National Space Centre Exhibition and Research Complex

The Basics

Location: Exploration Drive, Leicester, LE4 5NS, Leicestershire, England

Latitude/Longitude: 52°39'13"N, 01°07'57"W; altitude: 185'

Building Type: Space Museum and Research Facility

Annual Precipitaion: 606.2mm (23.9")

Square Footage/Stories: 7,600 m^2 (81,806 ft^2)/tower 41 m (135') high

Completion: Jun 2001

Client: National Space Centre Property Company

Design Team: Grimshaw Architects

Structural and Services Engineer: ARUP

Photo Credit: Philip Jordan

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Background and Context

In 1996, Nicholas Grimshaw and Partners won a national competition to design the National Space Science Centre, a Millenium Project for the East Midlands. Millenium Projects are community enrichment tasks selected by the Millenium Commission and funded by the UK National Lottery. The commission is an independent group yet under the oversight of the government. Their intent was to assist these communities in marking the transition from the second millenium to the third.

Leicester is located in the Midlands of England, north of London by about 100 miles. Like many English cities, Leicester's growth exploded during the Industrial Revolution. The Soar Canal allowed coal and iron to be easily shipped into town, spurring the growth. By the beginning of the 20th Century, Leicester had established itself as a hub of engineering. The College of Art and Technology opened in 1897, and transformed into Leicester Polytechnic in 1969, and then the University of Leicester in 1992. It is then obviously appropriate that a

Centre dedicated to scientific and engineering advacement be located in a city whose history is so tied to these endevours.

The National Space Science Centre is located on the banks of the River Soar, the historic lifeline of Leicester. The site occupies some of the grounds of the old Abbey Mills waterworks. Next door to the Centre, the Abbey Pumping Station, which was built in the early 1900s, is of historic importance and also draws visitors. Construction was started in 1998, and the Centre opened in June 2001.

Photo Credit: Jonathan Rawle

Design Intent and Validation

Goals for the project were lofty: the project aims to be an international beacon of education and research. The National Space Science Centre needs to serve the function of both a museum for the public and a research facility associated with the University of Leicester. Large displays, often on loan from foreign countries, demand voluminous and flexible gallery spaces in precision-controlled environments. School groups shuffle through daily, and the layout must promote movement through the galleries while comfortably housing fluctuating masses of guests.

Photo Credit: Philip Jordan

The Grimshaw proposal was chosen for this project particularly because of how it addressed the site conditions. Instead of filling it, Grimshaw proposed to use the existing 100-year-old stormwater tank by building the NSSC into its footprint. The 100 x 80 x 1.8 m tank provided a reuseable base that would cut down on the need to pour new concrete and waste energy on site modifications. This also provided an excellent way for the project to highlight its dedication to forward thinking and sustainability.

From there, the building was divided into two structures: the main exhibit and facilities space housed in a 5,000 sq m steel-framed box and fitted into the stormwater tank, and an annexed, organic-in-form, 40m-high transparent tower that contains two large rockets, the “Blue Streak” F16 and the Thor Able. A double-height, 14m steel grid frame provides the flexibility and space necessary for a 2.5-hour walk-through tour with more than 250 hands-on exhibits, audio-visual displays, and simulators. In the center of the exhibition space is a 20 m geodesic dome that contains a multimedia planetarium and theatre. This dome protrudes above the roofline of the rest of the exhibition space. The dome also acts as the “hub” from which the rest of the layout spins, both in the building and the site. A concrete spine serves as both the vertical circulation and the structural anchor for the tower. The skin of the tower is constructed of ETFE, a multilayer, thin, translucent foil that is stretched over a lightweight steel frame and inflated for rigidity. The translucence permits visibility of the rockets from the exterior and views of Leicester from the multiple stories of decks inside the tower.

Photo Credit: Graham Beardwell

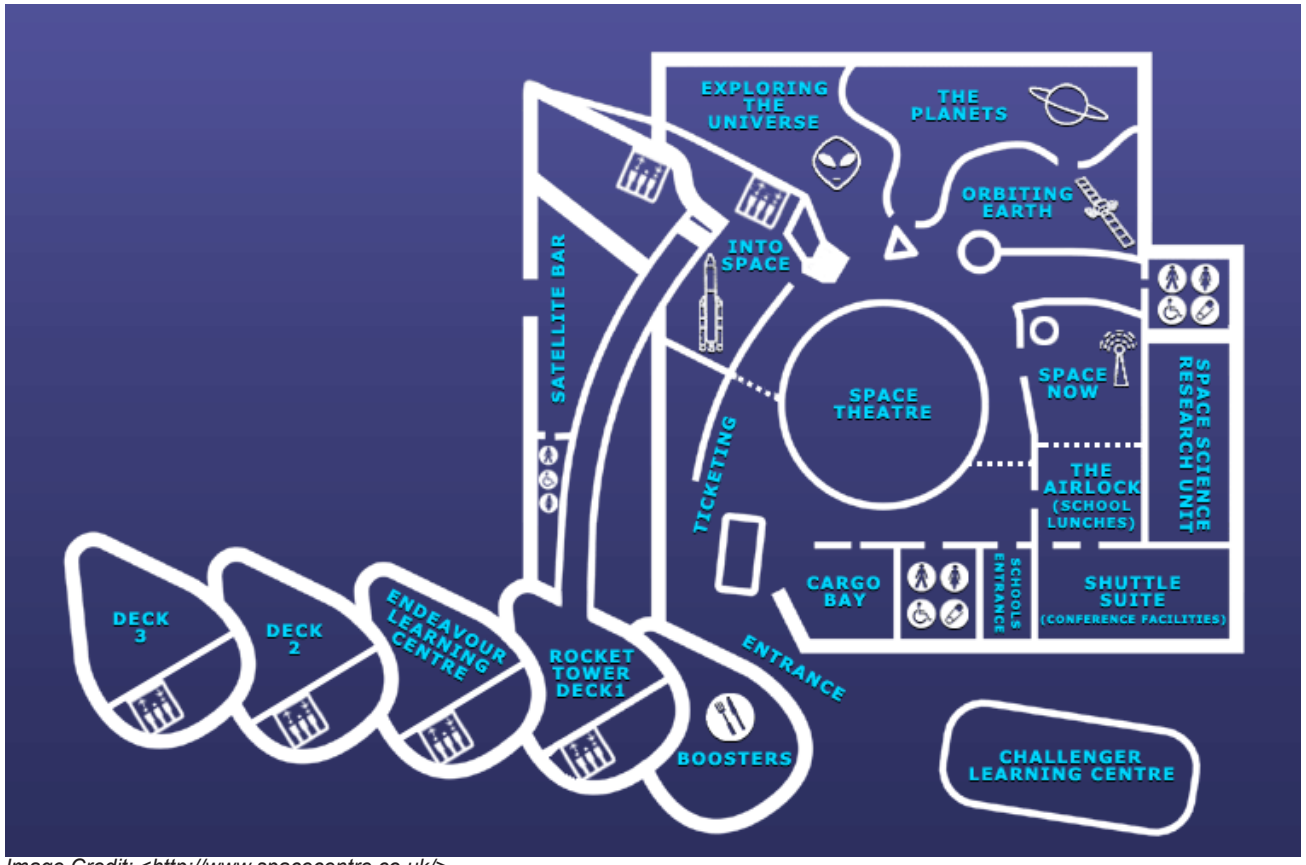

Image Credit: <http://www.spacecentre.co.uk/>

Photo Credit: Rona Burnett

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Key Design Strategies

Brownfield Redevelopment: The Abbey Mills site is a relic of the Industrial Era that is located along Leicester's most important natural resource, the River Soar. Portions of the old wastewater treatment facility had gone unused before construction of the NSSC. When this site was chosen, a conscious decision was made to not continue spawl past the limits of the city and to put to use a site that was already altered by humankind. Because of its former life as the city's wastewater facility, the site had to be rehabilitated. Besides general cleanup, the new NSSC was tied into the new riverwalk. When it was decided to reuse the stormwater tank for the building, 20,000 cu m of muck were pumped from the tank. 15,000 cu m were then recycled back in to stabilize the tank and the remaining 5,000 cu m were spread around the site for landscaping.

Photo Credit: Graham Gaunt

Reuse of Existing Structure: By building the main exhibit space down into the stormwater tank, the designers included a historical, yet misused, structure that expended large amounts of energy to create. They also avoided the need to pour thousands of extra yards of concrete and pollute the air with its off-gasing. The actual Abby Mills Pumping Station (next door on the site) was also employed to house part of the mechanical systems without compromising its historical character.

Thermal Mass: By building down into a partially underground concrete tank, the exhibit space is able to take advantage of the thermal mass of both the concrete and the earth past it. Since space exhibits, especially those on loan, need to be housed in highly controlled environments, this thermal massing aids in the stability of the environment inside and reduces the need for a system whose capacity must react to dramatically changing temperatures and humidity.

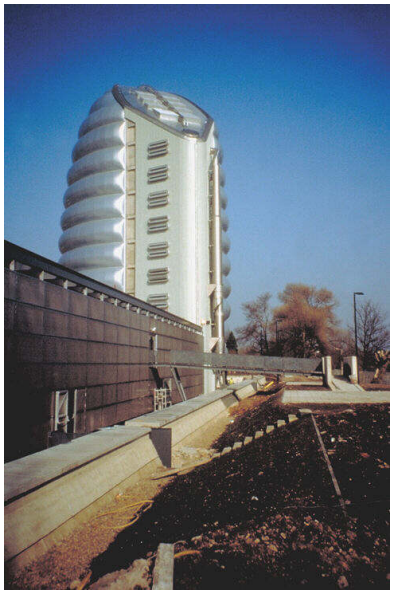

Photo Credit: Philip Jordan

Separation of Mechanical Systems: From a remote location on the site, the former pumping station houses two chillers, two gas-fired boilers, an electric substation, a main low-voltage switchroom, and a standby generator that provide a majority of the mechanical needs for the Centre. These systems are conveyed to the Space Centre through a series of underground conduits and insulated pipe work. The receiving mechanical equipment is located in the basement of the main exhibit space. Not only is space maximized for other uses, but by placing the mechanical equipment away from the exhibits, the designers succeeded in creating a naturally quiet museum space. This is necessary for its educational function.

Building Skins: The skin of the main exhibit space is a double-wall system. On the inside wall are the door and window openings with steel cladding wrapping the rest. The exterior wall is a homogeneous skin of perforated stainless steel panels. As well as giving the building a futuristic skin, the panels shade all the windows.

This keeps solar penetration from affecting the delicate environment of the exhibit space. ETFE foil constitutes the majority of the tower's skin. Pressurized air flows through the minimal, perforated steel frame for the ETFE. The frame injects air into the cavities between the triple layers of the foil which causes the ETFE to "pillow" outwards. This provides rigidity for the ribbed appearance of the material. The ETFE foil weighs approximately 1% of an equally thick glass. Small silver frits were painted onto the foil on the faces most exposed to sunlight to cut down on solar thermal gains. For its thickness, the foil provides excellent insulative values. Conditioned air can be passed through the spaces in the foil to increase thermal efficiency.

Natural Ventilation: Due to its transparency, the tower is suspect to solar gain and its subsequent temperature increases. Even with fritting blocking a percentage of the sun's rays, the design team had to devise a scheme to mitigate heat that would be trapped in the tower. ARUP employed CFD (computational fluid dynamics) to help solve the problem. They modeled heat gain in the space on computers and were able to contrive a natural ventilation scheme using both high- and low-level louvres. During times of extreme cold when extra heating is needed, the louvres are closed and radiating panels provide both the necessary heat and mitigation for any condensation that accumulates on the inside of the skin.

Photo Credit: Jonathan Rawle

Photo Credit: Graham Gaunt

Performance Studies

While there are a lack of post occupancy evaluations and studies published on this building's performance, the following information regarding the exhibit space environment was available. Because exhibits are often borrowed from the U.S., the exhibit must conform to Mecklenberg conditions. "Ideal" environment for museums is defined as 21°C and 50% humidity. Due to its use of thermal massing and exterior shading, modeling on the building has shown that these conditions can be attained 96% of the time without the need for full air conditioning.

The National Space Science Centre opened on 30 June 2001. By the end of October 2001, it had reached its visitor-number target for the year and was later chosen as the UK information centre for Near Earth Objects. In 2003, Grimshaw Architects received the RIBA Award for the project.

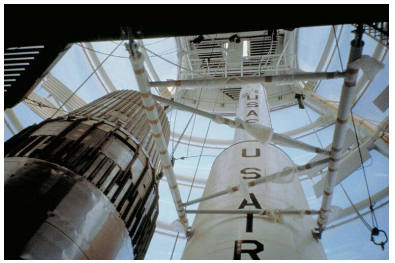

Photo Credit: Philip Jordan

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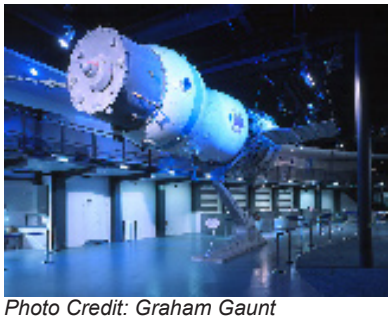
Further Information

<http://www.nssc.co.uk/>

<http://www.skyspan.com/>



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Case Study by Brant Hauser, Spring 2006