

## UNIVERSITY OF NOTTINGHAM – JUBILEE CAMPUS

---

**Rabih M. Borji**

*Beirut Arab University, Faculty of Architectural Engineering*

### *Abstract*

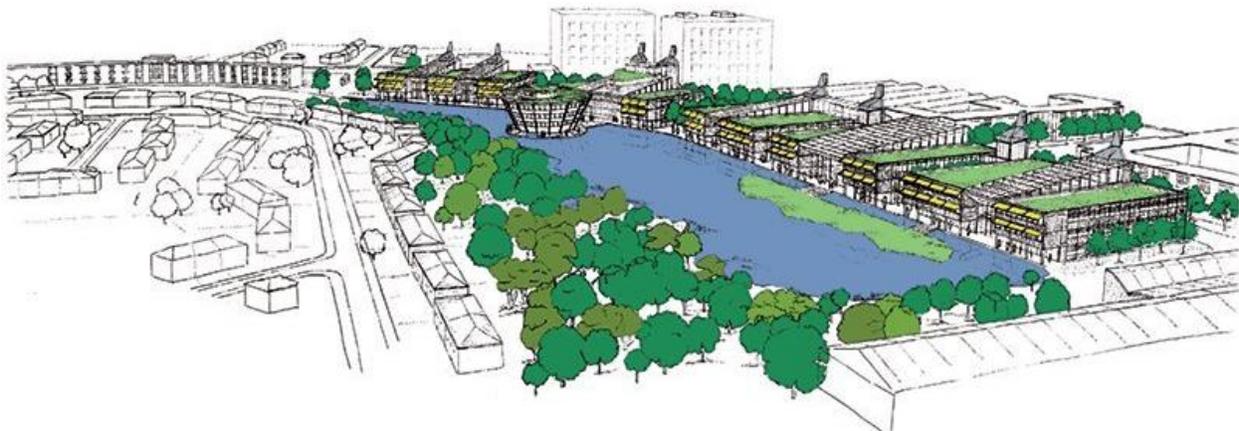
The University of Nottingham launched an invited design competition to establish a coherent master plan for a new campus on an 18.5 acre site approximately one mile from the main University campus. The development of the new site was to consist of a mix of residential, amenity and academic facilities. The brief from the university was to design a world-class sustainable campus utilizing renewable energy sources.

Five practices were selected to take part in the design phase from over 100 initial applications and the jury panel unanimously selected the scheme submitted by Hopkins Architects as the winner.

The panel felt this design was bold and imaginative in its strategic approach to the master plan. The design includes an artificial lake running the full length of the site which creates a visual link with University Park. A dramatic architectural feature of the design is an inverted cone structure, set on an island platform. This is the learning resource center providing a focal point for the whole campus and containing the library and a 24-hour access computer laboratory.

The total development cost for the project was £50 million. The building was officially opened by Her Majesty and HRH the Duke of Edinburgh in December 1999.

*Keywords: university, design, sustainable, world-class, structure, innovation*



### **1. Introduction**

Jubilee Campus primarily houses the Computer science and Nottingham University Business School. The campus is also the location of the National College for School Leadership and the University's International Office.

The campus opened in 1999, and is located about a mile to the east of the main University Park Campus on the site of the former Raleigh Bicycle Company factory. The campus plan and the buildings for first phase of the campus were designed by the architects Michael Hopkins and Partners following selection through an architectural design competition managed by RIBA Competitions and won the 2000 BCI

Award for "Building of the Year" and the 2001 RIBA Journal Sustainability Award. The campus name derives from the fact that 1998 was the Golden Jubilee of the granting of the Royal Charter that made the University an independent degree-granting organization.

Like the University Park Campus Jubilee has been constructed around an artificial lake and with similar green surroundings. The Hopkins buildings also contains many innovative environmental elements such as living roofs (Sedum) aiding storm drainage, insulation and promoting biodiversity, and solar panels. Particularly striking is the library, the Sir Harry

and Lady Djanogly Learning Resource Centre, a circular building situated in the middle of the lake with only one, spiraling, floor.

For the second phase of the campus, MAKE architects were retained by the university. They produced a revised campus plan, which moved away from Hopkins north-south orientation, and creates an east-west axis beyond the confines of the site. The first stage includes a group of three prominent buildings by the practice.

The new plan is centered on Aspire, the country's tallest piece of free-standing art, which was also designed by MAKE. The Aspire sculpture is described by the university thus:

Aspire stands for the aspirations of the city and people of Nottingham. Aspire stands for the ambition, knowledge and world leading innovation of The University of Nottingham. Above all, Aspire stands as a towering affirmation of optimism for the future.

International House and the Amenity Building have facades in multiple shades of red terracotta, whereas the Gateway Building is covered in galvanized zinc shingles. Critical reception to MAKE's buildings for the second phase has been mixed. The new campus buildings were runner up for Building Design magazine's 2009 Carbuncle Cup.



## 2. Profile

A serpentine lake was created following the line of the only remaining feature on the linear site - a belt of trees shielding housing. Along the lake are ranged the principal Faculty buildings, a Learning Resource Centre and a central teaching building.

A colonnade on the front of the buildings forms the pedestrian route through the site, leading from the playing fields to the main campus. It has views out over the lake and gardens, and engages with the restaurants, shops and atria meeting places at ground floor level. Above are the faculty rooms. The shape of the circular Learning Resource Centre and the conical lecture halls, proclaim their importance.

The program and costs were tight so the construction technology is simple, the emphasis being on refinement and

rationalization of detail. The main three-storey buildings have in-situ concrete frames. The external walls are clad in prefabricated timber panels and windows. Full height sloping glass atria, supported by laminated timber beams, link the blocks.

A low-pressure drop ventilation system uses corridors and stair towers as air plenums, reducing the energy needed to circulate air. Under normal conditions specially designed cowls create adequate wind effect. During hot weather, photo-voltaic cells on the atrium roofs generate supplementary power for the fan driven ventilation. [7]

## 3. Environmental Strategy

In pursuit of achieving environmental excellence the University of Nottingham is committed to the following aims:

- To facilitate the active participation of the University community in reducing the collective environmental impact of the

organization, through both formal and informal activity; To foster a culture of environmental citizenship within the University Community.

- To meet and, where appropriate, exceed all relevant UK, European and international legislative and regulatory requirements and agreements.
- To engage fully with the student body to ensure the involvement of a key stakeholder in environmental improvements.
- To improve the environmental performance of our buildings and the University's physical infrastructure by moving towards carbon neutral energy performance, adopting environmentally conscious procurement practice, promoting renewable energy systems, reducing water consumption and waste output.
- To systematically reduce resource consumption and progress to zero waste through best practice environmental management and cultural change.
- To ensure that all development and refurbishments go beyond current legislation and utilise environmental best practice where practicable, whilst seeking best value for the University at all times.
- To actively promote and market the University, internally and externally, as a leading 'Green University'; to facilitate dissemination of best practice and ensure that the University gets the recognition it deserves for its endeavors.
- To act in an environmentally responsible way.
- To continue the University's contribution to advancing the environmental agenda within both the region and the Higher Education sector.
- To integrate environmental responsibility into University and School strategies, plans and policies as they are written or revised.
- To sustain and build upon the University's profile in environmental research contributing to the global enhancement of the

environmental knowledge base for future generations.

- To actively promote and encourage the use of sustainable modes of transport across the University, acknowledging business needs, the University's research led focus and its internationalization agenda.
- To promote and encourage the use of technology to reduce the environmental impact of university operations and activities.
- To engage with the University's suppliers and contractors to ensure that goods and services procured meet the University's environmental standards and, in turn, that they demonstrate and progressively improve their own environmental performance.
- To support continuous environmental improvement by establishing challenging and measurable performance targets that are reviewed and reported annually.
- To develop, operate and maintain IT services and facilities in a sustainable manner, meeting and where practicable exceeding industry standards, seeking best value for the University at all times.

#### **4. Site Landscape**

Nottingham has some of the most prestigious grounds in the sector, documented by our numerous awards; include successive Civic Trust Green Flag Awards since 2003, the Britain in Bloom Public Park Award 2005, and Nottingham in Bloom and East Midlands in Bloom awards for horticultural excellence, Civic Trust and British Association of Landscape Industry awards for the Millennium Garden on University Park. Our grounds are central to the University experience and contribute to the overall Nottingham experience.

Over the last decade we have seen significant improvements in the standard of our landscape, creating and enhancing to create the high quality landscape we see today. Our planting very much reflects the diversity of our student body, using both exotic and native species. Our landscape covers a variety of styles including heritage areas, courtyard gardens, display gardens, water features, sculpture, more than 3,000 trees, woodlands, wildlife and grass

lands, all of which contribute to a rich diversity.

Grounds are managed with a strong environmental bias including composting all horticultural waste for reuse on site, minimizing the use of pesticides, eliminating the use of peat for soil amelioration, reducing the need for water by mulching, leaving areas of scrubland and felled trees for wildlife habitat, all of which contribute to the rich diversity we have.



Strategic Aim:

- To improve the environmental performance of our buildings and the University's physical infrastructure by moving towards carbon neutral energy performance, adopting environmentally conscious procurement practice, reducing water consumption and waste output.
- To act in an environmentally responsible way.
- To continue the University's contribution to advancing the environmental agenda within both the region and the Higher and Higher education sector.

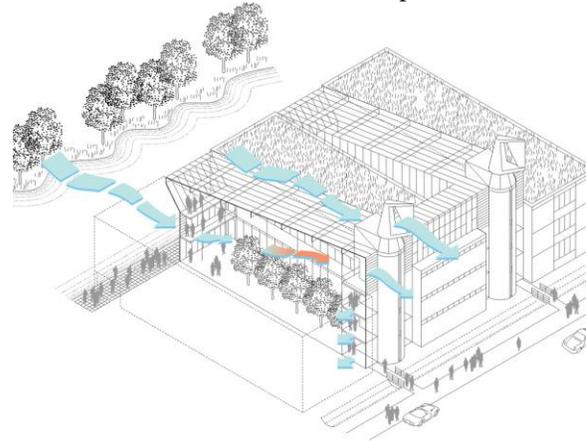
Objectives:

- To continue to manage our grounds with due regard to the environment.
- To increase the bio-diversity of our sites.
- To foster greater partnership with other organizations to promote sustainable grounds practice.

**5. Energy and Water**

In recent years there have been frequent sensational headlines regarding world fossil fuel energy reserves, climate change and energy price increases.

Over a relatively short period, public awareness and interest has been stimulated on an unprecedented scale.



The University has not been immune to these market issues, experiencing the most volatile price fluctuations in energy costs ever, with increases of 200% in oil, 225% in electricity and 250% in gas prices since August 2007. As such we have seen significant increases in our annual energy and water spend and in financial year 2008/09 this spend was £12.5 million.

Our flexible approach to energy procurement has ensured that we procure our energy in the most effective way. We have seen year-on-year energy reduction against a backdrop of increasing student numbers, a growing estate and increasingly energy intensive research.

Whilst water prices have not risen to the same extent as energy, we now pay over £1 million a year for water. Many opportunities for savings have been introduced, including urinal controls – Cisternisers, leakage detection work and grey water harvesting, as well as reviewing whether sites have been charged correctly for clean water, used water and surface water drainage.

Objectives:

- Reduce energy consumption whilst at the same time ensuring the University's activities continue
- Raise the awareness of the cost of energy
- Reduce the overall cost of energy
- Reduce energy waste
- Ensure that energy consumption and low carbon energy are considerations in the procurement process

- Reduce water costs and consumption
- Minimize pollution



## 6. Waste and Recycling

The limited capacity in landfill sites is well reported and we have seen increasing costs associated with the disposal of waste, landfill tax is increasing year on year. Several pieces of legislation in recent years have meant that there are increasing numbers of items that have to be disposed of via specialist contractors and not via landfill.

Recycling in the home environment is very much the norm, as such both our staff and students expect to be able to recycle at their place of work or study, and currently we offer facilities to be able to recycle a number of waste streams.

The University produce over 3,000 tons of waste per year which costs in excess of £300,000 per year in disposal. Over the last few years we have seen significant improvements in our recycling rates, from 4% in 2004/05 to 29% in 2008/09, with a target of 40% set for 2011/12.



### Objectives:

- To minimize and actively manage waste through elimination, reduction, reuse and recycling
- To promote management systems which reduce the production of potential waste materials
- To encourage the use of 'recycled' products where appropriate
- To promote purchasing and development processes that give due consideration to the true cost of waste
- Review all waste streams and work to minimize waste generation, maximize recycling and minimize unnecessary consumption
- Work with our building contractors to minimize the amount of construction waste.

## 7. Energy Efficiency

- Low-energy design with mechanical ventilation.
- British Construction Industry Awards winner.



The mechanical ventilation and temperature control is more energy efficient than natural ventilation.

Arup provided civil, structural and building services engineering design, planning supervision and acoustics and fire consulting for this extension to the University of Nottingham's Jubilee Campus.

Additions included new faculty buildings, dining and catering facilities, learning resource center, residential buildings and site works on a 6ha brownfield site.

#### *Low Energy*

The buildings adopt low-energy design techniques to create a sustainable solution without compromising the need for an adaptable and pleasant working environment.

Arup worked closely with the architect to design academic buildings that are mechanically ventilated and heated using systems that are more energy efficient than natural ventilation. Air handling units were designed specifically for this project.

Other low-energy design features include louvers for ventilation, light shelves that allow natural illumination into the building, photovoltaic cells and high-performance insulation for heat and sound.



Arup worked closely with Michael Hopkins and Partners to create sustainable academic buildings that do not compromise on quality.

#### *Award Winning*

The Jubilee Campus won the Building Award in the British Construction Industry Awards 2000. The Judges noted that:

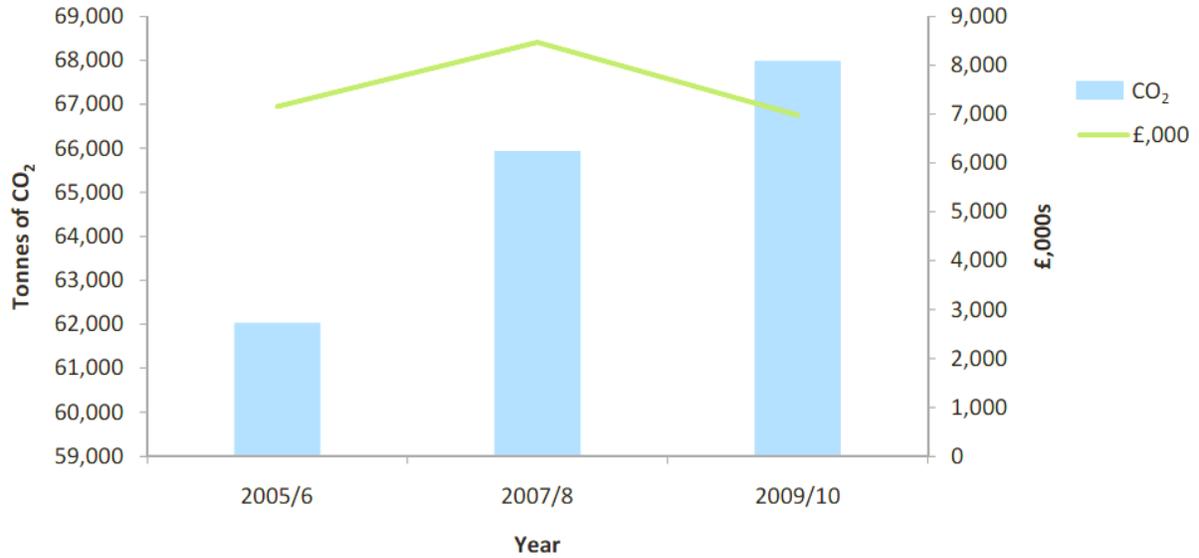
*"Highly sustainable design and immaculate construction have delivered a sophisticated but remarkably economical result. Students will be stimulated by the complex, which has established a new benchmark for university buildings."*

Following the completion of Jubilee Campus, Arup and the design team were appointed to work on the subsequent National College for School Leadership.

#### **8. Carbon Management Plan**

This Carbon Management Plan sets in place the University's target reductions in carbon dioxide (CO<sub>2</sub>) emissions to 2020 and identifies a framework for investment over the next 5 years that will be required to deliver CO<sub>2</sub> savings to meet University targets. The report identifies the main proposed areas of activity, and will evolve over time as new opportunities are identified and brought forward. The Plan has been developed to respond to the UK and HE sector CO<sub>2</sub> emission reduction targets and will deliver both environmental performance improvements and financial savings. It requires a new carbon investment program to be implemented to meet these targets, with the main areas of investment centered on:

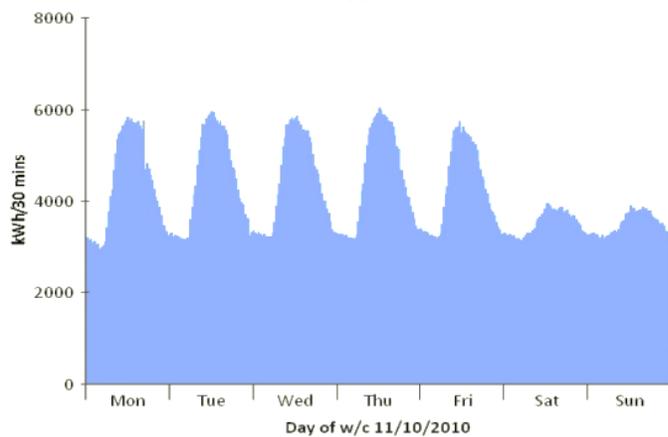
- a. Improvements in energy efficiency of buildings, including insulation, heating & lighting
- b. More efficient use of existing equipment including switching off when not in use
- c. Generation of energy from small/medium scale renewable energy systems
- d. Provision of information and training to staff and students to engage them with the objectives of the Plan
- e. A cultural change in the use of high energy consumption activities within premises and a strategy to replace with lower energy alternatives.



Total absolute CO2 emissions and energy spend

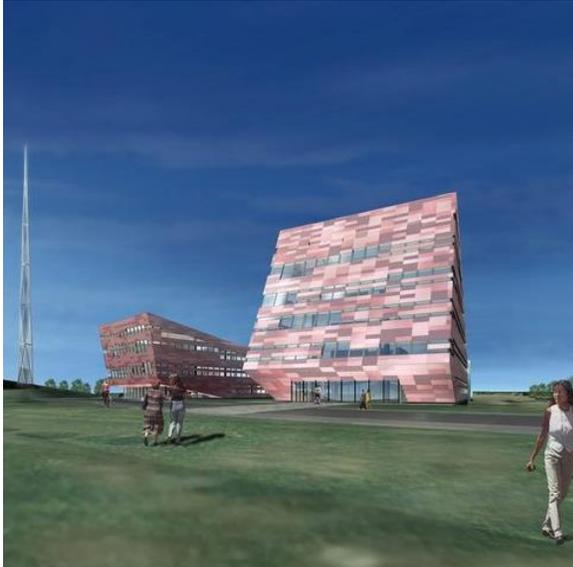


Absolute CO2 emissions by energy source

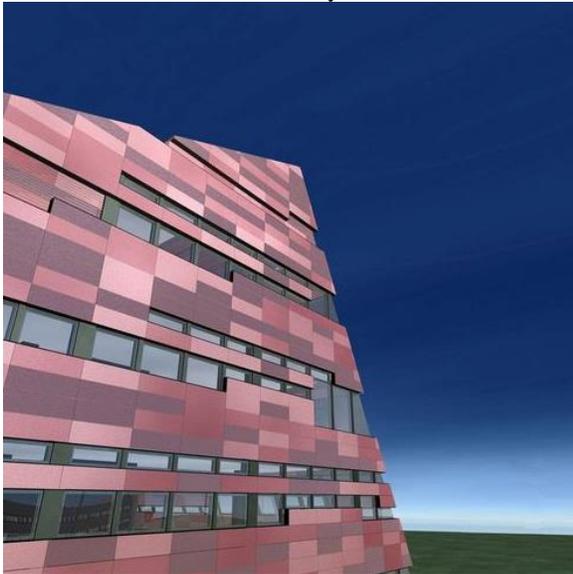


University of Nottingham electricity usage

## 9. Jubilee Campus Expansion



Makes master plan for Nottingham University's Jubilee Campus site will extend and enhance existing facilities so that the University can meet future needs and continue to offer students and staff the optimum environment for research, study, work and recreation.



The master plan institutes a new lateral route that opens up the site to create a richer and more diverse environment. This new route takes the form of a generous landscaped pedestrian boulevard with its own water feature that links the two bodies of water lying on the western and south-eastern perimeters of the campus, drawing the theme of nature through the campus and providing a focus for recreational and

leisure activities. The pedestrian boulevard terminates to the east at the River Leen, where an existing concrete culvert is to be transformed into a landscaped natural river bank, creating a new destination for the campus and the wider community.

Triumph Road, which runs north-south through the site, divides the campus into two main zones: academic and teaching facilities are located in the western half, while the eastern half forms the University's Research and Innovation Park. The three buildings have been identified for the first phase of the master plan, each containing facilities relating to the zone in which it is located, and all three structures have been designed as landmark buildings to create maximum impact and signal an exciting new phase in the development of Jubilee Campus. In particular, the form of each building has been developed to express the particular qualities and aspirations of the University departments it houses: at the same time, each structure emerges organically from the landscape and has been designed to establish its own relationship with the parkland setting rather than simply being imposed upon it.



International House and its companion, the Amenities Building, are sited in the academic zone of the campus. International House houses faculty teaching facilities and administrative offices, while the Amenities Building contains staff dining facilities, a fitness suite, and accommodation for visiting academics and multi-faith facilities and prayer rooms. The buildings are

uniquely formed to emerge from the ground like natural landforms, with a cladding system of terracotta tiles arranged in bands like geological strata. The color palette of the cladding also reflects the traditional brick construction that dominates the surrounding area. The grouping of these buildings defines a public edge along Triumph Road and each presents an open, glazed face to this principal route, expressing the University's active engagement with the city beyond.

The third building is very different but no less striking in appearance. Principally located within the eastern Research and Innovation Park, the Gateway building extends to straddle Triumph Road and forge a physical and symbolic link between the two zones at the very heart of the campus. The portion of the building lying west of Triumph Road is known as the Head Building and contains exhibition spaces and serviced office support areas. The section lying to the east of Triumph Road is dedicated to the University's Business Incubator Unit. With its distinctive curvaceous form this building embodies the circuit of communication between education and business which the University has established through its pioneering work to foster enterprise and entrepreneurial skills. The gentle curves of the building also echo the landscaped parkland that surrounds it, and the structure emerges from two landscaped mounds on either side of Triumph Road. Gleaming silver cladding establishes the building as a focal point within the campus, and relates to the zinc panels used in existing buildings.

All three new buildings have been designed to minimize the environmental impact of the development and incorporate a range of features to optimize energy efficiency and reduce carbon emissions. High performance facades will reduce building heating and cooling loads, with glazing kept to a minimum and all windows set back to shade the interior from high angle summer sun while admitting maximum levels of low angle winter sun. In place of costly mechanical ventilation, air quality will be maintained via a sophisticated displacement system which provides better ventilation efficiency and is quieter and more energy efficient than conventional systems.

Any artificial heating or cooling that is required will be generated using an important natural resource that already exists on the campus: a series of heat pumps extract embodied energy from the campus lakes through an open loop system, using them to cool the building in summer and heat the building in winter. In turn, all rain and run-off water is carefully collected and fed back into the lakes, in order to preserve the ecosystem and ensure that this valuable resource is not

depleted. In addition to ensuring that the new buildings are highly cost effective in terms of operation and maintenance, this energy strategy demonstrates the University's active commitment to a wide-ranging policy of environmental responsibility.

Chris Jagger, University of Nottingham, Director of Estates said:

The University (of Nottingham) intends through the expansion of the award winning Jubilee Campus to reconfirm its commitment to deliver signature architecture for both the University and City. Furthermore for this important regeneration project the intention is to improve on the strong environmental and sustainable credentials that were established with the original Jubilee Campus development.

The architectural designs of the next three buildings proposed by Ken Shuttleworth and MAKE have attracted very positive responses from within the University and through the consultation process with the City. We have every confidence that they will make a major statement and contribute to the development of our Jubilee Campus, providing a quality environment for the continued growth of the University.

David Patterson, Make project architect, said:

This master plan scheme offers all the facilities that the University requires to maintain standards and develop its role, within the context of a dynamic, welcoming and secure landscape that will become as much a part of the University's identity as the distinctive new buildings that sit within it.

Ken Shuttleworth, of Make, said:

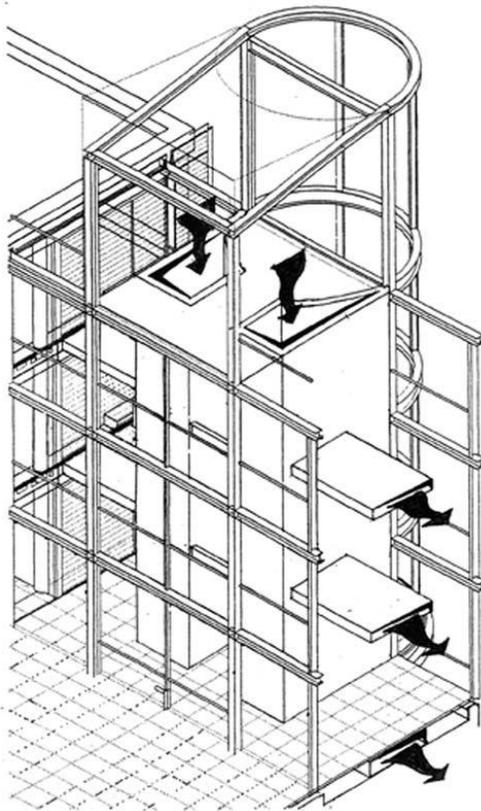
The Jubilee Campus project presents a fantastic opportunity to create a rich new environment for studying and teaching, working and leisure. Nottingham University has already established a reputation for architectural quality and environmental responsibility: the buildings we have designed for them will perform to the highest standards of energy efficiency while creating a striking new presence within the University campus and the city as a whole.



Hopkins and Partners). The firm reclaimed industrial land in a project in which architecture and landscaping, sun and wind, and an ingenious environmental strategy work together to produce pleasant conditions for study and socializing.

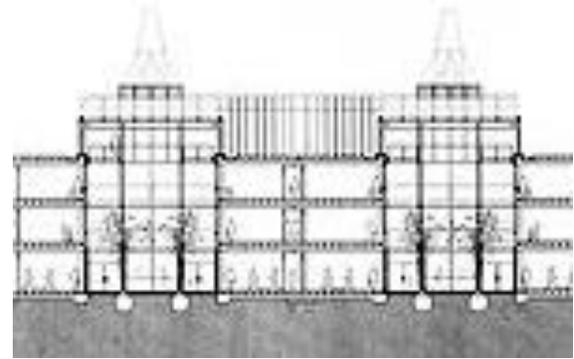
The Jubilee Campus is a milestone in green architecture. It pioneers an innovative strategy, a combination of mechanical and wind-driven ventilation, as well as bringing together a wide range of other green strategies. Despite starting with an industrial "brownfield" site, the buildings are now embedded in verdant nature.

More than that, the landscaping, the architecture, and its environmental systems are intimately fused into a single formal and functional whole. The landscaping is an intrinsic part of the architectural environmental systems: it filters and cools the air approaching the buildings and even extends onto the roofs to improve insulation and prevent the build-up of reflected heat. It also purifies the water running off roofs, roads, and parking areas.



## 10. Conclusion

One example in the Ten Shades of Green exhibition was the Jubilee Campus (1999) extension of the University of Nottingham, in the United Kingdom, designed by Hopkins Architects (formerly Michael



### Wind-Blown Cooling

The typical academic building consists of wings of rooms separated by atria that serve as thermal buffers between inside and out. The atria are naturally ventilated, drawing air in through their scoop-shaped lake fronts and exhausting it on either side of the stair towers.

With their plant rooms capped by rotating wind cowls, these are major elements in the wind-driven, mechanically-aided ventilation system of the academic rooms. The cedar cladding — from sustainably managed forests — was chosen as a replenishable material of low-embodied energy, and galvanized rather than stainless steel is used throughout because it is lower in embodied energy and less polluting to manufacture.

In the plant rooms over the stair towers and below the wind cowls, fans, a heat exchange wheel, and an evaporative cooler, and louvered dampers switch air through bypasses. They work in four primary modes according to season and time of day. In peak summer conditions, it is the exhaust air that is cooled before

passing through the heat exchange wheel. In this way, incoming air is cooled without humidification.

The academic rooms are naturally ventilated for much of the year and ventilated by the wind-driven mechanical ventilation system during hot and cold periods. To be driven by the wind, with assistance only from low-powered fans, the whole ventilation system is designed to entail minimal friction and pressure drop.

Intake air is admitted just below the exhaust cowl and blown down big ducts on either side of the stair shafts. From here it is guided into under-floor plenums from where it enters the rooms. It is then drawn out over sound absorptive material above the corridors, so as not to compromise aural privacy, before descending into the corridor.

The air is sucked back along the corridor to the stair shaft and up and out by the wind blowing past the cowl. On hot still days when there is insufficient wind to drive the system, photovoltaic cells shading the atria roof provide the electricity — indirectly, since it is fed into the national grid — to drive extract fans.

Wooden louvers exclude direct sun, while their white upper surfaces reflect light deep into the rooms. Nighttime lighting is by high-efficiency fixtures that provide up and down lighting from the same light source.

All the above has been achieved with buildings that cost only \$105 per square foot. This proves that even architecture that exemplifies all ten shades of green need cost no more than conventional buildings, yet will bring huge cost savings in the long term.



# Jubilee Campus & University of Nottingham Innovation Park (UNIP)



## Proposed Vehicle Strategy

### Proposed Pedestrianisation of Central Academic Areas

The proposed pedestrianisation of the central section of Cut Through Lane and Portland Hill will significantly improve pedestrian safety as well as enhancing the peaceful landscaped environment that characterises University Park Campus.

Vehicle access will not be permitted through this area except for service vehicles and buses.

The central area within Science and Engineering will also exclude vehicle access and parking (currently around the Chemistry and Tower buildings).

### Breaking the link between East Drive and Jubilee Avenue

The Trent Building will once again become a destination, rather than a through route. However, service access around the rear of the Trent building will be permitted.

As a consequence the traffic direction along Jubilee Avenue will be changed so that vehicles approach the Trent Building re-affirming its primacy.

### Maintaining Routes around the perimeter of the Campus

Consideration should be given to transforming Keighton Hill onto a 2 way route for vehicles. This will become the only link between the North and South Entrances.

Beeston Lane will remain as the only link between West and North Entrances. As the main route across the campus, consideration should be given to traffic calming measures.

### Car Parking

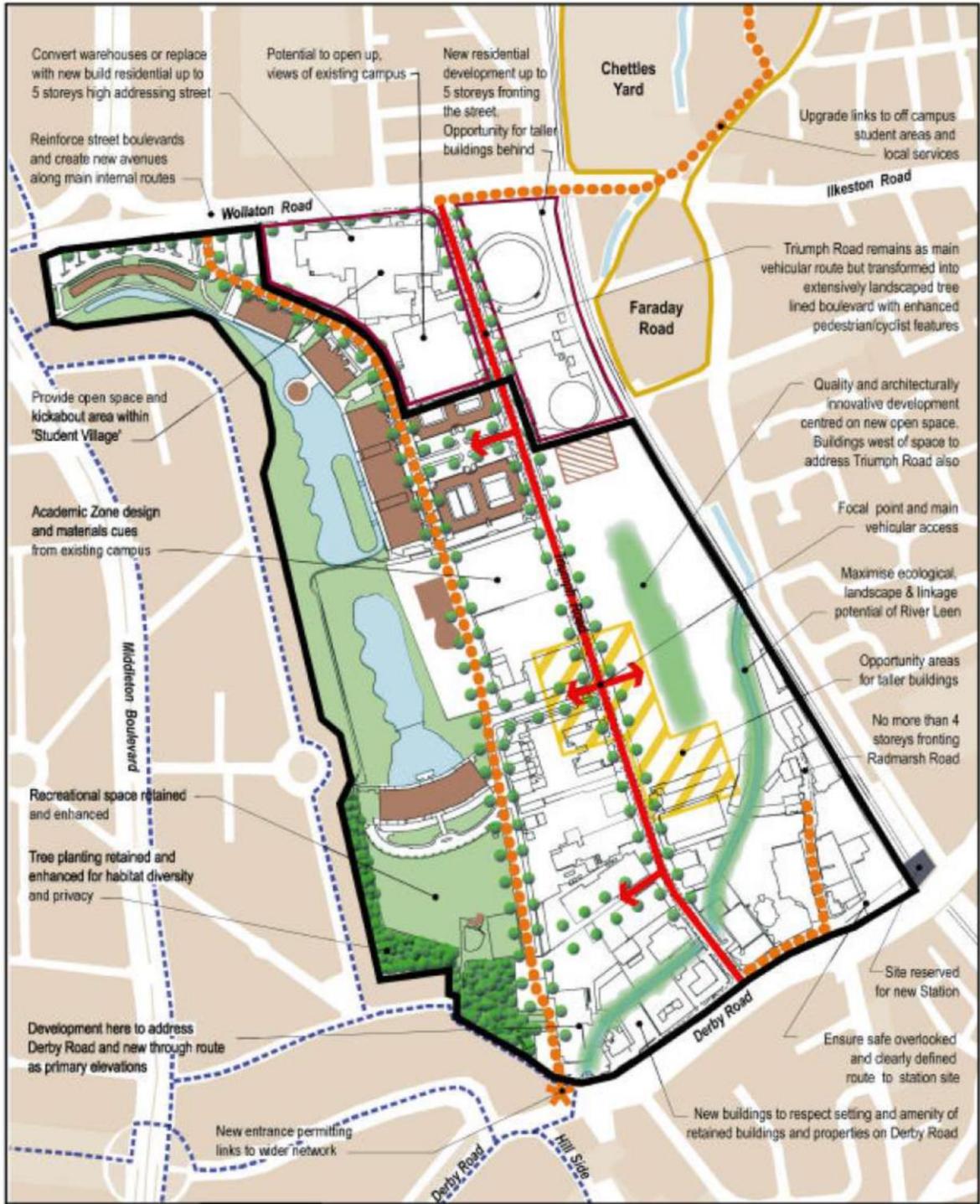
The proposed pedestrianisation of the central academic areas will result in some loss of spaces:

- Between the LSS building and Hallward Library
- Around the chemistry and Tower buildings
- The 2 way portion of Jubilee Avenue

These lost spaces will have to be found elsewhere on campus.

Access to the car park opposite the Hallward Library is now from Library road, which is a shared surface with pedestrian priority.





**PLAN 3 JUBILEE CAMPUS Design Principles**

Key	
	Pedestrian/Cyclist Network
	Main Vehicular Route
	Secondary route with Enhanced Pedestrian/Cyclist Facilities
	New/Enhanced Boulevard
	Existing /Proposed Student Areas
	Existing University Buildings
	Opportunity Areas for Taller Buildings
	Lakes
	Open Space
	River Leen

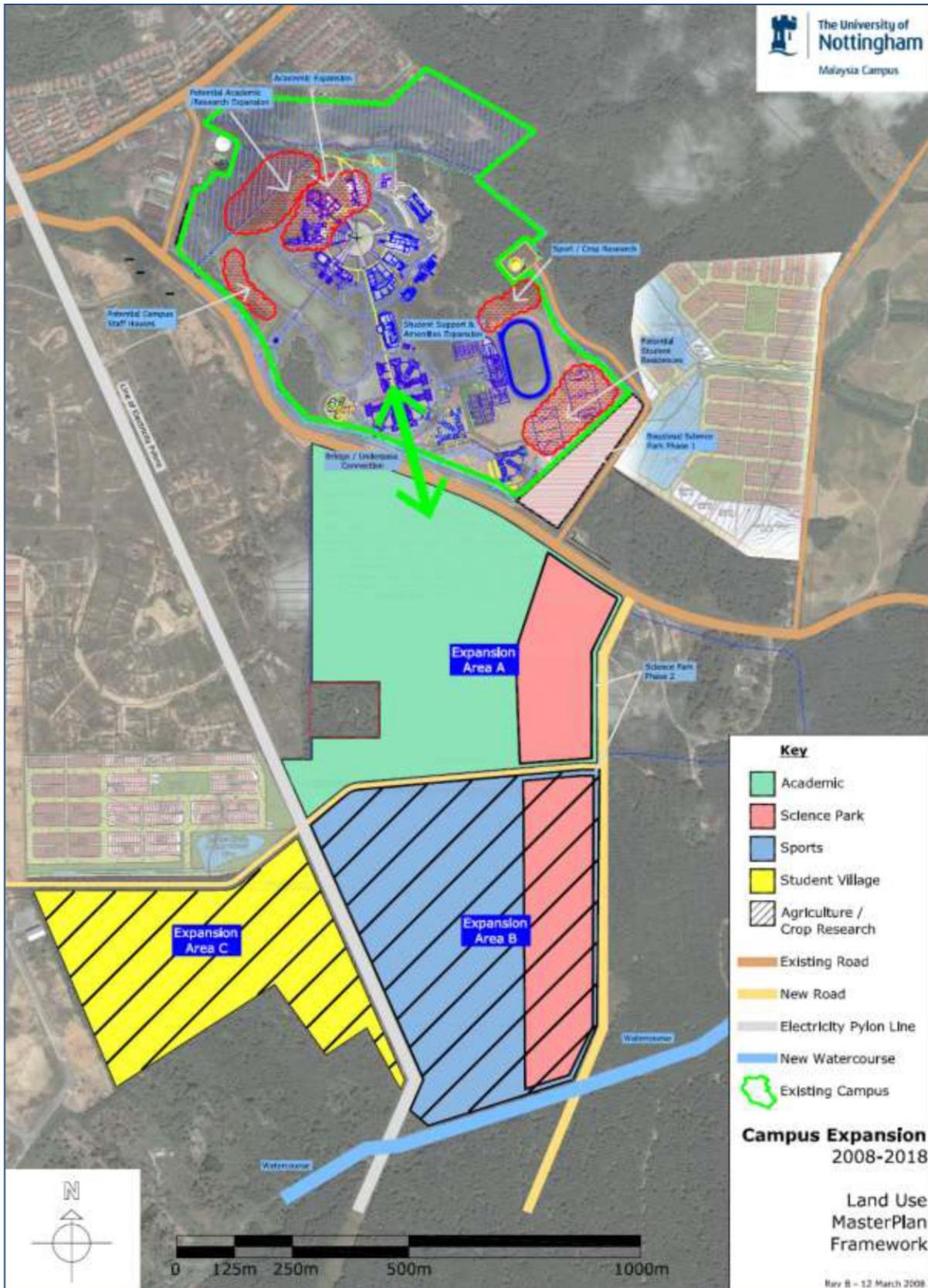
Map produced on 02/12/04

Map produced by PLM

Mapmaker

Not to Scale

\* This map is reproduced from Ordnance Survey material with the permission of Ordnance Survey on behalf of the Controller of the Map and a Crown Copyright. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. Nottingham City Council 10001017 2004.



**Key**

- Academic
- Science Park
- Sports
- Student Village
- Agriculture / Crop Research
- Existing Road
- New Road
- Electricity Pylon Line
- New Watercourse
- Existing Campus

**Campus Expansion**  
2008-2018

Land Use  
MasterPlan  
Framework

Rev B - 12 March 2008

References:

1. <http://www.architecture.com/UseAnArchitect/FindAnArchitect/Competitions/CaseStudiesNew/Education,HealthandCommunity/Education/JubileeCampus/JubileeCampus.aspx#.UpJEeMRpm2E>
2. [http://en.wikipedia.org/wiki/Campuses\\_of\\_the\\_University\\_of\\_Nottingham#Jubilee\\_Campus](http://en.wikipedia.org/wiki/Campuses_of_the_University_of_Nottingham#Jubilee_Campus)
3. Building review by Peter Wilson in Architect' Journal 2 October 2008
4. Press Release: Unveiled: design for Britain's tallest free-standing work of public art. 18 January 2008
5. Aspire sculpture microsite on University of Nottingham website
6. "Liverpool Ferry Terminal wins Carbuncle Cup 2009", Building Design magazine, 28 August 2009
7. <http://www.hopkins.co.uk/projects/2/90/>
8. <http://europaconcorsi.com/projects/17471-Jubilee-Campus-Expansion>
9. [http://www.architectureweek.com/2006/1018/environment\\_1-2.html](http://www.architectureweek.com/2006/1018/environment_1-2.html)
10. <http://walkingarchitecture.co.uk/eastmidlands/building.php?id=109>
11. [http://www.arup.com/Projects/Jubilee\\_Campus\\_University\\_of\\_Nottingham.aspx](http://www.arup.com/Projects/Jubilee_Campus_University_of_Nottingham.aspx)
12. <http://www.hopkins.co.uk/projects/2/90/>
13. <http://www.hopkins.co.uk/projects/8/183/>
14. <http://www.nottingham.ac.uk/estates/documents/estatesstrategy.pdf>
15. <http://www.nottingham.ac.uk/about/documents/carbonmanagementplan2011.pdf>
16. <http://www.nottingham.ac.uk/sustainability/documents/environmentalstrategy2010.pdf>
17. <http://www.architecture.com/UseAnArchitect/FindAnArchitect/Competitions/CaseStudiesNew/Education,HealthandCommunity/Education/JubileeCampus/JubileeCampus.aspx#.UpJEeMRpm2E>
18. <http://www.nottingham.ac.uk/sharedresources/documents/mapjubileecampus.pdf>