The University of Nottingham

UNITED KINGDOM · CHINA · MALAYSIA

POST OCCUPANCY EVALUATION REPORT

MATHEMATICAL SCIENCES BUILDING





QTC projects

JUNE 2013

FINAL

1. Introduction

QTC Projects were appointed to carry out the Post Occupancy Evaluation following the submission of a tender for services dated 23 November 2012 to the Development Director, University Estate Office.

2. Scope of the Review

Evaluation Technique

The evaluation was conducted at Project Review stage (1 – 2 years after handover) and has been undertaken in line with the criteria and guidance contained in the HEFCE/AUDE publication, 'Guide to Post Occupancy Evaluation'.

Analysis

Analysis broadly followed the University's brief for undertaking the evaluation and consisted of reviewing all written information received concerning the building together with information collated from the questionnaires and workshop. Particular areas reviewed were:

Purpose and scope of project (brief)
Some aspects of the building procurement process
Building user feedback
Cost management and control
Construction and project management
Functional and technical performance
Sustainability - Assessment against BREEAM criteria
- Review of energy efficiency measures incorporated into the design
- Reference to the University's Carbon Management Plan

Questionnaires

Questionnaires were developed to obtain information and feedback from four specific groups:

a) User (On-line survey)
- a representative sample of 72 users of the building being evaluated consisting of Academic/Admin/Research staff and PGR students

b) Consultant Design Team
- Architect
- Project Manager
- Quantity Surveyor
- Services Consultant
- Structural Engineer

c) Estate Office – Development

d) Main Contractor

A Sample of the User Questionnaires is shown in Appendix 1.

Interviews

Interviews were held with the following:

a) School of Mathematical Sciences
   - Andrea Blackbourn, School Manager

b) Estate Office
   - Tim Brooksbank, Development Director
   - James Hale, Project Officer
   - Barry Chadwick, Operations and Facilities Director

c) William Saunders Architects – Chris Houldsworth

d) Gleeds Project Manager – Maria Willis

e) Kier Construction – Richard Charman

f) B3 Building Services – Peter Daniels

Workshop

A one day workshop was held on 7 June 2013 (a list of attendees is shown in Appendix 2).

The format for the workshop was a presentation by QTC Projects acting as facilitator which included feedback from the user satisfaction questionnaires. The workshop helped to highlight the key issues that had been raised in the questionnaires and interviews which were then discussed and debated.

The information from the workshop provided important comment which has been incorporated into this report.

3. Building Data

Name	Mathematical Sciences Building
Size	4088m² (Gross Area)
No of Storeys	3 storeys
Occupants	School of Mathematical Sciences
Types of space	Offices (cellular and open plan) Research office space Meeting/seminar rooms Centrally Timetabled rooms Staff/PGR Common Rooms IT Resource room Informal study/social space 378 seat Auditorium
Construction Period	47 weeks
Start on site	1 June 2010
Contract Completion	25 April 2011
Practical Completion	10 August 2011

Net Construction Costs

At Start of Construction	£5,315,306
At Final Account stage	£5,710,562 (including additional works)
Funding	University

Consultant Team

Project Manager	Gleeds Management Services, Nottingham
Architects	William Saunders, Newark
Cost Managers/QS	Gleeds, Nottingham
Services Engineer	B3 Building Services, Altrincham
Structural Engineer	Curtins Consulting, Nottingham
Contractor	Kier Construction, Nottingham
Building Contract	JCT Design & Build 2005



4. Project Background and Description

The building concept was developed following the recognition that the School of Mathematical Sciences' existing split accommodation in the Maths & Physics and Pope Buildings would not deliver the type of space required for future needs.

The need for a more creative space for research, teaching, collaborative learning, social activity and administration was paramount. This was to be delivered through the creation of a dedicated and specifically designed building which co-located the School within a central location on the University Park campus.

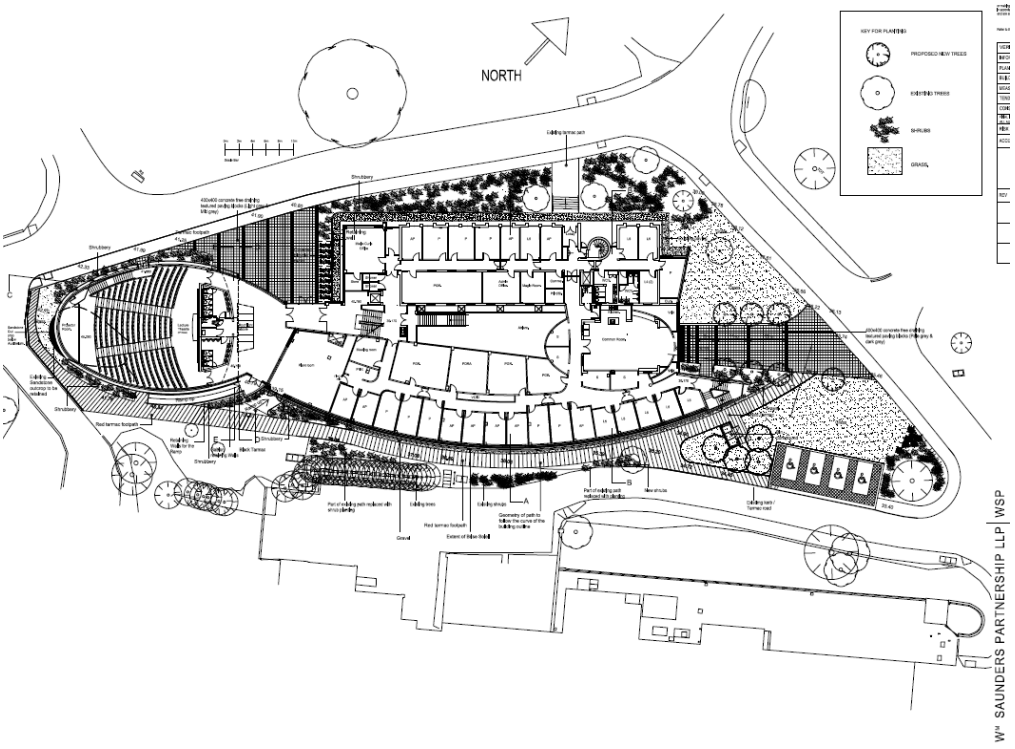
Thus the aim was to create a building which would provide:

- A strong presence for Mathematical Sciences on the University Park campus
- A welcoming environment for students at all levels
- An environment that contributes positively to the educational process by carefully integrating academics and students throughout the building

A design competition brief was issued by the University in March 2009. This identified the proposed site which included the existing Institute of Engineering, Surveying and Space Geodesy (IESSG) Building constructed in 1998. This building was to be vacated and the proposal was to extend this to provide a total internal floor area of 3,235m².

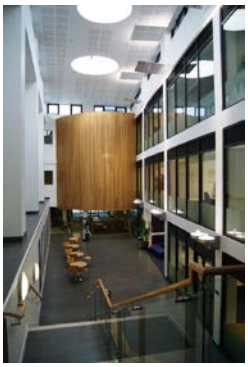
The brief also included the possible addition of a new large lecture theatre which eventually obtained funding approval and was included in the overall scheme. This increased the total internal floor area to 3,750m².

The site is very prominent on the campus, situated on a main arterial route and on one of the principle pedestrian thoroughfares. The building accommodation is arranged around a central tapering spine atrium which extends three storeys in height, the north side being formed by the existing building.

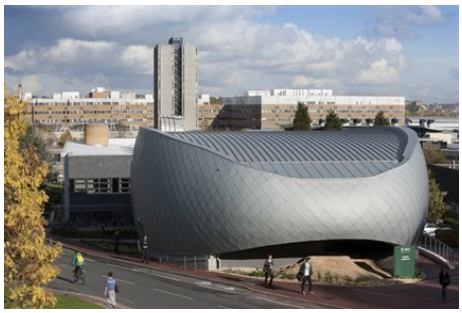


The north eastern extension to the existing building has been retained and remodelled to create the main entrance and an elliptical pod which accommodates

the common room at first floor level, post graduate space and break-out areas. The tapered end of the atrium provides vertical access to all levels including the lobby to the new elliptical shaped auditorium.



Offices are located on the two upper levels with the ground floor providing social space and study areas for postgraduate and undergraduate students, seminar room and administrative offices.

Externally, the building stands prominently on its sloping site when viewed from the north east. At the south west corner of the site, the main structure becomes less dominant replaced by the organic form of the auditorium which hovers over the sandstone outcrop which forms a geological feature at this end of the site.

The external materials chosen are intended to contrast with the face brickwork of the existing building. The vertical main entrance element is clad in white through-coloured render on a grey concrete block plinth. The curved walling materials on the south east elevation comprise blue/grey terracotta masonry and grey concrete block with brise soleil fitted to the glazed areas.

The auditorium organic form is clad in zinc with standing seam aluminium to the atrium roof incorporating large domed rooflights. Other flat roofs are single ply membrane.

Work commenced on site at the start of June 2010 but was delayed in the early stages due to discovery of unknown underground services and the location of the district heating main.

Despite this and additional works requested by the University, work was completed in time for the start of the new academic term. The building achieved a BREEAM 'excellent' rating (awaiting final confirmation), was awarded 'Construction Project of the Year' in the East Midlands Property Awards and was completed within budget.

A full list of project milestones is shown in Table 1.

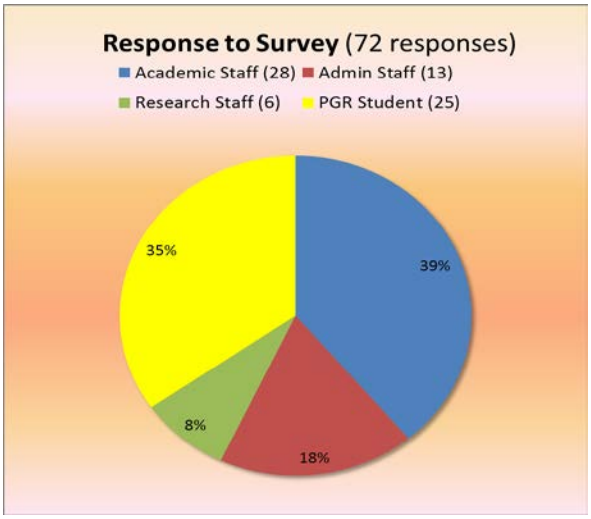
Table 1 Project Milestones

Project Execution Plan issued	February 2009
Original budget set	October 2009
Draft Stage D report	5 Oct 2009
Planning application submitted	19 Nov 2009
Planning approval	27 Nov 2009
Main contract tenders invited	4 Dec 2009
Tenders returned	25 Jan 2010
Tenders report	February 2010
Contract start on site	1 June 2010
Updated Project Execution Plan issued	21 July 2010
Contract completion date	25 April 2011
Partial possession	10 Aug 2011
Practical Completion certificate issued	7 Sep 2011
Completion of external works	14 Oct 2011
Final Account agreed	June 2012

5. User Satisfaction

Building user satisfaction has been assessed from the responses to the questionnaires received and analysis of the comments made. The results are shown in a series of bar charts covering the following areas:

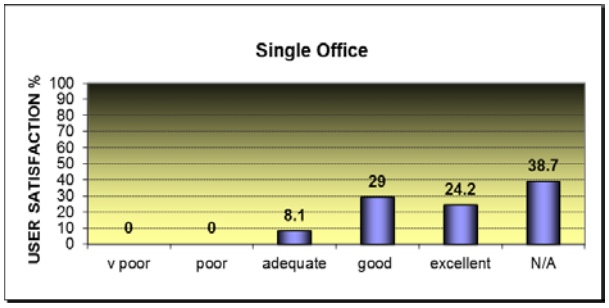
- Satisfaction with specific room types, ie shared and cellular offices, networking space, meeting rooms, central timetabled rooms, Archaeology Labs, storage and overall impression of the building
- Security
- Accessibility
- Cleanliness
- Internal room temperature
- Distraction from noise
- Lighting conditions, natural and artificial
- Data connectivity at the workspace
- AV equipment in teaching/lecture rooms

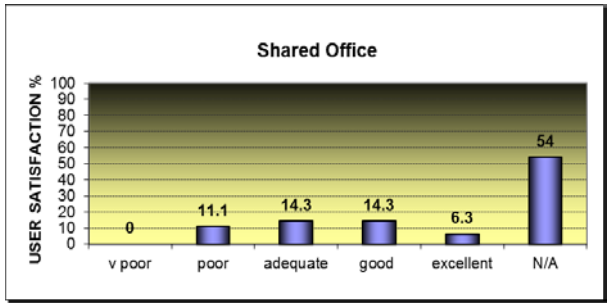


Overall, 72 responses were received from a representative group comprising academic/research/Admin and PGR students.

Users were asked to give a response on their overall impression of the building and this has shown a high level of satisfaction. 75% of respondents rated the building good to excellent.

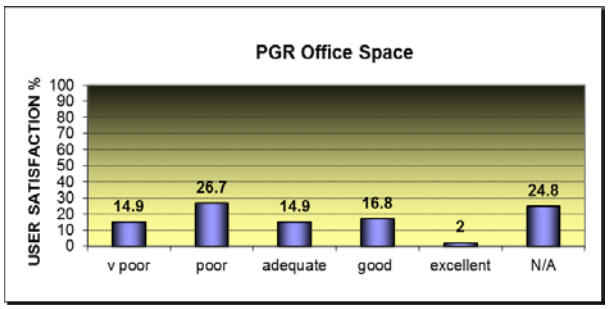
The single offices in the building comply with the University's space norms providing office sizes relative to the grade of post of the staff occupant. There are 62 single offices with all occupants responding to the survey. 87% rated them good to excellent.

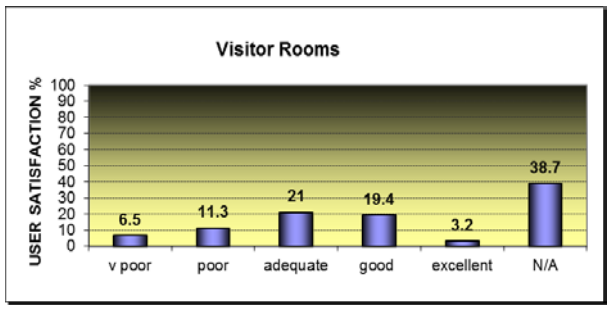




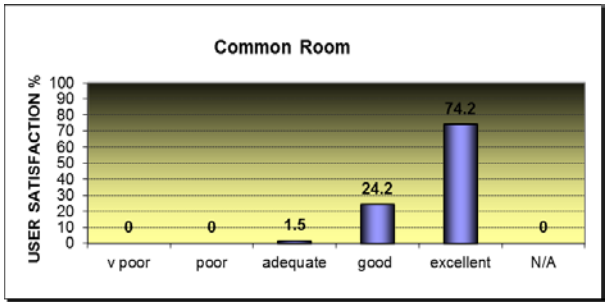
The shared offices had a range of responses with less satisfaction compared to the single offices. This is due mainly to the distraction caused by working in a shared space and the fact that the internal rooms suffer from poor air quality.

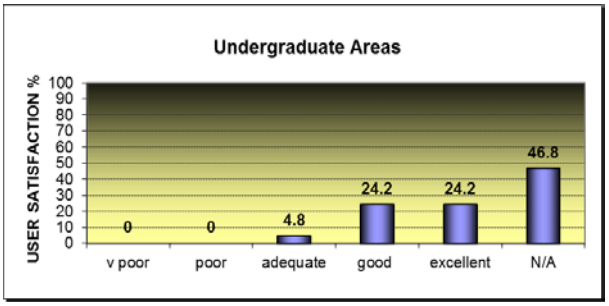
There were similar comments made concerning the PGR office space as some of these rooms are also internal. This accounts for the 21% of respondents rating the space as poor or very poor.





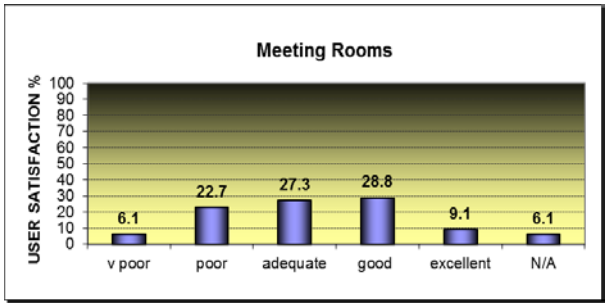
The office accommodation includes two rooms for visiting staff. The rooms, which are used by staff for periods of one or two weeks, are oddly shaped with minimal natural light. Generally responses are mostly in the range of adequate to good.

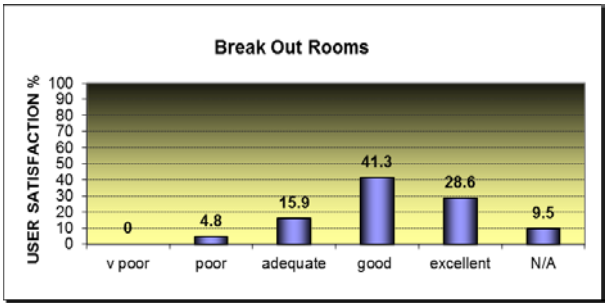




The Common Room is regarded as an excellent facility and provides a useful forum for staff interaction and collaboration. The inclusion of this room in the building is a direct result of user visits to other Mathematics buildings at other universities. Satisfaction levels are high with 98% of respondents regarding the space as good/excellent.

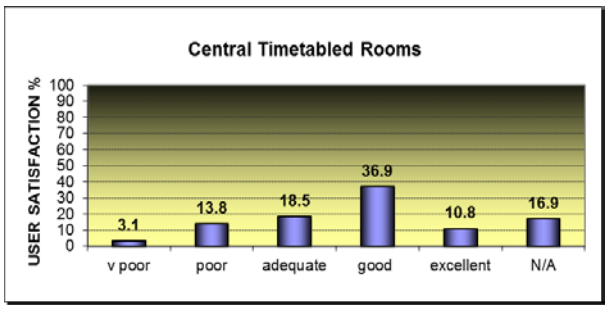
The undergraduate areas are also well liked with no negative responses.

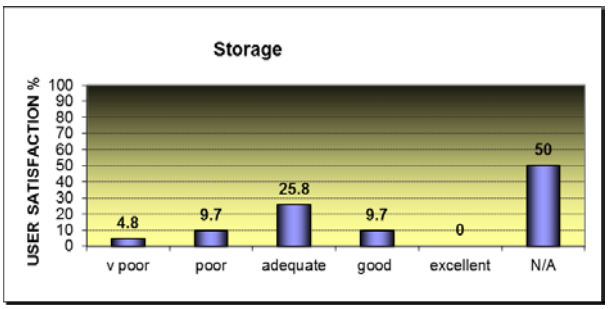




There are two meeting rooms in the building, one of which is in the existing building. Most responses are in the adequate to good range but may have been tempered by the fact that the seminar room is a central timetabled room rather than under the control and use by the School.

Break out rooms are regarded as a good facility despite them being internal rooms. They supplement the meeting rooms and feedback is that they are well used.

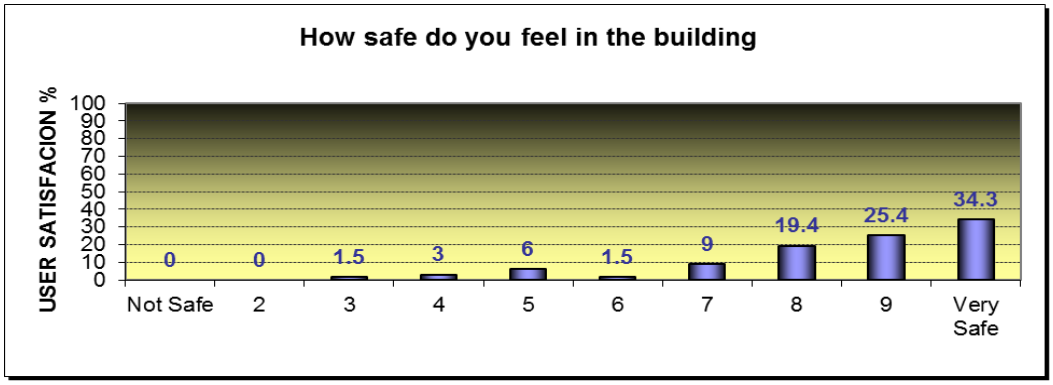


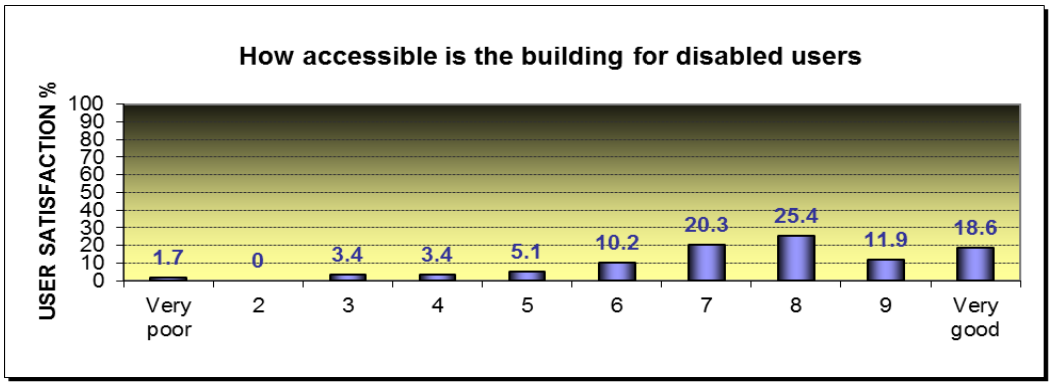


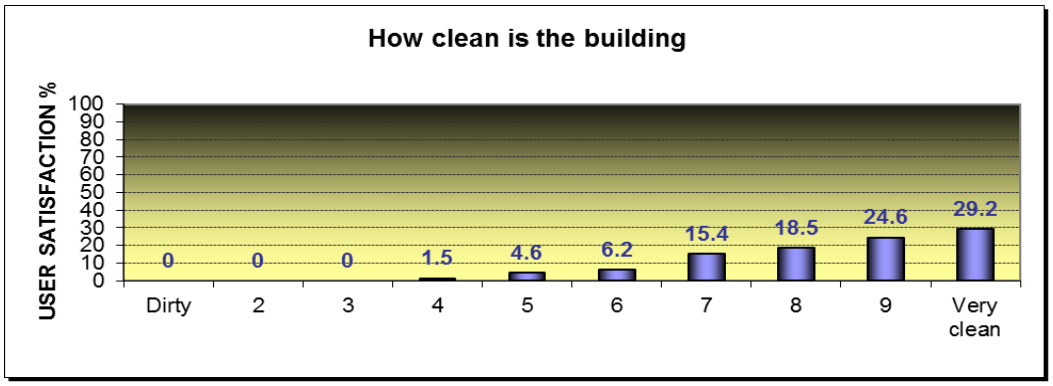
57% of users rate the seminar room A17 as good to excellent. Some comments have been made about the proportion of the room and the seating layout.

Relating to the question on storage, for those who require it as part of their job, the responses indicate that there is insufficient storage.

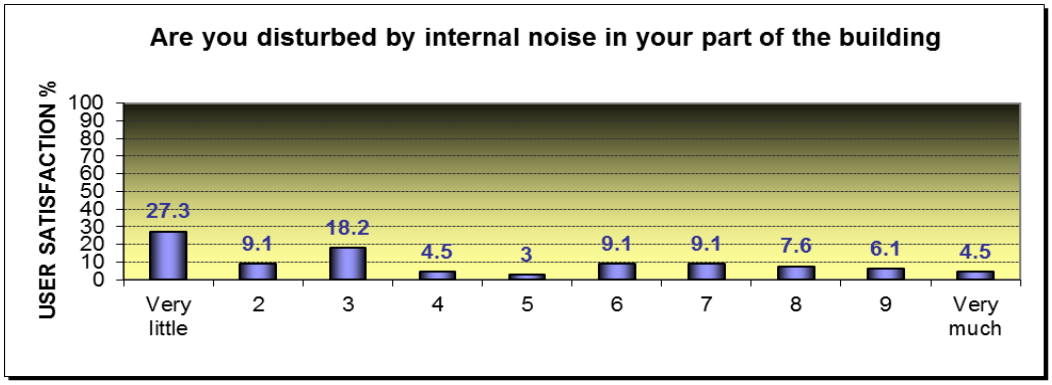
Looking at the charts for building amenity and comfort, most users felt safe in the building and it was considered fairly accessible. The only negative point raised concerning accessibility was the gradient/camber to the pavement approach to the main entrance. Cleanliness was considered good overall.



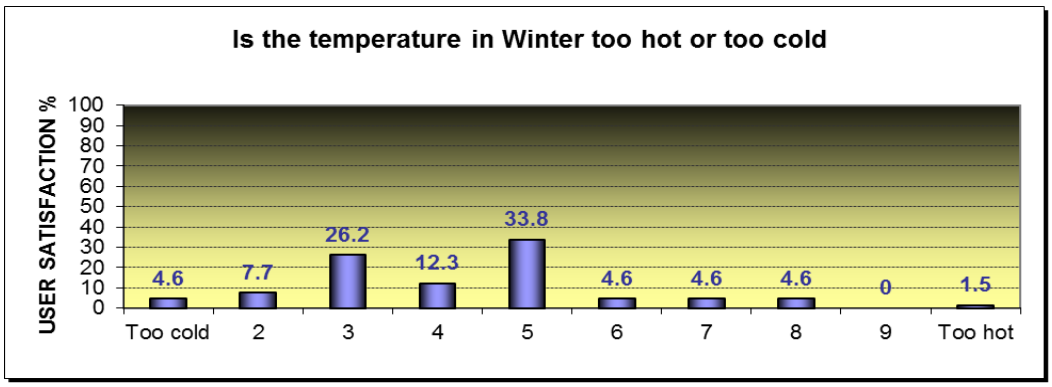


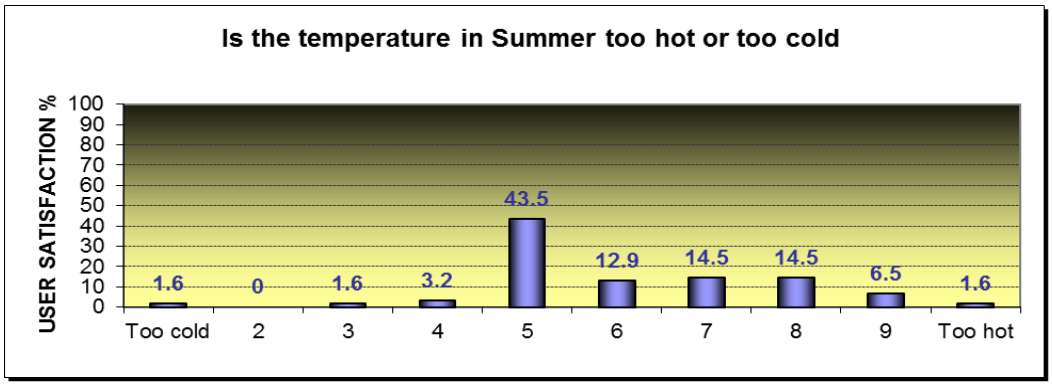


The response to the disturbance from noise question presented scores across the full range. Again scores were probably marked down due to working in open plan offices and some external noise emanating from adjacent roads and buildings.

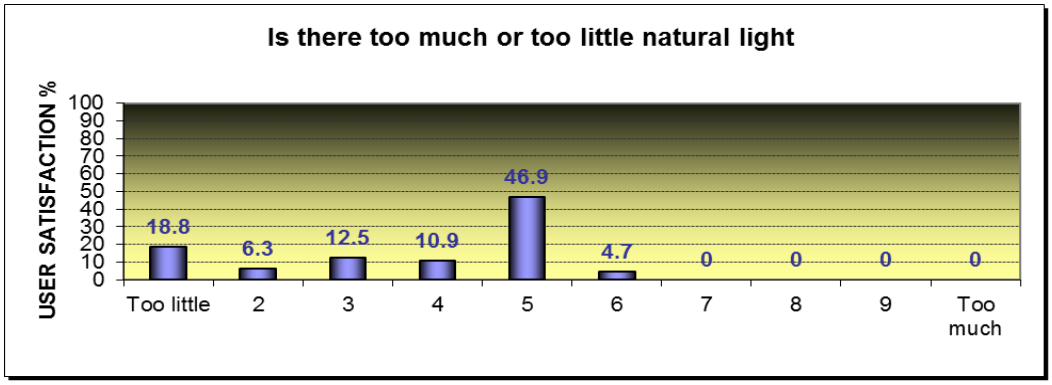


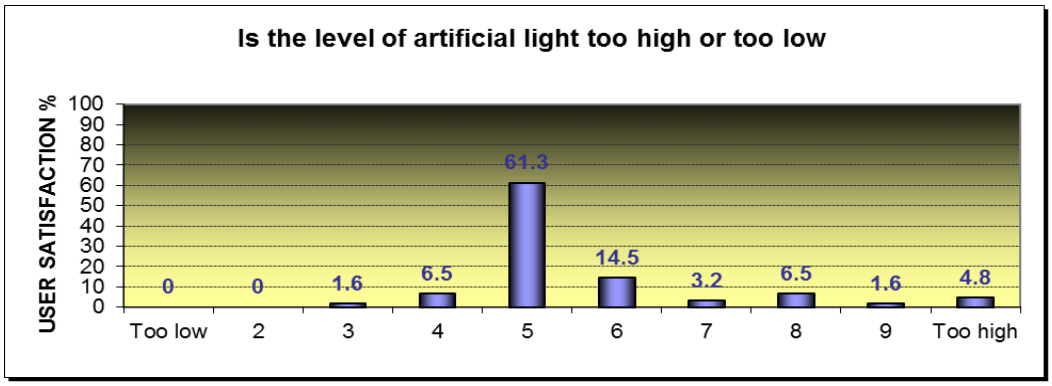
Regarding temperatures in the building, the charts show that for winter, 50% of users felt on the cold side perhaps due to ventilation flows. Comfort levels in summer show a similar response, again with negative comments coming from occupants of the internal offices.



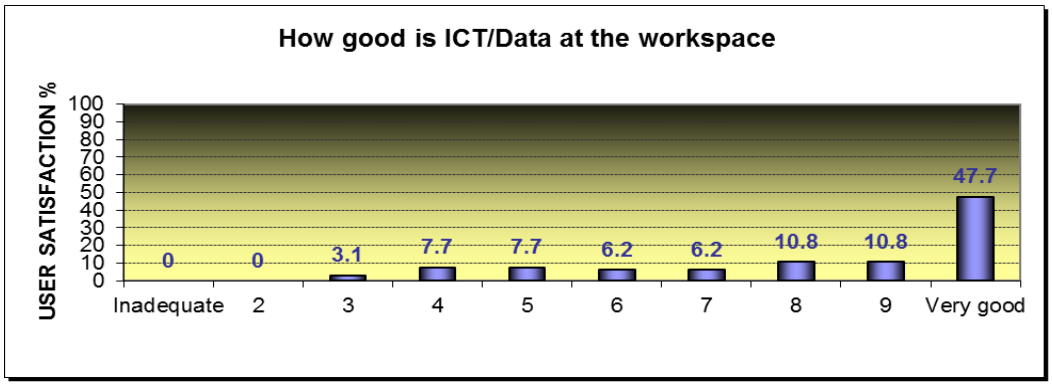


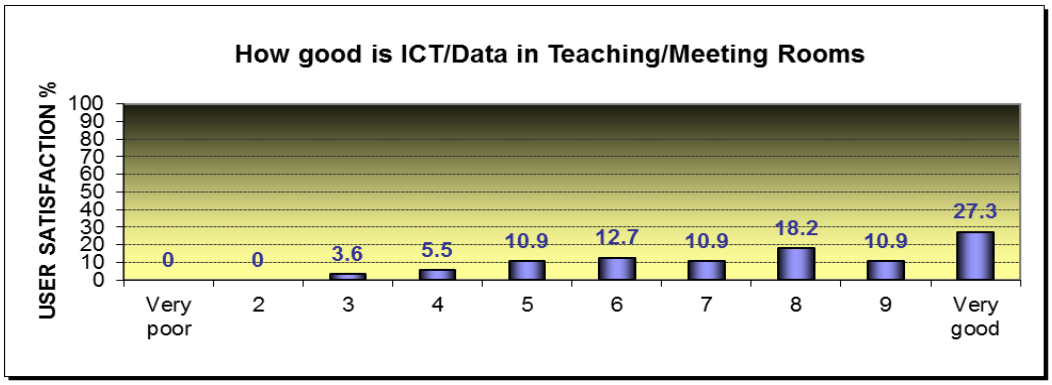
The chart for natural light shows some dissatisfaction with 48% of respondents considering there is not enough light. Again the comments are probably from occupants of the internal rooms which have borrowed light from the central atrium. Regarding natural light the responses are better with 61% of respondents rating this as about right.





The scores on how good the ICT is at the workplace were more or less across the full range although 82% presented a positive score. A similar response was given to the rating of ICT in the seminar room.





Resulting from the questionnaire responses, interviews and various discussions, a number of issues have been highlighted and were presented at the POE workshop for further discussion/debate. The issues have been grouped under the following headings and considered in more detail in this report.

- User Issues
- Design Issues
- Construction Issues
- Facilities and Operations
- Project Management
- Procurement and Cost Management
- Sustainability

6. User Issues

A number of user issues were raised during the interviews and from the questionnaire returns which were discussed at the workshop. These are listed below and commentary given.

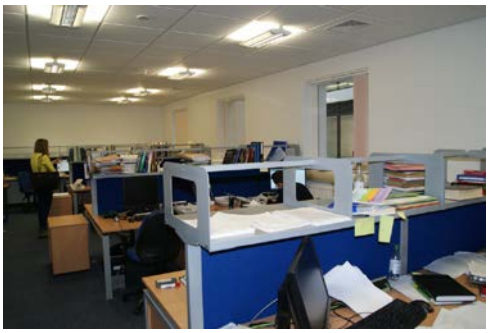
User Involvement at Design Stage

In discussion with the users regarding their involvement in the design development, they felt that they were included and being listened to. The users took a positive and proactive approach which considerably helped the process. Another initiative was to involve users in visits to new Mathematics Buildings at Manchester and Warwick Universities.

This approach worked well and enabled the users to see good design solutions in other comparable buildings. It should be adopted for future capital projects where identified users are available together with reasonable building comparators.

Internal Office Space

A major extension to the existing building on a very tight site inevitably meant that some perimeter offices in the existing building would lose some natural light. Although this has been replaced by borrowed light from the central atrium, this is not considered ideal. The occupants' comfort conditions are also affected by the ventilation system which provides the air quality needed to these internal spaces. Comments have been made regarding the effectiveness of the ventilation system and it is recommended that this is checked and adjustments made if necessary.



Meeting/Break-Out Rooms

Comments at the workshop indicate that the break-out rooms are a good facility and well used. Some comments were made regarding the lack of natural light but windows to the pod which would have provided some borrowed light proved expensive to install and were therefore not considered cost effective.

Users would like more meeting rooms and more use of seminar room (A17) which is a central timetabled room. B35 which is currently used as a meeting room is in the existing building but has no natural light even though it has a window. It is accepted that a rooflight should have been incorporated into the design of the adjacent void which would have given this room some borrowed light.

Overall, space for meetings, social interaction, informal study and staff collaboration are considered adequate and the seminar room can be booked if a larger space is needed.

Temperature

User comments relate to the heating in the building which some feel switches off too early. Internal rooms are regarded as being too warm and again some checks and adjustments where necessary to both heating and ventilation should be carried out

Paving Approach to main Entrance

Due to the sloping nature of the site, the paved approach to the main entrance is on a camber which causes problems for wheelchair users and in winter frost and ice can create slippery conditions made worse by the sloping pavement.

This was discussed at the workshop with the general view that due to the close proximity of the road and the cross-falls, the construction of a low retaining wall was not feasible.

Teaching Rooms

There is one central timetabled room within the main building (A17). This is well used as can be seen from the audit that was carried out in October 2012 (Table 2). A utilisation rate of just under 42% is a respectable figure and above the current median for the HE sector as a whole.


Seminar Room A17


Keighton Auditorium

The adjacent Keighton Auditorium, a centrally timetabled space, is an excellent facility with good levels of utilisation. It is well used not just for teaching but also for University wide events and open days.

Table 2 Central Timetabled Rooms			

Room	Usage	Occupancy	Utilisation
A1 KEIGHTON	86.11%	66.94%	57.64%
A17	77.78%	55.57%	41.67%
Overall	**81.94%**	**60.25%**	**49.65%**

Recommendations

i) Involvement of users during the design development stage in visiting other similar buildings is a good initiative and should be adopted on future capital projects where appropriate and where identified users are available together with reasonable building comparators

ii) Inspect the heating and ventilation to the internal rooms in the IESSG Building and make adjustments if necessary

iii) Consider increasing the time the heating is switched on in the building so that it stays on for longer periods

iv) Excessive cambers to pavements at main entrance approaches should be avoided where possible in order to assist wheelchair users

7. Design Issues

A number of comments relating to design were raised during the interviews and from the questionnaire returns which were discussed at the workshop. These are listed as follows and commentary given:

Design Brief

The University issued a design brief at the competition stage. This was adequately detailed and provided sufficient information on which to prepare preliminary designs. Engagement with the users by the Design Team was very proactive with the Head of School taking a leading role.

The contractor has commented that it would be useful to engage more with the users but the University policy has been to adopt the client role with the contractor and liaise with users separately. This is understandable bearing in mind the risk of introducing client changes at the construction stage. Nevertheless, a one-off workshop to enable the contractor to gain a better understanding of what the user's key drivers for the project are might be useful.

Planning Stage

It was noted at the workshop that there were no issues with obtaining the necessary planning approvals. The site is fairly embedded within the campus and there were no particular constraints from a planning point of view.

Site Survey Information

Obtaining accurate site survey information proved to be a problem and caused delays to the programme when unknown underground services were discovered.

Apparently the radar survey did not pick up some services and drainage runs as they were directly above and in line with lower services. It is therefore of paramount importance that the University's site services drawings are kept fully up to date as far as possible.

Retention of Existing Rear Projection

As part of the design development, the decision was made to retain the rear projection to the existing building and remodel this to form the pod which is now a feature of the atrium. Although this decision enabled additional BREEAM credits to be gained, the Architects felt that the removal of this portion of the building may have allowed "easier articulation of the design concept" and may have saved time and money.

It is understood that one of the reasons why the extension was retained was because it was funded from grants/bequests and therefore was a sensitive issue.

Smoke smells entering Ventilation System

It has been reported that smokers who stand outside the entrance to the Auditorium are fairly close to the ventilation intake and plant room doors. This is causing smoke smells to enter the building via the ventilation system which some users find unpleasant.

Management of smokers external to the building is an operational issue and therefore not part of this review. However, it might be useful to bear this in mind on future projects and locate air intakes well away from potential smoker locations.

Common Room

Entrance to auditorium adjacent to vent grilles

Common Room

The provision of a staff common room in the building is a facility welcomed by staff and enables the School to achieve its aim of promoting staff collaboration and interaction at all levels. This is a very positive aspect of the building's design and fitness for purpose.

Automatic Windows

The automatic windows that open to provide the night purge facility sometimes open erratically during the day and are noisy in operation. Checks should be made to ensure windows are operating correctly and consideration given to noise issues on future projects.

Recommendations

i) Consider holding a one-off workshop for the contractor to gain a better understanding of what the key drivers for the users are in delivering the project

ii) Ensure the University's site services drawings are kept up to date as far as possible

iii) On future projects the Design Team should be mindful of the location of potential smokers and locate the intake ventilation grilles appropriately

iv) Check the automatic opening windows to ensure they are operating correctly and give consideration to noise issues on future projects

8. Construction Issues

Programme

The construction period for this project was 47 weeks. In hindsight, the contractor considers this was fairly ambitious and 50-51 weeks would have been more realistic. It was a challenging site which required good management of site logistics. The contractor handled this well.

The discovery of underground services and their location once construction had commenced caused considerable delay to the programme. This, together with a period of adverse weather conditions, resulted in a total delay of 14 weeks for which an extension of time was granted. Progress was also hindered due to the steel and roofing subcontractors going into liquidation.

Estimates of dates for final completion need to be accurately reported by the contractor. Reporting dates that were ultimately not achieved did not help the client occupation and fit-out. For instance, furniture that had been ordered had to be delivered prior to completion which resulted in damage to some items.

Commissioning/Post Completion

It was considered that the commissioning stage could have been managed better. Due to the earlier delays on site, the commissioning period was very tight. The commissioning of mechanical and electrical services required more time, there were issues with the metering and links to the Building Management System and it took a long while for systems to be properly balanced.

Discussions at the workshop regarding the length of the commissioning period concluded that around six weeks should be allocated with the possibility of appointing an external commissioning engineer on more complex projects.

Design Complexity/Detailing

The design of the auditorium was complex due to the organic form of the superstructure. The contractor felt that this element of the project was not adequately detailed and that Building Information Modelling (BIM) might have helped in addition to the Autocad 3D used by the Architects.

There were elements of detailing that could have been better designed. For instance, the location of rainwater pipes and hoppers detract from the overall design of the flat roofed links to the auditorium structure.

Outstanding Defects

There are no outstanding defects recorded.

Health and Safety

There was an incident involving a student gaining access to the site out of normal hours and falling from a roof. The contractor generally conducted site operations in a satisfactory manner although concern was raised regarding the site boundary security and contractors should be reminded that they are working within a live educational environment.

Recommendations

i) During tender negotiations ensure that the programme put forward by the contractor is realistic and challenged if necessary

ii) Ensure dates for completion are accurately reported by the contractor and discussions held with the contractor's senior management when additional resources are needed

iii) Provide sufficient time in the programme for commissioning and consider appointing an external commissioning engineer on complex projects

iv) Consider using BIM techniques to improve design co-ordination and aid detailing on complex structures

v) Improve detailing on Design and Build contracts where possible through improved monitoring

vi) Contractors should be reminded that they are working in a live educational environment

9. Facilities and Operations

Involvement of Maintenance Team

The co-ordination of the involvement of the Maintenance Team has improved over the last few capital projects and better methods of communication are being reviewed with the Development Team.

Ways of improving the handover procedure are also being considered particularly the length of time required for commissioning. It is also important that the Maintenance Team are informed as early as possible when specification items have been changed or removed. It would also be useful to know what maintenance contracts, if any, have been included in the main contract.

Building Materials/Services Specification

There were no major issues concerning the specification of building materials and mechanical and electrical services. The Building Services Consultants had commented that as part of the cost saving process, the specification of a number of M & E items had changed for which the Consultants had not had the opportunity to advise the client.

The use of single ply membrane roof coverings was discussed at the workshop with the general view that although this type is widely used, standing seam and 3-ply flat roof systems are considered preferable as they are less susceptible to damage and leaks particularly where there is regular foot traffic on the roof.

Fault Reporting

There is still a lack of clarity regarding the users approach to reporting faults/defects following occupation. This needs to be clearly set out for the user particularly in the first few weeks after handover.

The procedure whereby users report all faults/defects to the Estate Office Helpdesk is the preferred approach as it enables data to be logged on the frequency and type of faults for future reference. The contractor had a presence on site for a month after handover to deal with issues as they arose. Although direct contact between the contractor and building user is inevitable, issues should still be reported to the Helpdesk.

Cleaning

There were no issues with cleaning, with the users feeding back positive comments on the service provided.

Security

There were no security issues raised.

Recommendations

i) Continue to improve the communication with the Maintenance Team and the review of handover procedures

ii) Notify the Maintenance Team as early as possible on changes to building and engineering specifications and what service contracts are in place

iii) Consider amending the Standard Design Guide regarding the use of single ply membranes for flat roofs

iv) Set out a clear procedure for fault reporting through the Helpdesk and encourage the building user to adopt this approach

10. Project Management

As with all University capital projects, this project was overseen and monitored by the Project Management Group (PMG) which had representation on the Group from the building user client. In this particular case it was the Head of the School of Mathematical Sciences who played an active role in developing the project at a strategic level.

The Consultant Project Manager produced a detailed Project Execution Plan at the early design stage which was updated at the start of construction. The Plan sets out clearly the scope and broad objectives for the project, communication protocol and change control procedures.

Client changes on the project were not excessive and these generally enhanced the overall project. The main (high value) changes were:

- Work to landscaping and piazza
- Change to class B concrete finish
- LED light and power to seating in auditorium
- Timber cladding to pod in atrium
- Suspended ceilings

Comments have been made regarding the change control procedure and the issue of instructions which took too long. The Estate Office would certainly like to receive costs of variations much sooner for consideration. However there is a balance between obtaining the information in a timely manner and ensuring accuracy of cost information from the contractor and his subcontractors.

It may help speed up the process if a change is agreed based on an estimated cost which would then be followed up by a fixed cost. There is an element of risk with this but it may enable the change control system to become more effective.

Risk management was a key part of the project monitoring process. This was handled well with a risk register being produced at an early stage and monitored by the PMG.

Recommendations

i) Review written change control procedures to enable decisions on changes and costs to be made in a timely manner

11. Procurement and Cost Management

Procurement

The appointment of the Project Manager and Quantity Surveyor took place very early on in the project which helped the process of defining the brief and gaining an understanding of the objectives and scope of the project.

The Architects acted as lead design consultant, being appointed following the outcome of a design competition. This has proved to be a worthwhile and beneficial process as it enables the client to consider a range of design initiatives and different approaches to interpretation of the brief.

The Architects and Structural Engineers were novated to the contractor at stage D+ with the Building Services Engineers being retained on the client side to provide a monitoring role and quality control service. It is considered that stage D+ or stage E is the most appropriate point in the design process at which to novate as more design certainty has been achieved by this stage.

The main contractor appointment followed standard OJEU and University procedures. Following a pre-qualification exercise, five contractors were invited to tender for the proposed works. The appointment of the preferred contractor took place following a detailed assessment of tenders, the process and recommendations being set out in a detailed tender report approved by PMG.

The form of contract used was the JCT Design and Build contract 2005 (revised 2009). This form of contract works well particularly since the contract clauses remain unamended and thus requiring less negotiation. In this form it is considered to provide good value in balancing cost and quality.

Cost Management

Table 3 shows the development and control of costs during the construction phase leading up to the final account. A sample of cost reports taken from those issued between June 2010 and March 2012 track the anticipated final construction cost against the agreed contract sum.

Table 3 Cost Management

No	Date	Construction Budget	Construction Forecast	Total Budget	Total Forecast	Variance
1	June 10	5,315,306	5,352,696	7,000,000	7,119,988	119,988
2	July 10		5,361,826		7,131,854	131,854
4	Sep 10		5,372,431		7,060,023	60,023
6	Nov 10		5,419,688		7,115,313	115,313
7	Dec 10		5,504,512		7,224,098	224,098
9	Feb 11		5,464,310		7,177,062	177,062
11	May 11		5,557,429		7,383,855	383,855
13	July 11		5,661,134		7,463,851	463,851
14	Aug 11		5,726,429		7,540,178	540,178
16	Oct 11		5,720,498		7,535,007	535,007
17	Nov 11		5,718,498	8,110,153	7,530,444	530,444
18	March 12		5,711,744		7,522,541	522,541
	June 12	Final Account	5,710,562			

The final account was agreed and issued 10 months after completion and reflects the client changes relating to the additional works (Plaza and related external works), VAT increase and ducting costs and cost of extension of time on the contract. If the ducting costs and VAT increase, which were genuine unforeseen items, are excluded then the out turn cost comes within the 5% allowable tolerance.

A value engineering exercise took place during the development of the project which helped to ensure costs were refined and that 'buildability' continued to be cost effective. This was a useful exercise which also assessed how tender market advantage could be achieved by using certain suppliers.

Costs were managed well on this project. Regular cost plans and cost checks were prepared prior to construction and once this commenced, regular cost reports were produced. The PMG was kept regularly informed through the cost reports and was able to monitor expenditure effectively.

12. Sustainability

The design brief for this project stipulated a BREEAM target of 'Excellent' which conforms to the requirement of the University's Carbon Management Plan. Although this has been achieved, the final certificate confirming this is still outstanding and needs to be actioned by the assessors as a matter of urgency.

It is a requirement of the Nottingham City Council Planning Guidelines that 10% of all energy used (interpreted through CO_2 emissions) in new developments over 1000m² be obtained from low carbon emission or renewable energy sources. The design intent was that following an appraisal of possible options this would be achieved through the provision of a ground source heat pump system which would be used for the heating and cooling of the atrium.

The utilisation of the University's District Heating supply also has the following advantages:

- Reduced plant room area
- No flues or emissions
- No natural gas brought on to site
- No emission noise from boiler
- No visible services for the heat generating plant

Energy Consumption figures have been obtained from the University's Estate Office for the period 22 May 2012 to 20 May 2013. It should be noted that the meters for the building have not been recording data since the building opened due to faults with the meters. Recordings for the District Heating and the GSHP only commenced in January and March 2013 respectively.

Only the summary total for electricity including comparative CO_2 emissions are therefore shown below and the emissions figure compared with the EPC rate:

	kWh/annum	$kgCO_2/m^2/annum$
Electricity	385,962	39.84
EPC		22.95

This shows that there is a wide discrepancy between the two figures which to a certain extent can be explained by the EPC figure excluding small power electricity consumption. Lack of data prevents comparisons relating to the District Heating and GSHP.

Table 4 Energy Predictions Compared to Actual Performance

	PREDICTED		ACTUAL	
	kWh/annum	kgCO2/annum	kWh/annum	kgCO2/annum
GSHP		(25,880)	Data incomplete	
District Heating	766,785	148,756	Data incomplete	
Electricity	255,595	107,861	385,962	162,875
Total		**230,737**		

It is accepted that the predicted figures are based on benchmark data for similar buildings and exclude small electrical power but there needs to be more accurate assessment made at the various stages of the project through to post occupancy evaluation stage by the Building Services consultants working in liaison with the University's Energy Manager.

The University commissioned Consultants, Anderson Green, to review the reporting methodologies between the predicted energy consumption and CO_2 emissions for new build capital projects and their report was published in April 2012.

The recommendation of the report was that for each capital project a Building Energy and Environmental Model (BEEM) should be produced with energy data compiled at design and construction stages and at post occupancy.

This will enable information to be produced on which a suitable predicted energy consumption target can be compared with real metered information at post occupancy stage.

Regarding recording of energy consumption currently, it is disappointing that it has taken a considerable amount of time to resolve the problem with the meters and that data has only started to be recorded on the Elcomponent MeterRing system. Closer monitoring is perhaps needed and actions taken as soon as problems are identified.

A number of energy efficiency and sustainability initiatives have been incorporated into the building, namely:

- Ground Source Heat Pump
- District Heating supply
- Passive design
- Underfloor heating to atrium
- Sensor controlled lighting
- LED lighting to Auditorium

Recommendations

i) Final certificate confirming the BREEAM 'Excellent' rating should be obtained as a matter of urgency

ii) Implement the recommendations of the Anderson Green Report to enable a suitable predicted energy consumption target to be compiled which can be compared to real metered information at post occupancy stage

iii) Closer monitoring is needed of the metering system so that actions can be taken in rectifying any data recording problems at an earlier stage

13. Summary of Recommendations

	Action
User Issues	
i) Involvement of users during the design development stage in visiting other similar buildings is a good initiative and should be adopted on future capital projects where appropriate and identified users are available together with reasonable building comparators	Capital Projects
ii) Inspect the heating and ventilation to the internal rooms in the IESSG Building and make adjustments if necessary	Operations & Facilities
iii) Consider increasing the time the heating is switched on in the building so that it stays on for longer periods	Operations & Facilities
iv) Excessive cambers to pavements at main entrance approaches should be avoided where possible in order to assist wheelchair users	Capital Projects

Design Issues	**Action**
i) Consider holding a one-off workshop for the contractor to gain a better understanding of what the key drivers for the users are in delivering the project	Capital Projects
ii) Ensure the University's site services drawings are kept up to date as far as possible	Operations & Facilities
iii) On future projects the Design Team should be mindful of the location of potential smokers and locate the intake ventilation grilles appropriately	Capital Projects
iv) Check the automatic opening windows to ensure they are operating correctly and give consideration to noise issues on future projects	Operations & Facilities
Construction Issues	
i) During tender negotiations ensure that the programme put forward by the contractor is realistic and challenged if necessary	Capital Projects
ii) Ensure dates for completion are accurately reported by the contractor and discussions held with the contractor's senior management when additional resources are needed	Capital Projects
iii) Provide sufficient time in the programme for commissioning and consider appointing an external commissioning engineer on complex projects	Capital Projects
iv) Consider using BIM techniques to improve design co-ordination and aid detailing on complex structures	Capital Projects
v) Improve detailing on Design and Build contracts where possible through improved monitoring	Capital Projects
vi) Contractors should be reminded that they are working in a live educational environment	Capital Projects
Facilities and Operations	
i) Continue to improve the communication with the Maintenance Team and the review of handover procedures	Capital Projects Operations & Facilities
ii) Notify the Maintenance Team as early as possible on changes to building and engineering specifications and what service contracts are in place	Capital Projects
iii) Consider amending the Standard Design Guide regarding the use of single ply membranes for flat roofs	Capital Projects Operations & Facilities
iv) Set out a clear procedure for fault reporting through the Helpdesk and encourage the building user to adopt this approach	Operations & Facilities

Project Management	**Action**
i) Review written change control procedures to enable decisions on changes and costs to be made in a timely manner	Capital Projects
Sustainability	
i) Final certificate confirming the BREEAM 'Excellent' rating should be obtained as a matter of urgency	Capital projects
ii) Implement the recommendations of the Anderson Green Report to enable a suitable predicted energy consumption target to be compiled which can be compared to real metered information at post occupancy stage	Sustainability Team
iii) Closer monitoring is needed of the metering system so that actions can be taken in rectifying any data recording problems at an earlier stage	Sustainability Team

APPENDIX 1

Sample Questionnaire

POST OCCUPANCY EVALUATION

BUILDING USER SATISFACTION QUESTIONNAIRE (On-line survey method used)

BUILDING: MATHEMATICAL SCIENCES BUILDING

Occupation (Please tick most relevant or state in 'other')
Academic staff
Admin staff
Research staff
PGR student

An evaluation of your building is being conducted to assess how well it performs for those who occupy it. This information will be used to assess areas that might need improvement and provide feedback that can be used for the benefit of similar future buildings.

Please complete the following questions relating to the above project by ticking the appropriate boxes and adding comments where requested.

1 – Satisfaction with types of space in building

Please rate the overall quality of the following areas:
(Please tick)

A: Single Office	1 V Poor	2	3	4	5 Excellent	N/A
B: Shared Office	1 V Poor	2	3	4	5 Excellent	N/A
C: PGR Office space	1 V Poor	2	3	4	5 Excellent	N/A
D: Break Out rooms	1 V Poor	2	3	4	5 Excellent	N/A
E: Meeting Rooms	1 V Poor	2	3	4	5 Excellent	N/A
F: Central Timetabled rooms	1 V Poor	2	3	4	5 Excellent	N/A
G: Common Room	1 V Poor	2	3	4	5 Excellent	N/A
H: Undergraduate areas	1 V Poor	2	3	4	5 Excellent	N/A
I: Visitor rooms	1 V Poor	2	3	4	5 Excellent	N/A
J: Storage	1 V Poor	2	3	4	5 Excellent	N/A
K: Overall Impression	1 V Poor	2	3	4	5 Excellent	N/A

2 - Security

2.1 How safe do you feel in the building? (*Please tick)*

Unsafe									Very safe
1	2	3	4	5	6	7	8	9	10

3 - Accessibility

3.1 How accessible is the building?

Not Accessible Very accessible

1	2	3	4	5	6	7	8	9	10

4 - Cleanliness

4.1 How clean is the building?

Dirty Clean

1	2	3	4	5	6	7	8	9	10

5 - Temperature

5.1 Is the temperature in winter too cold or too hot?

Too cold Too hot

1	2	3	4	5	6	7	8	9	10

5.2 Is the temperature in summer too cold or too hot?

Too cold Too hot

1	2	3	4	5	6	7	8	9	10

6 - Noise

6.1 Do you suffer distraction caused by noise in your part of the building?

Very significant Not significant

1	2	3	4	5	6	7	8	9	10

7 - Light

7.1 Is there too much or too little natural light?

Too little Too much

1	2	3	4	5	6	7	8	9	10

7.2 Is the level of artificial light too high or too low?

Too low Too high

1	2	3	4	5	6	7	8	9	10

8 - ICT/Data

8.1 How well is voice and data connectivity provided at the workspace?

Inadequate Well provided

1	2	3	4	5	6	7	8	9	10

8.2 Is the AV equipment in the teaching/lecture rooms effective?

Does not work well Works well

1	2	3	4	5	6	7	8	9	10

10 - Comments

If you have any additional comments that you would like to make about any aspect of the building and your working environment please note them here. If relevant to a particular question please give the question number.

Thank you for completing the questionnaire.
Completed forms should be returned to Tony@qtcprojects.co.uk

Appendix 2

MATHEMATICAL SCIENCES BUILDING

Post Occupancy Evaluation Workshop

Held on Friday 7 June 2013

List of Attendees

User Representatives

Andrea Blackbourn	School Manager

Estate Office

Mark Bonsall	Senior Engineer
Tim Brooksbank	Development Director
Steve Gilbert	Senior Building Surveyor
James Hale	Project Officer
Lisa Haynes	Space Resource Manager

Design Team

Chris Houldsworth	William Saunders – Architects
Maria Willis	Gleeds – Project Manager
Jeff Peters	Curtins – Structural Engineers

Contractor

Richard Charman	Kier Construction

Apologies

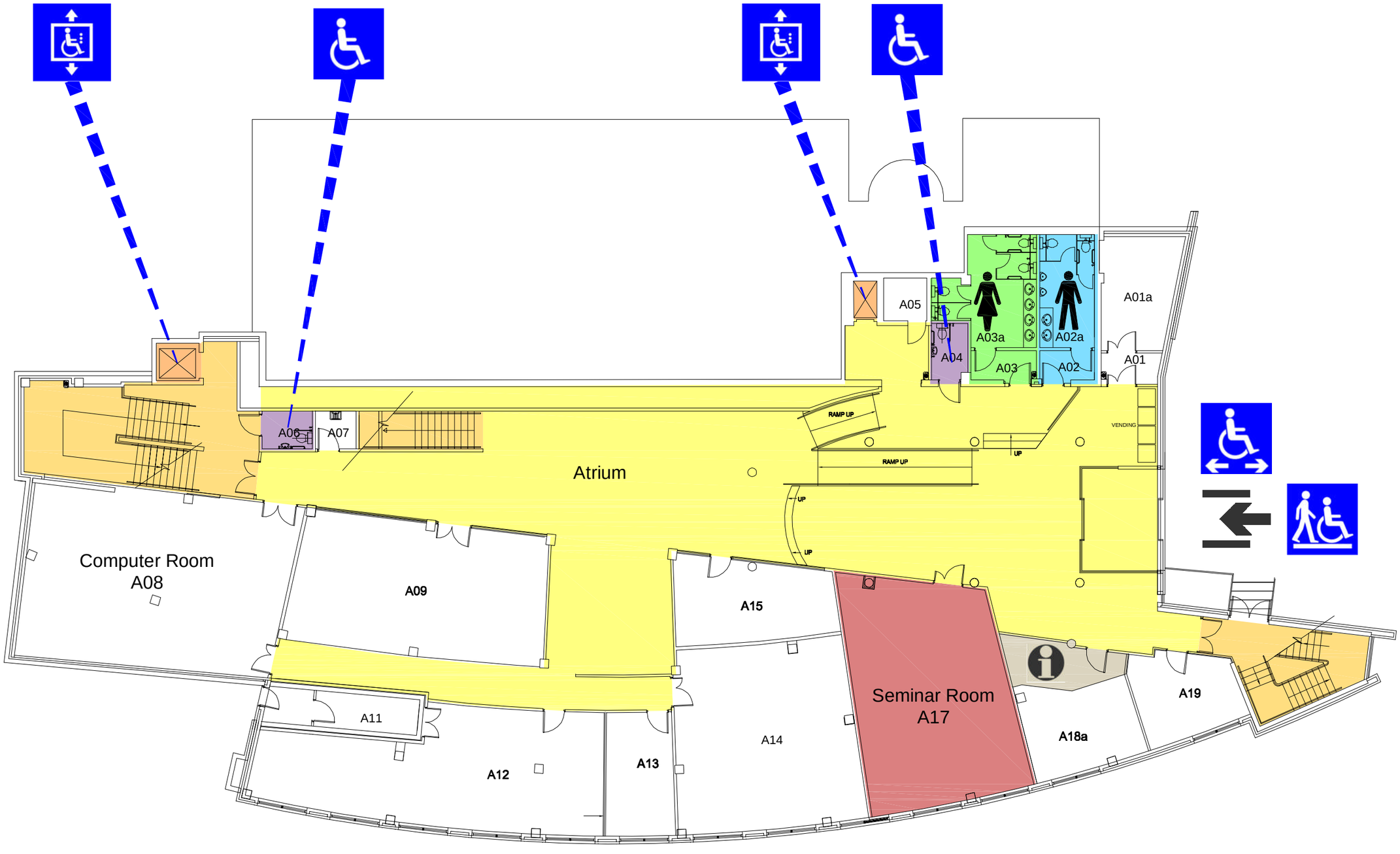
Peter Daniels	B3 – Building Services Engineers

APPENDIX 3

Floor Plans

Mathematical Sciences - A Floor Plan

The University of Nottingham



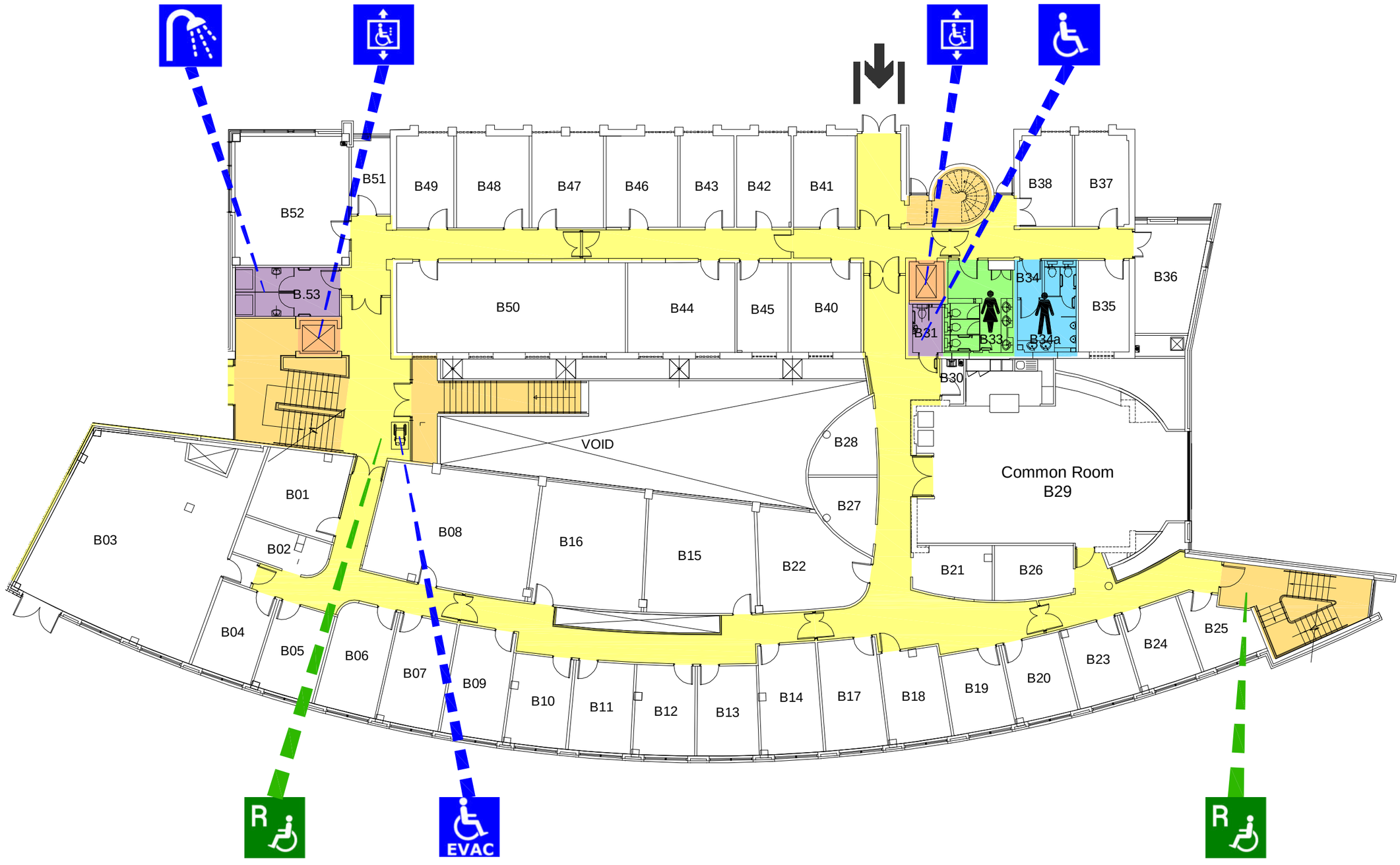
Key

- Designated Badge-Holder Parking
- Access Ramp
- Automatic Doors
- Accessible Lift
- Entrance
- Accessible Entrance
- Evacuation Chair
- Emergency Refuge
- Toilet (Female / Male)
- Accessible Toilet
- Shower
- Accessible Shower
- Stairs
- Lift
- Central Timetabled Room
- Circulation
- Reception
- Refectory/Cafe
- Fire Assembly Point

September 2011
Estate Office
www.nottingham.ac.uk/estate/

Mathematical Sciences - B Floor Plan

The University of Nottingham



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- Shower
- Accessible Shower
- Stairs
- Lift
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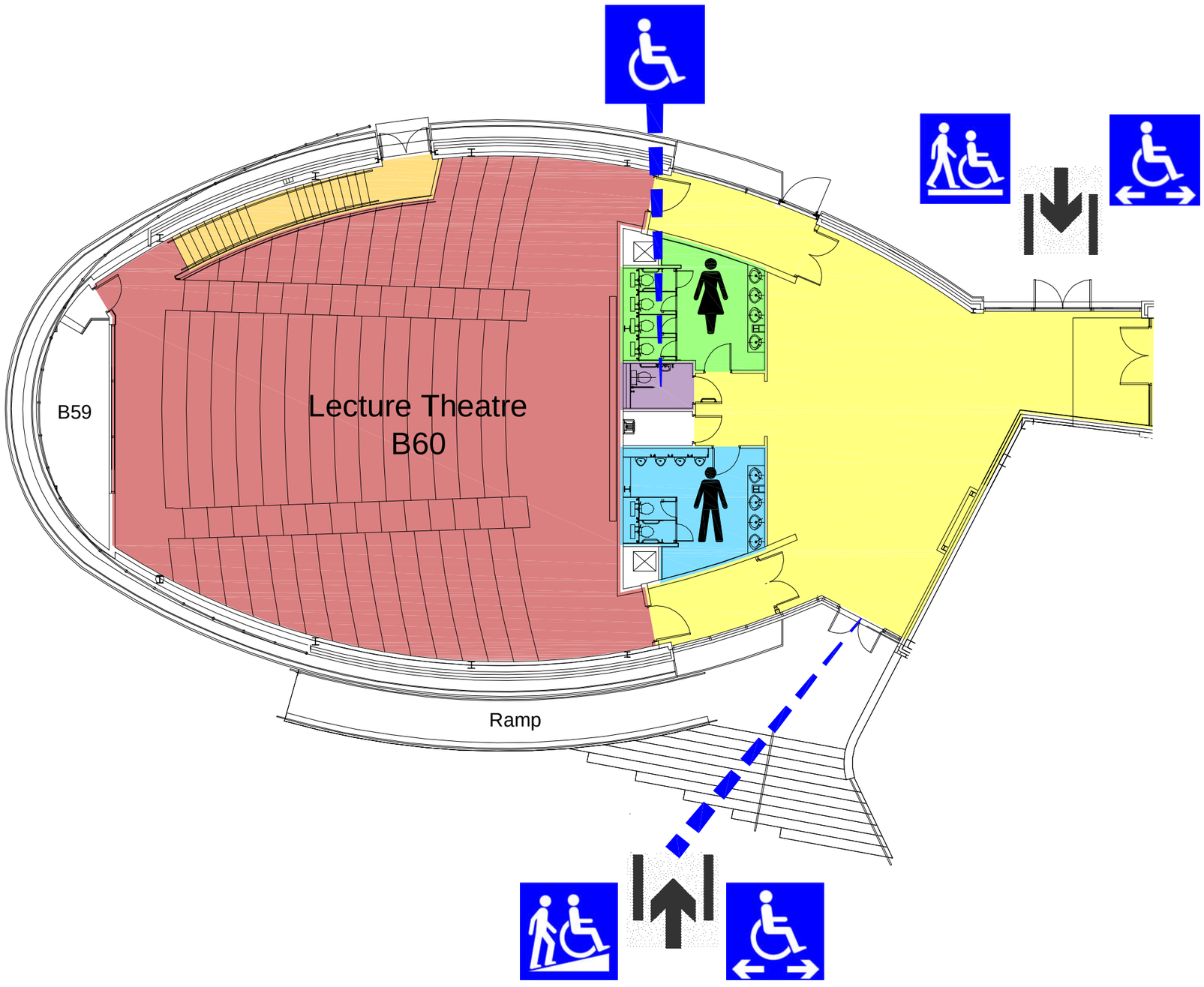
- Circulation
- Reception
- Refectory/Cafe
- Fire Assembly Point

September 2011
Estate Office
www.nottingham.ac.uk/estate/

Keighton Auditorium

The University of Nottingham



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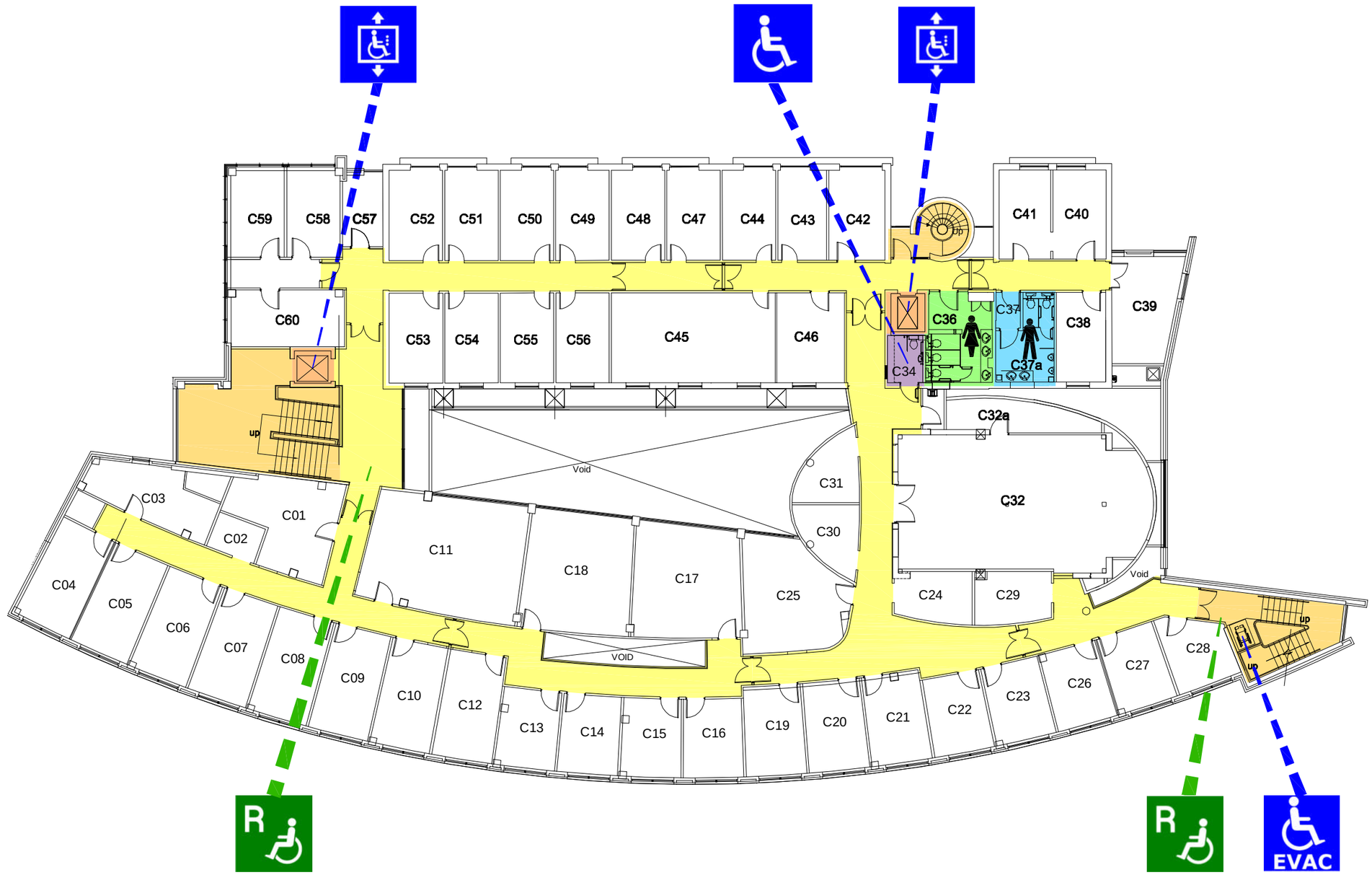
- Shower
- Accessible Shower
- Stairs
- Lift
- Central Timetabled Room
- Circulation
- Reception
- Refectory/Cafe
- Fire Assembly Point

September 2011
Estate Office
www.nottingham.ac.uk/estate/

Mathematical Sciences - C Floor Plan

The University of Nottingham



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