THE USE OF GLASS-REINFORCED POLYESTER IN PRESTON BUS STATION

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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].

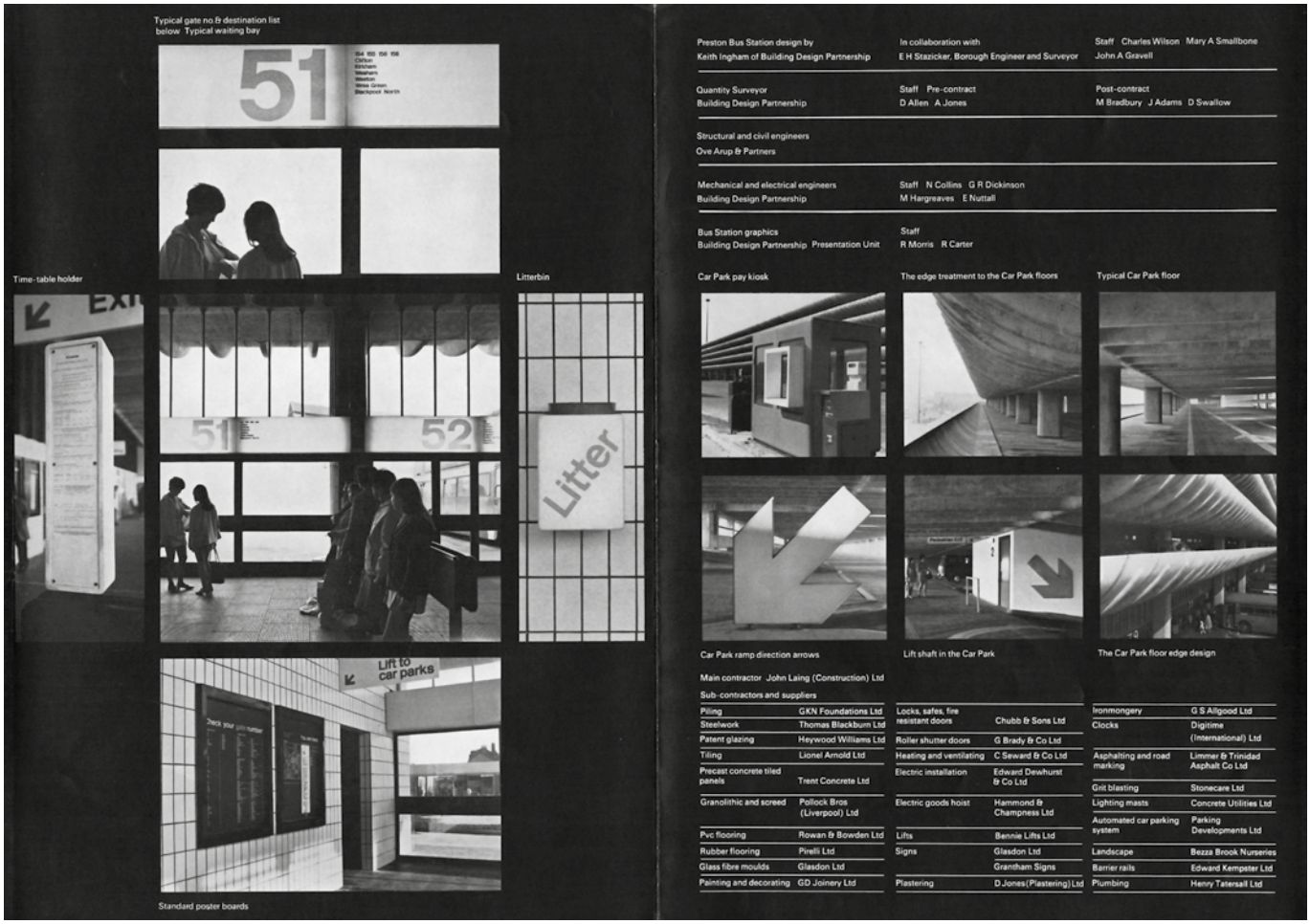
Two cranes were used on site. Precast units were lifted into position by a self-propelled Scotch derrick with a 10-ton carrying capability and 100 ft. (c30 m) reach, which operated on 600 ft. (c184 m) of track that ran the full 620 ft. (c189 m) frontage between the yard and the new building. This was 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.

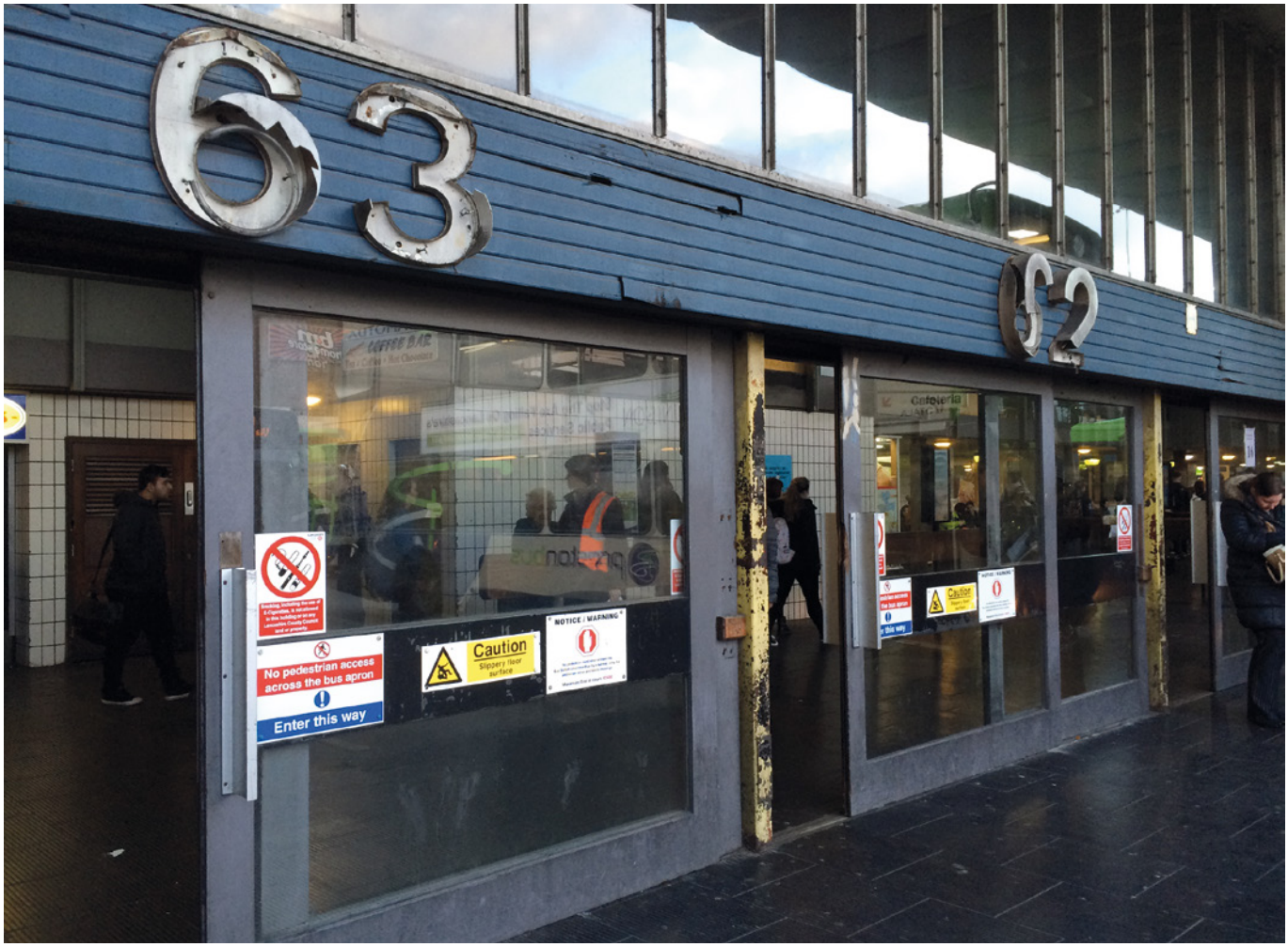
A particular legacy of the use of GRP in Preston Bus Station has been the design of the car park pay kiosks. Numerous references to the subsequent development of Ingham's design of the pay kiosks into a prefabricated sectional system appeared in the architectural and technical press in the early 1970s. 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]

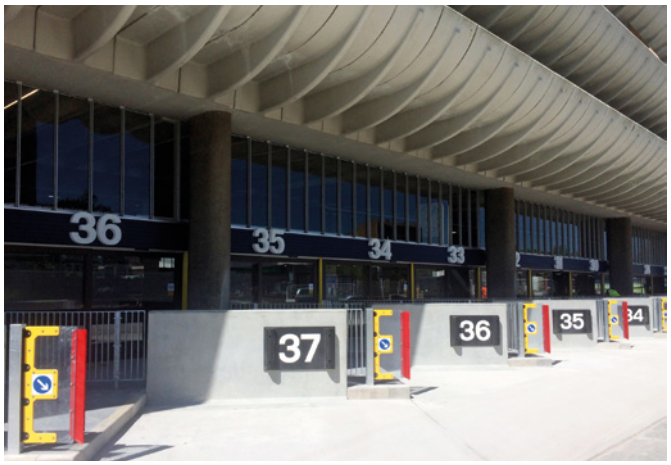
CURRENT CONDITION AND CONSERVATION

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.

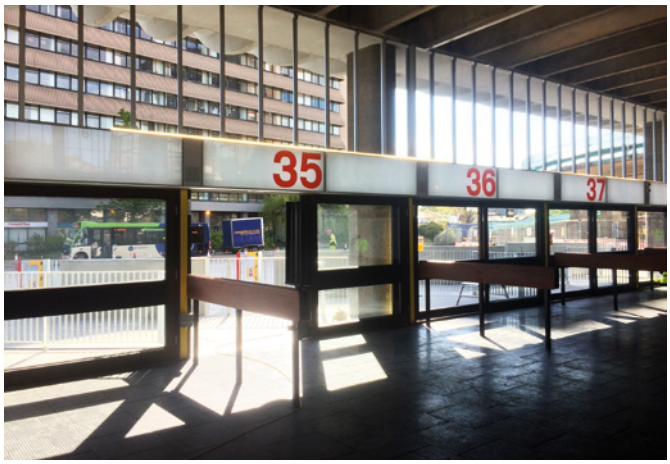
Following the building's listing in 2013 and the RIBA competition for its refurbishment, a Conservation Management Plan (CMP) was produced in 2016. In line with the List Description for the building, the CMP makes due mention of the significance of GRP in the design and creation of the building and several 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

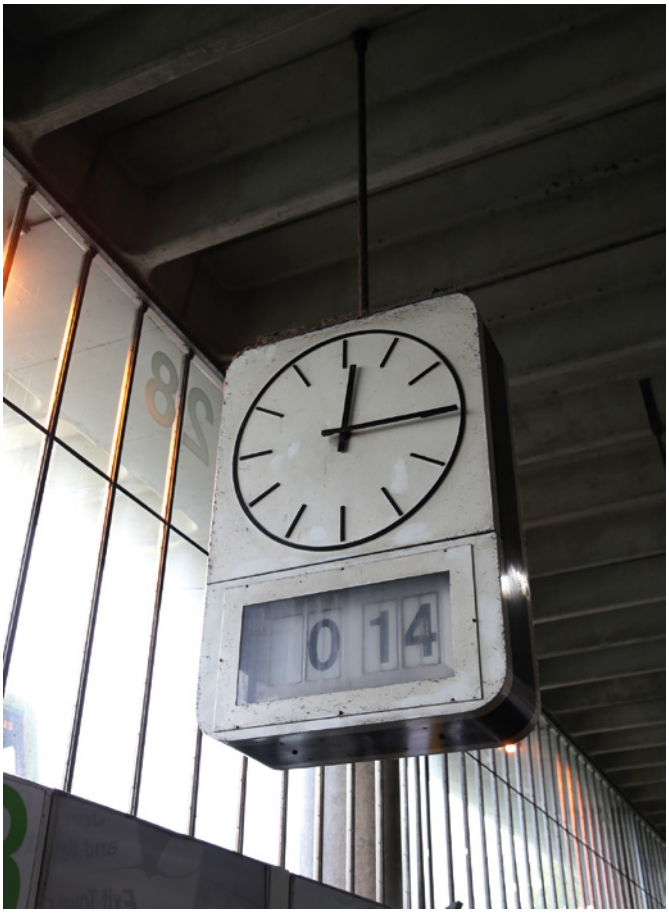
and the use of Helvetica typeface, and on applying extensive visual decluttering. Reinstating the lighting in the "box signs over the boarding doors" was also set as a priority.[26]

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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[27] John Puttick in email correspondence with the author, 7 June 2020.

[28] *Beautiful and Brutal: 50 Years in the Life of Preston Bus Station* exhibition, Harris Museum, Preston, Lancashire, England, 21 September – 24 November 2019.

[29] John Puttick in email correspondence with the author, 7 June 2020.

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