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Post-Occupation Evaluation Study Report

Project: Nanoscale and Microscale Research Centre, Cripps South Building, University Park

Date: October 2017

BUILDING UNDERSTANDING

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INTRODUCTION

In January 2017, Building Understanding submitted a proposal, to the University of Nottingham Estates Department, to conduct post-occupation evaluations. The proposal was accepted. The Nanoscale and Microscale Research Centre project is the second project to be evaluated by Building Understanding.

This report aims to detail the strengths and the weaknesses of the Nanoscale and Microscale Research Centre project, put forward recommendations and highlight best practise and excellence that can be applied to future projects at the University of Nottingham.

OBJECTIVES AND METHODOLOGY

OBJECTIVES OF THIS POST-OCCUPATION EVALUATION

- To bring to light any key issues associated with the building procurement process and management of the development project
- To draw out stakeholder feedback concerning the design of the building and the experience of its end users
- To facilitate a half-day workshop, to discuss and debate the key issues revealed through the primary research
- To analyse all output from the face-to-face depth interviews, online questionnaires and the workshop to provide a summary report with recommendations

SCOPE OF THE STUDY

Building Understanding sought feedback on the following aspects of the Nanoscale and Microscale Research Centre project:

- Overall user satisfaction
- Design issues
- Satisfaction with specific room types
- Construction issues
- Security
- Accessibility
- Air quality
- Cleanliness
- Internal room temperature
- Distraction from noise
- Lighting conditions: natural and artificial
- Data connectivity at the workspace
- Mechanical and electrical services
- Sustainability
- Operations and facilities issues

STUDY PARTICIPANTS AND METHODOLOGIES

Building Understanding conducted face-to-face interviews and telephone interviews. Five different questionnaires were prepared in order to canvas feedback from respondents drawn from the following categories:

- Consultant team
- Contractors and specialist suppliers
- End-users of the facility
- Estates office staff
- Internal client

The workshop

On Monday, 2nd October 2017, a workshop took place involving 12 attendees. The workshop objectives were to:

- Discuss and debate the SWOT analysis gleaned from the primary research
- Generate recommendations to be applied to future projects commissioned by the University of Nottingham
- Highlight nuggets of best practise and excellence revealed in the project that can be adopted and applied elsewhere

The workshop commenced with a presentation, by Building Understanding, of the SWOT analysis. Weaknesses and threats were then debated. Attendees were divided into breakout groups, with each group charged with assigning recommendations to specific points of feedback.

SAMPLE SIZES

It is important to emphasise that the quantitative statistics in this report are based on very small samples. A total of 16 respondents were approached for feedback and all of these individuals responded.

PROJECT DATA

Name of facility:	**Nanoscale & Microscale Research Centre**
Location:	University Park Campus
Gross area:	GF 788m2, F1 372m2
Number of storeys:	Two
Users of the facility:	This is a cross-disciplinary facility at University of Nottingham
Room types:	Labs, offices and clean room
Start on site:	8th June 2015
Date completed:	24th November 2015
Period on site:	16 weeks
Gross project cost:	£1,342,879.11 excluding Vat (Clean Room £291,000)
Funding:	University of Nottingham
Contract type:	Traditional

PROJECT BACKGROUND

THE NATURE AND FUNCTION OF THE NANOSCALE AND MICROSCALE RESEARCH CENTRE

The Nanoscale and Microscale Research Centre (NMRC) is located on the University Park campus of the University of Nottingham. It is a cross-disciplinary facility dedicated to supporting and promoting world-leading nanoscience and materials characterisation.

In addition to acting as a learning and research hub for nano, micro and materials science at the University of Nottingham, the Centre provides facilities and expertise for research across the engineering, physical and life sciences.

The Centre is a specialist resource for electron microscopy variants, with vast Transmission Electron Microscopy (TEM), Scanning Electron Microscopy (SEM), and electron microprobe infrastructure and dedicated technical support.

The NMRC was officially opened on the 20th April 2016 with the aim of enabling and advancing world-leading nanoscale and microscale research.

The electron beam lithography Clean Room is located within the Nano Centre. The Clean Room suite occupies around about 50 square metres, and is high specification in terms of cleanliness and temperature control because it houses the instrument room and the electron beam lithography tool.

This facility was designed principally for machines, rather than for people The NMRC houses ultra-sensitive equipment. This is a hypercontrolled environment which meant that the biggest obstacle for this project was the heating/cooling requirements.

The project involved the complete refurbishment of the interior of the building, with the exception of the Data Centre.

THE OBJECTIVE FOR THE PROJECT

The objective behind the creation of the NMRC was to bring together all the highly sensitive equipment for nano, micro and materials science, in an appropriate environment, under one roof.

The building housing the NMRC is perfectly located within the ‘chemistry and physics environment’ but is an appropriate distance from the tram, so that the equipment is not impacted by vibrations. The move of the equipment from its previous location has freed up space for other uses.

THE BIG PICTURE

A high level of satisfaction with the NMRC is reported by the stakeholders interviewed in this post-occupation evaluation. Across the sample of respondents, there is agreement that the resulting building represents a huge improvement, both to the building, and to the University's facilities available for nano and micro and materials science.

The building houses the University's Data Centre. Preventing any disruption to the Centre was a key challenge in this project and was critical because any disruption to the working of this centre would have had significant impact on IT systems both in the UK and Malaysia.

For the money spent and the timeframe within which the project was delivered, the outcome is good. Respondents also recognised that the building was not a particularly easy building to service.

"It is perfectly adequate and I am satisfied for the outcomes. You go around it and it feels pretty comfortable, it's light, it's airy and it seems a pretty flexible space in the Centre. I've got no real issues one way or another. It's a quirky building, it's still got oddities. If you'd have seen it before and what it came from; un-plastered offices, it's transformational in that sense."

Delivering a stable environment for the equipment

Maintaining a stable temperature, within a given tolerance, was the key concern. The original brief was for a temperature tolerance of +/-0.5 degrees but, in this end, for reasons of cost, this became +/- 3 or 4 degrees. In practice, the equipment works effectively at these temperatures and it was suggested, by one respondent, that some of the equipment suppliers may be over prescriptive in the temperature ranges that they specify.

Delivery against the programme

While the programme was not the most challenging facing a University of Nottingham project in recent times, the construction period was considered to be somewhat 'tight'. It was acknowledged that the main contractor did well in meeting the programme, albeit with a couple of legitimate extensions.

The design period presented more of a challenge. Originally, there was a very healthy design development period but when the budget figures came in it was effectively curtailed, and the project went out to tender within a matter of weeks, without the benefit of developing those savings with the department.

"I think delivering what was delivered in the time scale albeit a few weeks late, that was a success. Everybody pulled together to make sure that that was the case. It was no mean feat really, getting that turned around as quickly."

Value for money

Some respondents commented that the NMRC project delivered good value for money. A highly functional facility that meets the needs of the end users and which represents a huge improvement on what was there before, has been achieved at a relatively modest cost.

"It has been said by a number of people within Estates and within the design team, to take a building which was pretty tired and dilapidated and not spend a massive amount of money on it and actually produce what is over there now is quite a triumph."

The construction phase went well

Once work began on site, the project went smoothly. The design phase was the more challenging part of the project journey.

"The construction phase went well. The contractor did a good job. There was a lot of change they had to contend with and they got on with it."

Key features of NMRC

The key feature of the NMRC is that it is a hypercontrolled environment. The NMRC is a facility to accommodate highly sensitive equipment, which is important to the University. The emphasis here sits squarely on function. The needs of the people using the building are accommodated, but they are secondary. The building is not a public space and its style reflects that. There is no element of 'flashiness' about it.

Disabled access

The disabled access to the NMRC is considered appropriate for its present usage although it would not necessary meet requirements if it was a publicly accessible building or had undergraduate usage. There was no negative feedback pertaining to the level of access for disabled users.

KEY CHALLENGES FACING THE NRMC PROJECT

Minimising vibrations

In order to mitigate vibrations, which may affect the highly sensitive equipment, an anti-spring floor was installed. This was a key challenge for the design team and for the main contractor as it was not known how deeply the supporting piles would have to be laid, until a decision was received from Building Control. For the main contractor, this was the most challenging element of the project.

Keeping the Data Centre running throughout the project

Whilst the project involved complete refurbishment of the building, aside from the Data Centre, the proximity of this critically important facility created its own set of challenges. Any disruption to the Data Centre would be potentially catastrophic as it runs the 'network nexus' for the campus network. Managing this risk inevitably slowed the main contractor down.

To manage the Data Centre, during the entire programme, 24-hour access had to be maintained for University staff and therefore stringent safety precautions were required.

The project delivered an additional benefit, over and above the brief, in separating the electric supply to the Data Centre and the NMRC, thereby reducing risk.

"The supply to the IT room was spread across two or three main panels and we were able to segregate that so the building has effectively two uses. One is IT, one is the rest of the building. If a problem happens with one it doesn't affect the other now. It should have been that way from [the start]."

Controlling dust levels

The construction team was aware that, because of the proximity of the Data Centre, the dust levels, during construction, had to be carefully controlled. Extraction systems were used throughout in order to remove any dust that was generated.

Routing of services

The existing building, with its low ceilings, was not designed to be a heavily-serviced building and this impacted on how the services had to be routed.

Alterations to the brief, due to budget considerations

There was a gap between the needs of the scheme, outlined in the original brief, and what the budget could deliver. To date, however, the facility appears to be functioning effectively and the impact of the budget constraints has not been significant.

Maintaining a stable temperature, within a given tolerance, was essential. The original brief was for a temperature tolerance of +/-0.5 degrees but, in the end, this tolerance was increased to +/- 3 or 4 degrees. As it stands, the facility is functioning well but factors such as unusually hot weather and the addition of equipment that was not originally included in the plan for the space has brought temperatures very 'close to the mark' although, to date, no issues have been reported regarding the operation of the equipment.

QUANTITATIVE FEEDBACK

Quantitative satisfaction ratings were collected during the face-to-face and telephone interviews. Respondents were asked to rate their satisfaction with various aspects of the project on a scale of ‘zero’ to ‘ten’, where ‘one’ is very poor and ‘ten’ represents excellent.

Bar charts displaying the percentage split by rating, are shown in Appendix I. It is very important to emphasise that these quantitative results are drawn from very small samples and are therefore not statistically significant. What they do show, at a glance, is the high level of satisfaction with the Nanoscale and Microscale Research Centre project.

Here is some commentary to the charts:

The areas showing the highest levels of satisfaction are the quality of the NMRC, security, provision for disabled users, functionality of the space, operation and management of the Centre, sustainability, air quality and cleanliness.

Lower levels of satisfaction were reported for noise levels, temperature and the toilet facilities.

Provision for disabled users

Two of the four respondents answering this question rated ‘ten’, whilst the remaining individuals rated ‘five’ and ‘nine’, respectively. It is considered that the access for disabled users is appropriate.

Security

Satisfaction ratings for security at NMRC ranged from ‘seven’ to ‘nine’ but four out of five respondents, who gave a rating, awarded ‘eight’ or nine’.

Satisfaction with the quality of the facility, now that works are complete

The majority (seven out of 13) of the interviewees asked to give a rating, awarded an ‘eight’ here, whilst one gave a rating of ‘seven’, four gave a ‘nine’ and the single remaining individual gave a ‘ten’.

Handover

This is one of the key areas for improvement. One respondent gave a rating of ‘four’ and another rated ‘six’. There are some interesting points for improvement in the handover to be found on page 19 of this report.

Sub-contractors and suppliers

Satisfaction with the quality of the work of sub-contractors varied between a ‘five’ and a ‘ten’. Respondents were clearly satisfied with the work carried out by the main contractor. However, there were other contractors and sub-contractors who got some criticism.

M&E services

Three of the five respondents asked to give a rating for their satisfaction with the M&E services, gave a rating of ‘seven’. The remaining two individuals rated this ‘eight’ and ‘ten’.

Satisfaction with how defects were handled
Interviewees reported a minimal level of defects at NMRC. The satisfaction ratings here are very variable, ranging from ‘four’ to ‘ten’.

Satisfaction with room types, their space and design
Seven out of eight respondents who were asked to rate this question gave a rating of ‘eight’, whilst the remaining individual gave a rating of ‘seven’.

Satisfaction with the functionality of the space
Three out of the five respondents invited to give a rating, awarded an ‘eight’, whilst the remaining two individuals rated this a ‘nine’.

Operation and management of the building
All respondents who gave a rating rated the operation and management of the building highly. Ratings were split evenly, with two respondents rating ‘ten’, two rating ‘nine’, and two rating ‘eight’.

Environmental performance
The only respondent who was able to give a rating, rated the environmental performance at a ‘nine’ saying that the building is insulated and that the glass is of a good specification.

Air quality
Satisfaction with air quality is high, with all responses falling between ‘eight’ and ‘ten’. There was no negative feedback on air quality.

Temperature
A constant temperature for the sensitive equipment is critical in the NMRC and this has been achieved, except on abnormally hot days. However, several respondents commented that the office areas can become warmer than is comfortable.

Lighting
The artificial lighting in the NMRC received ratings ranging from ‘seven’ to ‘ten’.

Noise levels
Due to the issues with the UPX Lab and the loud humming from the chillers, one end user of the building rated the noise levels at a ‘three’, whilst two end users rated a ‘seven’ and one a ‘ten’.

Data connectivity
Of the four respondents rating this question, one rated ‘six’, two rated ‘eight’ and the remaining individual rated ‘ten’. The rating of ‘six’ did not truly reflect dissatisfaction with data connectivity, in general. It was related to frustration with not being able to see the HVAC performance via the University’s campus intranet.

Cleanliness

All interviewees rating this question gave high ratings. Three respondents rated ‘nine’ and four rated ‘eight’.

Toilet facilities

This is one of the areas with the lowest levels of satisfaction, particularly amongst the end users of the building. Two out the four respondents asked the question rated this a ‘four’, one rated ‘eight’ and the final interviewee gave a ‘ten’.

QUALITATIVE FEEDBACK - THE DESIGN AND THE CONSTRUCTION PHASE

The more difficult part of the programme was the design phase, when work began on site, the project went well.

"Once we were on-site it was good. Once we were designing what we knew we were delivering, again it was fine. Works on site went well for the complexity of what we were doing. Overall it was delivered to the time frames we targeted."

FEEDBACK RELATING TO COMMUNICATION AND COLLABORATION

Issues with communication are a key theme running through this Post-Occupation Evaluation.

Consultation with the occupiers of the building

This study has highlighted an opportunity to pay greater attention to understanding the needs of the people who occupy this building. While the NMRC is designed to accommodate the needs of highly sensitive equipment, rather those of people, the success of the facility means that its user numbers have been growing.

The NMRC is now included on campus tours and there are many visitors to the building. The discussion in the PoE workshop highlighted the need to better understand the user 'journey' and the use of an end-user workshop, at the start of the project, was proposed.

Recommendations

- There is an opportunity to pay more attention to the impact on the people who will occupy the building
- Look at involving end-users in a discussion or a workshop, at the design stage, regarding their needs in order to map out the 'user journey'

Communication between the academic staff and the consultant team

Communication between the academic staff and the consultant team was good initially, but this dialogue ceased in the November, when the project went out to tender.

Once the costs came back, the project manager was charged with making savings of £2Million within a period of ten days and so there was no time for discussion. The scheme could not go ahead without this cost reduction.

There were some tensions between the value engineering requirements and the 'devil in the detail'. One participant at the workshop confirmed the requirement to ensure that information supplied by the academic staff is fully understood by the consultant team. For example, there were certain restrictions, such as the location of liquid nitrogen, which were vitally important for reasons of safety. It was essential that this information was communicated clearly.

Tight version control is required on any documents connected to a development and there were some issues here during this project. Facts and figures were collated into a

spreadsheet during the feasibility stage. Multiple copies were in circulation and as a result mistakes were made.

The consultant team needed to get a full briefing and gather all the specific details, so that assumptions did not have to be made. As people whose specialism is outside this area of science, it was difficult to gather all the necessary information on the supporting secondary equipment, such as the pumps.

It was noted that some University departments, such as Chemistry and Engineering, have individuals in place, with technical knowledge, who are also used to interacting with construction professionals and can therefore form a bridge between the two groups. Such individuals have not been identified in all departments. The NMRC is a cross-disciplinary facility, which makes this more difficult. However, it is critical to identify a person who can form the interface and provide 'sanity checks' at key points. This individual should be in place from the commencement of the project.

More time for the necessary discussions between the academic team and the design team would have been helpful but was not possible due to the project timeline, which was described as 'fast-track'.

Recommendations

- Appoint a single end-user technical contact so that this person can filter out irrelevant information and keep track of the detail. This person should have in-depth knowledge of the building
- Make efforts to put this individual in place as close as possible to the commencement of the project
- Monitor the flow of the information and keep track of the detail, and version control of key documents
- Conduct regular 'sanity checks' with the end-user technical contact
- Aim to allow sufficient time for proper discussion and consideration to take place, especially around value engineering

Communication with the Clean Room contractor

The Clean Room was a specialist installation carried out by a specialist contractor. While the Clean Room is regarded to be one of the major successes of the project, there were some difficulties as the contractor reported directly to the University, meaning that they were not answerable to the main contractor.

Whilst comments on the work carried out by the clean room contractor were positive, there were several comments regarding poor communication and a lack of collaboration.

While it is not usual for members of the supply chain to be employed directly by the University, the workshop participants recognised the issues that this arrangement had caused on this project. However, there were good reasons why this arrangement came into being. On future projects, it is the intention that subcontractors should be employed through the main contractor.

Communication about works planned for neighbouring buildings

The workshop participants agreed that better communication about works planned for services in nearby buildings would have been helpful. One example of this is that a new high voltage cable was being run down the side of the chemistry building next door. The very sensitive machines in the Nanoscale and Microscale Centre can be affected by stray magnetic fields. Another example is that approximately a month after the NMRC was complete, a trench was dug for the building next door. The NRMC could have potentially tapped into that drain rather than installing the mechanical drain mentioned on page 19.

Workshop participants acknowledged that better information about what is happening, or planned to happen, in adjacent buildings would be helpful. However, it was also put forward that the University does already make efforts to communicate this information.

Recommendation

- Explore ways to improve the internal communication within the Estates Department to make information on works planned for neighbouring buildings more readily available to project teams

Detailed building plans

The building has undergone significant changes in use and refurbishment since it was built in the 1970s and, as a result, the building is complex. One respondent highlighted how detailed plans showing cabling and power would have been extremely useful as the planning stage of this project.

FEEDBACK RELATING TO THE VALUE ENGINEERING

There was a restricted time scale for the value engineering. The time-line did not allow for sufficient discussion with the academic staff about cost savings and their implications.

"Being blunt about it, 'finger in the air' cost savings had to be made in a very short amount of time. I think that was a success."

FEEDBACK RELATING TO DESIGN AND CONSTRUCTION ISSUES

Mechanical and Engineering

The building did present some challenges to the installation of M&E services, such as low ceilings which had an impact on how services could be routed. These difficulties were amplified by the time pressures.

Generally, the M&E on this project was considered to be good. However, it was reported that the M&E work in the Clean Room was not well scheduled in collaboration with the main contractor.

The drawings came in late, past the point where the designers could incorporate them and issue instructions. The designer said that he never saw a plantroom layout at all and the roof plant room plan never got corrected.

There was a design for the lab but there was critical detail missing that was needed by the construction team.

While having an M&E coordinator would bring benefits, on this project, there is a question about whether it would be justified. This is a ‘grey area’. Some respondents believing this would have been useful, others feeling it was not necessary on this project.

Recommendations

- If considered appropriate for the individual project, appoint a single point of contact for M&E, at the start of the project journey, to liaise with the contractor
- Make sure everyone involved in the project knows who the coordinator is, and maintain consistency of communication with them
- Ensure that there are regular meetings throughout the construction phase
- Best practice would be to use 3D BIM modelling (although this may only be appropriate for larger projects) to minimise problems on M&E

Protection of equipment that may be affected by dust

One respondent had insisted that the UPS batteries needed to be covered during the building process to protect them from dust, however this didn’t happen and all three were lost either during or shortly after the build. This meant that the Data Centre was “running under risk that there wasn’t a back-up” while the batteries were replaced.

Recommendation

- In situations where significant amounts of dust are being generated, take precautions to protect delicate and critical equipment

Design and layout issues

Few issues were raised in relation to the design. Those mentioned by the respondents are detailed below:

Room types and decor

Generally speaking the room types work well. Respondents recognise that they could have been further improved, but that those improvements would have incurred costs.

However, inevitably things change and some areas in the NMRC are not being used as was originally envisaged.

Entrance to the Clean Room

The entrance to the Clean Room is through a seminar room and this space is being used more than was originally expected. The room was always intended to be a laboratory-type space but it is now being used somewhat differently than planned. Heavy use of the space was not envisaged at the outset. It is somewhat awkward when someone is giving a seminar or a training event and people have to walk through to get to the Clean Room.

The curtaining that is in place seems to be a workable solution, although there is scope for improvement. However, it can distract speakers who are presenting in the space when somebody pops out from behind the curtain.

Putting in partitions would not be helpful as they would limit the use of the room.

Recommendation

- If the Centre has the budget available, extend the curtaining to minimise the distraction of users of the seminar room by the coming and going of staff to the Clean Room

Décor

One respondent with a very practical viewpoint, feels that sometimes on other developments there is a focus on how good things look rather than the practicalities of maintaining the facilities, however he didn't feel that this was the case here.

A pragmatic approach has been taken to the décor of the NMRC. The décor is simple with plain white walls and is designed to be easy to re-touch. This was deliberate so that if surfaces get damaged, they can be easily repaired or replaced.

"It's not flash space and it's not in a flash building, so it feels perfectly appropriate. It's not a very public building, by the nature of its work and by virtue of the other occupants of the building that are very important to the University."

Gas lines

Several respondents commented that it would have been helpful if more gas lines had been installed for services such as compressed air, nitrogen and oxygen. One respondent commented that these would probably have to be retrofitted within the coming six months.

There was one gas line missing from the drawings, this came to light when a senior technical manager became involved in the project. An additional Argon gas line is required in the XPS lab. Had a 'technical lead' been appointed sooner, this omission would have been detected.

Recommendation

- If the Centre has budget available, consult with members of the technical team to ensure that additional gas lines, are installed where required

Additional power points

More plug points are required in hallways and on stairs in order to make the cleaning of thoroughfares easier and safer

Recommendation

- Department to consider investigating where additional power points would improve safety and efficiency of cleaning the stairs and hallways

Ensuring suitability of air conditioning units

Some of the air conditioning units in the localised plant rooms are not considered to be fit for purpose as they are comfort cooling systems, which were not designed to be left on continuously. The heat in the plant room, from the water recirculating in the chiller, increases the temperature, causing the room to overheat. The overheating chillers cause the microscopes to cut-out, before the air conditioning starts to bring the temperature down

again. Remedial action is being taken to address this issue, using ducting to remove heat where rooms have external walls.

In the workshop, there was some disagreement as to whether the load of the equipment that was installed in the rooms was the cause of the issue but, nevertheless, the chiller units are approaching the limit of what they can cope with.

Recommendations

- Build in ‘sanity’ checks during the design process, using a representative academic/lead to ensure the detail or understanding are not missed
- Encourage the involvement of the maintenance teams earlier in the process so that issues are likely to be noticed sooner
- Seek advice from the maintenance team to see if they have had previous experience of any issues with the same systems
- Encourage the sharing of best practice with other universities installing similar systems to spot issues earlier in the process

Plant exposed on the roof

One interviewee voiced concerns that there is exposed plant on the roof of the building, whilst acknowledging that there was no real alternative as to where the plant room could be located. The life expectancy of plant is reduced when it is placed outside and exposed to the elements and a crane has to be used to assist with maintenance if plant is located on the roof.

Recommendation

- Consideration should be given, during the value engineering exercises, as to whether placing plant rooms on a roof, without cover, is a false economy as the life of the plant will be compromised

The mechanical-pump water drain in the wet-processing area

A water drain was required in the ‘wet processing area’. The design was for a traditional, gravity-fed drain which would have worked but it would have gone across a duct, which has asbestos in it. The decision to go with the mechanical drain was done on the basis of cost and time. The clean room contractor was asked to design a system that pumps the water up one floor level, transports it across the building and then into the drain. This is a mechanical system and several respondents, are concerned that here is a risk that the pump may break down. It was reported that it was originally intended that there would be two pumps but this was removed. Having a spare would have been prudent. If this goes wrong at a later date, the cost will not fall on the project but on the operation of the building.

While a gravity-fed solution would have been cheaper and more durable, an acceptable solution for drainage was found and implemented.

Recommendation

- Consider whether it should be University policy to avoid pumped drainage systems, where possible and, where they cannot be avoided, to install a spare pump in case of a breakdown

FEEDBACK RELATING TO HANDOVER

The study gathered feedback on various aspects of the handover of the NMRC.

The handover of the Clean Room was considered to be well conducted. Tests and checks were performed as required. However, one respondent commented that the Clean Room could have been handed over in a cleaner condition.

"They did clean up but it's the difference between a construction company cleaning up and the Clean Room user, wearing a full clean room suit cleaning up using fully compliant clean room materials."

There were some negative comments regarding the handover of the NMRC. The O&M manuals were delivered three weeks' late. Late delivery of the O&Ms can make it hard for the Estates team if there is a fault reported and they have no documentation to refer to. The maintenance team needs the test certificates for electrical installations to enable the team to do statutory inspections throughout the life of the building. A good understanding of the equipment, such as chillers, by the end-users would also be helpful.

The occupation period for this project was very protracted. The facility was handed over as empty spaces. Looking back, one respondent felt that a sanity-check would have been beneficial regarding the readability of the Clean Room BMS and to check if the balance is right from the end user perspective.

A few weeks prior to handover, it would be helpful to consider exactly what familiarisation is needed from both perspectives and whether there should be 'follow ups' later. It was suggested that two different sets of demonstrations would be helpful: one technical demonstration for Estates and any maintenance contractors to show how the BMS works, where the access panels are and what maintenance is necessary. The second type of demonstration would be to key personnel based in the building, to show such things as how the lighting and the air conditioning works. The end-user familiarisation could be presented in workshop format.

Recommendations

- Make the information about the equipment in the facility as accessible and comprehensive as possible
- Think about the best way to communicate the information to the end-user
- Consider holding a workshop to impart the information to the end-users

Earlier involvement of the maintenance team

With refurbishment projects, there has not always been the opportunity to involve the maintenance team early in the process, nor has it been seen as necessary. However, there was agreement that it would be useful for the team to be involved in these refurb or upgrade projects particularly when upgrades can be more complex than the new builds and retro-fitting could be difficult.

The maintenance team could provide a useful sanity check, at a relatively early stage, to ensure that the critical points of detail are not lost. It would also be helpful for the maintenance team to be informed that specific systems are coming, which will be added to the maintenance inventory and exactly what the requirements will be.

This opportunity was also spontaneously mentioned by a member of the consultant team: **"It's a lot easier if their engineers are involved through design, taking periodic interest, through construction so they're familiar with the building, how it's being wired and how it's being connected. These guys probably don't have enough time to do that so they get landed on at handover and said, 'there's a building to look after'. I've never found an organisation who can grant their guys enough time to get involved in capital projects but I think there's real benefits there."**

Recommendations

- Bring the Estates Department maintenance team into the process earlier on refurbishment or upgrade projects
- Seek advice from the maintenance team to see if they have had previous experience of any issues with the same systems elsewhere on campus

Resolution of defects

Feedback on the resolution of defects is generally good.

"There was quite a low level of defects on this job, but the defects that I remember are mainly about the overheating within plants. There were a few lags in responses because I think a lot of the time it was down to the fact that they weren't easily rectifiable."

Several participants reported problems with reaching a workable solution with the liquid nitrogen enclosure. It took several months before this particular problem was resolved, meaning that cylinders of liquid nitrogen had to be used in the meantime. This was inconvenient for the end users of the facility.

The issues have now been resolved, a large tank has been installed, it's properly enclosed and it works well.

FEEDBACK RELATING TO SUSTAINABILITY

The environmental performance of the NMRC is difficult to isolate as it is affected by the energy usage of the Data Centre. This was not a building that had to meet any specific environmental targets, such as BREEAM. However, the performance of building's insulation is regarded as 'pretty good for a retro-fit'. The same individual rated the sustainability highly, awarding a rating of 'nine'.

"The building's insulated. The glass is of a very good specification. It's pretty good for a retro-fit."

QUALITATIVE FEEDBACK - POST-OCCUPATION ISSUES

FEEDBACK RELATING TO THE QUALITY OF THE INTERNAL ENVIRONMENT

"Based on where we are now, it is 'eight' or 'nine'. The snag problems have been rectified. We are now in a position where the Centre is doing its job. It is fit for purpose and it's a good working environment."

Lighting

The quality of the artificial lighting is generally acknowledged to be good.

Noise levels

Noise was highlighted as a particular issue in the XPS Lab, as it is reported to be 'almost at legal levels'. Each microscope comes with its own water cooling system and it was explained that it is usual practice to place this in a separate plant room, or even outside of the building, because of how noisy they are. At the planning stage of the project this was requested but was refused by the University, it was suggested due to the aesthetics of the building, but also as a result of value engineering decisions that were taken. The end users hadn't appreciated quite how loud the chillers would be with "substantial humming sounds", and this has meant that on occasion conversations can't be heard in that room.

The chillers are now due to be re-located outside the building. An alternative solution would be to put the chiller in a separate, soundproofed room, although the resulting heat build-up would also have to be dealt with.

Recommendations

- Evaluate the decibel levels from equipment prior to locating them in occupied spaces
- Design to best practice standards, minimising noise in the workplace

Temperature

Maintaining a constant temperature, within specific parameters is critical to the functionality of the NMRC. As things stand, excepting abnormally hot summer days, the facility functions in the way that it was intended to.

"In practice, the machines work and the environment they're in now is better than they were before, so it's a net improvement. Within a couple of years technology will move on and you may ultimately regret limiting the infrastructure because there's no easy way to improve that. You're back to the drawing board of a full refurbishment and you can't simply retrofit this stuff."

Hot days in summer

It was reported that, on exceptionally hot days in the summer, there were issues maintaining the stable temperature required. However, respondents acknowledged that for the majority of the time the temperature was maintained at appropriate levels.

Office temperatures

End users report that the temperature in the office areas is higher than is comfortable.

Recommendation

- Department to consider funding the addition of solar filtering to the windows, in order to reduce the temperature in the offices

The temperature control is not connected to the campus internet network

One participant described that it is necessary for Clean Room users to have reassurance that the temperature control is stable before starting a very sensitive sequence, which could take up to twelve hours. As the control system is connected to the Estates back-net, rather than the campus internet, any alerts can easily be missed by the Estates team. The facility depends on temperature and humidity control and the control area for this is in a 'grey area' outside of the Clean Room and it is technically possible to connect to the internet or the campus internet network.

It would be helpful if temperature performance could be monitored remotely and workshop participants agreed that this should be straightforward to do.

Recommendation

- Two respondents, consulted as part of this POE, are to meet with relevant person in Estates team to establish and effect a solution, possibly a stand-alone system that does not send an alarm to the Estates team

Maintenance of the air conditioning system

One respondent noted that the filters on the air conditioning system were not originally being maintained by Estates and that this resulted in blocked filters. However, this has now been rectified and they are now being correctly maintained by the Estates team.

The V-belt

The V belt of the air-conditioning system kept breaking after approximately six months of operation. The respondent who raised this explained that the clean room contractor had organised for the motor manufacturer to come back and put two V-belts onto the system instead of one and since then everything has run well.

Preventing damage to equipment, in case of flooding

The workshop attendees discussed the risk to equipment damage, should a flood occur.

There was an incident of flooding in the past couple of months, where the water got into the Data Centre and was picked up by the Data Centre's flood detection alarm.

One participant had suggested that a flood detection alarm would be a useful addition, and was in place in other physics water treatment plants elsewhere in the University. However, others suggested that the requirement is more to stop water from reaching the equipment in the first place, by either removing the water or by covering the equipment. This is most important where the area is not staffed. One respondent noted that canopies are, in fact, in place to cover the machines located beneath the wet chemistry lab.

Recommendation

- On future projects, consider ways to protect equipment from flooding

FEEDBACK RELATING TO OPERATIONAL AND QUALITY ISSUES

Operational problems and issues relating to quality have been few:

The facility was designed to accommodate existing equipment

In the view of interviewees, the facility's layout was designed to accommodate equipment that was either in existence, or was known about. Stakeholders have since either changed some of the equipment, or added extra equipment into the space. As a result, operation is a bit further 'to the edge' because the thermal output of any additional equipment has to be carefully taken into account.

While it is accepted that it is never possible to future-proof a building, it is important to be as pragmatic as you can with entrances, and circulation routes and the provision of resources. Projects are capital-limited and therefore it is not possible to plan for the future. However, several workshop attendees suggested that it would be prudent to build in additional resource provision, for instance, additional water and power.

"I think the designers designed spaces to accommodate the equipment that was there and known about. Stakeholders perhaps then changed that equipment or put extra equipment into the space or just that the space was probably a little bit on the cusp as far as the design element was concerned. Consequently, quite a few areas over-heated which meant that the chillers in those areas cut out. Therefore, the subsequent experiments that were taking place had to be suspended while the equipment was being repaired."

"I think there are lessons to be learnt on the output of equipment and perhaps future proofing."

Recommendations

- Although it is never possible to 'future-proof' a building, consider planning space power and water capacity, into future projects

Security

The Centre uses card control, University access control, and additional layers of security for the computer room. Beyond the access control zone, a standard University approach of door locks is in place. While overall security was rated favourably by respondents, three issues were highlighted:

When the fire alarm goes off, all the electronic doors open

While it is clearly necessary for safety that people in the building are easily able to exit in the event of a fire, misuse of the system could result in a breach in security at the Centre

Delay in doors closing

Outside normal working hours, anyone accessing the building is required to use their staff card, and then press a button in order to exit. However, one respondent highlighted that because the doors take some time to shut once they have exited, somebody "hanging around outside" could gain access before the doors shut.

Accommodating Bank Holidays

One interviewee reported that the security system is not programmed to recognise Bank Holiday Mondays, resulting in the doors not being on the 'out of hours' access setting, and raised concerns that this could be a security risk.

Recommendations

- Department to discuss with the Estates Helpdesk access control timings to the building, and investigate whether Bank Holidays can be accommodated
- Department to review, with the Security Department, the options for the Department to fund additional measures to protect the more critical areas, including proposed works to the back door and the cost of installing a camera

Toilet facilities

One respondent reported dissatisfaction with the location and size of the ladies' toilets. The building is highly functional and operational but, with hindsight, it was recognised that more attention might have been paid to the user 'experience'. One respondent commented that people are the University's most important resource and it is important to cater for their comfort.

The decision was taken to combine the ladies' toilet with the accessible toilet in order to free-up space for a kitchenette. An accessible toilet has to be a mandatory size and have an outward opening door. The facilities are not perfect solutions, but it was agreed that what exists is the best outcome possible for the NMRC.

The Centre is proving more popular than expected

In a sense, the Centre is a victim of its own success. Usage levels are higher than anticipated, with many visitors and students coming to the Centre. While one respondent referred to it as a "nice challenge to be faced with", this has put some pressure on the space and how it is used.

"It is a living structure. It is not static, it is constantly being changed."

Kitchenette

End users report that the kitchenette is too small for the growing team in the NMRC. As the NMRC has proved to be such a success, more people are using the building. There are now 12 staff. There are a lot of visitors to the building and the NMRC is incorporated into the campus tours so it is necessary to be able to provide visitors with refreshments.

The kitchenette was in the original scheme, but had to be removed due to space constraints, this was reinstated when space was obtained by combining the ladies' toilet with the accessible toilet.

While the current space is too small, accommodating no more than two people at a time, no workable solution was found and no recommendations put forward.

Boxing in of pipes

One respondent mentioned that the clean room contractor should now be asked to come back to the MNRC and box in some pipes. It has not been necessary to ask them to do so up to now because the users were waiting until they were sure that no additional pipes needed to be installed.

Fire alarms causing 'trips'

There have been issues with the fire alarm tests, on Tuesdays, causing trips. This has now been resolved by lengthening the delays.

FEEDBACK ON MAINTENANCE ISSUES

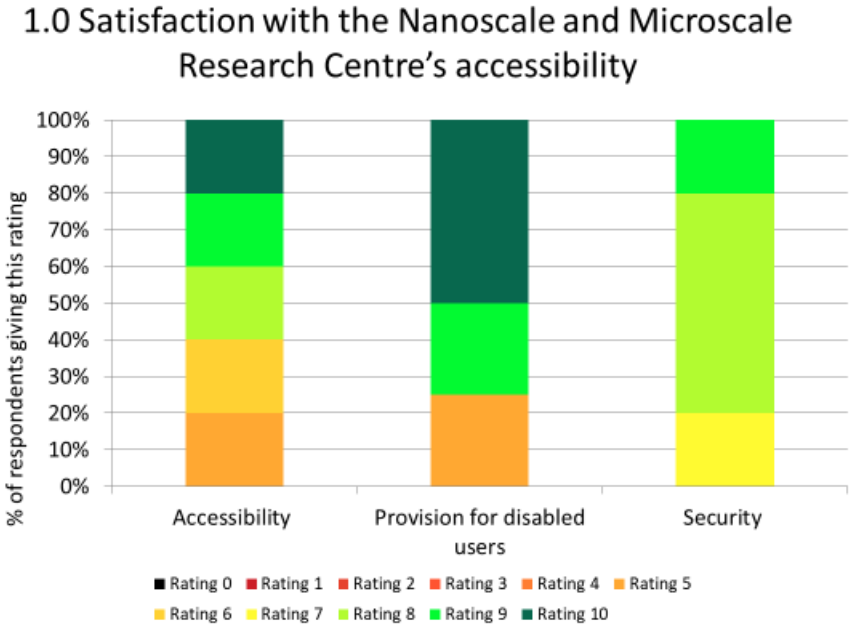
Maintenance

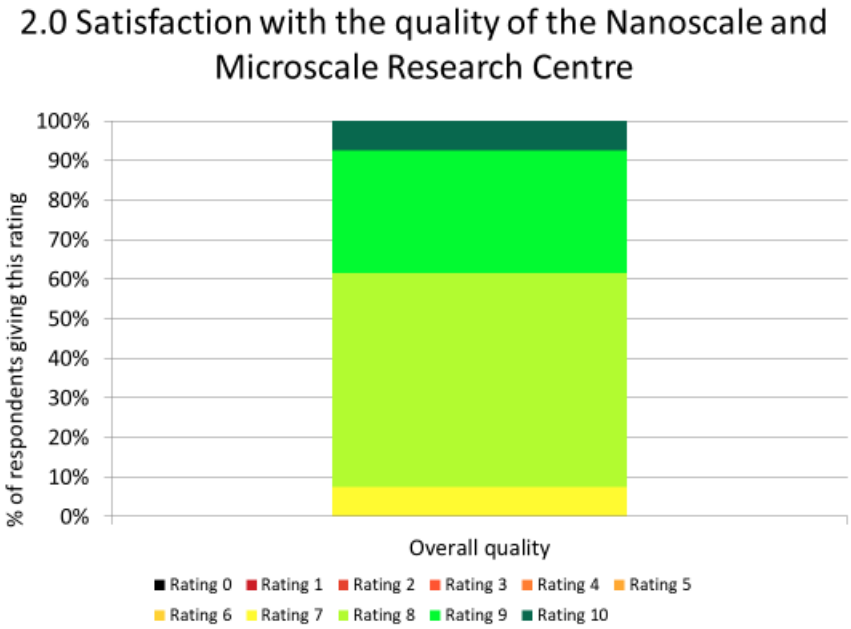
The original assumption for the BMS and temperature controls was that the NMRC was a nine-to-five building, whereas, in reality, it operates on a 24-hour basis. This was an important learning point. Users of the facility would like to be better informed about maintenance schedules as ensuring that the equipment critical to their operations stays running.

Maintenance of the Clean Room

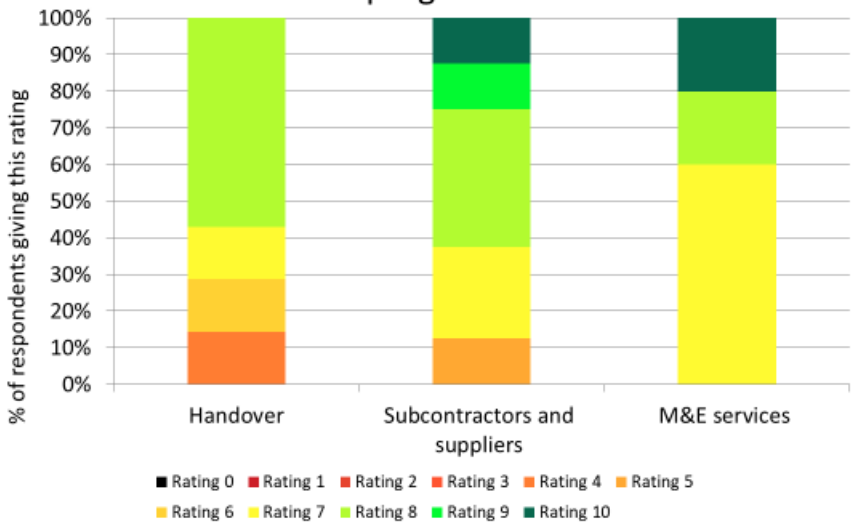
A question was raised as to whether the clean room contractor should handle the maintenance of the Clean Room, rather than the Estates team, as is done in other universities. To date, the Nottingham University Estates team has elected to keep this 'in-house' possibly for cost reasons. However, one respondent put forward the argument that, if the cost of 'down-time' is taken into account, that this may not, in fact, be a saving.

APPENDIX I: QUANTITATIVE RESULTS





3.0 Satisfaction with the handover of the Nanoscale and Microscale Research Centre and the team involved in the programme



4.0 Satisfaction with the how defects were handled

5.0 Satisfaction with the space in the Nanoscale and Microscale Research Centre

6.0 Satisfaction with the operation and environmental performance of the Nanoscale and Microscale Research Centre

7.0 Satisfaction with the Nanoscale and Microscale Research Centre's internal environment

APPENDIX III: SUMMARY OF RECOMMENDATIONS

RECOMMENDATIONS FOR APPLICATION TO FUTURE PROJECTS

Consultation with occupiers of the building

- There is an opportunity to pay more attention to the impact on the people who will occupy the building
- Look at involving end-users in a discussion or a workshop regarding their needs and map out the 'user journey', at the design stage

Communication between the consultant team and the academic staff

- Appoint a single end-user technical contact so that this person can filter-out irrelevant information. This person should have in-depth knowledge of the building
- Make efforts to put this individual in place as close as possible to the commencement of the project
- Monitor the flow of information to keep track of the detail
- Conduct regular 'sanity checks' with the end-user technical contact
- Try to allow sufficient time for proper discussion and consideration to take place, especially around value engineering

Communicating works planned for neighbouring buildings

- Look at ways of improving the internal communication within the Estates Department to make information on works planned for neighbouring buildings more readily available to project teams

All contractors to be employed through main contractor

- In future schemes, all sub-contractors will be employed through the main contractor, rather than through the University, which is, in fact, the usual arrangement (there were reasons why this was not the case on the NMRC project)

Coordination of M&E

- If considered appropriate for the individual project, appoint a single point of contact for M&E, at the start of the project journey, to make contact with contractor
- Make sure everyone knows who the coordinator is, and maintain consistency
- Ensure that there are regular meetings throughout the construction phase
- Best practice would be to use 3D BIM modelling (although this may only be appropriate for larger projects) to minimise problems on M&E

Protection of equipment that may be affected by dust

- In situations where significant amounts of dust are being generated, take precautions to protect delicate and critical equipment

Ensuring suitability of air conditioning units

- Build in ‘sanity’ checks during the design process, from a representative academic/lead to ensure the detail or understanding are not missed
- Encourage the involvement of the maintenance teams earlier in the process, so that issues are likely to be noticed sooner
- Seek advice from the maintenance team to see if they have had previous experience of any issues with the same systems
- Encourage the sharing of best practice with other universities installing similar systems to spot issues earlier in the process

Exposed plant on roof

- Consideration should be given, during the value engineering exercise as to whether placing plant rooms on a roof, without cover, is a false economy as the life of the plant will be compromised

Mechanical water drain

- Consider whether it should be University policy to avoid pumped drainage systems, where possible and, where they cannot be avoided, to install a spare pump in case of a breakdown

Improvement of the handover process

- Make the information as accessible and comprehensive as possible
- Think about the best way to communicate the information to the end-user
- Consider holding a workshop to impart the information to the end-users

Earlier involvement of the Maintenance Team

- Bring Maintenance Team into the process earlier
- Seek advice from the Maintenance Team to see if they have had previous experience of any issues with the same systems elsewhere on campus

Minimising noise levels on future projects

- Evaluate the decibel levels from equipment
- Design to best practice standards and minimise noise in the workplace

Additional power and water supplies

- Although it is never possible to ‘future-proof’ a building, consider planning space, power and water capacity, into future projects
- Consider including additional bays in distribution boards, for extra capacity

Preventing damage to equipment, in case of flooding

- On future projects, consider ways to protect equipment from flooding

RECOMMENDATIONS FOR POST COMPLETION CHANGES TO THE FACILITY, IF THE NMRC IS ABLE FUND THEM

Entrance to the Clean Room is through the meeting room

- Department to consider the possibility of funding the extension of the curtaining to minimise the distraction of users of the seminar area by the coming and going of staff to the Clean Room

Additional gas lines

- If funding is available from the Department, consult with members of the technical team to ensure that additional gas lines, are installed where required

Additional power points

- Department to consider investigating where additional power points would improve safety and efficiency of cleaning the stairs and hallways

Connecting temperature monitoring to the Campus network

- Two respondents, consulted as part of this POE, are to meet with relevant person in Estates team to establish and effect a solution, possibly a stand-alone system that does not send an alarm to the Estates team

Temperature

- Department to consider funding the addition of solar filtering to the windows, in order to reduce the temperature in the offices

Security

- Department to discuss with the Estates Helpdesk access control timings to the building, and investigate whether Bank Holidays can be accommodated
- Department to review, with the Security Department, the options for the Department to fund additional measures to protect the more critical areas, including proposed works to the back door and the cost of installing a camera