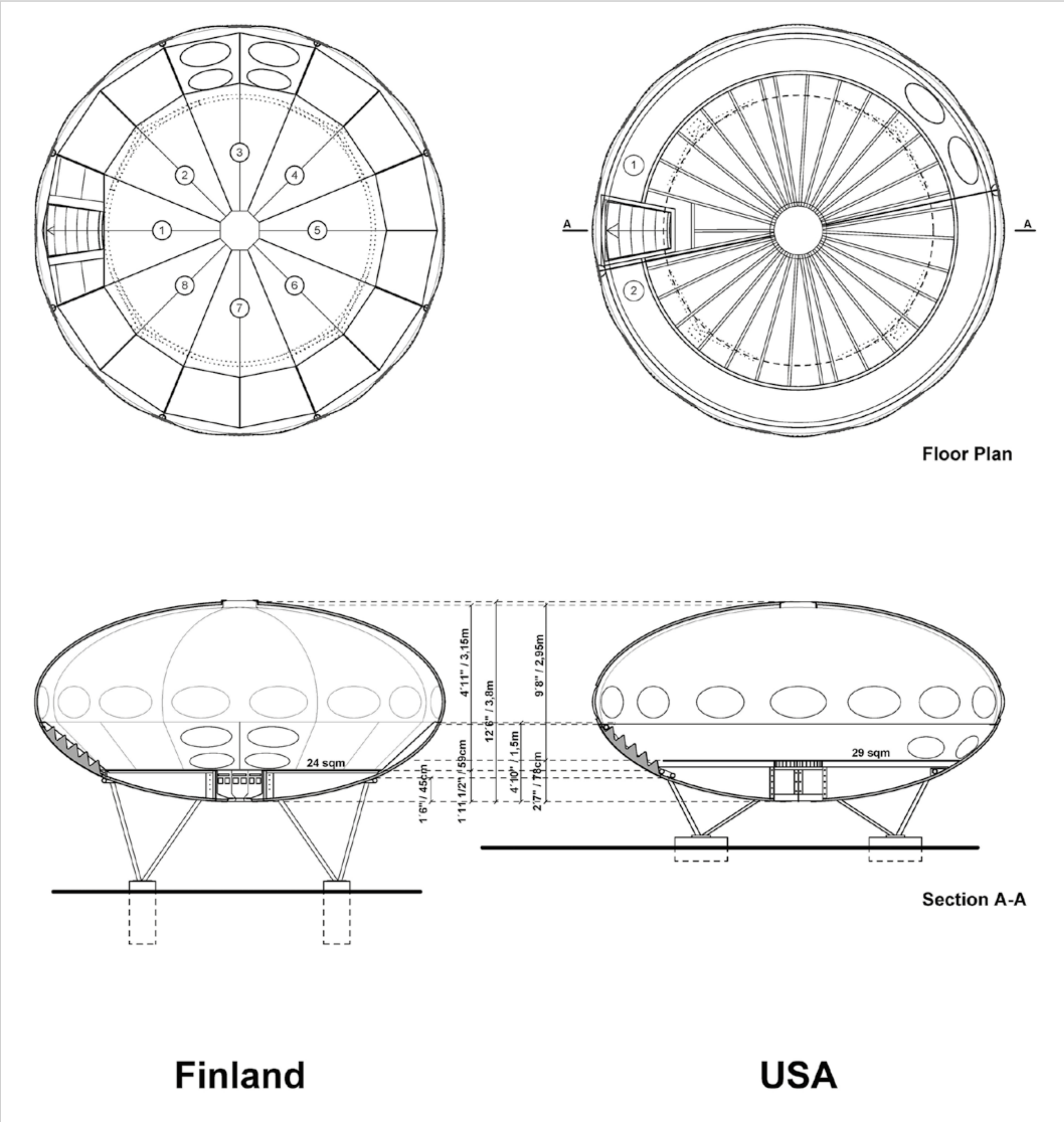
13 Cutting and orientation of the PUR insulation in the sandwich visible in sidelight. © P. Voigt, 2016

Four shell elements were assembled in the factory to form a half shell, and the individual joints then over-laminated. In some cases, the remaining vertical joints were over-laminated during assembly, so that only the horizontal joint divided the otherwise smooth surface. Also, for design reasons, the folding door was installed directly under a window. The door opening interrupts the support ring, which is why a steel reveal was inserted at that spot in order that the ring remained structurally effective.

Another difference to the original Futuro is the steel structure shown in the plan [FIGURE 14], and also visible in the photos [FIGURE 15, 16], consisting of the steel ring, a central metal frame, and steel beams arranged in a star shape, which function together as the main supporting structure with the entire building shell hanging from the internal steel ring. The detailed laminate structure, material specifications and connection details have not been published.

Interior Finishings: The approximately 24 m² floor space of the original Futuro is perfectly divided for a short holiday stay into entrance area, bathroom, lounge with attached kitchenette, and sleeping niche. As described above, Matti Suuronen designed the Futuro including the interior. Every detail refers to the ellipsoid overall shape and the round ground plan. This entirety forms the unmistakable design. In principle, the Futuro is a one-room building, as the inserted partitions can be changed quickly and easily by the user. Only the sanitary block and the kitchenette are fixed in their position due to the water and electrical connections [FIGURE 17].

The most fascinating part of the fitted interior is the extendable reclining seats. These recliners are positioned radially along the curved outer wall in the living room and are grouped around a fireplace grill placed in the



14 Drawing support structure in ground plan and section of the Finnish and American Futuro. © P. Voigt, 2020

15 Support structure of the Finnish Futuro. © P. Voigt, 2016

16 The American version and the thefuturohouse. © Rockwall-Texas, 2019

17 Berlin-Futuro No. 013. © Archiv FOMEKK, BU Weimar, 2004

18 Berlin-Futuro No. 013. © Archiv FOMEKK, BU Weimar, 2004

middle [FIGURE 18]. Suuronen called the backs of the seats between the loungers horses because of their two humps (Cleworth Archive). Integrated lamps make them attractive as reading seats. The fireplace grill stands in the centre of the Futuro and also serves as a table. This and the reclining seats best illustrate Suuronen's intention: the sociable, relaxed get-together of friends after skiing.

Thanks to the thermally favourable shape of the building with a minimal external surface area in relation to its volume, the insulation and the powerful electric-finned tubular heating elements in the intermediate space under the floor, it was possible to warm the Futuro up to a comfortable room temperature within 30 minutes, even in cold northern winters. In summer, air conditioning or a fan was required (Suuronen, 1983). Alternatively, an openable skylight enabled natural ventilation, as in the case of Wilp-Futuro in Munich. The kitchen is equipped with a sink, work surface, storage space and boiler for preparing coffee, tea and snacks. According to the owner of the Berlin Futuro, there was a lack of good planning of the individual parts. The sanitary unit was located between the entrance area and kitchenette, and contains a wash basin, shower and toilet. Since this cell is seamlessly formed from GRP, all that is needed is a drain on the floor to let the shower water run-off. Since the door threshold is 23 cm above floor level, the water is otherwise kept in the bathroom cell.

Futuro buyers could order individual elements, the entire interior or Futuros without interior finishing.

The American Futuro Licencee adapted the Futuro to the needs of the American market for more usable space (29 m^2), a more spacious bathroom and kitchen and a perimeter bench instead of the reclining seats [FIGURE 19, 20].

The first Futuros were coloured in white, yellow and light blue. The productions in other countries also offered gold and green. The interior was painted in a different colour, e.g. blue, red, orange or violet (Suuronen, 1983).

CONCLUSION

The Futuro captivates people all over the world with its space-age imagery. As a coherent architecture of the 1960s and 1970s, it is not only regarded as a museum piece now, but there are new lovers who continue to use the original Futuros. The preservation of architecture presupposes an understanding of the materials, the structure and the technical details. Why did this and that decision come about during the original production process? Why did that and this damage occur? The comparison of different models of the Futuro series and the American variant, adapted to different users, transport sizes and technical practices, sheds light on these questions. The preservation of museum objects serves not only to preserve the appearance, but, above all, to preserve the state of knowledge of the object at its time of creation. The maintenance of privately used buildings, on the other hand, may deviate from these principles and is therefore understood as repair that may include technical evolution. The case studies illustrate design and modifications of the Futuros to serve different needs and show the complexity of the conservation process.

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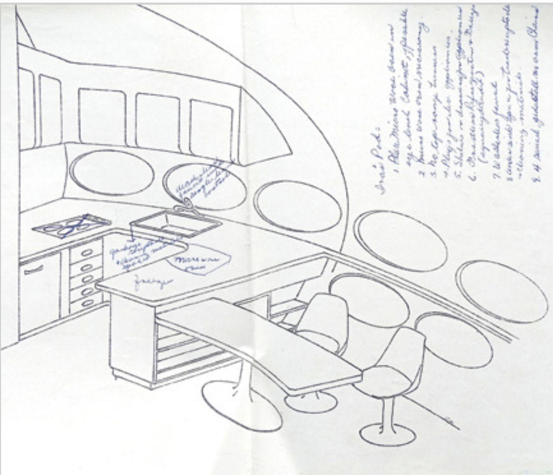
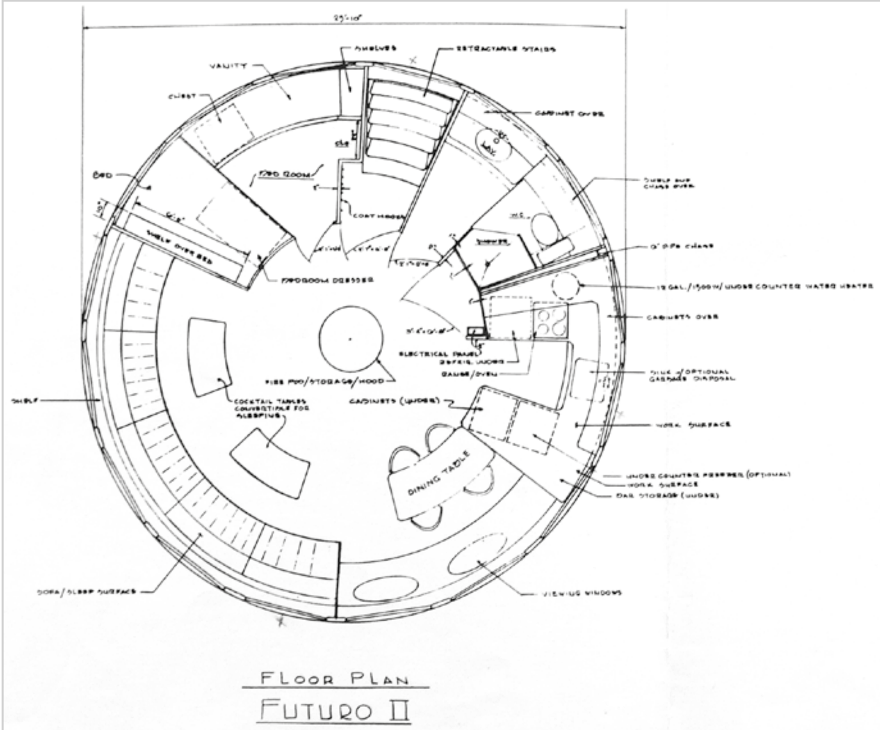


19 Sales documents from 1970. © Archive thefuturohouse, Futuro-Austin-Texas, USA



20 Detail of floor plan. © Archive thefuturohouse, Futuro-Austin-Texas, USA

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ENDNOTES

1 https://thefuturohouse.com/Futuro-Demolished-Locations.html#-frankammain [saved: April 15, 2020]

2 https://thefuturohouse.com/Futuro-Demolished-Locations.html#-frankammain (saved: April 15, 2020)

Pamela Voigt *(Dr. phil.), architect, studied architecture from 1994 to 2001 at the Bauhaus University Weimar. From 2001 to 2005 she taught and researched within the interdisciplinary research group for material-appropriate design and construction with fiber-reinforced plastics (FOMEKK) at the Bauhaus University Weimar. Early 2007, Pamela Voigt finished her dissertation on the art-historical topic: Die Pionierphase des Bauens mit glasfaserverstärkten Kunststoffen (GFK) 1942 bis 1980 (The pioneering phase of building with glass fiber reinforced plastics (GRP) 1942 to 1980). Since 2008, Pamela Voigt has been actively planning renovations and new developments of plastic structures, partly in cooperation with Elke Genzel as the BAKU working group.*
www.kunststoffbauten.de

THE DONALDSON FUTURO

Rescue, Relocation, and Restoration Challenges

Milford Wayne Donaldson

ABSTRACT: Space Age aesthetic was manifest in the 1960s and embodied in plastic, prefabricated houses. After several decades, the acquisition and restoration of Futuro houses can be a challenging process. The freedoms in the implied promise of the Futuro houses are tested against realities of logistical and building codes for which non-standard solutions are required.

KEYWORDS: San Diego; Stan Grau Collection; Space Age, Donaldson Futuro

INTRODUCTION: The year was 1969, and the lure of all these new plastic materials at the fingertips of a young architect were too strong to ignore. I had a love of other worldy pursuits after experiencing Neil Armstrong's and Buzz Aldren's live walk on the moon in 1969 and found Matti Suuronen's Futuro design something of a novelty as well as a personal pursuit. The tale that follows stands to showcase the unique perspective of the livable Futuro house and how it continues to provide enjoyment in the 21st century.

Playboy magazine called the Futuro a funhouse and that "It's a flying-saucer-shaped hideaway designed for whirlybird (helicopter) delivery and instant livability in any clime." "Buyers can choose from four exterior shades–blue, gold, green and white–that have been color coordinated with the interior." The magazine promoted the Futuro as the ultimate bachelor pad showing photographs of beaches, snow and tropical resorts, with romantic interiors.[1]

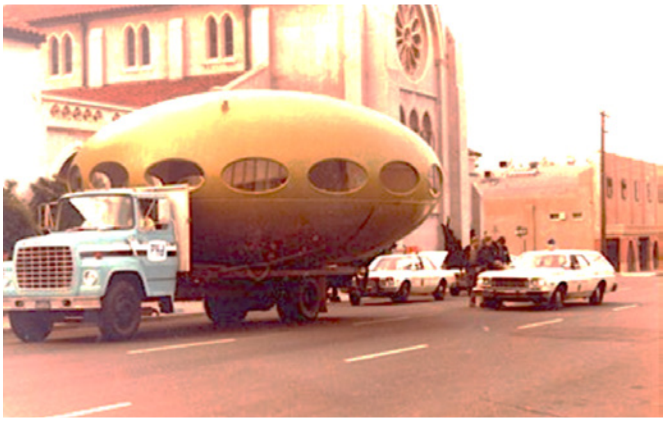
Join me on my journey to go boldly where no man has gone before, as my team and I faced challenges of designing, development, transporting, and restoring plastic materials, code compliance, and looking toward the future of preserving these unique cultural resources. The restored Futuro is listed on the National Register of Historic Places and as a California Historical Landmark on the California Register of Historical Resources, officially known as the Donaldson Futuro. The official language on the plaque is the following:

> *"The Donaldson Futuro is significant as an example of America's collective confidence as a leader in space flight, technological advancement, and economic prosperity. Designed by Finnish architect Matti Suuronen, this space-age home was the first Futuro to arrive in California, in 1969, and the only Futuro to obtain a building permit for residential occupancy. Its modern futuristic space-age design, materials, and workmanship retain a high level of integrity from its period of significance. The property is identified as the Donaldson Futuro in recognition of owners Wayne and Laurie Donaldson's extensive restoration effort that successfully preserved this fragile resource and raised the profile of early mid-century plastic buildings."*

BACKGROUND AND RESCUE OF THE DONALDSON FUTURO

The Futuro is a structural reinforced fiberglass polyester plastic portable home, meant to be easily moved, usually by helicopter, to a desired site. The final shape of the

01 Proposed design feature and uses for the Grauhaus. © Stan Grau Collection, undated.



02 Moving of the Futuro in San Diego, ca. 1969. © Stan Grau Collection, undated.

03 The Donaldson Futuro at the parking area behind the Design Center, San Diego. © M.W. Donaldson, September 2002

Futuro evolved into an ellipsoid shell as researched and developed by Polykem Oy (Ltd) to be potentially suited to serialized industrial production. The Finnish prototype measured 8.03m (26′-4″) in diameter, 4.01m (13′-2″) in height, 25 square meters (269 square feet) in floor area and weighed approximately 4,000 kg (8,800 pounds). The Finnish model was built in 16 sections, so could be easily transported and bolted together on site. The model also nested in an exposed metal ring once all the sections were bolted together.[2]

The production model that was built by FUTURO Corporation, headed by Leonard Fruchter in Philadephia, Pennsylvania, under a U.S. license agreement, became an instant hit in the United States. The overall size was similar to the Finish prototype, but the floor area and weight were quite different. The partition walls radiate from the center fireplace. The USA model was delivered in two completed shell pieces and bolted together on site. The Finnish model also had a third row of windows at the dining area versus the two rows of windows for the American model. The interior of the Finnish model was all molded plastic including the seats, kitchen, and bathroom area. The American model was built more like a traditional trailer with wood counters and built-ins covered with a plastic laminated top similar to Formica, shower unit and typical small appliances for the kitchen. The door to the Finnish model was centered beneath two windows, while in the American model it was directly underneath a window. Made entirely of fiberglass reinforced polyester plastic, a fairly inexpensive but durable material, the Futuro sold in the United States for between $12,000 and $14,000 (approximately $99,000 today)[3].

Mr. Stan Grau purchased a Futuro from the FUTURO Corporation and had it delivered to San Diego, California in 1969 [FIGURE 01]. Mr. Grau was to act as a salesman for Futuro Enterprises but soon discovered that he could improve on the prototype by providing operable rectilinear windows, and combine two or three Futuros for a larger home, as well as mid-rise condominiums.[4] He moved the Futuro around San Diego, loaning it on one occasion it to the US Naval Training Center sited across the street from the USS *Recruit*, a land-based faux destroyer at 3/4 size and used for training purposes.[5] The Futuro finally landed in a parking lot behind the Design Center, 3601 5th Avenue, San Diego. It sat there for years, brush painted with a green latex paint, slowing deterioration [FIGURE 02].

04 a -d The Futuro at the San Diego Boat Yard, damages before restoration (a) removal of green latex paint, (b) cracks and poor condition of the yellow gel coat, (c) delamination and material loss on the exterior surface, (d) removed portion from the roof area showing the rigid foam and GRP laminate. © M.W. Donaldson, October-December 2002

New owners purchased the Design Center in 2002 and tried to demolish the Futuro, but only cracked a side and busted out two temporary glass windows [FIGURE 03]. In the end, I purchased the Donaldson Futuro for $15,000, but had to move it within a week. Not knowing where to move it, I asked Corky McMillan, developer for the Naval Training Station (Liberty Station) who granted permission to move it to the Naval Training Center, as I was his architect for the current restoration following the base closure years before.[6] However, this was not popular with the City of San Diego, who still owned the Naval Training Center and asked Mr. McMillan to move it off the property.[7] It was moved to the San Diego Boat Yard off of Mission Gorge Road, east of San Diego to have the exterior restored while I looked for property. After all, the Donaldson Futuro is built more like a boat than a house.

THE RESTORATION OF THE EXTERIOR OF THE DONALDSON FUTURO

The decision was made to restore the exterior, make it structurally sound, and provide the necessary support for the move. Upon removing the green latex paint, the original Harvest Gold color could be seen in very poor condition, having been heavily sanded to apply the latex paint.[8] The original gel coat on the Donaldson Futuro was a high performance polyester resin used in boats with excellent handling characteristics, superior UV resistance, flexibility, and reduced emission. The gel coat was badly damaged from exposure, especially on the top half, having had no maintenance for years. There was a large section at the top slowly deteriorating, including the fiberglass and the polyurethane foam interior [FIGURE 04 a-d].

The restoration process, after several trials and errors was as follows:

- Starting with the original yellow gel coat, covered by green latex paint. Grind down with 30 and 60 grit sandpaper to remove paint and determine how much cracking was present in the original gel coat [FIGURE 04b].
- An area of about 2.44m (8 feet) in diameter on the top of the Futuro had to be removed because it was so badly deteriorated. New fiberglass was added to repair the deteriorated roof section as well as at several window locations to secure the new rings for the acrylic windows.
- The fiberglass was Owens-Corning 2415, 2.4 oz, 1 1/2 mat. Two fiberglass mats were used 18/15 @ 90 degrees and 17/08 bi-directional @ 45 degrees.
- All flare-in, or a gradual widening of repairing with glass fiber, was done with Dyna-glass. Some of the resin-based filler had embedded chopped fibers. Sand as needed to a smooth surface.
- Went over all the areas with Duratec, a resin-based polyester.
- Used a skim-coat of Poly-fare, and sanded down to a "feather."

05 a-b One of the steel leg supports showing the typical extreme rust at the connection point (a) and (b) exterior of the Futuro near to top of the door opening where the top and bottom halves are joined. The vertical joint was where the two halves where connected with bolts. © M.W. Donaldson, December 2002

06 a-b Moving the Donaldson Futuro along Interstate 15 blocking traffic (a) and up State Highway 243 to Pine Cove passing through Mountain Center (b), accompanied by California Highway Patrol officers. © J. Guevara, December 8, 2004 and M.W. Donaldson, December 8, 2004

- Applied high-build epoxy primer (up to 3 coats or more applied).
- 100 – 120 grit sanding.
- Standard Epoxy coat applied, 220 grit sanding.
- Applied top coat of Sterling linear-polyurethane
- Applied Awlgrip #545 Tint using 37.9-45.5 l (10-12 gallons). This was the actual paint, minimum five coats "Futuro Covering and Repair Process including Materials Specifications."[9]

The exterior restoration took from December 2002 until December 2003. During this time, the rusted 3.18 mm (1/8") thick-walled steel leg supports were replaced in-kind with 6.35 mm (1/4") thick-walled stainless-steel supports following a structural analysis for wind and snow loads. One half of the Donaldson Futuro had separated and needed to be slowly jacked into place over a five-month period. After the damaged sections were repaired with new fiberglass, the rusted bolts were replaced with new stainless-steel bolts, and the two halves at the bottom were pulled back together. The top half was permanently sealed together with fiberglass. However, new fiberglass and a cellular polyurethane 76.2 mm (3") core was used to restore the top of the Donaldson Futuro. During this time, a friend in Australia sent an original window from his Futuro so I could duplicate the exact size, approximately 0.61 m x 1.22 (2 x 4 feet), oval shaped with a 76.2 mm (3") rise in the middle[10] [FIGURE 05 a-b].

THE RELOCATION

A remote site was finally selected in Pine Cove, a small community about five miles north of Idyllwild in the San Jacinto Mountains at 1,981 m (6,500 feet) elevation. It was approximately 3,035.14 square meters (3/4 acre), a flag lot on large rock outcropping. Investigations were made with Erickson Air Crane of Central Point, Oregon, since the Donaldson Futuro was too heavy to be lifted by standard helicopters. Once I sent a photo, I knew they questioned my seriousness! But they were patient and explained that the cost would be astronomical, and that I would need a permit to pass over any federal or state highway and stop traffic. Along with a myriad of other permits, and given the altitude of the location, they highly recommended to move the Donaldson Futuro by road.[11]

The Donaldson Futuro was finally moved on December 8, 2004, under a boat permit since early visits with the Riverside County Building and Safety Department had certain requirements for moving a house onto a vacant lot that had not yet been satisfied.[12] The 209 km (130-mile) journey up Interstate 15 from San Diego, complete with a highway patrol escort, proved to be more challenging than initially thought [FIGURE 06 a-b]. It was moved as a single structure since it was advised to not separate the Donaldson Futuro on the basis that it may not easily go back together, especially after the restoration of the exterior.[13] Being 8.03 m (26'-4") in diameter it took up three lanes of Interstate 15 and hung over the mountain road, clearing one area between two trees by only 76.2 mm (3″). Although the route was carefully planned by Larry Wood of the San Diego Boat Yard, who was also the driver, it was still an adventure.[14]

The Donaldson Futuro finally arrived on site late in the day, in 1°C (34°F) cold and fog. The crane had problems getting up the hill to Pine Cove in the snow and, at one point, almost quit. However, the power and telephone lines had to be dropped for the lift, and the neighbors were without power and a land line. Finally, the crane dodged trees and lowered the house but had to stop because the crane operator could not see the end of the crane boom over the rock outcrop. The Donaldson Futuro weighed 5.500 kg (11,900 pounds) with the support structure, so the crane operator stopped five feet short and would not override the computer.[15] Getting five people on each leg, it was swung slowly onto the previously designed and constructed 2,068 N/square cm (3000 psi) concrete foundations, in the dark at 11:30 p.m.

RESTORATION OF THE DONALDSON FUTURO ON THE HILL

Moving the Donaldson Futuro was only the beginning of its restoration. The unrestored interior had suffered the loss of the majority of the asbestos popcorn ceiling, damage to the wood floor and portions of the steel substructure supporting the floor and tying into the exterior leg supports [FIGURE 07 a-b]. None of the original bubble windows remained [FIGURE 08].

The original kitchen range and built-in seating area, as well as all of the interior fixtures, cabinetry, shelves, and center console were still in the Donaldson Futuro. The coffee tables, when pushed together next to the seating area, would form sleeping areas, and the dining table was extant and in reasonable shape. The only items missing were the dining chairs.

The acrylic bubble windows were custom made at Planet Plastics in Corona following the design of the original window sent from my friend in Australia. The window prototype was very flimsy and severely crazed, so it was decided to use 6.35 mm (1/4″) Plexiglass acrylic instead. The windows were recommended to be heated and air-blown rather than formed over a mold so there would be no distortions [FIGURE 09a].[16] Using automobile windshield technology, a special H-shaped neoprene gasket was designed by Donaldson with a zipper type insert to hold the windows in place. A mockup of the window opening was made and taken to Planet Plastics for their fitting of the acrylic window [FIGURE 09b].

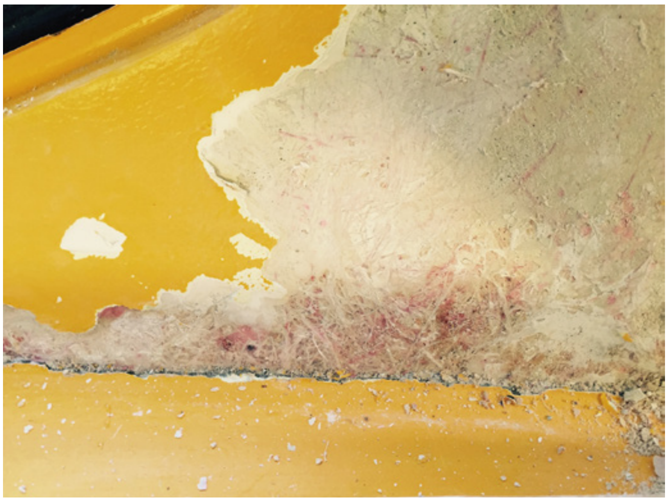
CODE COMPLIANCE CHALLENGES AND SOLUTIONS FOR THE DONALDSON FUTURO

The final construction documents were completed by the author on March 24, 2004,[17] and finally approved for construction on August 7, 2007.[18] Subsequent inspections and code compliance issues followed as all work was required to "comply with currently adopted Uniform Building Code, Uniform Plumbing Code, Uniform Mechanical Code, National Electric Code, and Ordinance 457 by the County of Riverside."[19] One outstanding challenge was that the Donaldson Futuro was only 48.30 square meters (520 square feet) total area, and the building ordinance for the County of Riverside required an 74.32 square meters (800 minimum square footage). A separate building, a Family Room, was designed and attached to the Donaldson Futuro with a covered walkway. Later in the inspection cycle this condition was removed as the Donaldson Futuro was built in 1969 as a residence.[20] The occupancy permit was obtained on February 4, 2009, after the lot merger for the septic and leach lines were approved.[21]

The structural analysis was performed by Eric Stover of LZA Technology based on shell design. The calculations were based on the 2001 California Building Code and the 1997 Uniform Administrative Code since the Donaldson Futuro was not a qualified historic structure at the time and could not take advantage of the California Historical Building Code. It was shown that the Donaldson Futuro could support a total snow load of 2,623 kg (5,783 pounds) when code only required 1,424 kg (3,140 pounds).[22] Additional analysis was supplemented by the theories found in *Elementary Statics of Shells*.[23] Wind and seismic load resistance were almost twice as that required by code. Overall, the Donaldson Futuro is very strong due to its egg-like double-curved shape. Similar calculations for the Finnish Futuro can be found in the publication *Kunststoffbauten: Teil 1 – Die Pioniere*.[24]

Because of the high threat of fires, it was required that a fire truck be able to get within 15.24 m (50′) of the structure to fight a fire caused by the residence.[25] This was impossible due to the constraints and height of the site. In addition, the nearest fire hydrant was 60.05 m (197 feet) from the property and could not be used to fight a fire at this location.[26] The County also wanted a Type A fire resistive roof but had a difficult time determining where the roof began, and the exterior walls finished. They also wanted the bottom of the Donaldson Futuro to be fire protected but could not find a code reference that noted that the bottom of a structure needs to be protected.[27]

Complying with state mandated Title 24 Certificate for Energy Compliance for Residential was challenging, mostly due to the form that was required to be filled out.



07 a-b Portion of the interior, near a window opening showing the fiberglass and uncured reddish polyester (a). This continues to be an ongoing problem as it leaches through the finish paint surface and acoustical ceiling. © M.W. Donaldson, December 2002. (b) Original linoleum floor at the kitchen area. This floor was badly damaged but was restored and the original pieces under the current linoleum floor that closely matches the original in color and texture. © M.W. Donaldson, August 15, 2006

08 Interior of the Futuro showing the interior damages, missing windows and bench seat sitting area. © M.W. Donaldson, August 15, 2006

09 a-b (a) Sample of the heated and blown acrylic window with a 3" (76.2 mm) curvature at Planet Plastics, (b) Installing the acrylic window in a mock-up frame. © M.W. Donaldson, May 22, 2003

10 Donaldson Futuro with the hinged downward opening door with integral stairs in summer. © P. Kozal, March 26, 2018

11 Installation of the zipper gasket pull-ring. © M.W. Donaldson, November 13, 2008

For instance, there are different values for the walls versus the roof, and, as mentioned before, where does one end and the other begin? Located at 1,981 m (6,500 feet) elevation also was a challenge due to extreme high winds and cold temperatures with many days below freezing. However, the Donaldson Futuro is tightly sealed with no heat loss from air leakage; the fiberglass and cellular polyurethane sandwich construction, overall 89 mm (3.5") thick, had a U-factor of R-35 (Code requires R-30), and the walls had a U-factor of R-46 (Code requires R-19); and the windows were only 15 percent of the exterior surface.[28] Although a new heating and cooling system was installed, the Donaldson Futuro was in full compliance without any exterior modifications.

Upon consultation with the Riverside County Fire Department they agreed to allow a sprinkler system to be installed meeting NFPA 13D.[29] That was simple enough except the California Department of Forestry and Fire Protection does not allow the use of the water supply system, as it is required in times of emergencies when fighting a fire nearby.[30] Further research led to a stand-alone pressurized 300 gallon water tank system completely off the power and water grid called The D System by Home Fire Sales Inc..[31] The sprinkler system was installed neatly by Advanco Fire Protection.[32] It was decided to not install the metal fireplace that sat on the original circular storage console, due to the extremely high fire threat according to the United States Forest Service. The opening now has a bubble skylight, and the fireplace is stored on site.

Exiting the Donaldson Futuro became a challenge with the County of Riverside Department of Building and Safety. The County wanted a regular wooden door enclosure structure to be constructed on the ground and the plastic Futuro door to be permanently fixed in an open position. The Inspector, however, was very gracious and came up to try the counter-balanced door as he exited the Donaldson Futuro. He was satisfied that the door was safe and easy enough to open in case of an emergency [FIGURE 10].

The other challenge for exiting was that a person needs to go through a window or a door straight from the bedroom directly to outside.[33] The window area met code for the size of the opening. However, the windows in the bedroom, as installed, are fixed, so the code was mitigated by providing a pull-ring wire that would release the zipper insert, and the windows could then be easily pushed out [FIGURE 11].

The septic and sewer system were not possible to install on the property, because it was one large outcropping of rocks and offered no place to put the leach lines.[34] A neighbor was nice enough to sell me a small portion of his property to install the leach lines and allow the contractor to install them. However, a lot tie agreement had to be filed and approved by the County of Riverside Department of Building and Safety.[35] This process required a complete topographic map and verification of both of the property's boundaries. In the process, since the property was a flag lot, surrounded by seven properties it was discovered that most of the property stakes were in the incorrect location.[36] An encroachment permit also had to be filed for transitioning the driveway onto Big Rock Road.[37] The entire process took years to approve since the surveyor's work was questioned by the other residents surrounding the Donaldson Futuro lot.

By 1973, the Donaldson Futuro and its plastic brethren were no longer in production due to the Organization of the Petroleum Exporting Countries (OPEC) induced oil crisis, when motorists lined up for fuel and petroleum prices rocketed.[38] Plastic was no longer cheap, nor competitive with wood or metal as an architectural material. "Embargo or no, the Futuro came with some built-in problems. It was small, oddly shaped, and expensive. Critics called it 'the Mercedes-Benz' of prefabricated houses."[39]

IN THE END

The process was one of research, discovery, and finally successful restoration and code compliance [FIGURES 12, 13, 14, 15]. It was a long journey, full of surprises and challenges, and it's

12 Living Room showing original fixtures and furniture. © P. Kozal, March 26, 2018

13 Dining area showing original dining table and coffee table © M.W. Donaldson, December 28, 2018

14 Interior of the restored Futuro showing the kitchen and central console. © P. Kozal, March 26, 2018

15 Bedroom showing under bed storage. © P. Kozal, March 26, 2018

no wonder that many of the Futuros throughout the world are in dire shape. The concepts of ease of relocation, little or no maintenance because it was plastic, and the early salesmanship of meeting the regular codes all proved to be a challenge. The lack of expertise on restoring plastic materials and the amount of experimentation with each step also became not only a challenge but expensive. However, in the long run, the adventure was a myriad of discoveries, solving the challenges with clever solutions and just a bunch of fun along the way. The lessons learned have been carefully cataloged and should be of use to people in the future who may want to rescue, relocate, or restore a Futuro.

"Many fans see the Futuro as nostalgia—a spaceship fit for Barbarella, with smooth, sybaritic curves. The Futuro provides a mid-60s vision of the future that was already falling out of touch with the zeitgeist by 1968—more Dean Martin and Hugh Hefner than Crosby Stills and Nash—and certainly out of line with the Mothers of Inventions song 'Plastic People.' *("I'm sure that love...will never be... a product of...plasticity")*."[40]

The Futuro is an important part of architectural and social history. What the Futuro represents is an optimistic vision of a future that never came to pass, when families would live in lightweight, inexpensive, durable, and easy-to-clean plastic houses they could move whenever the family moved. "Fans believed the Futuro would make these dreams come true."[41] Many of these dreams came alive during the process of rescuing the Donaldson Futuro, and everyone involved was proud of their work along the way. Throughout the whole project, I was accompanied by my wife, Laurie, who was a trooper during the restoration. She loves the Donaldson Futuro, having given so much of her life's energy to its move and restoration [FIGURE 16]. Her stories still bring laughter to family and friends as she reminisces about them time and time again. We love our Donaldson Futuro.

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16 Typical snow at the Donaldson Futuro in the winter. © M.W. Donaldson, December 3, 2009

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MATTI SUURONEN'S 'FUTURO' - PROTOTYPE 1968 AFTER 50 YEARS

Lydia Beerkens

ABSTRACT: The Futuro house was designed in 1968 by the Finnish architect Matti Suuronen. Its prototype, *Futuro no. 000*, currently in the collection of the Museum Boijmans van Beuningen in Rotterdam, underwent a major conservation treatment at the time of its acquisition a decade ago. The construction, the architectural details and the surface of fiberglass reinforced polyester (GRP) elements had suffered from transport and handling during the many assemblies on various sites, indoors and outdoors, over the previous decades. Before starting the restoration a research project was set-up to investigate the options for conservation. A clear vision about the best ways to exhibit the prototype was developed in order to avoid further deterioration. The decision to only exhibit the Futuro within the museum was essential for its conservation treatment. In contrast with the original function of the mass-produced Futuro houses as summer houses or ski-huts, it proves to be the best option to preserve the unique prototype for the future.

KEYWORDS: *glass reinforced polyester (GRP), outdoor sculpture, Futuro house, prototype, modern architecture*

INTRODUCTION: In 1968 architect Matti Suuronen (1933 - 2013) presented his newly designed Futuro, a fully equipped summerhouse/ski-hut, as an innovative construction based on a modular system that was easy to assemble and position in the Finnish landscape.[1] The spectacular design went into production worldwide with options for a personal choice of color, chairs, bedrooms and kitchen.[2]The UFO-like oval shape consists of a shell of 16 modular, rounded elements of double-skinned GRP sandwich panels. In the lower half are eight panels, one of which includes the entrance door and stairs, while the top half has eight panels with two oval windows each.[3]

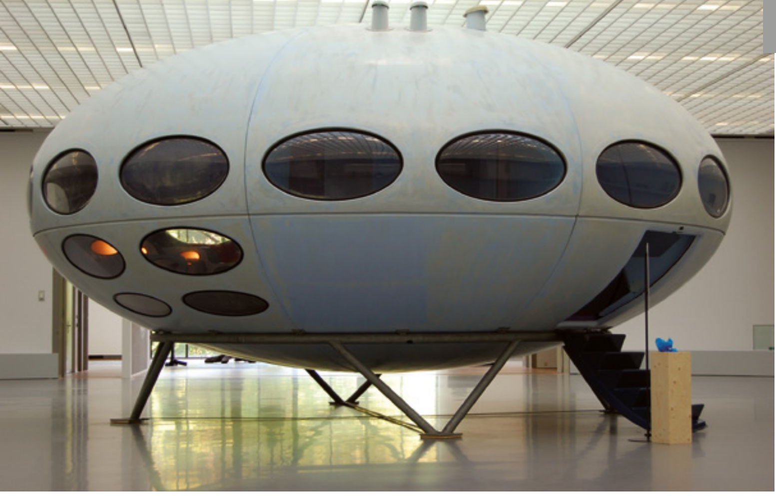
The prototype is *Futuro* number 000. It was produced in a light blue color for the outside and all the GRP parts inside, where it was combined with purple for the walls in the open central living space and red for the kitchen and bedroom cupboards, the cushioning on the chairs and beds, and the carpeting [FIGURES 01 - 03]. After years of travel to sales presentations, art exhibitions and periods of semi-permanent private use it was purchased by the Museum Boijmans Van Beuningen in Rotterdam in 2007. Research into the Prototype was undertaken, followed by a major conservation intervention of the house and its interior.[4]

FUTURO PROTOTYPE: STATE AND STATUS

Investigations of the Futuro were started that would establish an understanding of the both the materials and the status (cultural value) of the building. First, an insight was needed into the current condition of all single elements, missing parts, the general condition of the whole assembled piece and the originality of some materials, such as the internal red textiles and purple color on the wall. Secondly, a deliberation took place on the special meaning of the prototype Futuro. To what extend does the prototype differ in appearance, in construction details and in production technique from the later mass-produced Futuros and why? Both outcomes merged into a specific approach for the conservation treatment and the preservation of this Futuro prototype in the future.

SHORT HISTORY (1968 TO 2007)

The biography of the prototype was reconstructed through information from various sources.[5] Although a complete account of the exact whereabouts of the prototype during its first 40 years of existence cannot be made, there have been more than ten occasions of assembling and disassembling, and several periods when it was used for living in Finland in the first decades. After the 1996 exhibition in Vienna the prototype entered the collection of the Centraal



01 Futuro Prototype. Overview after conservation, 2011. © N. van Basten

02 Futuro Prototype. Interior view in after conservation, 2011. © N. van Basten

Museum, Utrecht where it was exhibited in the courtyard a few times and sent on loan occasionally. All the transportation, re-assemblies and exposure to the Finnish and Dutch climates had resulted in it being in poor condition by 2007 when it entered the collection of the Museum Boijmans Van Beuningen in Rotterdam. With the investigation into both the technical state of preservation and status (cultural value), of the *Futuro no. 000*, the museum underlined its importance to the world's cultural heritage and to the many Futuro houses globally.

MATERIAL CONDITION

The condition of all individual parts and the variety of types of damage were inventoried. The outer shell had obviously suffered the most, both from natural deterioration and from mechanical damage. The distinctive symptoms of deterioration caused by sunlight, rain, snow and moisture, extreme temperatures in summer and winter, large fluctuations in temperature between day and night are: chalking of the gelcoat, micro-cracks in the polyester and fading of color. Characteristics of mechanical impact are the large fractures, deformations, delamination of the sandwich layered shell construction and losses in the material. A range of phenomena can be ascribed to a combination of mechanical damage and weathering. Wear of the gelcoat surface together with micro-cracks and breaks in the surface allow moisture to enter into the GRP substructure, to cause mold growth and eventual delamination of the top layers of polyester. When penetrating deeper, water could reach the polyurethane foam layer, resulting in a loss of stiffness of the sandwich layers, and eventually, in more fractures on the polyester surface. This is just one example of the cause and effect of damage in the current condition of the prototype. On the other hand, the light blue GRP elements in the interior are in a very good condition. Here, no chalking or micro-cracks on the surface of the GRP are visible apart from minor mechanical damage. Old sales brochures show the fashionable interior with blue polyester elements combined with plain red cushioning and purple walls. The cushions for the beds and the chairs now have a floral design and date from the time when the Prototype was sent to the 1996 exhibition in Vienna. The red carpet had been replaced every few years.

To estimate the amount of time and the different types of work needed, experts in the field of outdoor GRP sculptures, of other Futuros and of GRP from both industry and conservation were consulted.[6] A substantial discussion on the future of the prototype addressed the question of the long-term preservation of the object against the wish to present it outdoors.

03 Futuro Prototype. View of the kitchen area after conservation, 2011. © N. van Basten

DECISION MAKING

Certain preconditions have to be feasible for the practical exhibition of an artwork or design object. With its robust presentation size of around 4,5m height, 8m width and approximate weight of 3.500 kg (its volume in its disassembled state requires three truckloads) the Futuro is not an easy object in a museum collection. A permanent space indoors is difficult to find, which then implies regular assembling and disassembling of the work and the risk of further damage. Placed outdoors, the GRP shell will continue to suffer from environmentally caused deterioration. This will require the application of a protective coating, either a sacrificial one with yearly maintenance (implying extra costs), or a permanent but irreversible coating, that changes the original look and smoothness of the work.[7]

The misconception of the Futuro being a moveable object probably originates from the spectacular photograph of the Swedish Army transporting their specially ordered Futuros by helicopter. Transport like this is hardly practical in a city like Rotterdam today, even disregarding costs and safety.[8] The assumption that the Futuro - designed as a modular system kit - was intended to be a real, mobile home that would sustain regular re-assembly has proved to be wrong, when one considers the worn state of the prototype and the architect's information on this topic.[9]

WEIGHING THE OPTIONS

The pros and cons of indoor or outdoor exhibition, and of a permanent or semi-permanent site were discussed in detail. If exhibited outdoors the prototype's shell would need a high-maintenance protection layer or irreversible recoating. Technically it is not possible to add a new gelcoat on top of the existing coat. The gelcoat functions as the first layer in a mold during fabrication.[10] The only way to add a further good coating would be to sand the original surface, and apply a 'DD lacquer', (a two-component polyurethane lacquer) by brush or spray. This is an irreversible intervention. In theory there is a choice between a transparent layer and a pigmented layer, but either will give the prototype a new surface and different appearance that clashes with the original production technique and aged look. As there is no guarantee that supports the industry's claim that these lacquers will not become yellow, the only alternative is a sacrificial wax coating to be reapplied after every cleaning, preferably twice a year.

However, if indoor presentation were to be chosen, the difficult issue about its original function and meaning will arise. In the discussion about whether the value of the Futuro lies in its being Art or Design it was argued that the prototype as such was at least unique.[11] In the meantime another aspect revealed itself. Under the dirty and chalky surface layer, the gelcoat had changed in color, shifting due to the influence of light into a rather patchy pattern of light blue, greenish beige and grey-purple color. This particular phenomenon, however puzzling, was regarded as another reason to rule out options of recoating the surface, and finally led to the choice of indoor exhibition as it was the only way to combine preservation with a minimal intervention that respects the surface of the original outer shell.

An additional advantage of internal exhibition is the possibility of open or supervised access to the fascinating interior for the public. When inside, there are no climatic constraints, as long as the work is protected from direct influences, such as rain, frost, sun and temperature fluctuations. The decision for indoor exhibition enabled a more restrained conservation treatment as there was no need for watertight connections between the shell elements, or to protect the Futuro against mice, birds, and insect infestations. Furthermore, exhibiting indoors would also prevent damage from graffiti or vandalism.

TREATMENT

To start the treatment all elements were transported to the Poly- Products company. Tests for cleaning, repairs, filling and retouching were made, together with further research into the technical properties and construction of the prototype. It was decided to re-assemble the prototype to learn, step by step, about the stages of assembly, to register them systematically, and at the same time, to locate all the damage and peculiarities that needed attention.

The elaboration of the conservation concept was developed during the course of testing for treatment. Due to the enormous size of the object however it proved difficult to predict the effect and the actual visual result of the cleaning, polishing and repair on the ca. 20x20 cm test areas. How to deal with every piece of the ca. 160 elements of the Futuro, ranging from the huge shell elements to the smallest cupboard door?[12]

OUTSIDE SHELL

After the re-assembly it was possible to review the prototype as a whole and put into context the disturbing impact of all the areas of damage at the ridges and edges of panels. The worn and dull chalky surface layer with patches of old repairs, graffiti, and the dusty, oval shaped windows - some missing their black rubber lining - gave an overall shabby look.

The partial delamination of the insulation foam from the inner and outer polyester layers of the shell elements (as a result of handling stress and storage under tension in different positions) had weakened the elements and possibly caused more fractures in the polyester. The door and stairs also showed delamination, which weakened the stairs.

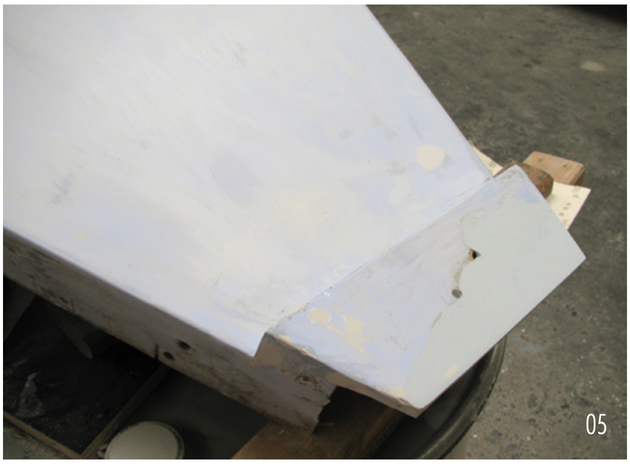
The poor appearance differed clearly from early photographs where the prototype would have been bright light-blue, similar to the interior elements that had kept their glossier surfaces and full color.

CLEANING THE GELCOAT

During the cleaning of the outer shell a remarkable shift in colors showed up [FIGURE 04, FIGURE 05]. The gelcoat colors are not monochrome blue anymore but seem to have faded partially due to sunlight exposure. Another possible reason for the patchy appearance could lie in the working method in the production. It is possible that the colors for the gelcoat had not been mixed well in the first place. In some areas large brushstrokes deriving from the application of the gelcoat mixture on the mold could be seen. The overall multicolored shades, which varied from blue to purplish beige and green grey, were not visible on the few remaining early photographs. How this process started is still the object of research [FIGURE 06, FIGURE 07].

THE INTERIOR

The blue polyester interior was in much better condition than the exterior although a similar but less pronounced shifting of the blue color could be detected there as well [FIGURE 08]. Some polyester interior elements were still fully blue, such as the bathroom where there has been very little exposure to direct sunlight [FIGURE 09]. Patches of dark retouched areas disturbed the purple walls and the ridges covering the bolted connections between the shell elements. The surface structure, typical of the GRP 'lay-up' method, was painted with a matt acrylic house paint. It was decided to completely repaint the inner walls and all purple elements rather than painstakingly try to remove the patches as there was no aesthetic or artistic value to this painted surface other than its color.[13] The cooperation with Poly Products B.V. provided the know-how for the repair and treatment of aged GRP objects. The conservation treatment was carried out by Poly Products employees in their factory with a lifting hoist, which enabled easier handling during assembly. The treatment consisted in a lot of cleaning and light polishing, filling larger lacunae



04 Detail of one of the shell elements; halfway the surface cleaning treatment. © L. Beerkens

05 Detail of the same element during the cleaning process. © L. Beerkens

06 Detail of the damaged top end of one of the shell elements. © L. Beerkens

07 Detail of the same element in figure 06 after repair of the loss. © L. Beerkens

08 Two fiberglass reinforced polyester elements from the seats in the living room. © L. Beerkens

09 Detail with a small shelf from the interior, still bright blue, in front of the faded blue shell element. © L. Beerkens

and old drill holes with the appropriate filler materials used in the polyester industry and mixed in matching colors [FIGURE 06, FIGURE 07]. This made it possible to execute a good and robust restoration within a reasonable time and budget. The door and stair element were cut open to add extra plywood and polyester reinforcement, and then closed-up again [FIGURE 10]. To preserve the prototype by refraining from future outdoor exhibition the treatment could be limited to cleaning, local repairs, small reconstructions and strengthening constructional components. The assembly in 2011 showed a good final result from the conservation treatment: the repetitive black lines of the oval windows and the smooth bluish polyester surface re-emphasize its character. The Futuro prototype has regained its strong features of futuristic design and lifestyle, and was welcomed back by its architect Matti Suuronen at the opening of the exhibition in the museum in May 2011.

MUSEOLOGICAL ACTIVITIES

During a two-year period the condition and status of the prototype Futuro 000 was investigated.

Taking into account its age and original appearance the prototype was treated on the basis of obtained results, and after consideration of the various conservation options for its optimal presentation. As the GRP outer shell is now over 50 years old, the prototype has reached the projected age where deterioration of the material becomes significant. Due to the poor condition of the worn polyester surface and deformations in the shells that hinder a watertight assembly of the outer shells, a continuous outdoor location is problematic. The Museum Boijmans Van Beuningen chose a conservation approach that avoided irreversible additions and made the interior accessible to the public. Outdoor exposure would have required a total repair including recoating the outer shell surface to enable it to be located in its original outdoor setting. With the completed conservation treatment, the Museum Boijmans Van Beuningen reached the goal of preserving the prototype for a longer period than its expected lifespan estimated by the production companies. Maintenance is manageable as harsh outdoor climatic influences are excluded.

At the end of the 2011 exhibition the Futuro had to be dismantled once more to be removed from the museum. A year later it was re-assembled as part of the Sarkis Exhibition, 'Ballads' in the spectacularly large space of the 'Onderzeebootloods', a former submarine building in Rotterdam harbor. Outside a non-museum environment even permanent guards could not prevent the public from leaving small marks and graffiti on the interior. After this exhibition the prototype was dismantled again, and since then the Futuro has been in storage, awaiting the opportunity to be visible again, after the major renovation of the Museum Boijmans Van Beuningen.

Parallel to this, in 2012 the very first of the mass- produced Futuros, house no. 001 was completely restored after being acquired by the WeeGee Exhibition Centre in Espoo, Finland.[14] Futuro 001 is placed outdoors, on the Centre's courtyard and is open to the public during summer.

The approach for this Futuro differed from the treatment applied to the prototype. Futuro 001, with its yellow exterior and red and yellow interior, has received an entirely new coating to the outer shell that recreates the bright yellow gloss finish which also protects it from the Finnish climate. Research into construction details of the Futuro 001 and its production technique has enabled a comparison with the prototype, and brings to light differences in construction and execution.[15] The Futuro 001 is protected by a maintenance plan that includes annual cleaning and checks.

10 Futuro Prototype. View of the entrance after conservation, 2011. © N. van Basten

CONCLUSION

In retrospect, a decade after the 2011 conservation intervention, the main argument in the decision making process still stands. The optimal strategy has been to both apply minimal conservation interventions to the existing materials and a few local constructional treatments and repairs. This approach however, requires the prototype to be kept and exhibited inside the Boijmans Van Beuningen Museum.

The minimal interventions respect the original handicraft production and keep the specific qualities of the making of the prototype visible. For the load-bearing construction to retain its strength and to enable a complete and functional assemblage of all building elements, a more intrusive treatment to a limited number of elements has been inevitable. In this way the twofold conservation intervention highlights the importance of the Futuro 000 as being the prototype of many following Futuro houses.

ACKNOWLEDGEMENTS

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During the entire project of the conservation of the Prototype many have been involved. Special thanks for this current, revised article to Christel van Hees, head of conservation and restoration at the Museum Boijmans van Beuningen. See also the acknowledgements in the initial article.

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1 See: Marko Home, Mika Taanila (eds.) FUTURO, Tomorrow's House from Yesterday, Helsinki 2002. This 192 pages publication plus DVD entails the key informa- tion on development, production, spreading world-wide of the FUTURO, with contemporary films and footage by many authors, including promotion films and a filmed interview with the architect.

2 Pekka Granqvist, contact person for Matti Suuronen, informed us on 18-5-2011 about an estimate of some 1000 FUTURO ´s worldwide and 23 licences to other countries and continents. The client could order from the modular system the amount of chairs, bedrooms and beds, and select any combination of colors for the external and internal polyester and upholstery.

3 See for a technical study: Frederic Rasier, Het Futurohuis, Universiy Gent, Belgium 2002,unpublished thesis at the Faculty of applied Sciences, Architecture & Urban development, on the technical aspects of the design, the build-up and dismantling of the house, the variety in design between the Finland produced FUTURO's and houses produced under license in other countries and continents.

4 See: http://www.boijmans.nl and https://www.boijmans.nl/collectie/kunstwerken/131959/futuro accessed 20 May, 2022. The museum Boijmans van Beuningen website contains various films on the restoration, on the buildup and references to relevant literature and links.

5 Pekka Granqvist stated that the Prototype has been assembled in Finland in Kalpalinna, Keitele and Kotka, before traveling to Vienna exhibition in 1996.

6 The restoration project of the Mobile Home for Kröller- Müller generated a lot of technical insight in the micro- climate inside small houses and objects in the outdoor. See: S. Stigter. L. Beerkens, H. Schellen, S. Kuperholc. Outdoor Polychrome Sculpture in Transit: Joep van Lieshouts' Mobile Home for Kröller Müller. Proceedings Icom CC Triennial Meeting New Delhi, India September 2008: Working group Modern Materials and Contemporary Art. p. 236-243. On protection of fiberglass reinforced polyester from outdoor climate influences see: L. Beerkens, S. Stigter, T.van Oosten, H. van Keulen: Go with the flow, Conservation of a floating sculpture from 1961 made out of glass fibre reinforced polyester resin, Victoria & Albert Museum Londen Symposium: Plastics, looking at the future, learning from the past, Mai 2007. Archetype Books 2008.

7 See for the research into the technique and conservation issues on FUTURO no 13: Tim Bechthold "Houston - We have a problem; when flying saucers become brittle" in Plastics. Looking at the Future and learning from the Past, Conference Papers, V&A London, 2008, pp. 28-35.

8 Home, Taanila (2002), op. cit. page 30. Photo by: Lehtikuva/ Pressens Bild.

9 Pekka Granqvist and Matti Suuronen, both present at the opening of the 2011 exhibition of the Prototype in the museum kindly explicated to us that the modular design together with the four legs first of all enabled placing the house in almost any landscape without the need of a flat platform. As the house was to be connected to a generator for electricity and heating and also needed water supply it is hardly conceivable to have it moving around as a real mobile home.

10 The other production method, which can be found on the inside of the shell elements is the so called 'hand lay up' technique. This results in a rougher surface with the internal structure of the fiberglass still visible.

11 For more insight in the current discussion in conservation on original, artist proof, replica, series produced etc. Tate organized the meeting Inherent Vice and Vice: The Replica and its Implications in Modern Sculpture Workshop, in October 2007, see: Tate Papers 2007 https://www.tate.org.uk/research/tate-papers/08

12 Information kindly provided by Nikki Van Basten Conservator of Modern Art, who registered the complete inventory of all elements of the Prototype in 2011.

13 Information from an employee of the production firm who stated that the purple walls had been overpainted in preparation of the Prototype for the 1996 exhibition in Vienna.

14 See: www.weegee.fi for more information by Marko Home. Both the Prototype and Futuro 001 were published in a sales brochure in 1968, see: Home, Taanila (2002), page 17

15 Prior to its restoration Futuro 001 was examined on its need for conservation. See: Anna-Maija Kuitunen, Futuro no 001, documentation and evaluation of preservation needs, Bachelors Thesis, Conservation Historical Interiors Metropolia University of Applied Sciences Vantaa Finland, 2010.

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Prototype fg 2000 Building System used as prefab-upper floor, Altenstadt/Hessen, firm fg design, Wolfgang Feierbach, FRG 1968.
@ Pamela Voigt, 2015

THE FUTURO HOUSE IN LIMNI, CORFU

A Living Space

Eugenia Stamatopoulou, Maria Karoglou, Asterios Bakolas

ABSTRACT: The restoration of the Futuro house in Corfu is complicated by being both an art object and a living space. The glass-fiber reinforced polymer (GFRP) materials showed damage that could be related to ageing and exposure to the local, unfavorable environmental conditions (light, humidity and temperature). In order to establish the technical condition of the building, non-destructive techniques were used. Additionally, indoor air quality was tested. The research has shown that the most relevant causes of damage to GFRP materials are moisture, exposure to sunlight and thermal changes. The intervention strategies applied so far are not conclusive. Maintenance is always needed. Further investigations are deemed necessary to understand the properties and state of conservation of the materials at a micro scale.

KEYWORDS: Futuro, GFRP, Investigation, degradation, preservation

INTRODUCTION: The Finnish architect Matti Suuronen exhibited the first Futuro house in 1968, a portable plastic house in the shape of a flying saucer.[1] [2] An important design idea was the development of sandwich construction in which fiber-reinforced plastic was combined with polyurethane insulation for interior thermal control.

This paper presents an overall approach to study and document the condition of the Futuro house, as well as an evaluation of the stability of previous restorations, particularly related to the environmental factors affecting composite plastics materials.

The Futuro house that is presented here was produced by Polykem Ltd., under the Belgium/Benelux license for International Promoting Co, SA. Bruxelles, between 1968 and 1969.[3] In 1969, three Futuro houses were imported into Belgium; one of those was located near Brussels until 1999, when it was saved from demolition by the Belgian architect Philemon Van Langendonck.[4] The same Futuro house, was later shown (2007) in the exhibition titled, "Tomorrow Now - When Design Meets Science Fiction", at the Grand Duke Jean Museum of Modern Art (MUDAM), in Luxembourg.[5] After MUDAM, the Futuro house travelled to Paris to be included in Christie's Auction (27/11/2007), "*Arts Décoratifs du XXème siècle et Design*", as Lot 391. It passed to a new owner to be transported to Greece to be installed in a courtyard of a private house in Limni, on Corfu, where it is still standing.[6]

DESCRIPTION OF THE CONSTRUCTION AND CONDITION OF MATERIALS (2007-2019)

The Corfu Futuro house is a single space, ellipsoidal form, consisting of eight identical upper and eight lower segments. They are made from 4 mm thick, random chopped glass-fiber, reinforced unsaturated polyester panel skins and a thick core of polyurethane foam. Each panel is numbered separately (0B to 7B for the bottom segments and 0T to 7T for the upper ones). The position of the panels is numbered clockwise starting with the staircase/door panel (0B). The overall diameter of the house is 5.50 m with a net interior area of 24 m^2. The house is carried on a slender circular steel ring held on four triangular legs 1.48 m above the ground. The overall weight of the plastic building is 2,500 kg. The individual segments are bolted together through stabilizing ribs at the edges of the elements. The house is accessed through a trap door that fits flush with the exterior of the building.

Each segment consists of GFRP sandwich panels created by hand lay-up molding. The inner and outer surfaces of these panelswere covered over the years with several layers of gel coats. Actually, the outer surface of the panels

01 Wooden reinforcement of the lower elements of the building, covered with the characteristic purple and grayish topcoat. © E. Stamatopoulou, 2008

02 View of the interior depicting element 4T. The arrows point the newly reshaped openings. © E. Stamatopoulou, 2008

is covered with a gray gel coat whereas the inner surface is coated with a purple primer and a graying top coat. In several areas with losses of the gel, underlying red color which results from the mold level where a red resin was used for the mold making, is also visible.

The lower panels are internally reinforced with wood and steel to strengthen the construction [FIGURE 01]. Additionally, the building has twenty oval windows of doubled Perspex (PMMA) sheets.[7]

The condition of the house was first examined and documented in 2007 by a team of engineers from KU Leuven in the course of research on composite materials.[8] During this investigation, the authors reported mechanical damage such as fractures, cracks and micro-cracks, as well as areas of delamination and flaking of the gel coat throughout the exterior surface. Larger cracks have been related to the brittleness of the GFRP in combination with local stress concentrations, especially on the holes for the bolted joints. This is probably due to excessive pressure applied during assembly of the panels. Micro-cracks and delamination of the coat gel were highest in the upper panels, particularly those oriented to the south. Clearly, the condition of the gel coat was related to the environmental factors (UV-radiation, heat and humidity), where the house had been located for several years.

UV-radiation and heat are both particular factors that can dramatically damage the condition of the GFRP's gel coat. Also, the rain and frost-thaw cycles in Belgium may create a fatigue load on the core due to moisture infiltration that results not only in crack growth, but also in gradual deterioration of the underlying glass laminate.

In 2008, after the acquisition of the Futuro House by the present owner, urgent and necessary repairs to stabilize the construction were undertaken at a French marine workshop specializing in the repair of GFRP.[9] The restoration consisted of the consolidation and reinforcement of cracked and broken parts of the edges and surface of the panels. Furthermore, restoration was focused on the repair and stabilization of mechanical damage at the midline of the house. Finally, some of the grooves holding the window seals had deteriorated, which allowed water to leak into the house. Therefore, it was also decided to re-form the openings and to secure the seals with mastic [FIGURE 02].

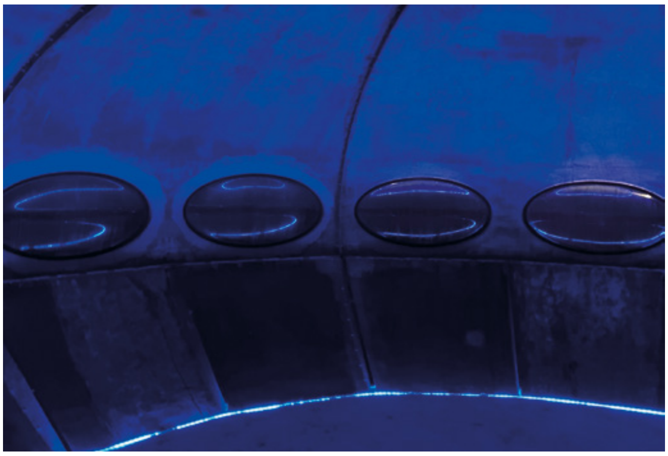
Internally, the upper panels of the house were partially covered with a grayish top coat, and the lower segments were upholstered with carpet [FIGURE 03].

In order to keep the overall aspect of the Futuro House intact, it was decided to retain the interior upholstery and coating as a historical reference of the materials used. Additionally, no intervention was made on the outer surface at the level of the gel coat.

After the 2008 restoration the Futuro house was transported to Limni in Corfu and installed permanently in its current location where it is surrounded by high trees and vegetation. The Futuro was meant to be used by the family as a space for relaxation and was kept unfurnished. A white carpet was laid, and blue-tinted hidden lighting was installed to create a calm and peaceful atmosphere in the inner space [FIGURE 04].[10]

Temperatures in Corfu vary during the seasons and between night and day, which can contribute to the deterioration of the materials. In order to protect the building, it was decided soon after installation in 2009 to treat the outer surface with a new clear coating, and to partially retouch some of the areas that were flaking and losing material. A restoration project was planned with the aid of a group of specialist boat painters in Greece.[11] Loose material was stripped in order to consolidate voids and cracks, then fiberglass reinforced resin was applied. Finally, a primer was applied for retouching the areas with a two-part gray epoxy. The entire surface was protected with a final varnish.[12]

03 Interior of the Futuro house, 2007. Arrows show the layer of top coat with a grayish color on top of purple primer and the presence of a synthetic carpet at the lower part of the segment. © E. Stamatopoulou, 2008



04 Interior of the Futuro house at night with the blue light installation. © E. Stamatopoulou, 2008

05 a-b Condition of the top coat in the interior of the Futuro house in 2007 (a) and in 2010 (b). © E. Stamatopoulou, 2010.

06 The Futuro house installed in Limni, Corfu, in its current condition. © E. Stamatopoulou, 2019

07 Detail of the deterioration of the exterior top coat in 2019 that had been applied during the restoration of the Futuro house in 2009. © E. Stamatopoulou, 2019

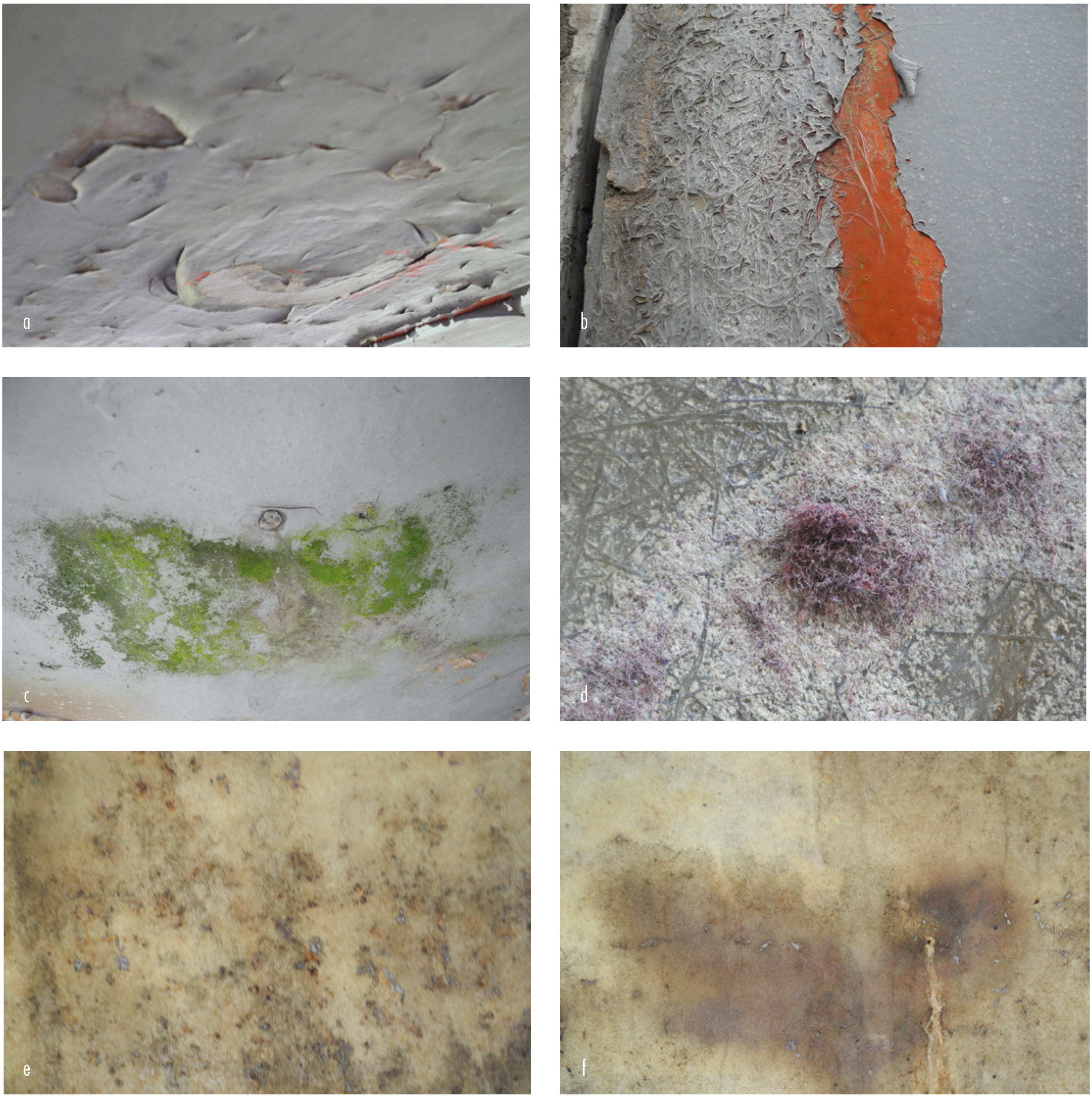
A year later in 2010, severe damage (extensive flaking) to the internal primer and top coat was noted [FIGURE 05]. Also, the carpet was moist and emitting a foul smell.

This could have been related to the increased impermeability of the outer surface after restoration which hindered the dispersal of internal moisture. As a result, condensation under the primer and top coat may have caused it to swell and flake, which was then exacerbated by seasonal temperature variations. Later in 2010, both the cracked and flaking internal primer and top coat were entirely removed.

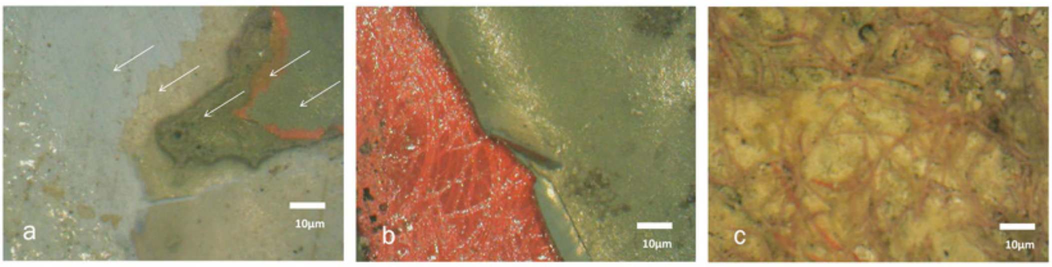
Today the condition of the Futuro House is poor and plans for restoration need to be reviewed. A recent inspection, made in summer 2019, revealed extensive areas of new flaking, cracks, blisters and material loss on the exterior top coat [FIGURE 06, FIGURE 07].

NON-DESTRUCTIVE INVESTIGATION TECHNIQUES

In order to understand causes of deterioration, it was decided in 2019 to implement systematic investigations of the structure using non-invasive techniques.



08 a-f Macro – photographs of the inner and outer surface of the Futuro house showing, (a) exfoliation of the outer coating, (b) areas with previous restoration, (c) growth of mold on the outer bottom region, (d) growth of reddish mold in the inner surface, (e) inner areas with surface irregularities, (f) inner area with extended change of color from yellowish to brown. © E. Stamatopoulou, 2019

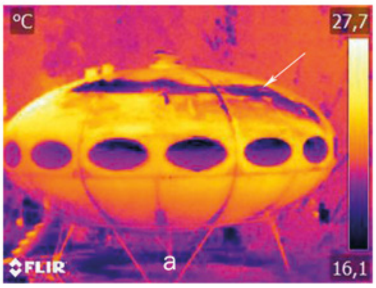


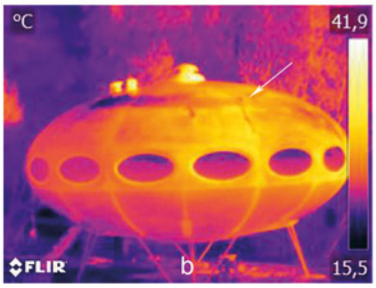
09 a-c Documentation of the outer and inner surface of the Futuro house using a portable digital microscope with x50 magnification. (a) The arrows mark the various layers on the outer surface, (b) region with exfoliation of the grey gel coat leaving visible the original inner core of red resin, (c) inner surface of the GFRP material depicting the random disposition of the glass fibers. © E. Stamatopoulou, 2019

The photographic documentation illustrated a range of defects such as exfoliation and cracks, as well as areas of previous restoration. [FIGURE 08].

Additional examination of selected areas with the use of the portable digital microscope (I-Scope, Moritex), revealed the surface characteristics of the panel core as well as various layers of coatings on the outer surface [FIGURE 09].

Finally, the structure was examined using infrared thermography (FLIR, B200) to detect damaged areas.[13] The thermographs taken were processed using the





10 a-b The arrows point the area where measured temperature at 10 a.m. is 18 °C (a) when at 6 p.m. is 30 °C (b).
© M. Karoglou, 2019

ThermaCAM QuickReport 1.1. software. The examination of the structure revealed an uneven distribution of temperature during the day [FIGURE 10].

These temperature fluctuations may severely affect the stability of the composite material by causing local cracks, humidity condensation and exfoliation and delamination of the various layers.[14] In the case of GFRP, the coefficient of thermal conductivity of the polymer is greater than that of the fibers. This means that the behavior of the constituent parts of the composite material differ, resulting in residual tensions.[15]

Additionally, atmospheric humidity and surface moisture are considered to be one of the most important causes of long-term degradation of polymeric composites. For the structure, water solutions affect the composite by decreasing the glass transition temperature, stiffness and strength of the composite, and increasing its volume.[16] Osmosis, defined as "*the migration of hygroscopic solutes within a laminate owing to moisture ingress, which ultimately results in blistering of the gelcoat*" is very characteristic of GFRP, causing extensive areas of blistering, cracking and final loss of the protective gel coat.[17]

EXAMINATION OF INDOOR AIR QUALITY OF THE FUTURO HOUSE

During the summer of 2015, the owner of the Futuro house reported an irritating odour inside the house. Concerned about the quality of the air, he requested an analysis that was carried out by a specialist company.[18] Tests were done for excessive aldehyde emissions, using a passive system for collecting the volatile organic compounds (VOCs) according to ISO/FDIS 16000-4:2004.[19] The samples were then analyzed using HPLC (High Performance Liquid Chromatography). The results showed the presence of various aldehydes with higher concentrations on acetaldehyde (9.1 μg/m^3), formaldehyde (82.2 μg/m^3) and isovarelaldehyde (10.8 μg/m^3).

In order to prevent significant sensory irritation in the general population from formaldehyde exposure, the World Health Organization recommends an air quality guideline value of 100 μg /m^3 as a 30-minute average. This guideline value represents an exposure level at which there is a negligible risk of upper respiratory tract cancer in humans.[20]

The presence of aldehydes in the interior of the Futuro house is associated with the thermal ageing and weathering of the polymers. Thermal degradation refers to the chemical and physical processes in polymers that occur at elevated temperatures, and photo-oxidation that occurs due to radiation (especially UV's) absorption. Both degradation types involve the reaction of free radicals from the polymer with oxygen to form peroxide radicals (PO), that in relation with other climatic quantities such as heat and moisture may generate hydro peroxides (POOH). These hydro peroxides can dissociate further to produce a series of decomposition products including aldehydes and ketones.[21]

The concentration of formaldehyde detected in the Futuro house was lower than the acceptable exposure levels and non-risky for the habitants. Nevertheless, it was advised to use a system to regularly renew the indoor air. For this reason, a ventilation and air-conditioning system to provide fresh air was installed on the ceiling of the house and the temperature for the interior was set at 18°C annually [FIGURE 11].

RESTORATION AND PRESERVATION DECISION-MAKING

The owner considers his Futuro house in Limni to be an artwork and a living space, which should be a consideration in the restoration and preservation of the structure. Consequently, it is imperative to preserve as much as possible of any original material from 1968/69, but also to safeguard and stabilize the construction over the time.

The environmental conditions of the location need to be taken into account in planning the conservation. The defects of the material are mostly related to environmental conditions, repairs and additions of new materials. Failures may consist of cumulative damage to the matrix, interfacial separation with the fibers, and chemical attack of the fibers, or a combination of two or more of these processes. The consequential effects may be loss of stiffness and mechanical integrity of the composite material.

In order to determine the conservation for this Futuro house, other laboratory tests are necessary to:

1 Provide information about the mechanical characteristics and stability of the composite material and determine the nanomechanical properties of polyester matrix composite using nano-identification.
2 Provide information about the composition and deterioration of the polymer, by means of Fourier Infrared Spectroscopy (FTIR), Raman Spectroscopy (μ-Raman), as well as Differential Scanning Calorimetry (DSC) to estimate the cross-linking degree of the polymer and Scanning Electron Microscopy (SEM) to help to identify the type of polymer and to localize the failure.

The results will be evaluated and used as a base for the establishment of an overall restoration and conservation plan that will include the application of materials in the inner and outer surfaces of the house, address issues of moisture permeability and protect the original coatings in the years to come.

CONCLUSION

Research has shown that, in this case, the most relevant causes of damage to GFRP materials are moisture, exposure to sunlight and thermal changes. The interventions applied so far are not conclusive. Maintenance is always needed. Further investigations are deemed necessary to understand the properties and the condition of the materials at a micro scale.

11 Interior of the Futuro house. The arrow indicates the position of the air-conditioning. © E. Stamatopoulou, 2015

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7 Sixteen of these windows are located on the bottom part of the top segments (two windows in each panel, slightly curved. The exterior windows are 96x50 cm and the interior sheets are 93x48 cm). Four double sheet windows are located in the upper part of segment 2B: these are sized at 91x48 cm (outer sheet) and 90x45 cm (inner sheet). The windows are secured with silicone rubber seals. Internally, the floor is covered with eight 18 mm plywood sheets.

8 idem 3.

9 The restoration was conducted by Roman Touly at the A.C.C.F. Chantier Naval, at Pont-l'Abbé, France between February and June 2008.

10 Statement given by the present owner in October 2019.

11 The name of the local company is *Mitakidis-Michailos* and are professional boat painters (official site: http://mitakidis-michailos.com/en/)

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FROM DETERIORATION TO REVIVAL

Approaches to the Conservation of Plastic Buildings

Ashal Tyurkay, Uta Pottgiesser

ABSTRACT: The four Futuro case studies *(Futuro No. 000, Corfu-Futuro, Donaldson-Futuro, Munich-Futuro*) presented in this journal document conservation approaches to plastic buildings and elements – in this case, glass-reinforced plastic (GRP) sandwich panels. They contribute to the definition of general conservation approaches, and at the same time reveal the knowledge gaps related to their individual histories and the necessity of a framework for managing interventions that are suited to GRP sandwich panels. The history and physical fabric of the selected Futuros, and the interventions done are compared in this article. The comparative analysis demonstrates how important it is to integrate a framework for adequate research and documentation into the conservation processes, in order to understand each building's significance and plan the interventions accordingly. The arguments deduced from the analyses demonstrate which factors differentiate the conservation solutions of the case studies in order to reframe the Futuros' expected life-span into a managed life-cycle.

KEYWORDS: Futuro, deterioration, Conservation Management Plan (CMP), comparative analysis, plastics

INTRODUCTION: The scarcity of conservation methods and processes for 20th century built heritage compared to built heritage of previous eras manifests itself as a critical issue according to the Madrid-New Delhi Document.[1] Early plastic buildings–represented in this paper by the Futuros–are, in particular, at risk to deteriorate and disappear due to lack of awareness and recognition. The four selected cases from the Netherlands, Greece, the United States and Germany, are significant examples of modern architectural expression and of experimental construction from post-WWII [FIGURES 01 - 04]. They witness an iterative construction process using innovative forms, materials or joints in connection with traditional building methods and techniques.[2]

An informal survey carried out in preparation of this paper showed that out of more than 100 Futuros there are about 60 left worldwide today [Voigt, Pamela, "The Futuro – History, Design and Construction in Finland and the USA" Docomomo Journal 66: 2022/1, p. 40-49]. Some have been relocated and dismantled, but

01 *Futuro No. 000* (prototype) before conservation in 2003 exhibited outside in the Centraal Museum in Utrecht. © K. Vermaas, 2003

02 The *Corfu-Futuro* house installed in Limni, Corfu island. © D. Joannou, 2014

03 The *Donaldson-Futuro* is placed outside and serves as a private guest house. © P. Kozal, 2018

04 The *Munich-Futuro* in Witten (Germany) before transportation to Munich. © BAKU, P. Voigt, 2016.

only few have been restored.[3] All Futuros compared here were designed and produced in the late 1960s and had periods of progressive deterioration, related to relocation and changed ownerships. Most of them were dismantled and reassembled several times, exposed to different environmental conditions and used for different functions. These events explain different types and levels of deterioration to their glass-reinforced plastic (GRP) shells, which required different intervention approaches.

Although the use of GRP sandwich panels as an exterior shell and for structural purposes was already tested, the Futuros are considered to be the first multiple-produced plastic buildings.[4] Neither had the service life of GRP sandwich panels been accurately estimated, nor its behavior under long-term exposure to varying environmental conditions. Due to uncertainties about the production and maintenance processes as well as missing information about the types and causes of deterioration, combined with the unprecedented uses of GRP panels, no conservation procedures for Futuros and plastic buildings in general have been developed and established. The four accompanying case studies of Futuros may offer material to put forward a method for study and evaluation.

CONSERVATION PHILOSOPHY AND INTERVENTION CATEGORIES

Ethics of conservation have been debated over the years and four criteria have been internationally recognized in the Charters: minimal intervention, minimal loss of fabric, reversibility, legibility of new work.[5] The timelines in this article indicate all the conservation activities in each Futuro's lifetime and how these criteria are met. The timelines also aim to inform decisions on the selection of the necessary materials and techniques for future interventions, thus supporting the development of a conservation policy. In order to define the extent of changes and interventions in line with the ethical criteria from the Charters, the following intervention categories are used: restoration, rehabilitation, replacement.[6]

- Restoration: the act of returning an object to a state of particular earlier period by removing features from other periods and reconstructing missing features with minimal introduction of new material.
- Rehabilitation: the act of improving performance or introducing a compatible new use through repair, alterations, and additions while retaining historical and cultural significance.
- Replacement: the act of removing severely deteriorated materials or features and substituting them with in-kind or visually similar materials.

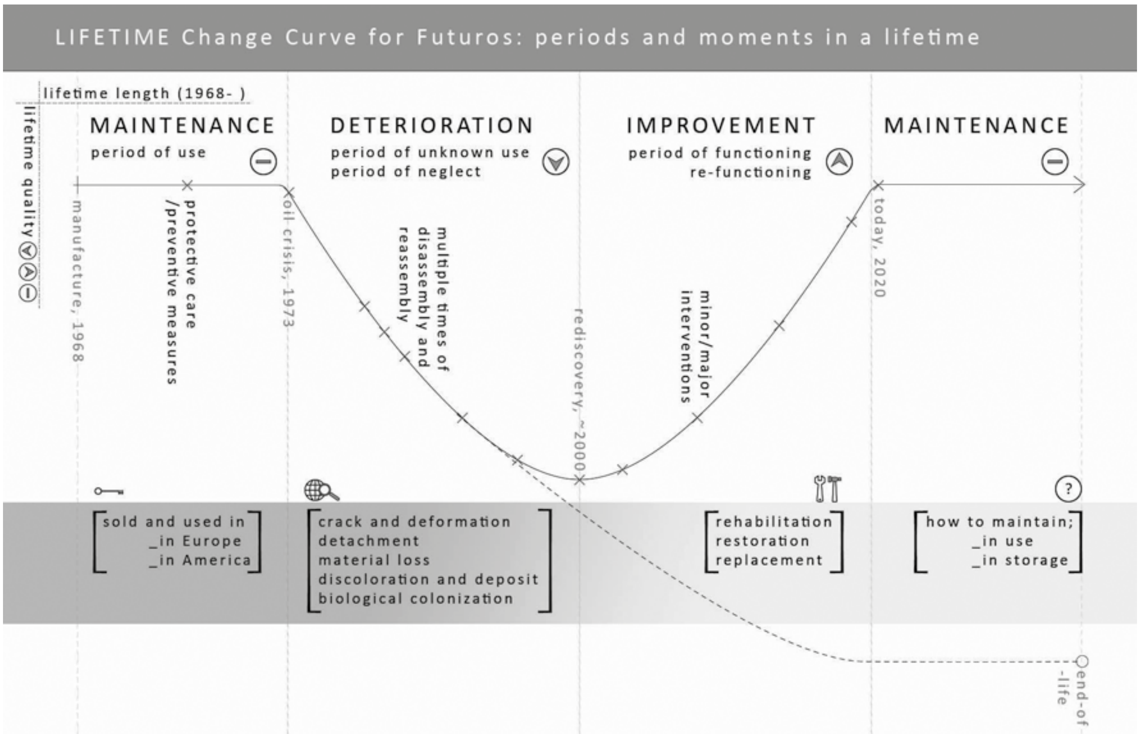
Criteria and processes of conservation could be applied to the lifetime of the Futuros [05]. Taking the manufacture or creation date of the Futuro as the start of its life, the lifetime could be described, including maintenance, deterioration and conservation intervention (improvement).

METHODOLOGY

It is crucial to analyze the presented cases to identify the elements of significance according to the structure of Conservation Management Plans (CMP) which are developed as guidance and evaluation frameworks through a conservation process.[7] All models emphasize that understanding the value of an object by applying a significance assessment provides the basis for developing and implementing conservation and change management strategies to guide future interventions.[8]

This article collates the histories and interventions of the four Futuros described separately elsewhere in the journal. Finding comprehensive documentation of the four Futuros has clearly proved difficult,[9] so a comparative analysis has been established to better understand and visualize the history of the case studies and the evaluation frameworks for their conservation.

Sources of the significance assessment come from historical documentary evidence and from physical evidence in the fabric as-found.[10] Understanding the place and object as a whole enables the creation of a chronological sequence of surviving elements.[11] This article presents two timelines. The comparative history of each case is



05 The Lifetime Change Curve describes the periods and moments of deterioration and intervention. © Authors

presented in a historical timeline [Table 1] with key dates and actors of design/manufacture, use and interventions. The comparative history of construction and materials, with a chronology of damage and intervention is presented in the technical timeline [Table 2].

The data for the two timelines are collected from the case study articles in this journal by extracting, comparing and analyzing them and contacting the authors for additional information. The information on each case study is grouped focusing on deteriorations and interventions. The deterioration data are supported with findings and underlying causes, the intervention data are described within a step-by-step approach, differenciating the treatments concerning the exterior and the interior of the Futuros.

OWNERSHIP, USE, CONSERVATION APPROACH AND INTERVENTION

In this section the historical and technical timelines are further described. The Futuros are similar in design, form, material use and manufacture date—namely 1968. The evidence for their original production and their current conditions can be documented in most cases, whereas tracing the chronology of ownership, use and change is very difficult. The historical timeline [Table 1]) presents the chronological similarities or differences in ownership and use, the relative histories of the case studies with a "provenance" approach.[12] Use and ownership of Futuros include intangible values and documentary evidence.[13] Based on designation and type of ownership, the statutory system of heritage protection dictates specific legislative and constraints on the owners. Ownership affects also the balance between inherent needs of the place and owners' interests or benefits, including financial policies.

After being used by their first owners for a few years, all Futuros underwent a period of approximately 30 years where they faced the threat of becoming obsolete. Surprisingly, all presented Futuros were saved from complete deterioration or demolition towards the end of 1990s. With this rediscovery the Futuros found new owners and different functions at new locations, followed by different intervention approaches.

The "provenance" approach proved suitable for both, individual-owned and museum-owned Futuros, not only in terms of valuation but also for defining the conservation strategies. In fact, the conservation specialists have developed different solutions for their interventions because each Futuro has a different history of use and ownership. The *Donaldson-Futuro* is owned by a private individual (an architect) and is now used for living purposes. The *Corfu-Futuro* also belongs to a private individual (an art collector) but has a semi-exhibitory use with living purposes, being kept within a group of collected art objects in the owner's residential garden. *Futuro No. 000* and the *Munich-Futuro,* on the contrary, belong to institutions (museums) and are used as collection objects and thus solely for exhibition purposes. Three Futuros are exposed to the outdoor environment, only *Futuro No. 000* is kept indoors.

The record of use and ownership together with the interventions in relevance to time help to understand how and why the changes to Futuros have been managed in the way they were. The 50-year lifetime of the Futuros resulted in severe damage due to material decay and handling of components as well as undergoing several interventions. The collected data on deterioration and interventions are transferred into the technical timeline [Table 2] with a 'system approach' for each Futuro. The 'System approach' does not only provide analytic understanding of the sub-systems of Futuros, but also illustrates the implementation of interventions recorded in the case studies. All elements other than structural and connecting components—shell, windows, partitions, furniture—are made of plastic and have undergone different treatments. For example, the interior and exterior surfaces of the shell are treated differently due to the shell's function of separating two environments (indoor and outdoor), and newly designated uses for the Futuros. Therefore, these elements are analyzed separately; the focus is laid on the exterior and interior GRP shell surfaces, and the windows.

Table 1 Historical timeline with key data on ownership and use of the Futuros.

FUTURO NO.000 - THE NETHERLANDS	MANUFACTURE	UNKNOWN/NOT DOCUMENTED PERIODS	REDISCOVERY AND PROCUREMENT	INTERVENTION	EXHIBITIONS AND STORAGE
	1968, Finland Matti Suuronen, Oy Polykem Ab ski lodge outdoor	**1968-1996, Finland** more than ten moments of dis-/re-assembling outdoor	**1996-2007, Europe** **1996, Vienna** exhibition **1997, Utrecht** exhibitions **2007, Rotterdam** exhibitions collection object indoor/outdoor	**2010-2011, Netherlands, Rotterdam** Lydia Beerkens, Samy Supply, Nikki van Basten, Poly Products BV collection object indoor	**2011** disassembled **2012** reassembled **2012 - Rotterdam, Netherlands** stored in pieces (disassembled) collection object indoor
CORFU-FUTURO - GREECE	MANUFACTURE AND TRANSLOCATION	PERIOD OF NEGLECT	REDISCOVERY AND AUCTION	INTERVENTIONS	USE AND INSPECTIONS
	1968, Finland Matti Suuronen, Oy Polykem Ab **1969, Belgium** under Belgium/Benelux license outdoor	**1969-1999, Belgium, Tildonk** remained at the same place outdoor	**1999, Belgium** saved from demolition P. Van Langendonck **2007, Luxembourg** exhibition **2007, Paris** auctioned off to Dakis Joannou indoor	**2008, France** Roman Touly at A.C.C.F. Chantier Naval **2009, Greece** Mitakidis-Michailos collection object & leisure space outdoor	**2010/2015/2019, Corfu, Greece** deteriorations; awaiting restoration collection object & leisure space outdoor
DONALDSON-FUTURO - USA	MANUFACTURE AND TRANSLOCATION	PERIOD OF NEGLECT	RESCUE AND PROCUREMENT	INTERVENTIONS	USE
	1968, US-PA Leonard Fruchter, Futuro Corp. Philadelphia **1969, US-CA** Stan Grau outdoor	**1969-2002, US-CA** used for naval training and architecture tours for a short time, then remained unused at a parking lot outdoor	**2002, US-CA** saved from demolition M. Wayne Donaldson transport in assembled state to San Diego Boat Yard (later Idyllwild) outdoor	**2002-2003, San Diego Boat Yard,** exterior intervention: San Diego Boat Movers and Planet Plastics, Corona **2004-2015, Idyllwild** interior interventions. M. Wayne Donaldson outdoor	**2009 - today, Idyllwild, USA** occupancy permit obtained weekend home outdoor
MUNICH-FUTURO - GERMANY	MANUFACTURE AND TRANSLOCATION	PERIOD OF USE	REDISCOVERY, 1ST PROCUREMENT AND INTERVENTION	2ND PROCUREMENT AND INTERVENTIONS	USE AND EXHIBITION
	1968, Finland Matti Suuronen, Oy Polykem Ab **1970s, Germany** ASV Stübbe, Vlotho outdoor	**1970s-2010, Vlotho** ASV Stübbe exhibition object & company boardroom outdoor	**2010, Witten** Charles Wilp Museum transport in assembled state **2010-2013, Witten** Interior interventions collection object outdoor	**2015, Munich** die Neue Sammlung – The Design Museum, Pinakothek der Moderne **2016-2017** Tim Bechthold with Pamela Voigt and SKZ: Das Kunststoffzentrum collection object outdoor	**2017 - today, Munich, Germany** die Neue Sammlung – The Design Museum, Pinakothek der Moderne collection object outdoor

Table 2 Technical timeline with comparison of deterioration and intervention data of Futuros.

Futuro	Sub-system	Construction and visual properties of sub-systems: Original	Construction and visual properties of sub-systems: Current changes	Natural / human deterioration factor: Atmospheric factors	Ageing and "time"	No use and/or maintenance	Handling and transport	Previous interventions	Vandalism	Deterioration level and category: Crack and deformation	Detachment	Decay and/or material loss	Discoloration and deposit	Biological colonization	Intervention motivation: Preservation / Conservation	Materials decay	Safety / security	User comfort	Energy conservation	Deterioration level	Intervention category and outcome
FUTURO NO.000 - THE NETHERLANDS	GRP EXTERIOR	top/bottom: 8/8 panels GRP/PUR/GRP: 3/45/2 mm gelcoat: light blue	original	•	•	•	•	•	•	•	•	•	•		•	•				high	**Restoration** (2010-2011) Clean/polish gelcoat Repair with resin/fiberglass Inject resin/filler into voids Reinforce steps with plywood/polyester
FUTURO NO.000 - THE NETHERLANDS	GRP INTERIOR	acrylic paint: purple	latex paint: purple	•	•	•	•					•	•		•	•	•			medium/high	**Restoration** (2010-2011) Clean/polish the surface Fill lacunas and old drill holes Repaint the entire surface
FUTURO NO.000 - THE NETHERLANDS	WINDOWS	PMMA: double-layered double-curved seals: black silicone rubber	original	•	•	•						•			•	•				high	**Restoration** (2010-2011) Clean original rubbers Clean original PMMA panes
CORFU-FUTURO - GREECE	GRP EXTERIOR	top/bottom: 8/8 panels GRP/PUR/GRP: 4/xx/4 mm gelcoat: grey	varnish: transparent	•	•	•	•			•	•				•	•				high	**Restoration** (2008) Repair with resin/fiberglass
				•			•			•	•	•			•	•				medium/high	**Restoration** (2009) Remove flakes Repair with resin/fiberglass Apply grey primer and paint partially Varnish the entire surface
				•	•					•	•	•		•						high/medium	Based on investigations in 2019 Awaiting **restoration**
CORFU-FUTURO - GREECE	GRP INTERIOR	primer/paint: purple/grey	original	•				•			•		•	•	•			•		high	**Restoration** (2010) Remove flakes and wet carpet
				•	•						•		•	•						high/medium	Based on investigations in 2019 Awaiting **restoration**
CORFU-FUTURO - GREECE	WINDOWS	PMMA: double-layered double-curved seals: black silicone rubber	new seals	•	•	•				•						•			•	high/medium	**Restoration** (2008) Reshape openings Install new seals

Structure and content of the technical timeline allow for comprehension of the constructive and visual features of the initial design and the final condition at the same time, and give insight to specific deterioration states and interventions in between. Thus, all information is provided in a reason-result relationship. The timeline could be used as an inventory of as many case studies as possible which will highlight both, similarities and differences in intervention approaches.

The technical timeline covers tangible values of Futuros and describes the physical evidence which requires historical research as well as condition assessment of their fabric as-found. Historical research forms the baseline of information on construction and material configuration and how both changed over time. If the physical evidence of these changes was not recorded at the time the change was made, it could be identified and located by several assessment techniques such as stereophotogrammetry, digital recording tools and measurements.[14]

Building	Sub-system	Construction and visual properties of sub-systems: Original	Construction and visual properties of sub-systems: Current changes	Deterioration level	Natural / human deterioration factor: Atmospheric factors	Ageing and "time"	No use and/or maintenance	Handling and transport	Previous interventions	Vandalism	Deterioration category: Crack and deformation	Detachment	Decay and/or material loss	Discoloration and deposit	Biological colonization	Intervention motivation: Preservation / Conservation	Materials decay	Safety / security	User comfort	Energy conservation	Intervention category and outcome
DONALDSON-FUTURO - USA	GRP EXTERIOR	top/bottom: 2/2 panels GRP/PUR/GRP: x/x/x mm gelcoat: Harvest Gold	panel sealing: permanent	-none-	•	•											•				**Rehabilitation** (1969-1972) Paint with green latex
			paint: yellow	high	•	•	•	•	•	•	•	•	•	•		•	•	•	•	•	**Restoration** (2002) Remove green latex Repair and repaint the entire surface Seal the top halves with fiberglass
	GRP INTERIOR	finishing material	color	high	•	•	•					•	•	•	•	•	•		•		**Restoration** (2004-2015)
	WINDOWS	PMMA: double-layered double-curved seals: black silicone rubber	windows PMMA skylight PMMA	high	•	•	•			•			•			•	•		•	•	**Rehabilitation** (2007) Install new seals Install new PMMA window panes
			zipper gaskets: H-shaped, neoprene	high	•	•	•				•	•	•	•					•		**Rehabilitation** (2007) Remove a section (ø=2.5 m) from top Install a skylight
MUNICH-FUTURO - GERMANY	GRP EXTERIOR	top/bottom: 8/8 panels GRP/PUR/GRP: 2.5/40/3.5 mm gelcoat: signal white (RAL 9003)	PUR foam: partial GRP laminate: partial	low	•	•										•	•				**Restoration** (2010-2013) Paint entire surface, seal joints with silicone
			panel sealing: silicone paint: signal white (RAL 9003)	medium/high	•	•	•		•	•	•	•	•	•	•	•	•				**Restoration** (2016-2017) Replace PUR and GRP where necessary Remove coatings down to gelcoat Repair with resin/fiberglass Repaint the entire surface
	GRP INTERIOR	GRP finishing: orange (RAL 2011) or signal white (RAL 9003)	paint: orange (RAL 2011)	medium/low															•		**Replacement** (2010-2013) Plaster and paint (white) entire surface
				medium/high	•	•			•		•	•	•	•	•	•	•	•			**Restoration** (2016-2017) Clean the entire surface Remove all added coatings Repair with resin/fiberglass Repaint the visible surfaces
	WINDOWS/SKYLIGHT	PMMA: double-layered double-curved seals: black silicone rubber	windows PMMA skylight PMMA seals	high						•			•			•		•			**Replacement** (2010-2013) Install flat PMMA panes
				high					•	•			•			•					**Restoration/replacement** (2016-2017) Install new window- and skylight-panes Install new seals

Deterioration data include categories, factors and levels. This information is obtained generally with condition assessment techniques before an intervention is made, so with each timely different intervention new data are obtained regarding deterioration and intervention. The recorded deterioration types in the case studies are grouped into five deterioration categories as described in the *Illustrated glossary on stone deterioration patterns* prepared by ICOMOS-ISCS: crack and deformation, detachment, features induced by material loss, discoloration and deposit, biological colonization.[15] The causes for deterioration are collected as explained in the articles and classified with sub-factors of natural and man-made deterioration factors: atmospheric factors, ageing and "time", no use and/or maintenance, handling and transport, previous interventions, vandalism. The deterioration level is ascribed to a sub-system with the help of the in-text information and pictures from the articles and authors in this journal.

Natural deterioration (atmospheric factors, ageing and "time") is an inevitable phenomenon and common to all buildings and objects in an outdoor environment, and which work particularly effectively against the integrity of GRP shell elements. Directly linked with these factors is the maintenance and inclusion of maintenance planning with periodic cleaning and repairs within conservation management plans to slow down deterioration and prolong the lifetime of plastic buildings. The absence of use or maintenance is, however, a recurrent cause of damage to the Futuros. Handling and transport may lead to cracks and deformation, which was often the case of Futuros with multiple dismantling and re-assembling and changing locations. This weakened connections and overall structural stability. Drill-, pin- and service-holes created weak points in the construction due to material loss and and increased susceptibility to atmospheric factors and biological growth.

Previous interventions also induced deterioration, when the quality of the workmanship was low, or due to wrong material selection and faulty planning in application decisions. Correcting the previous treatments often led to a more invasive intervention due to the more extensive damage triggered by the initial misguided intervention.

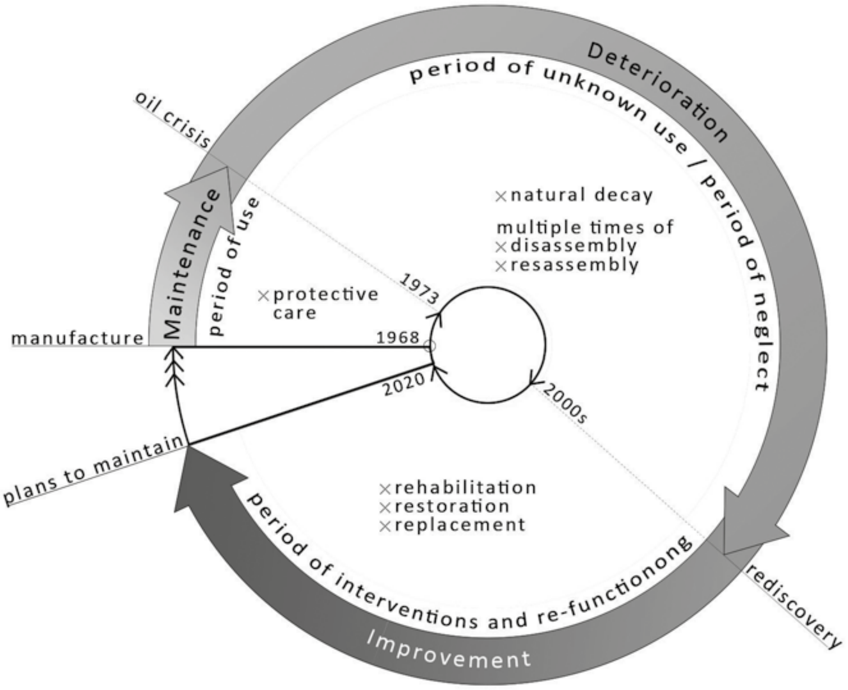
The intervention information is recorded under descriptive outcomes, categories and intentions. Intervention outcome is a step-by-step narrative of the applied procedures. Based on this description together with the prior state of conservation of an element, the category for the intervention is identified: restoration, rehabilitation or replacement. This motivation is classified under one or more of the five main drivers for interventions[16]: historic preservation/heritage conservation, materials decay, safety/security, user comfort, energy conservation.

Despite the high level of deterioration to the exterior of the GRP shell in *Futuro No. 000* the restoration was less invasive than that of the shell's interior. It was not intended to bring back its new and polished look as in 1968, but to re-establish the structural stability of the shell structure as a result of deciding to exhibit and store the Futuro inside. The same strategy was followed for the restoration of windows, no longer exposed to atmospheric factors. The interior location delays the progress of material decay and the Futuro's historical and cultural values were preserved by maintaining the exterior's latest appearance. However, the Futuro was restored to its original state inside, to allow visitors experience its unique atmosphere when they step in.

Unlike the *Futuro No. 000,* the *Corfu-Futuro* is kept outside, so the elimination of the adverse effects of atmospheric factors was of great importance. The restoration in 2008 aimed to repair the exterior surfaces of the Futuro without altering its appearance. Consequently, the old-worn window seals were replaced and a transparent varnish was applied to its exterior shell surface to protect the shell structure and the indoor environment against atmospheric factors. However, only one year later, the interior surfaces developed new moisture-related damage due to condensation. Because both restorations in 2008 and 2009 have caused further damage after 10 years, a conservation management plan for the *Corfu-Futuro* should be developed.

Different from other Futuros, the *Donaldson-Futuro* is used as a living space. Making the construction conform to building legislation and obtaining building permits had caused significant delays and a long intervention period. User comfort and energy conservation have gained importance in the GRP shell's interior restoration and in the rehabilitation of windows together with the addition of a skylight. The *Donaldson-Futuro* is an example of the necessity of regular maintenance. Although it was painted once for protection against environmental factors, the absence of further maintenance and care in the following 30 years resulted in serious damage. To bring it back to a usable condition as a living space to be kept in a suburban area, *Donaldson-Futuro* had to be almost recreated again. The permanent connection of the two halves during the interventions on the exterior precluded disassembly for transportation which turned out to be an advantage for the shell's long-term structural stability.

In contrast to *Futuro No. 000*, the *Munich-Futuro* was restored for exterior exhibition to present its original surfaces and original configuration. Previous interventions to the GRP panels had altered its appearance with the change of color and had led to the reduction of its structural performance. The restoration of the surfaces back to their original appearance and construction had become the only viable



06 The Life-time Change Curve can be transformed into a life-cycle concept through conservation. © Authors

option. Replacement of the old window seals and completion of missing PMMA panes were necessary to create a safe and secure indoor space and prevent leaking.

FROM LIFE-SPAN TO LIFE-CYCLE

Periodical maintenance works and timely repairs are the prerequisites to conserve plastic buildings and to bring them into a life-cycle, i.e. not opting for "replacement", but prolonging their life-span, initially considered to be less than 50 years, but for which research indicates may be up to 100 years [Loader, Robert, "Deterioration, Harm and Conservation of Building Plastics Heritage" Docomomo Journal 66: 2022/1, p. 84-93] [FIGURE 06].

CONCLUSION

The use of plastics in architecture is an innovation belonging to the 20th century. The study of four Futuros has shown that design and construction, use and maintenance of a building belong to different areas of expertise. The applied historical and technical research builds up a holistic approach based on understanding the significance to develop strategies for conservation works and finally a Conservation Management Plan. Due to its technical and historical complexity it is crucial to find experts to build up an interdisciplinary team, and to plan the conservation works keeping in mind the use of the plastic building.

Guidelines to approach the conservation of plastic buildings need to be developed. The Conservation Management Plan should also include a maintenance plan for the future and recommendations for carrying out monitoring and controls.

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ENDNOTES

1 ICOMOS ISC20C, 2017
2 Wilp-Futuro (Munich) uses wood to stabilize the plastic shell and the San Diego-Futuro has wood counters and wooden built-ins covered with a plastic laminated top, indicating that the plastic was not trusted.
3 To prepare this article and issue an internal overview of the Futuros was created based on several websites and publications to identify suitable objects and cases to be presented in this comparison: Lola Kleindouwel and Uta Pottgiesser, Internal Research and Documentation, TU Delft, Section Heritage & Architecture, 2019.
4 See VOIGT, 2007. In the appendix of her dissertation Voigt has provided a comprehensive catalogue of plastic prototypes and projects.
5 See BELL, Dorothy, *The Historic Scotland Guide to International Conservation Charters*, Edinburgh, Historic Scotland, 1997, p. 1.
6 See AYON, Angel, POTTGIESSER, Uta, RICHARDS, Nathaniel, *Reglazing Modernism: Intervention Strategies for 20th-century Icons*, Basel: Birkhäuser, 2019, pp. 29-31. In their publication the authors use this categorization based on the definitions of the *US Secretary of the Interior's Standards for the Treatment of Historic Properties* with the accompanying *Guidelines for Preserving, Rehabilitating, Restoring and Reconstructing Historic Buildings*.
7 Today the Burra Charter (AUSTRALIA ICOMOS, 2013) and the Madrid-New Delhi Document (ICOMOS ISC20C, 2017) are frequently used as a source to follow in developing CMP especially for Modern Movement heritage, for instance, Eames House Conservation Management Plan (BURKE et al., 2018). The Burra Charter takes the understanding of cultural significance of a place as basis to decision-making on conservation policies and implementations of the policies. Nevertheless, the courses of action for conservation activities had been mapped out earlier in Technical Advice Note, No 8 (TAN 8) - The Historic Scotland Guide to International Conservation Charters (BELL, 1997) by synthesizing from international Charters of UNESCO, ICOMOS and Council of Europe in the 20th century which can be taken as a compact summary of previous developments in CMP methods.
8 The framework could be used before making an intervention but also during and after an intervention as the Madrid-New Delhi Document 2017 suggests.
9 Therefore, doing historical research is crucial and in a comparative manner can become even more essential as the knowledge of comparable places gains value in interpreting and reconstructing the missing information of a specific place (KERR, 2013, pp. 7-8).
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13 History of ownership is not only relevant to heritage values, but also to the current state of the place. See HISTORIC ENGLAND, *Conservation Principles, Policies and Guidance for the Sustainable Management of the Historic Environment*, 2018. p. 35.
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DETERIORATION, HARM AND CONSERVATION OF BUILDING PLASTICS HERITAGE

Robert Loader

ABSTRACT: From the 1950s to 1970s a handful of architects and designers developed the use of glass-reinforced plastic (GRP) for external building skins that expressed the nature and possibilities of the material. External panels were designed as non-structural interchangeable cladding and also as structural folded plates and shells.
Many GRP buildings were designed as temporary structures and have long since disappeared. Some have survived and, in England, a few have been recognised with listed status for their architectural quality. At about fifty years of age the condition of polymeric components, such as external panels, fixings and joints, is beginning to present new problems in conservation. The case studies in this paper indicate that early estimates for the design life of GRP buildings and components have been surpassed, and that a range of approaches is available and necessary for their conservation.
Innovative plastic buildings and components also remain at risk of damage and demolition from a lack of awareness of their existence and value by heritage protection bodies.

KEYWORDS: GRP; United Kingdom; heritage listing; documentation; prototype

INTRODUCTION: The impetus for this research followed the two seminars in Delft and Antwerp organised by the Docomomo International Specialist Committees for Technology and Interior Design. The seminars addressed the problems of understanding the technical characteristics and performance of polymers in construction. This article focuses on 'architectural', external plastic elements, where large components enclose and define the character of a building, and it takes examples from the UK, where there are a few listed buildings with significant plastics content. As a note, GRP is the abbreviated term for glass-reinforced plastic/polymer, or, more precisely, glass-fibre reinforced polyester. The term, FRP refers more generally to fibre-reinforced plastic or polymer that could include reinforcement materials such as carbon fibre, Kevlar and graphite. Much of this article is informed by discussions with chemists, conservators and practitioners, but detailed descriptions of the chemical and physical properties of polymers in building should be sought elsewhere. Other uses of plastics, such as internal sanitary components, represent a rather different technology, and their life-cycle is outside the scope of this article.

EARLY DEVELOPMENT OF GRP BUILDINGS

In the 1930s the two main components of GRP, unsaturated polyester resin and woven glass fibre were sufficiently developed to enable commercial use, and by the early 1940s the composite material was in use for aircraft components. The 1950s was a period of wide experimentation: in 1954 Buckminster Fuller developed geodesic electromagnetically permeable radar domes in GRP. The use of GRP for small boats and vehicle bodies increased dramatically, and translucent, corrugated wall and roof panels such as *Kalwall* were marketed to immediate success.

Architectural development of prefabricated GRP buildings emerged in the mid to late 1950s with multiple experimental exhibition and holiday houses, most of which have not survived. In 1956 Ionel Schein, Yves Magnant and R. A. Coulon demonstrated the all-plastics *Snail Shell* house at the Paris Exhibition which proposed incremental extension around a central living space. At the end of the same year the group exhibited a motel cabin with double curvature forms designed for easy transportation and grouped assembly. In Germany in 1958 Rudolf Doernach showed a small weekend house of double-curved roof-wall shell panels and vertical fluid-filled, translucent, honeycomb-cored panels.

The best-known example from the period is the *Monsanto House of the Future* (sponsored by the Monsanto Chemical Company), which was designed by Hamilton & Goody with Professor Albert Dietz as engineer and completed in 1957. It featured four large GRP wings cantilevered from a central core. The shell sandwich panels that enclosed the 4-inch honeycomb core were 8ft x 16ft, and tests throughout its 10 years in Disneyland showed excellent structural performance.

Also, in 1957 an all-plastics house designed by Cesare Pea consisting of four GRP boxes to be assembled in different configurations was exhibited at the Milan Exhibition. Subsequently, at the 1962 International Prefabrication Exhibition in Milan a group comprising R. Piano, R. Foni, B. Huet and C. Ruggieri under the direction of Professor G. Forti of the Technical University of Milan showed a hexagonal holiday house comprising 12 floor and roof panels and 6 vertical wall units. Piano continued further experimental work with GRP wall and roof panels through the early 1960s, during which time he met engineering professor Z. S. Makowski, who was teaching in London at the Battersea Institute of Technology (later Sussex University). Makowski had contributed to the structural design of the (aluminium) stressed skin pyramidical roof of the UIA Pavilion erected in London in 1961, and over the next decade he continued to lead significant research and practice in GRP, space structures and structural panels.

None of the examples above prompted popular mass production of prefabricated GRP dwellings. However, in 1961, Mickleover Transport, a vehicle body manufacturer, began producing self-supporting wall and roof panels to enclose signal relay rooms for British Rail. There were three different panel types: a corner unit and two side units of different spans. Each phenolic-cored sandwich panel comprised wall and roof in a single double-curvature shell. They could be easily assembled on sites with difficult access and were later used for electricity sub-stations. Further variations included a two-storey telephone exchange for Bakelite in Tyesley and, in 1963, a research station for the British Antarctic Survey on Signy Island in the Antarctic [FIGURE 01]. None of these small functional enclosures are known to still exist.

In the late 1960s the development of the *Futuro* house, designed by Matti Suuronen and the *fg 2000* house by Wolfgang Feierbach achieved greater popularity and multiple production. Both were exhibited from 1971 at the IKA (International Plastic Housing Exhibition) in Ludenscheid, Germany - a high point in public enthusiasm for plastic buildings. After this, the decline in the viability of GRP buildings can be attributed to the massively increased costs of polyester resin following the oil crisis of 1973, and lingering, unresolved technical concerns of fire safety.

01 The Biological Research Laboratory at Signy Island, Antarctica, nearing completion in April 1964. Double curvature GRP panels produced by Mickleover Transport. © F. Topliffe, 26 February 1964. Reproduced courtesy of the British Antarctic Survey Archives Service. Archives ref. 2006/2.1

COMPOSITION AND DEGRADATION OF GRP

GRP is a composite material made of glass fibre reinforcement encased in a thermosetting resin, which, for building purposes, is generally polyester (epoxy, polyurethane and vinyl are also sometimes used). When suitably protected, GRP has good corrosion and weather resistance, making it suitable for long-term use in external conditions.

GRP panels and components for single building projects are usually fabricated by 'hand lay-up', rather than mechanised fabrication that would be more economic for longer production runs. Panels are formed by laying fibreglass and liquid polyester resin into moulds. The fibreglass is pressed in, and the resin is poured over and cured (hardened) by the addition of catalysts. Successive layers of glass fibre and polyester build-up tensile and compressive strength.

Within the range of glass fibre there are different weights and thicknesses of material, various weaves, or random chopped strands that are selected according to application. The resin may contain fillers and plasticisers, UV stabilisers and other additives for colour retention, toughness, surface quality and protection against flammability. Varying mechanical properties are created by different combinations of the polyester base components.

Degradation of polyester can be caused by physical forces, light, UV radiation, oxygen, water, contaminants, chemicals, temperature and humidity. The associated visual changes include loss of gloss, yellowing, surface cracking, loss of material (in the form of chalking – filler leaching out), deformation and delamination. There may also be loss of mechanical strength. Stability against these problems variously depends on the type of polyester, the application of the glass fibre and the workmanship.

Moisture will attack the interstices of glass fibre reinforcement, so the outside of a panel is protected by a layer of resin known as the gel-coat. This is a relatively

02 James Stirling in the Anmac factory, Nottingham. © R. Nicholson

03 Drain-pipes and vents cut through a GRP panel at the Olivetti Building, December 2018. © R. Loader

thick protective resin layer of about 0.5 mm that gives the characteristic high gloss finish of new, un-weathered GRP. It is applied as the first layer to the waxed and polished mould as a thick liquid, and while still tacky, the next layer of resin and fibreglass is applied. The gel-coat is usually pigmented in order to hide the substrate.

Research into the ageing and conservation of plastics is mostly located in the world of sculpture and furniture conservation. Prominent examples are the conservation of the GRP Panton chairs at the Vitra Design Museum as part of the Axa Art Conservation research programme.[1] Artists such as Nikki de St Phalle (1930-2002)[2] and Joep van Lieshout (*1963)[3] have produced large GRP outdoor sculptures that have undergone significant conservation interventions. In the case of museum and art objects, intensive investigations are carried out to identify the base components of the polyester and glass, the methods of polymerisation and manufacture.

Sculpture can be brought indoors, either for treatment, or to be permanently relocated away from the causes of degradation. The Floating Sculpture, Otterlo from 1961 by Marta Pan (1923-2008) in the Kröller-Müller Museum is brought inside each winter.[4] The Futuro house held by the Museum Boijmans van Beuningen in Rotterdam has been repaired, cleaned and waxed, but is now only displayed indoors. Clearly, this approach is not a solution to buildings in use. The following section describes the condition of five buildings, and the maintenance measures that are in place.

EXAMINATION OF FIVE GRP BUILDINGS

GRP buildings that survive from the 1950s or 1960s are virtually unknown. The section below describes the context and conclusions of visual assessments from 2018 to 2021 on the state of conservation of four buildings from the 1970s, three of which are listed:

- the Olivetti Building in Haslemere, Surrey (now the Jamia Ahmadiyya), completed in 1972,
- the Kennington Road Primary School classroom in Fulwood, Preston, completed in 1974,
- the Herman Miller Factory in Bath (now Bath Spa University), completed in 1978, and
- Yachtsmen's Showers and Lavatories at Brighton Marina, completed in 1978.
- Prototype acrylic bathrooms for ICI, ca. DATE

THE OLIVETTI BUILDING, HASLEMERE, SURREY

The Olivetti Training Centre (now the Jamia Ahmadiyya), designed by James Stirling and completed in 1972, is now listed Grade II*. This is a high level of heritage protection, though at nearly 50 years old, the building has not yet had major maintenance work.

The GRP panels at Olivetti are ambitious in terms of size and form: wide single panels merge from wall to roof and special panels project over window heads. Alternating coloured GRP panels were previously used at Stirling's Runcorn housing (now demolished) to line the sheltered deck access fronts and soffits, which emphasises the playful and 'artificial' nature of the material. The panels consist of 12 mm polyurethane foam faced each side with GRP and, for fire-resistance, mineral wool is attached to the inner face of the panel. The outer finish of the panels is not a typical gel coat, but a two-part polyurethane applied later and under more controlled conditions than were available at the time of manufacture. R. Nicholson, the project architect, has recounted that the 1972 miners' strike had disrupted supplies of heating coal to the Anmac factory in Nottingham [FIGURE 02], so conditions for curing panels with consistent colour were not reliable.[5] Walker described the polyurethane to have been badly weathered

04 Corner voids due to an absence of glass fibre matting behind the outer gel-coat layer at the Olivetti Building, December 2018. © R. Loader

05 The classroom at Kennington Road Primary School, October 2018. © R. Loader

after fifteen years.[6] Trial repairs were carried out using a two-part polyester spray filler as an isolator between the original surface and new coatings, but it is not evident that the whole building was treated.

The worst damage to the GRP is man-made, comprising various service and drainage connections that have been drilled through the panels [FIGURE 03]. These will compromise the fire protection to the panel and water penetration will result in delamination of the fibreglass. For minor mechanical damage to GRP there are well-tried techniques to rebuild solid fibreglass components, as previously recorded by Beerkens for the repair of the entrance steps to the Futuro House at the Boijmans Museum.[7] However, damage caused by pipe holes, especially through foamed sandwich panels, presents a more awkward problem. Face-fixed GRP disks would be a straightforward solution to seal the exterior and interior and, although visible, once painted, would then be relatively unobtrusive.

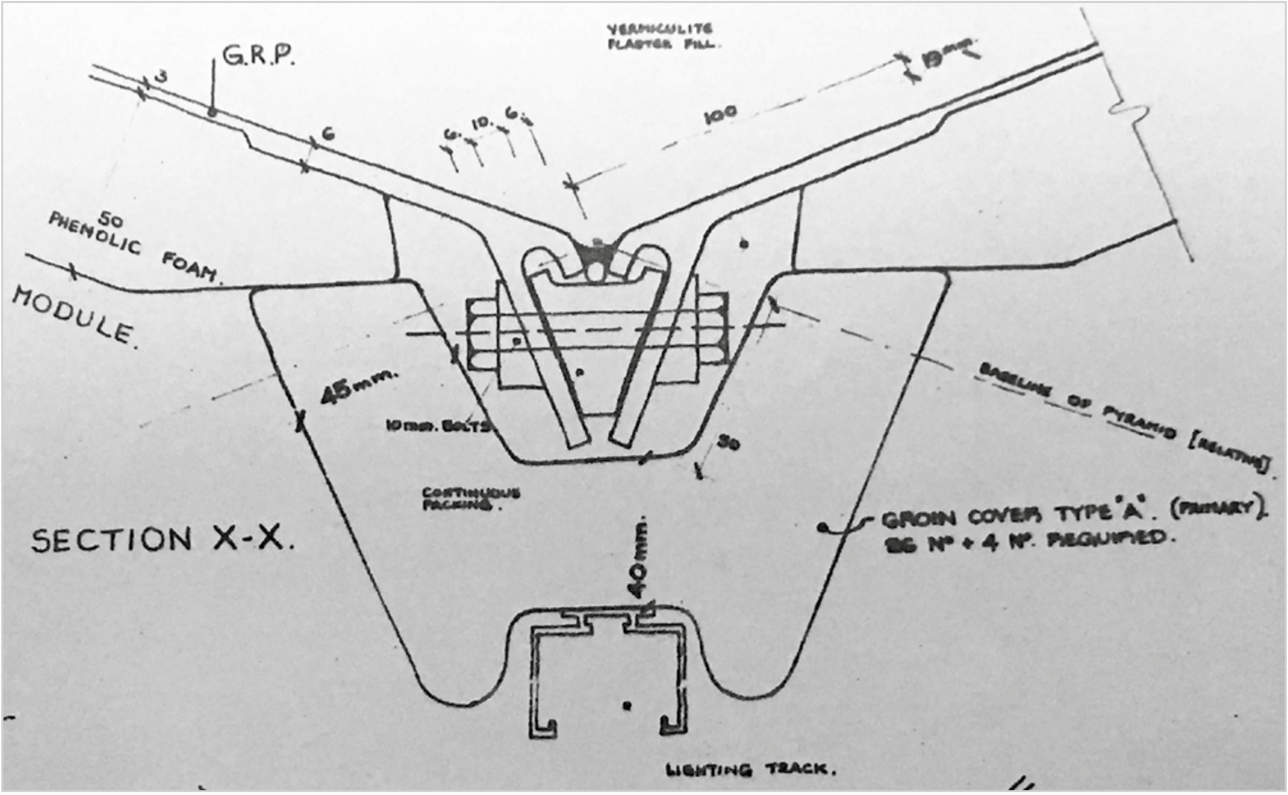
Along the external corners of many panels on the Olivetti building are small voids [FIGURE 04], similar to those found on the *Futuro* house held at the Boijmans Museum. This is a common problem with tightly radiused panel corners and is due to poor fabrication workmanship. If fibreglass is not sufficiently pressed into the corners during manufacture, a cavity is left between the fibreglass-polyester matrix and outer gel-coat which will eventually collapse. In the case of the *Futuro* house these voids were fairly easily treated by injecting gel-coat resin and filler into the void.[8] But if left untreated these voids provide an easy route for moisture to penetrate to the interior of the panel.

Orientation and surrounding flora may also have a significant impact on external GRP. The long east facade of the Olivetti building is close to a dense plantation of pine trees, and there is a build-up of algae on the parapets each winter. At the base of the building a small brick parapet (probably not original) inhibits air movement and evaporation from the bottom of the panels.

The outer coating of the GRP panels is clearly ageing with some small areas of delamination. Overall the surface is becoming progressively rougher, which in turn increases the retention of water and dirt on the panels, and thus increases the likelihood of water penetration and decay within the panels. Preliminary work with the new owners by the author suggests that future maintenance and recoating strategies will need to embrace the spirit of GRP amateur enthusiasts who, after some training, will be able to dedicate their own time and effort to maintaining the building.

EXPERIMENTAL CLASSROOM AT KENNINGTON ROAD PRIMARY SCHOOL, FULWOOD, PRESTON

The classroom at Kennington School in Preston is a sophisticated assembly in a modified icosahedron shape using tetrahedral folded-plate structural panels [FIGURE 05]. The building was designed by Lancashire County Council Architects Department (Architects: Ben Stephenson and Mike Bracewell under Roger Booth, County Architect, and Structural Engineer Roy Partington). It was completed in 1974 as a prototype for a full-sized primary school that was never built due to the rapid increase in oil and hydrocarbon prices in 1973. The classroom was listed Grade II in 2017. It is unusual to use GRP in this way, and the engineer, Roy Partington was an important figure in the design team in promoting folded plate construction. Z. S. Makowski with L. Holloway of the University of Surrey were later appointed as consultants to assist with detailed analysis of the structural design, and Holloway and Partington subsequently published their work.[9] The attention to economical structural design is exemplified in the very thin GRP walls: the main body of the panels is only 3 mm thick, increasing to 6 mm at edges and corners [FIGURE 06].



06 Panel to panel construction detail showing fixings through teak spacers and a phenolic groin cover to provide continuity of insulation and fire protection. Part of drawing titled, Prototype GRP Structure for Experimentation, file SMFu/1/4. © Lancashire County Council Archive

The panels at Kennington School had an intended structural design life of 40 years on the basis that excessive deflection due to assumed GRP deterioration would cause building failure.[10] The variability of initial assumptions regarding the durability of the material, combined with the rapid technical developments during this period makes a reliable estimate of the design life extremely difficult. However, after nearly 50 years the building appears to be in sound condition. and this observation was supported by the Building Research Establishment (BRE), which concluded that the potential design life of GRP components could be extended to up to 100 years.[11] Encouragingly, there have not yet been reports of structural failure in the many shell structure Futuro houses that exist, some of which are closely monitored by their private or institutional owners.

Phenolic foam was added to the Kennington School panels for thermal insulation and also to act as fire protection to the interior face of the single skin panels. After the outer face had been fabricated by hand lay-up, a timber form was located 50 mm away to create a two-sided mould for phenolic insulation to be injected between both skins.[12] An initial fire test found that the foam cracked and quickly caused the panel to fail.[13] To solve this problem, a 'veil' of chopped strand glass-fibre matting was attached to the inner former which bonded to the inner face of the phenolic foam. When set, the inner panel was lifted off and the foam exposed. This reinforced face performed very well in subsequent fire tests and is still in place as an exposed (now painted) finish [FIGURE 07].

07 Photo during construction showing the pink exposed phenolic insulation (subsequently painted). The panel to panel joints are yet to be clad with pre-formed phenolic groins. © M. Bracewell

The original, finely corrugated character of the outside of the panels (formed by an acrylic insert in the production mould) is no longer visible due to recent waterproofing work in which a thick, fibre-reinforced liquid resin, Acrypol+, has been applied over the panels. Previously, the fine, incised lines controlled and directed water runoff, while the new rough coating is quite effective at trapping the water, dirt and algae that accumulate every

08 The classroom panels in February 2019 before cleaning. A build-up of dirt and algae is trapped in the fibres of the new reinforced polymeric coating. © S. Pritchard

09 Cut-away section through a typical Herman Miller panel showing the double sandwich panels and air cavity. The panel face is painted, but the original gel-coat colour is visible around the perimeter edge. © R. Loader

winter [FIGURE 08]. Once applied this coating is practically impossible to remove.

While the owners of Futuro houses may often be willing to dedicate their spare time to applying a protective wax coating to the GRP shells of their homes, this technique may not be suitable for the owners of larger buildings. Where exposed to the weather the outer surface of GRP will, over time, become rougher and less able to shed water and dirt, at which point it is usually necessary to add a suitable and sympathetic secondary coating. Interesting new developments of more robust finishes that incorporate hydrophobic nano-coatings that accelerate water run-off may soon offer further enhanced protection to GRP.[14]

In terms of planned maintenance for the external skin of GRP buildings a few points are generally valid. The external coatings of all the examples here have been over-painted and have variable maintenance regimes. As a minimum, most are cleaned down regularly, the purpose being to remove dirt and algae that will retain water on the panel. The Olivetti building is pressure washed every spring, and, unsurprisingly, some leakage internally is sometimes noted. Pressure washing is not recommended. The Kennington Road School classroom is cleaned every spring with de-ionised water. This, too, is not usually recommended as de-mineralised water can more easily penetrate an exposed gel-coat. As a generalised and simple approach to cleaning, warm, soapy, ph-neutral water should be sufficient.

THE HERMAN MILLER FACTORY, BATH

The Herman Miller furniture factory in Bath by Farrell & Grimshaw Architects, was completed 1978, and listed Grade II 25 years later in 2013. It is recognised as an important early work by one of Britain's foremost Hi-tech architects. The building has recently been converted to a school of art for Bath Spa University under the supervision of Elyse Howell-Price and Allan Green of Grimshaw Architects and specialist facade consultant, Harry Montressor.

The outer envelope of the building was designed to provide a flexible building façade with standard and easily demountable and interchangeable units of insulated GRP panels, louvre panels or glazed panels. The panel thickness at the flange is 6 mm to match the glass thickness and to enable a universal joint for either GRP or glass. Neoprene cappings are pressed into aluminium top hat sections to hold the panels in place without mechanical fixings through the flanges. This protects the panel edges and allows thermal expansion of the GRP. The GRP panels have an elaborate construction: two separate sandwich panels were fabricated and then joined to form a captive air cavity between both [FIGURE 09]. The inner panel contains 25 mm polyurethane foam and the outer has 19 mm foam. Jeffrey Scherer, the project architect for the original building explained the rational:

We knew that there was a conundrum in having the panels all with a 6 mm flange. The thermal bridge at this pinch-point was not ideal. However, after calculating the relativeness of loss from this flange, we decided it was, in the end, a fairly minor element in the overall heat transfer values. We mitigated this loss by expanding the cavity (filled with foam insulation) and increasing the insulating capacity of each panel. Since we had a large number of repetitive panels, we could invest in high-quality moulds that were specifically tailored to the unique duality of demands: aesthetic and technical. In addition, the gel-coat could be custom color to give us the richness of "clotted cream" that we wanted. We also needed to have soft edges in the transition from the flange to the cavity to let the light refract. This, we felt, would help to transform a pre-engineered and manufactured "machine part" into a more human-scaled element.[15]

At an early stage of the renovation seven panels were removed for examination. The results showed them to be in reasonable condition with only two having some damage along edges. This led the design team to revise the initial working assumption of complete panel replacement to a strategy of retention and renovation whenever possible.[16] This approach was also encouraged by the local authority conservation officer. Subsequently the cost of replacement panels for the whole building was estimated at many times more than refurbishment, which helped ease the decision to support the potential risk and costs of more frequent maintenance of the older panels.

Subsequent and more detailed visual inspection of the internal and external condition of the GRP panels found that approximately 53% of the panels were classified as being in a 'Good' condition, 30% were 'Repairable' and 17% were classified as 'Condemned', to be removed and replaced. As seen at Olivetti the main cause of damage in condemned panels was deliberate interventions such as drilled services holes.

The original gel-coat on the Herman Miller panels had already been over-painted at least twice and probably three times. Anthony Walker records that in 1992 the original gloss finish had weathered to expose filler material which was leaching to the surface.[17] Degradation of the outer layer had also exposed pin holes in the face of the panel which was very conducive to algae growth. The cladding panels were retained in position on the building, sanded down and re-sprayed with two or three coats of two-part polyester, followed by a 30-50 microns fluoropolymer top-coat.

In the recent major renovation work (2018-19) all the panels were removed and completely sanded to avoid possible problems of adhesion with the new finishing paint. Three adjacent, temporary tents for sanding, cleaning and spraying were erected within the building. The finished coating comprised two coats of spray applied Selemix 7-532 polyurethane paint. A high gloss was not chosen in order to avoid highlighting imperfections in the substrate. By the end of the project, only about 50 new panels had been made which were all fabricated to the same double-panel design and also spray painted for uniformity. The neoprene gaskets that hold the panels in position had hardened over the years and were replaced with heat-cured silicone gaskets to the same profile.

While the Herman Miller panels were sized and designed for easy interchangeability, the panels at the Olivetti building are extremely large, and fixings are hidden behind internal casings. Until further investigation takes place it isn't clear how easy it would be to remove any individual panel for repair or replacement.

The external GRP skin on buildings such as Olivetti or Herman Miller is highly significant, and preserving the integrity of the GRP must be the priority in caring for the building. This usually means protecting it from water ingress by maintaining the outer coating. In an external environment it may be necessary to differentiate between the conservation of the finished coating and protection of the underlying panel, so where an original gel-coat exists, it is necessary to accept that it will only be temporary and sacrificial. However, it is also a reality that secondary paint coatings applied in-situ are not yet able to recreate the depth and smoothness of original gel-coats. Typically, a top-coat will have a thickness of up to 100 microns, and so cannot reproduce the very deep, polished appearance that is typical of gel-coats (500 microns thick). In addition, secondary coatings have to be re-applied regularly, especially if they are carried out on a building site where temperature and humidity cannot be well controlled.

Alternatively, if a highly polished and smooth finish is important for the significance of the building, it is possible, where an intact gel-coat still exists (and budget allows), to use a diamond paste (a fine abrasive) that will bring back the colour and polish. This removes about 10 microns of gel-coat (from 500 micron gel-coat thickness), so, even with repeated polishing it can be expected that the life of the gel-coat can be significantly extended. The choice between conserving the original gel-coat or accepting a gradual loss of gel-coat over the expected lifespan of the panel will be determined by an evaluation of the significance of the building and its components. It should be borne in mind that a renewed high-gloss appearance will, like the original, only last a few short years before it again dulls down.

YACHTSMEN'S SHOWERS AND LAVATORIES, BRIGHTON MARINA

It is often assumed that the small surviving collection of plastic buildings has been completely documented.[18] However, two small buildings in Brighton Marina designed by Eva Jiricna while she worked at the Louis de Soissons Partnership in the 1970s were recently 'discovered' and documented by the author. These are small, utilitarian dock buildings for what was termed, 'yachtsmen's' showers and lavatories. The buildings are constructed from GRP, prevalent in boat-building, so a directly analogous and logical material choice for marina buildings (later structures by others using steel cladding show considerable deterioration in the sea-side environment).

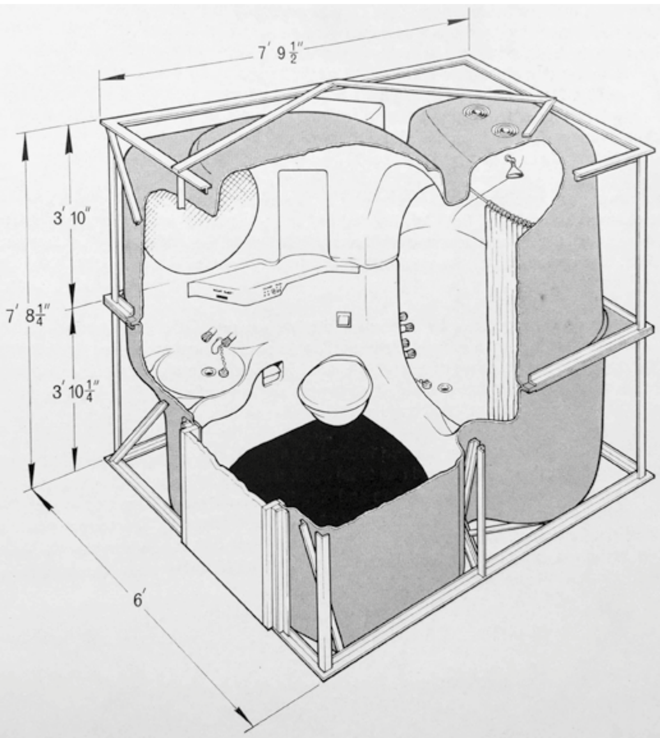
The structure of the buildings is clearly expressed as deeply ribbed GRP sections that utilise the inherent properties of the material to form self-supporting composite wall and roof sections [FIGURE 10]. Panels are bolted together with cover strips over the joints between each segment. The deep corrugations span the full width over the building before neatly terminating at the bases above an elegantly recessed concrete upstand on each side. Doors and louvred vents are carefully set into specially designed panels. The structural design for the self-supporting segments was carried out by Arup, but as there were no published design codes at the time that were accepted by the local building control authorities a steel frame had to be introduced under the roof in case of panel failure.[19]

The building panels have been largely unmaintained over decades, but as they are located beneath the main jetty structure the GRP is largely protected from direct sunlight and rain, so is in quite good condition for its age. Nevertheless, the building owners have already demolished two similar unlisted structures, and the two surviving structures remain at risk. The author has proposed to the local authority that these buildings should be locally listed, which remains under consideration by the local authority at the time of writing.

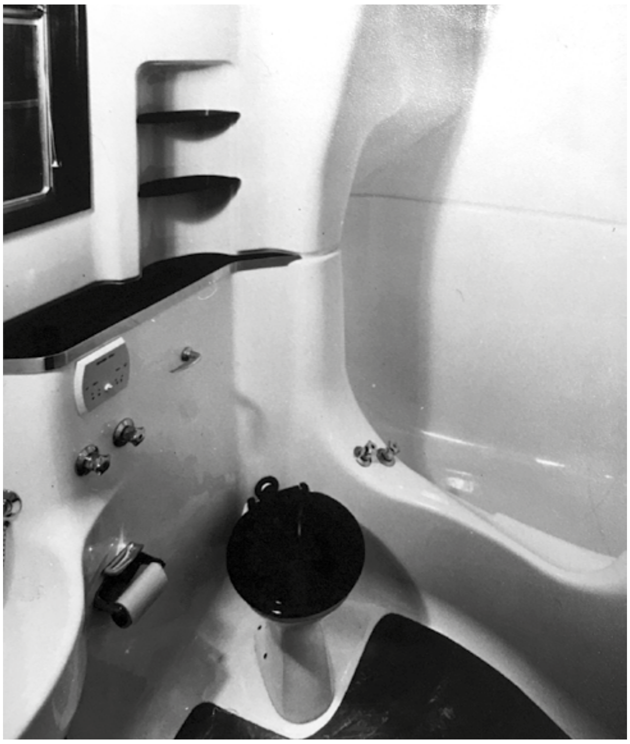
10 Building for Yachtsmen's Showers and Lavatories at Brighton Marina. © R. Loader, October 2019

RECENTLY LOST

A recent loss of plastics heritage is an early example of a full bathroom in vacuum-formed acrylic that was designed by David Kirby at ICI in the mid-1960s.[20] In 1962 Kirby joined the Building Development Group at ICI to explore commercial opportunities in the building industry. About twenty prototypes of domestic service cores were fabricated for new houses [FIGURE 11, FIGURE 12], and one installed



11 Drawing by David Kirby of the ICI acrylic bathroom and kitchen pod. © ICI Building Development Group, Bulletin 1, Service Cores and Prefabricated Bathrooms, June 1964



12 Photo of the ICI acrylic bathroom and kitchen pod. © ICI Building Development Group, Bulletin 1, Service Cores and Prefabricated Bathrooms, June 1964

13 Intact ICI prototype acrylic bathroom, Hartford, England. © R. Loader, November 2021

14 Remains of a prototype ICI acrylic bathroom pod recently removed from a house, Hartford, England. © R. Loader, November 2021

in Kirby's own house [FIGURE 13]. Development of these pods preceded some better-known examples of bathroom and kitchen modules that were produced in GRP such as Farrell and Grimshaw's bathroom tower in Paddington and in Charlotte Perriand's work at Les Arcs. ICI did not continue with the programme for fire safety reasons and because the economic viability for mass production was unlikely to be achieved. Sadly, at a recent visit we found the remains of the upper bathroom in the garden that had just been removed from the house and destroyed by new owners [FIGURE 14]. Some years ago the house and bathrooms were considered for local listing, but not included.

CONCLUSION

The recent 'discovery' of the Yachtsman's dock buildings in Brighton and the loss of the ICI prototype bathroom in Hatfield indicate that a comprehensive catalogue of significant plastic buildings has not been completed in the UK, so leave potentially important buildings at risk.

Relatively little attention has been given to the maintenance of GRP buildings, either in terms of reactive repairs or planned maintenance. External GRP panels do not survive external conditions without regular maintenance and occasional recoating, and various options for protecting GRP panels and preserving or renewing the outer coating exist. Where feasible, damaged cladding panels have been successfully replaced in facsimile. However, where a complete listed building comprises structural GRP panels, it may have to be envisaged that the solution will lie outside the usual range of conservation remedies and may even need to extend to complete replacement.

The topics and case studies above illustrate that the construction of plastics buildings of the 1960s-70s varies greatly, which reflects the experimental and inventive nature of the emergent technology. Substantial research is necessary to properly understand the unique structural and material characteristics of each building. Not only owners, but also the heritage authorities need to be more aware of the characteristics of GRP, how to care for it and that it is suitable for consideration as part of our conserved built heritage.

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THE USE OF GLASS-REINFORCED POLYESTER IN PRESTON BUS STATION

Christina Malathouni

ABSTRACT: This article describes the use of glass-reinforced polyester (GRP) in Preston Bus Station in Lancashire, England, designed by Building Design Partnership (BDP) and completed in 1969. GRP was used both for concrete moulds that play a key role in enabling the construction of the building's distinctive elevation, and for kiosks, signage and smaller fittings. A survey of articles shows that the use of GRP for concrete moulds enabled innovative and efficient construction and this practice continues to date. Some smaller fittings in GRP which were expected to be durable and maintenance-free have been modified, damaged, or removed, yet, others survive and are in a good condition. The legacy of the car park pay kiosks was to last as a prototype for a prefabricated sectional building system.

KEYWORDS: GRP; heritage listing; construction technology; design; conservation

INTRODUCTION: The Central Bus Station and Car Park in Preston, Lancashire, England, is a purpose-built complex completed in 1969, known as Preston Bus Station. The building is famous for its imposing dimensions – about 170 m long by 40 m wide – and the "upwardly sweeping ends of [its] cantilevered parking decks" [FIGURE 01].[1] Designed to accommodate eighty double-decker buses and 1100 cars, the bus station is located at the heart of Preston city centre, strategically close to the city's ring road with direct links to the broader motorway network. The complex has played a key role in Preston's recent history and in the development of motor transport in England: the first section of England's motorway network was opened in 1958 as the Preston by-pass.[2]

An initial commission in 1959 for a combined car park and bus station, from what was then the architectural firm of Grenfell-Baines and Hargreaves, proved inadequate for the rapidly increasing road traffic volumes and needs of Preston. In the final commission, Preston Corporation handed the scheme to Keith Ingham and Charles Wilson of Building Design Partnership (BDP) which had evolved out of the firm of Grenfell-Bairnes and Hargreaves. Ingham was designer of the realised scheme, with consulting structural engineers Ove Arup and Partners, and the borough engineer and surveyor was E.H. Stazicker.[3]

The building has had a troubled journey towards its current protected status: having been subject to threats of demolition for fifteen years, it was listed at Grade II in September 2013 after three listing attempts were supported by the heritage sector and grassroots campaigners, but repeatedly turned down by politicians. The successful third listing application was enabled by the discovery of information about the use of GRP, previously overlooked.[4] Following its listing, a Royal Institute of British Architects (RIBA) international architectural competition for its refurbishment, won by John Puttick Associates, led to a national and three regional RIBA Awards in 2019, as well as a Royal Town Planning Institute (RTPI) Award (Heritage and Culture Award category) to planning and heritage consultants Cassidy + Ashton. Two years later, in November 2021, the building was also awarded the World Monuments Fund / Knoll Modernism Prize. Barry Bergdoll, jury chair of the 2021 prize, noted: "Preston Bus Station is the largest project honored by the World Monuments Fund/Knoll Prize and the first at the scale of regional infrastructure". It is also only the second building from the post-World War II period – and the youngest so far – to have won this prize.

01 Keith Ingham for BDP, Central Bus Station and Car Park, Preston, Lancashire, England, 1969, west elevation as presented in printed publicity material. © BDP Archive (London), c1969

THE USE OF GLASS-REINFORCED POLYESTER (GRP)

Although largely identified with concrete only, upon its completion, BDP promotional material described Preston Bus Station as a building built of "concrete and GRP". These were considered to be "the two dominant materials in this scheme". The bus station is indeed constructed of reinforced concrete, a great part of which is in the form of 2800 precast concrete units cast in GRP moulds. This use of GRP was to become effectively invisible once the scheme was completed, but the material also remained in evidence throughout the building in other applications. It was used for litter bins, poster boards, and numerous signs including gate number and destination lists, timetable holders and the large yellow arrows which directed drivers up and down the car park ramps. The car park pay kiosks were also designed by Ingham and constructed entirely of GRP.

For the manufacture of all GRP products, BDP collaborated closely with Glasdon, another local company, founded in Blackpool in 1959[5] that has grown to become an international group.[6] The company was founded on the conviction "of the potential of plastic material" as it "sold a 'halt' sign that never needed painting, to a local authority". At the time, Glasdon "pioneered the use of plastic material for road signs and street furniture" and "low cost and long life compared to conventional materials", as well as "low maintenance", were amongst the principal advantages of the new material.[7]

GRP FORMWORK: TECHNICAL REQUIREMENTS AND ACHIEVEMENTS

The use of GRP moulds for the precast units of the building's concrete structure was a key decision during the tendering stages.[8] The many compound curves within the lines of the main beams and the upswept curves of these edge units were important factors in the decision to use GRP formwork: by using GRP moulds the architect was able to create a building with curved edges and a smooth surface finish, although considerable technical difficulties had to be overcome by the manufacturers in order to produce the moulds. Their production was therefore a technical achievement that involved close collaboration between the architects, engineers and contractors.

As the site area was large enough to allow the economical establishment of a site production system, this enabled the close control of all details. Casting was carried out on the east side of the building, one of the largest precasting yards on a building site, managed by contractors John Laing Construction Ltd – a major building company that undertook numerous infrastructure projects that profoundly shaped post-war Britain. It occupied a new concrete apron at the front of the old bus station. The level of the

02 Keith Ingham for BDP, Central Bus Station and Car Park, Preston, Lancashire, England, 1969, construction site. © Historic England Archive. John Laing Photographic Collection, c1969

03 Keith Ingham for BDP, Central Bus Station and Car Park, Preston, Lancashire, England, 1969, construction site. © Historic England Archive. John Laing Photographic Collection, c1969.

04 Keith Ingham for BDP, Central Bus Station and Car Park, Preston, Lancashire, England, 1969, construction site. © Historic England Archive. John Laing Photographic Collection. c1969

yard had been lowered so that the coaching apron could be paved over the concrete bases of the large formwork cradles [FIGURE 02].

Two cranes were used on site. Precast units were lifted into position by a self-propelled Scotch derrick with a 10-ton carrying capability and 100 ft. (c30 m) reach, which operated on 600 ft. (c184 m) of track that ran the full 620 ft. (c189 m) frontage between the yard and the new building. This was used for lifting the steel reinforcement into the moulds, for raising completed units from the moulds and for placing them in position on the building. For placing wet concrete for the in situ structural topping, a travelling tower crane was used on the west side [FIGURE 03, FIGURE 04].

Under these site conditions, a total of 12 000 tons of precast concrete was produced in 50 weeks with a high degree of accuracy. Moulds were used for the 1 395 four-ft (c1.2 m) high curved parapet units of the car park's four storeys, which overhang the bus bays by eight or nine feet (c2.4-2.7 m) and constitute the most striking architectural feature of the scheme along both main elevations. There were also twelve moulds for the main beams. Others were for the ramp units and special beams, for example, 40 ft. (c12 m) long concrete beams for the floor structures, which weighed four tons each.

Each mould, weighing about 305 kg (6 cwt), was set separately into a timber cradle, bolted to the concrete and individually levelled to allow a built-in camber of 51 mm (2 in). A mild steel datum face incorporated into the moulds facilitated correct register in the timber cradles. The mould was only a semi-rigid, single skin of GRP, with mild steel local reinforcement. In December 1969, *The ARUP journal* reported extensively on the peeling technique used:

The timber formers for the moulds were made in Blackpool by Messrs. Glasdon Signs Ltd. and the fibre glass moulds were made in Nelson by Bennett Plastics Ltd. Thirty moulds were made in all … and these were then set up in the site casting yard by the contractor. …

A concrete base was laid over the casting area and to this were fixed timber cradles which support the moulds. The cradles are at 3 ft. (910 mm) centres and have a removable tie across the top to prevent the mould bowing in its length. They also have guides and stops which allow the mould to lift about 3 in. (76 mm) off the cradles with the unit when it is being stripped. This lifting of the mould was introduced by the contractor to help the stripping operation, the idea being that the flexible mould would tend to peel off when the unit was supported at its lifting points by the crane. The units are demoulded 24 hours after casting and they are then stacked between the rails of the derrick crane until they reach their designed strength and are needed on the job. In practice there have been no demoulding problems and 15 units per day are leaving the yard.[9]

05 Keith Ingham for BDP, Central Bus Station and Car Park, Preston, Lancashire, England, 1969, GRP fixtures and fittings as presented in printed publicity material. © MMU Archive. c1969

The mould structure had to be designed to be capable of standing up to the extreme wear that would be inflicted upon them in a heavy casting schedule. The moulds were used to cast 100 precast concrete units each. The general thickness of the mould was 3/16" (10 mm). The high number of moulds required for this work (30) was in relation to the brief contract period, not an indication of the working life of GRP moulds; that is, had the contract period been longer, fewer moulds would have sufficed. A surface tissue was laminated into the face of the mould to eliminate the possibility of cracks appearing in the face during their working life.

Upon the completion of the building, the architect praised the work by the contractor, John Laing, as extremely well organised and, overall, the chosen system was proven financially sound, allowed for quality control to be directly under the supervision of site management and consultants and saved transporting units from a concrete factory to the site through the town centre.

GRP SIGNAGE, FITTINGS AND KIOSKS: GRAPHIC DESIGN AND DURABILITY

The extensive use of GRP formwork was supplemented by use of GRP in a number of fittings throughout the building [FIGURE 05].[10] First of all, the public transport function of the building was assessed to require clear wayfinding. BDP set up a special graphic design department to ensure this, and Ingham explained: "In a building of this size, people could be somewhat overwhelmed by the space and the number of choices they have to make, so we have a 12 ft. (c3.6 m) long model at our office to work out the best method of achieving this".[11] The main destination signing system above the perimeter sliding doors - gate number and destination lists - consisted of "fluorescent tubes behind lettered opal acrylic diffusers".[12] GRP was extensively used for additional way-finding and other information requirements: display units and notice boards throughout the main concourse, as well as numerous advertising and travel information panels in the two subways designed to take passengers into the central concourse without facing hazards from manoeuvring buses. The signposting system was designed to be an integrated system within the building and demanded a very high standard of typographical reproduction. To maintain this high standard of lettering the necessity for future repainting had to be obviated, and both double and single sided versions were to be completely free from visual interference of joints, brackets, frames, rivets, etc.

What is more, GRP signs had flush, smooth faces and were therefore visually compatible with the white tiled walls and overall architectural and graphic design applied to the project. Exceptional weathering properties and lack of maintenance were also key requirements in response to the rough use and public ownership of the building. All

06 Keith Ingham for BDP, Central Bus Station and Car Park, Preston, Lancashire, England, 1969, car park ticket kiosk. © MMU Archive. c1969

finishes were therefore chosen to withstand hard wear. In a similar way, the large free-standing arrows which direct motorists around the multi-storey car park area were made of GRP. The same criteria applied to other fittings designed and constructed of GRP, i.e. litter bins and telephone cabinets. Finally, in a larger scale, GRP was used for the more architectural design of the striking orange car park pay kiosks [FIGURE 06]. These were again designed by Ingham and made of GRP because of its design flexibility and the material's expected exceptional weathering properties. The use of GRP allowed for streamlined design that could stand out through minimal support elements and striking colouring. GRP was particularly amenable towards these characteristics and colouring was most noticeable in the direction arrows and pay kiosks at the car park.

CONTEXT AND SIGNIFICANCE

The use of GRP in Preston Bus Station is also of special interest in the broader context of architectural plastics in Britain. Varied experimentation with plastics was active during the 1960s and some of this was related to the moulding of sculptural concrete panels. In his March 1970 article, "*UK Lagging Behind in Use of Plastics*", [13] architect David Kirby noted the use of plastics foams and resins to form and decorate surfaces of concrete panels. This technique had been developed by a number of artists and used in many buildings. For instance, Antony Hollaway's sculptural wall at London Road in Manchester is notable for the "constructional and technological quality" of the structure, as well as its innovative method: "It is constructed of high-quality concrete to engineering standards, and demonstrates the skills and methods developed by Hollaway during the 1960s in the research for the Cement & Concrete Association."[14] An illustration in Kirby's article also shows the gable ends of the Faraday Building (Manchester College of Technology), again by Hollaway and using GRP for its relief casting (1967; architect H.M. Fairhurst of Harry S. Fairhurst & Son). William Mitchell's mural for the former Lee Valley Water Company Offices in Hatfield, Hertfordshire, completed in 1965, is also worth a mention here[15] due to his use of an exceptionally experimental technique that involved lining the shuttering with 10 inch (c25 cm) polystyrene.

Although the above examples are slightly earlier than Preston Bus Station, they refer to structures in which GRP (or other plastics) casting was used for the creation of a decorative surface effect. They were also the result of an artist and architect partnership. The GRP moulds used for the bus station are therefore quite distinctive in that they were used to shape the sculptural edge units of the main elevations which also constitute an integral part of the structural framework of the building. This is considered to have been a pivotal moment, as plastics were soon to start taking on a more central role in building construction, and this position is supported by experts in the early 1970s and in more recent assessments of the bus station, as discussed below.

Kirby's article specifically noted that the use of plastics was introduced in the English building industry at a slower pace than in other countries:

> *Plastics is now a well established material. The building industry already uses some 300,000 tons of plastics each year, and the rate of consumption is growing steadily at between 12% and 15% a year. Nevertheless, the consumption of plastics in this country is less per head of population than in the USA, Germany, Sweden or Japan. And the use of plastics in the building industry, as a percentage of total plastics output, is also less in this country than in those mentioned above.*[16]

Kirby also made special note of the GRP formwork used in Preston: "One of the more intriguing areas in the development of plastics is its use for special shuttering for concrete. This may take the form of standard shutter elements, used to produce bold repetitive shapes, as in the example of a bus station at Preston designed by Building Design Partnership."[17]

More than four decades later, the significance of the GRP moulds used for the bus station is still acknowledged by experts. Whilst the third listing application was under consideration, the *New Civil Engineer* interviewed Brian Crossley, chairman of the Institute of Civil Engineers Panel for Historical Engineering Works (PHEW), who argued that the concrete structure of the bus station was of no special engineering interest. This position was supported by Mouchel director Ian Weir, also a PHEW panel member, and by BDP chairman Richard Saxon.[18] However, the tone shifted significantly when GRP was brought into the discussion: BDP civil and structural engineer director Jonathan Pye argued that "the use of GRP, basically fibreglass, was essential to achieving the desired finish" and supported the position put forward by the listing application: "The architect wanted an organic look with smooth curves", Pye is quoted to have said; and continued: "[Preston Bus Station] was one of the very early examples of this type of mould, using ground-breaking technology to create a piece of outstanding architecture, it was ahead of its time."[19]

The next decade, however, was to bring rapid developments that superseded Preston achievements, as recognised by February 1971. The technical journal *Architectural Plastics* again noted the extensive use of GRP in the bus station, but concluded by stressing: "In summary, Preston's new bus station provides a fine illustration of the versatility of GRP for building purposes, with the emphasis in this case on the material as a machine tool rather than a structural medium in itself."[20] Soon after, the use of GRP in the building industry was to become bolder and more visible. Notable examples are James Stirling's Olivetti Training Centre at Haslemere, Surrey (1971-2) and the New Covent Garden Market / Flower Market at Wandsworth, London, by Gollins, Melvin, Ward and Partners (1971-4, recently demolished).[21] Listed at Grade II*, the former is specifically acknowledged as "important in the development of GRP as a sophisticated building material in England, for it is the major building by a major architect to be built in GRP in Britain".[22]

INTEGRATED DESIGN AND THE LEGACY OF THE BUS STATION'S GRP STRUCTURES

Although different in scale and function, both uses of GRP in the bus station were fully in line with the "integrated design" ethos of BDP with all functional and structural priorities dictated by the building's demanding programme. On the one hand, the precast concrete units allowed for a robust structure, as required by the heavy-weight and rough use of a building for vehicular access and accommodation. The curved edge units were seen as a natural evolution of the T-beam structure and the result was a structure truthful to its heavy materiality. At the same time, the skilful interplay of solid and void, and light and shade, in the strongly sculptural elevations is marvellously refined by means of the smooth surface treatment and curved shapes effected by the use of GRP moulds. On the other hand, the GRP internal fittings, signage and the car park pay kiosks were lightweight, small-scale accessories that supplemented the principal structure with essential way-finding or other supporting functions: they allowed for visual consistency and clarity and also for durability and low maintenance.

A particular legacy of the use of GRP in Preston Bus Station has been the design of the car park pay kiosks. Numerous references to the subsequent development of Ingham's design of the pay kiosks into a prefabricated sectional system appeared in the architectural and technical press in the early 1970s. Marketed under the name "Europa Kiosk System" by Glasdon Ltd, the new system could provide kiosks of various sizes for different applications that could be easily erected and needed little maintenance.[23]

This was a line of work that BDP, and Ingham in particular, were to follow even further. In a letter to Mr A. Barrie of House Publications & Publicity (Technical) Ltd, dated 30 November 1970, Ingham wrote about "the considerable use of GRP in various ways" in the bus station and other of BDP's work in plastics. He noted that "other items such as the car park arrows, litter bins and notice board frames may well also go into production". Ingham also commented on BDP's work with the English Electric Reinforced Plastics Division (EERPD) and explained that this "mainly concerned a sub station enclosure which was designed to exploit the potential of extruded GRP wall panels but [was] at present available only in hand lay up form". Finally, Ingham mentions that BDP had also been "commissioned to design a low cost GRP house for developing countries".[24]

CURRENT CONDITION AND CONSERVATION

Setting aside the impact of GRP formwork on the principal structure of the building, little has actually survived from the use of plastics in Preston Bus Station. Yet, the reasons for this are in most instances independent from the material's performance. Instances of vandalism were reported in the local press soon after the building opened[25] and over the years several of the smaller GRP fittings, such as litter bins and car park arrows, have been lost. The car park ticket kiosks have also long been removed.

Following the building's listing in 2013 and the RIBA competition for its refurbishment, a Conservation Management Plan (CMP) was produced in 2016. In line with the List Description for the building, the CMP makes due mention of the significance of GRP in the design and creation of the building and several of its fixtures and fittings. There is also a clear emphasis on safeguarding the significance of BDP's "integrated design" ethos, on reinstating the original aesthetic - including the colour palette

07 Keith Ingham for BDP, Central Bus Station and Car Park, Preston, Lancashire, England, 1969, bus station gates external signage, pre-refurbishment. © J. Puttick, c2016

08 Keith Ingham for BDP, Central Bus Station and Car Park, Preston, Lancashire, England, 1969, bus station gates external signage, post-refurbishment. © J. Puttick, 2017

09 Keith Ingham for BDP, Central Bus Station and Car Park, Preston, Lancashire, England, 1969, bus station gates internal signage, post-refurbishment. © J. Puttick, 2017

and the use of Helvetica typeface, and on applying extensive visual decluttering. Reinstating the lighting in the "box signs over the boarding doors" was also set as a priority.[26]

When the recent refurbishment of the building started, the signage above the sliding doors in the bus station was visibly in poor condition. Externally, many of the gate numbers were missing or badly degraded [FIGURE 07]. Internally, some original signage appeared to be in existence, but in many other places this had been altered over the years: in many cases the original panels had been replaced by new ones with different colours, bus company logos, etc. and little of the backlighting was working. During the refurbishment, new signage of similar plastic material, dimensions, font, and colour was installed externally, however, the numbering was altered to reflect the new organisation of the building (re-arrangement of gate numbers on the east side; and text over the entrances from the new piazza on the west) [FIGURE 08]. Internally, new panels were installed to the original dimensions, reinstating the original black and orange colour scheme and British Rail font lettering, but with updated bus routes and destinations. The backlighting was also reinstated [FIGURE 09].[27]

The large clocks in the bus station concourse are still surviving and were in relatively good condition. They were designed with analogue faces – visible from a distance – and 24-hour displays to match how bus times were displayed around the building [FIGURE 10].[28] During the refurbishment, they were taken down, cleaned and repaired. The only modification was the replacement of the mechanical 24-hour time display boards with digital displays.[29]

CONCLUSION

The use of GRP in the construction of Preston Bus Station constitutes an early and innovative example of the introduction of plastics into the British building industry. GRP formwork continues to be used in the building industry to the present day whereas its legacy in the design of small self-supporting structures continues in prefabricated sectional building systems. The bus station was a fine illustration of the versatility of GRP for building purposes: the dual use of GRP – both as formwork for its precast concrete units and for the numerous fittings of varied scale and function – demonstrates the material's design flexibility, form-making flexibility, high quality finish, the possibility for striking colouring, and freedom from maintenance. The extensive use of GRP moulds for the creation of the powerful visual effect of Preston Bus Station's concrete structure was an intelligent solution to a very demanding building programme that involved vehicular access and large numbers of visitors, and therefore could have looked much more bulky and inelegant than the curved ends of the devised design solution. The use of GRP for internal fittings and smaller structures (kiosks) also served the programme's high demands for easy way-finding and durability. Overall, the use of GRP reinforced BDP's integrated approach that brought together structural framework, architectural expression and graphic design and, despite the loss of several of the smaller original fittings, the design ethos survives in the refurbished building.

10 Keith Ingham for BDP, Central Bus Station and Car Park, Preston, Lancashire, England, 1969, bus station concourse clock, pre-refurbishment. © J. Puttick, c2016

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Christina Malathouni *Senior Lecturer, School of Architecture, University of Liverpool, UK. She holds a PhD from The Bartlett, UCL, has worked for The Twentieth Century Society (London), and is full member of the Institute of Historic Building Conservation (UK). She identified the use of GRP in Preston Bus Station which enabled its listing.*

GRP-micro bungalow BANGA with a total of 9.4 square meters, Design by Carlo Zappa, Italy 1971-85. @ Pamela Voigt, 2018

THE 'SHELTER' ALMOST SAVED BY HENDRICK DE KEYSER

The 'Shelter' was at risk of demolition: a fascinating story by the architect, Kor Aldershoff, and the restoration architect, Ann-Katrin Adolph.

The 'Shelter' is a fantastic example of a circular plastic house with a diameter of 8 m that is somehow comparable to the 'Futuro'. It was conceived by the Dutch interior architect Kor Aldershoff, who developed a prototype in glass-reinforced polyester (GRP) shells held on a metal frame (1971). This kind of house is unique for the Netherlands and therefore of great importance. The 'Shelter' was meant for providing a home for refugees in Africa. The prototype was light and could also float on water. The production of the metal supporting frame was entrusted to the Nederlandse Dok en Scheepsbouw Maatschappij (N.D.S.M.) in Amsterdam-Noord and the GRP parts to the firm Resicon in Medemblik. The hall, living room and one bedroom were arranged around an empty column for the disposal of rainwater.

The 'Shelter' prototype was exhibited at different locations, but its dismantling and reconstruction proved difficult and damaged various components. It further suffered from lack of maintenance until its condition became so critical that it ran the risk of demolition. It was found by Pi de Bruin, chairman of the board of the Association Hendrick de Keyser, who had it dismantled and brought to their atelier in Medemblik.

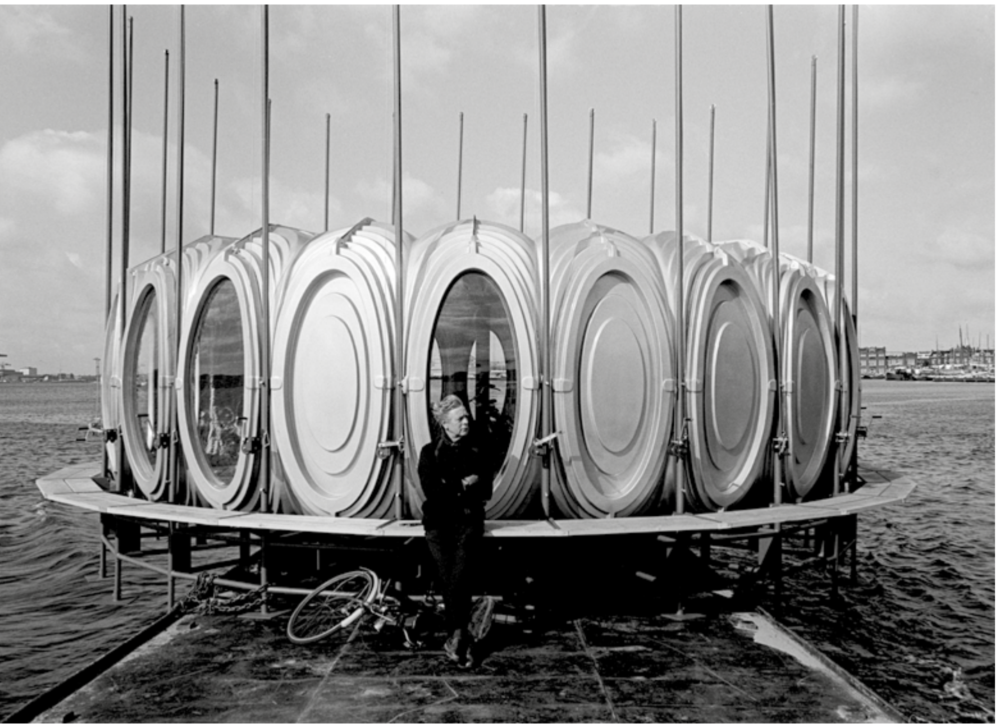
The restoration architect of the Association Hendrick de Keyser, Ann-Katrin Adolph, explains in an interview that they wanted to retain and restore the original materials in line with the aims of the Association. A specific difficulty in planning the works was related to the fact that the prototype was unfinished, and new problems and dilemmas in conservation arose due to the unfamiliar material, GRP. The exposed outer surface of the elements could no longer be remediated, and a new layer of GRP had to be added. In some cases, substitutions were necessary.

Also, within the original shells were large voids/pockets which had to be filled. Left unattended, the ingress of moisture to these voids would eventually lead to the detachment of the glass-fiber and polyester. This was a complex but necessary intervention to ensure the conservation of the 'Shelter' prototype.

The next step will be to find a suitable location for the 'Shelter', which will open to the public.

https://www.hendrickdekeyser.nl/de-huizen/shelter

Silvia Naldini



01 The 'Shelter' and architect Kor Aldershoff. © Roos Aldershoff, daughter of architect

02 The 'Shelter' dismantled, under restoration. © Ann-Katrin Adolph

Among the broad selection of publications on plastics are two in particular that have been selected for a detailed response. The oldest, 'The Plastics Architect', was clearly written for architects and designers as something of a primer for understanding the material, 'how to do it' and 'why you should love it'. It is most likely that the book was largely written before the 1973 oil shock, but its publication in March 1974 coincided with the end of the crisis by which time the price of oil had risen 300%. The economic viability of plastics in building was much reduced and there is a palpable disjunction between the content of the book and the world into which it was launched. The most recently published of the selected books, 'Life in Plastic' is a wide collection of articles intended for a contemporary and critical reader that takes in a longer view of the cultural history of plastics. Its various approaches examine our perceptions of the material, the optimistic and pessimistic iterations of plastics and waste, and its shaping of global society in the past and for the future.

THE PLASTICS ARCHITECT

1974
ARTHUR QUARMBY

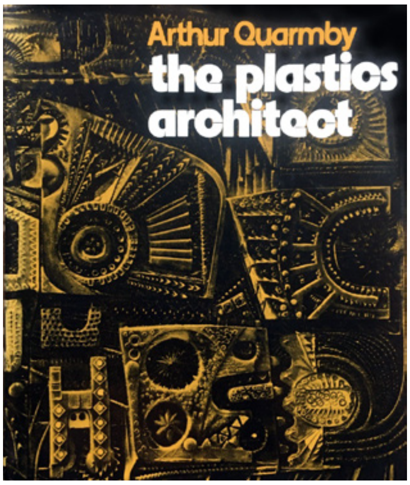
ISBN: 978-0269028250

By the time of publication of The Plastics Architect Arthur Quarmby had already spent a decade and a half as a practitioner and educator, immersed in the design and promotion of plastics for buildings. The book was initially reviewed for the Architects' journal by Reyner Banham whose position on the formalism of the first machine age is well known, along with his advocacy of the non-architecture of environmental technology, so well expressed in 1965 through the images of Francois Dallegret.

Quarmby offers a fairly comprehensive survey of the experimental and aformal nature of the most exciting early structures in plastics, and this may have suggested that Banham would offer at least a patiently sympathetic and tolerant review. That was not to be the case. Even Peter Collins's magnificent Concrete, which Banham reviewed in 1960 finished with the rather parsimonious, "No one who appreciates good scholarship, good writing and cogent argument could fail to take pleasure in all but a few pages ...". However, The Plastics Architect had a much more brutal response. Titled, "For a moulded environment" the review excoriates the book with multiple criticisms: "[un] systematic", "not even a connected narrative", "amiable and informed ruminations", "occasional anecdotal digression" and, damningly, "fire problems get scanty coverage".

Banham ends: "There is a lot of useful information to be found in it, and it will stand in for a general book on the subject until the standard work finally comes along. More than that, however, it is already an unwitting monument to the days of hope when the dream of an instant plastics architecture was still fresh and untarnished, when the millennium was going to be forged out of the white heat of technology; the environment moulded nearer to heart's desire – but literally moulded." From our current viewpoint it now seems like the 'standard work' never did come along in the first plastics age.

Robert Loader



LIFE IN PLASTIC

ARTISTIC RESPONSES TO PETROMODERNITY

2021
CAREN IRR, EDITOR

ISBN: 978-1517909888

For some years, plastics have been gathering the attention from many disciplines and various angles, often highlighting one instance of the material's vast applicability, resulting in thoroughly developed, eye-opening conclusions but within a narrow scope. At first glance, one would expect a similar experience from the volume Life in Plastic. Artistic Responses to Petromodernity, edited by Caren Irr and published in 2021 by the University of Minnesota Press, Minneapolis and London. Featuring contributions by 13 authors, the focus lies on artistic responses to the plastic age without lingering too much on disciplinary boundaries in art, architecture, interiors or design. Nevertheless, we do think this book deserves attention in the Docomomo Journal issue on polymers because of the remarkable and overwhelming depth of the contributions. What sets it apart is probably due to most of the authors of these extensive essays being literary specialists who are surveying the broad cultural output surrounding a hundred years' worth of plastics.

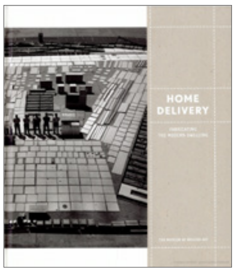
Organized in four themes – The Plastic Sensorium, The Plasticity of Genre, Plastic's Capitalism and Postplastic Futures – the book provides a plethora of topics and approaches.

For instance, one theme is the influence of plastics in graphic storytelling. Both plastics and superheroes emerged in the post-war era, both enticed society with the promise of surmounting obstacles and 'to boldly go where no-one has gone before', and both grow out of human control. A graphic novel analyses the effects of plastics, which, by permeating everything cause an apocalypse after which they are the only substance surviving. Another contribution deals with our warped perception of the senses, linking the odourless plastic to hygiene-obsessed Modernism in an analysis of the failed 'Odorama' film experience. The vinyl album too, still stubbornly among us despite its slow yet inevitable degradation within the digital revolution, is exposed as a symbol of plastics' status in our modern world. One essay convincingly questions the success with which ingenious and profound art installations are communicating references to climate issues in the art scene. Another deals with von Hagens' 'Body Worlds', in which plastination of the human body seems to fluidify the terms of life and death. Even more uncanny are the ways in which plastics appear to be interwoven with the capitalist system and society. The Bakelite promotion documentary 'The Fourth Kingdom' from 1937 and interpretations of the term 'plastick' through writings by Bruno Latour, Walter Benjamin, Jane Bennet, and Marxist or post-phenomenological thinkers, lead to amazing parallels with the underlying systems of human and non-human existence. It is striking how a novel can clarify at the micro and the macro levels the impossibility of understanding our 'petrochemical unconscious', misguided as it is by agents such as advertising. Plastic waste is abundant in this book, luckily accompanied by astounding, complex insights, for instance by coining the terms 'slow violence' or 'hyper object' for the problem of oceanic plastic. Not specific to any jurisdiction and far exceeding human lifespans, oceanic plastic presents itself as no-one's responsibility, and therefore requires a rethinking of the representation of plastics as a form of waste. As waste it is mostly invisible, perhaps it should not be considered waste at all, but an all-encompassing process of self-exploitation. In other words: "In a world mostly peddling neoliberal individualism, what kinds of affective representations might illustrate the interconnectedness of global capitalism as rendered through one of its key waste products, plastic?"

The astonishing transformative effects that plastics propose to humanity blind us to the gloomy future on the horizon. Life in Plastic does live up to its title. It convincingly portrays the material(s) as unflinchingly fulfilling its potential to 'mould' the world through optimism and myth, in sync with capitalism. Both promise rational material progress, mastering nature and global colonization to the far reaches of the Earth, by inextricable creation, extraction and pollution.

Reading these lines, it should not require much effort to recognize the links with the Modern Movement. This is not the usual book for architects, designers or conservationists. Neither a coffee table book. But it is one that provides valuable insight on fundamental questions such as: What is the heritage of the past century? How did it emerge and seduce us? How does it persist and change? And how do we deal with it?

Zsuzsanna Böröcz



HOME DELIVERY, FABRICATING THE MODERN DWELLING

2008
BARRY BERGDOLL; PETER CHRISTENSEN

ISBN: 978-3764388621

As the world's population swells and the need for sustainable ways of living grows ever more urgent and obvious, prefabricated architecture has taken center stage. Even before our current predicaments, the mass-produced, factory-made home had a distinguished history, having served as a vital precept in the development of Modern architecture. Today, with the digital revolution reorganizing the relationship between drafting board and factory, it continues to spur innovative manufacturing and design, and its potential has clearly not yet come to fruition. Home Delivery traces the history of prefabrication in architecture, from its early roots in colonial cottages though the work of such figures as Jean Prouvé and Buckminster Fuller, and mass-produced variants such as the Lustron house, to a group of full-scale contemporary houses commissioned specifically for the MoMA exhibition that this book accompanies. In addition to an introductory essay by Barry Bergdoll, Chief Curator in the Museum's Department of Architecture and Design, this volume contains essays on prefabricated housing in Japan and in Nordic countries by Ken Tadashi Oshima and Rasmus Waern, respectively. It also includes focused texts on approximately 40 historical projects and five commissions, as well as a bibliography.

PREFAB HOUSES

2010

ARNT COBBERS; OLIVER JAHN

ISBN: 978-3836507530

A Prefab is a mass produced house, constructed in a factory and assembled on site in a few days or weeks. Once regarded as a cheap, easy solution for urgent housing problems, the prefab has evolved to become a synonym for ambitious design and sophisticated detailing solutions.

The amazing history of prefabricated houses started in England in the 1830's with a building kit for emigrants moving to Australia. Even today, prefabricated houses provide a high percentage of living spaces in many countries of the world. This book covers prefabs from the USA via Europe to Asia and Africa, giving insight into the various industrially prefabricated components, the difficulties of delivery to the building site, and the intricacies of assembly and completion. As well as tracing the liaison between modernism and industrialization that evolved to produce the latest prefabricated solutions, it also features a unique compilation of one-off prefabricated houses by well known international architects, as well as successful dwellings manufactured off-site for everyday modern living. Readers will also find contact details for relevant suppliers and manufacturers.

COLD WAR HOTHOUSES: INVENTING POSTWAR CULTURE, FROM COCKPIT TO PLAYBOY

2004

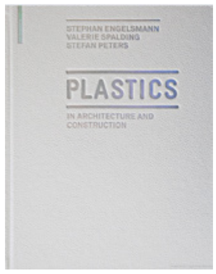
BEATRIZ COLOMINA; ANNEMARIE BRENNAN; JEANNIE KIM, EDS.

ISBN: 978-1568983028

The technological innovation and unprecedented physical growth of the cold war era permeated American life in every aspect and at every scale. From the creation of the military-industrial complex and the beginnings of suburban sprawl to the production of the ballpoint pen and the TV dinner, the artifacts of the period are a numerous and diverse as they are familiar. Over the past half-century, our awe at the advances of postwar society has softened to nostalgia, and our affection for its material culture has clouded our memories of the enormous spatial reorganizations and infrastructural transformations that changed American life forever.

Cold War Hot Houses casts a clear, even playful, eye on this pivotal time in history, examining topics as diverse as the creation of the interstate highway system and the shopping center, and the domestication of the national parks as well as the production of such seemingly mundane products as the drive-in theater, aluminum foil, and the king-size bed. The result is a vivid snapshot of American culture that still resonates today.

This beautifully illustrated collection of essays is based on a series of seminars focusing on the impact of the Cold War on the built environment, which was recently conducted at Princeton University by Beatriz Colomina. Colomina is editor of Sexuality and Space.



PLASTICS IN ARCHITECTURE AND CONSTRUCTION

2010

STEPHAN ENGELSMANN; VALERIE SPALDING; STEFAN PETERS

ISBN: 978-3034603225

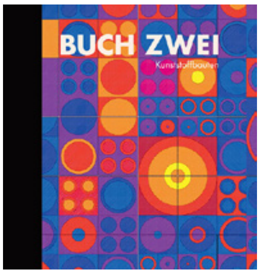
Plastics are high-performance materials of wide use in the built environment. Their versatile technical properties are particularly fascinating.A broad range of form-giving and finishing processes makes plastic especially interesting for complex geometries in combination with digital planning processes. Following the pioneering plastic structures of the 1970s, a number of spectacular buildings have in recent years highlighted the outstanding technical and aesthetic potential of the material.

KUNSTSTOFFBAUTEN: TEIL 1 – DIE PIONIERE

2005
ELKE GENZEL; PAMELA VOIGT

ISBN: 978-3860682418

Building with plastics stands for the joy of experimentation, the spirit of research and the search for new ways of living. But was it primarily architects or engineers who provided the decisive impetus for plastics construction?
The authors have found a nice way to present and honor the respective achievements of each professional group and their contribution to the further development of the material and its possibilities: by dividing their book into two parts, an "architects' book" and an "engineers' book. In this way, two works (standing side by side) have actually been created, both equally comprehensive, informative, and even exciting. If the reader follows the explanations of architect Pamela Voigt, for example, he will learn something about the influence of the first successes in space travel on the shape of the weekend house Futuro (1968); if, on the other hand, he is mainly interested in the static system, he will rather read the texts of engineer Elke Genzel. In this rather original way, the authors approach a total of ten projects from the years 1954 to 71 that were realized with fiber-reinforced plastic. The middle section of the book also contains large-format color photos taken by three students from the Leipzig Graphic and Book Art Class, documenting the current condition of the buildings that still exist. At the end, a chronologically arranged collection of examples - a kind of catalog raisonné of plastic buildings - lists further projects with photos and basic information.
A nice addition that gives the reader the opportunity for quick orientation and expands the volume into a reference work.



BUCH ZWEI – LEBEN IN KUNSTSTOFFBAUTEN

2021
ELKE GENZEL; PAMELA VOIGT

ISBN: 978-3982132778

How does it feel to live in a UFO?

The children who grew up in such a space capsule-like structure in the 1960s/70s say: quite normal. Her parents, however, had to be almost "naive and brain-drained" to venture such an experiment: living, working and loving in a plastic cave, a single large room or in small capsules. Today, roughly 50 years later, there are hardly any first owners living in their UFO houses. A new generation is just rediscovering these buildings. They find them on the beach, in the woods, or on abandoned industrial grounds and save them. For these new keepers, the UFOs are liberating places of thought.

The authors divided the work for this book into two halves: Elke Genzel visited the old builders and their families, Pamela Voigt visited the young residents and new users who made other people's dreams their own. Book Two – life in plastic buildings – are not only the stories of family life, but also of guests staying at the beautiful Hotel Ještěd, arriving after an alpine hike at the Polybiwak Refuge, or researching at the Inukshuk Igloolik Research Centre in Antarctica.

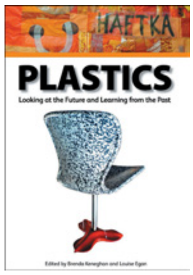
FUTURO, TOMORROW'S HOUSE FROM YESTERDAY

2002
MARKO HOME; MIKA TAAMILA (EDS)

ISBN: 978-9525339130

The Futuro house designed by Finish architect Matti Suuronen was first introduced in 1968. Its flying-saucer-like elliptical shape still retains its appeal even today, reflecting the space-age optimism and utopian vision of the sixties. This book offers a detailed, extensively illustrated history of the Futuro as well as a journey into our recent futuristic past. Also included is an exclusive DVD featuring the 29-minute documentary film FUTURO - A New Stance for Tomorrow (1998) plus 45 minutes of rare amateur film and other archive footage.

Translated with www.DeepL.com/Translator (free version)



LOOKING AT THE FUTURE AND LEARNING FROM THE PAST

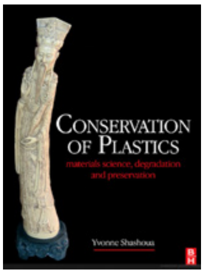
2008
BRENDA KENEGHAN; LOUISE EGAN (EDS.)

ISBN: 978-1904982432

This volume of postprints of a conference held at the Victoria and Albert Museum, is intended as a 'marker in the sand', a record of current perceptions and considerations of plastics within museum collections.

Artists' concepts of plastic as a medium, and their views of ageing and decay, challenge museum ethics. The dichotomy between an artist's intent and engagement with their contemporary culture and longevity has resulted in many different resolutions - from the display of original (decayed) materials to recording and recreating digital images of the original to the creation of aesthetically interpretable replicas. The balance between using and preserving 'plastic' artwork is a fine and delicate line of compromise.

The complex enigma of how to identify from which (of the many) synthetic polymers, the mass-produced 'plastic objects' within our collections are formed, remains, as yet, unsolved. Instead, through experience, observation and research, museums are developing collecting policies, recording techniques and preservation strategies which take pragmatic and utilitarian approaches, differentiating between stable and unstable plastics on the grounds of age, colour, design etc. Whilst generic understanding of decay mechanisms are becoming more fully understood, there has been limited success in creating the tight environmental controls needed to extend the longevity of plastic-based materials.



CONSERVATION OF PLASTICS: MATERIAL SCIENCE, DEGRADATION AND PRESERVATION

2009
YVONNE SHASHOUA

ISBN: 978-0750664950

Plastic objects are included more than ever in museums and galleries collections these days, but these items can start to deteriorate when they a just a few years old. In this book Yvonne Shashoua provides the essential knowledge needed to keep plastic pieces in the best possible condition so that they can continue to be enjoyed for many years.

The historical development of plastics, as well as the technology, their physical and chemical properties, identification, degradation and conservation are all clearly and concisely covered within this single volume, making it an invaluable reference for the increasing number of conservators and curators that are encountering plastics in their day to day work.

POST-WAR BUILDING MATERIALS IN HOUSING IN BRUSSELS 1945-1975

2015
STEPHANIE VAN DE VOORDE; INGE BERTELS; INE WOUTERS

ISBN: 978-9491912047

In 2013-2015, VUB Architectural Engineering has been working on a research project on post-war housing in Brussels (see projects > retrofit), funded by Innoviris (http://www.brusselsretrofitxl.be/). The research has resulted in a trilingual book and website which help to shed light on the development and applications of innovative building materials and techniques in house building in Brussels (and Belgium) in the period 1945-1975. The book and website will assist a broad group of stakeholders in recognizing and valorising typical post-war materials in restoration and retrofit projects.

The book and the website are composed of eight chapters, each dealing with a specific material or building product that was invented or innovative and was commonly applied in residential buildings in the post-war period: lightweight concrete; thermal and acoustical insulation; glass and glazing; prefab floor systems; window frames; cladding and sandwich panels; precast concrete façade panels; and heavy prefab systems. Along with the characteristics of these materials and building products, common brands and manufacturers are documented and applications in residential buildings in the Brussels Capital Region are illustrated. Moreover, a large collection of product advertisements and applications published in contemporary architectural journals can be accessed from the website by means of easy search tool. The website also provides additional research content, including an index of (obsolete) products and company names, and a trilingual lexicon with most relevant technical terms.

The book and website (www.postwarbuildingmaterials.be) were launched on December 10, 2015, in the CIVA in Ixelles. The book is out of print, but it can be downloaded in pdf using the link below.
(https://www.vub.be/arch/project/post-war)

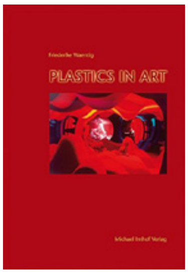
DIE PIONIERPHASE DES BAUENS MIT GLASFASERVERSTÄRKTEM KUNSTSTOFF - 1942 BIS 1980

2007
PAMELA VOIGT

https://e-pub.uni-weimar.de/opus4/frontdoor/index/index/docId/821

No other material affected the design and the architecture of the 19th century more than the plastics. There is a great variety of different sorts of plastics and therefore as well of architectural projects. That's why this thesis limits itself to the glass-fibre reinforced plastics (GRP). The glass fibres are bounded by the polyester resin. In this way they transfer the arising forces – therefore the GRP are suitable in the best way for load-bearing construction units.
The glass-fibre reinforced plastics went through a very short but productive pioneer phase (1942 to 1980).
This is a very short periods for a building material. The comprehensive analysis of the three phases consists of the investigation of the economical, political, social and cultural influences. About 260 different GRP units had

been realized world-wide out of self supporting/supporting elements. Those are listed in detail within the catalogue in the appendix. Buildings made of GRP were not alone modern due to the new material, but also due to their free mould ability, translucent facades, remarkable colours and the flexible use, according to an optimistically minded modern democratic society. These projects – some of them are still in use – prove the high developed know-how of the pioneer-constructers. The GRP-pioneers had achieved an enormous variety of forms. The analysis of the predecessors and the Sources of inspiration and the following variety of forms are basis of an objective evaluation of these buildings. Architects and civil engineers searched for ideal operational areas and structural variants for these building material, that until than had been free of associations. The used concepts: House, Second home, Exhibition, Playing equipment and the development of parts of building as Building cover, Roofing, Façade are examined in the general context and following the optimal usefulness. The knowledge about the process of the pioneer phase, the seasons for and against the use of GRP, formulated at that time, and the developed constructions, Connection techniques and structure could be helpful for a renewed use of the GRP. The request of this thesis is to show the GRP as a useful material within architecture. This analysis is to uncover the hidden knowledge, to show the prejudices developed in the 1970s and to present the glass-fibre plastics as an efficient building material for curved and folded constructions.



PLASTICS IN ART
2008

FRIEDERIKE WAENTIG

ISBN: 978-3865684059

In this book, the development and manufacture of plastics, since the nineteenth century, is discussed within their economical and cultural context. Various plastic materials are characterized, their ageing Behavior described and conservation examples given. Finally the issue of storage is addressed. The main focus lies in recent experiences in the conservation of plastics in art. Plastic objects are ubiquitous in our daily life, and are found in a myriad of types and forms in design and art works. However, their ?modern? appearance when compared to traditional materials ? like stone, wood or ceramics ? can lead to an erroneous perception of ?permanence?, with no special need for care or conservation. The reality is different. Plastics age faster than traditional materials, and therefore it is imperative to understand. Their ageing mechanisms and conservation requirements.

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https://docomomo.com/iscs/

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The docomomo ISC/Registers was created to engage national/regional chapters in the documentation of modern buildings and sites. Its mission is the development of an inventory of modern architecture, including both outstanding individual buildings and 'everyday' examples.

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- Robert Loader (co-chair, docomomo UK), studio@gardenrow.net
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The mission of the docomomo ISC/ Urbanism+Landscape is to promote research, documentation and protection of modern ensembles and environments, as opposed to individual 'setpiece' monuments. In practice, our current work focuses almost exclusively on research and documentation.

- Ola Uduku (chair, docomomo Ghana), o.uduku@liverpool.ac.uk
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The docomomo ISC/Education+Training has the mission of educating to protect "by prevention". This means to preserve not by action-reaction to specific threats, but by creating a general awareness and appreciation of modern buildings in the younger generation, general public and the society at large. The workshops in the framework of the Docomomo International Conferences are increasingly successful and prove that young people like to be involved in assignments concerning modern heritage. The ISC on Education and Training would like to provide these young people the possibility to excel in the Documentation and Conservation of modern heritage.

- Andrea Canziani (co-chair, docomomo Italy), andrea.canziani@polimi.it
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The docomomo ISC/Interior Design focus on Interior Design, an issue of major relevance for the Modern Movement and Modern Living. Interior Design gives us important spatial, ideological and aesthetic information necessary for a full awareness and experiencing of Modernity. The Modern Movement considered Interior Design as being in close relation with architecture and the other arts. This implied the demand for a new aesthetics in response to new technology and a need for a total work that embraces all the expressions into a unitary (and also utopian) environment for humanity. The Modern Interiors' identity is characterized by a strong and coherent style which results from a unity between architecture, furniture, design, decorative arts, utilitarian objects, equipment, textiles and light.

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ISC/PUBLICATIONS

In order to have more coordination between the ISC's and other docomomo bodies regarding publications, the Advisory Board unanimously agreed on the creation of a Docomomo International ISC/Publications, integrating all the ISC chairs and the Docomomo International Chair. This may concern their content and editing status (indexed) but also the use of funding and external resources and the contacts with publishing houses.

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