TECHNICAL DESIGN NOTE

Hydrock

Project name	Birkbeck Gordon Square		
Design note title	Preliminary Overheating Analysis Note		
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1. INTRODUCTION

This technical note has been produced for the Birkbeck- Gordon Square refurbishment project. The aim of this note is to inform the design team what impact the possibility of overheating will have on the current proposals for the teaching spaces and meeting rooms on the ground and first floor, as well as fourth floor offices.

It is proposed that the class/seminar rooms are to be densely occupied with up to 56 people. As they are currently only ventilated by operable windows on one façade, it may not be possible to support this level of occupancy without the risk of overheating. To gain a preliminary indication of how the spaces will perform, three indictive classrooms have been selected for analysis. As the site is a listed building the options are limited compared to a new-build development, and we have opted to take a sensitive approach prioritising passive measures over active ones where possible.

At this stage a representative sample of meeting rooms and academic offices have also been tested to verify if overheating in these spaces can be controlled purely via opening windows.

The results of this study have found that even with a reduced occupancy in the classrooms, the majority of spaces still do not pass the overheating assessment. It has further been confirmed in review meetings that there is no flexibility in the occupancy levels to be provided to these spaces. On this basis, we have concluded that for the classrooms to fulfil the function assigned in the brief, active cooling to these spaces is required.

The meeting rooms are also at risk of overheating with the current design, and therefore it is recommended that as the classrooms are being cooling then the meeting rooms should also utilise this system. The academic offices on the upper floor however, are not at risk of overheating, so active cooling is not proposed here.

It is not proposed that the spaces are comfort cooled to a specific design temperature, in the way that a comfort cooled office building would be, simply that supplementary cooling is provided at peak times in order to ensure that the adaptive comfort criteria outlined in the assessment methodology are achieved.

The classrooms tested are as follows:

- House No 40, G.31 - Classroom 56 Desks, representative of the high occupancy deep plan ground floor lecture theatres
- House No 40, 1.26 - Classroom 28 Desks, representative of the shallower lower occupancy teaching spaces on the first floor
- House No 41, G.32 - Classroom 35 Desks, representative of some of the less densely populated deep-plan lecture theatre spaces on the ground floor

Meeting rooms tested:

- House No 40, 1.22 - Meeting/Small Classroom, representative of smaller meeting room
- House No 42, 1.20 - Meeting/Small Classroom, representative of larger meeting room

Offices tested:

- House No 41, 4.07 - Office (1P), representative of a north facing 1 person office
- House No 41, 4.08 - Office (1P), representative of a south facing 1 person office
- House No 42, 4.27 - Tutorial, representative of a south facing tutorial room
- House No 42, 4.30 - Tutorial, representative of a north facing tutorial room
- House No 42, 4.29 - Office (2P), representative of a north facing 2 person office
- House No 42, 4.28 - Office (2P), representative of a south facing 2 person office

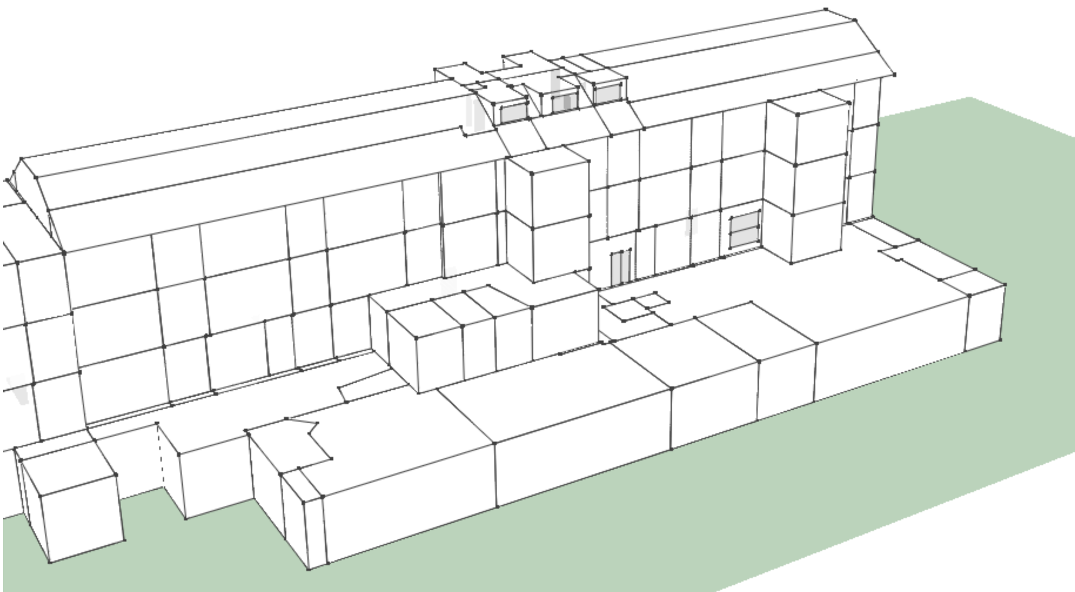

Figure 1 IES model

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2. ASSESSMENT METHODOLOGY

The assessment has been conducted in line with "CIBSE TM52 -- *The limits of thermal comfort: avoiding overheating in European buildings*" which is the standard compliance tool for assessing overheating, and used extensively within the education sector. This is an adaptive comfort tool and as such measures perceived comfort levels, rather than imposing strict temperature limits, so for example during periods of warm weather, higher internal temperatures are permitted, as occupants will be acclimatised to them. In this methodology 3 criteria are set out, of which 2 must be satisfied for each space to achieve a pass. The criteria are as follows:

2.1 Criterion 1: Hours of exceedance (He)

The number of hours (He) during which the room temperature is greater than the adaptive thermal comfort temperature by one degree (K) or more during the period May to September inclusive shall not be more than 3 per cent of occupied hours.

2.2 Criterion 2: Daily weighted exceedance

The daily weighted exceedance, measures the degree to which operative temperature exceeds the adaptive thermal comfort temperature. To allow for severity of overheating, the weighted exceedance must be less than or equal to 6 in any one day. This in effect states the space can exceed the target temperature by a small amount for a reasonably long period, but can only exceed it by a large amount for a relatively short period.

2.3 Criterion 3: Upper limit temperature

The third criterion, the upper limit temperature, sets an absolute maximum temperature experienced at any occupied time, the internal operative must not exceed the external temperature by more than 4K.

3. ASSUMPTIONS

The Birkbeck building is an old listed Georgian building, meaning that the thermal fabric properties are unknown at this point and are expected to be low performing compared to modern materials. As a result, for this analysis a number of assumptions have been made:

- External walls are solid brickwork assumed to be 550mm thick, their U-value has been estimated using the simulation software
- Roof U values have been benchmarked from the Dwelling Energy Assessment Procedure (DEAP) document
- All glazing is single pane with a high g-value
- Unless otherwise stated windows are only openable between 09:00 and 21:00
- All windows are open when the room temperature is greater than 22°C

Table 2 - Thermal properties summary

Element	Value
External Wall U Value	1.0 W/m²K
Roof Dormer Wall U Value	2.5 W/m²K
Roof U Value	2.2 W/m²K
Window U Value	5.1 W/m²K
Window g Value	0.82

Table 1 - Internal gains

Internal Gain	Value
Lighting	10 W/m2
People	90 W/person (sensible) 60 W/person (latent)
Equipment	10 W/m2

4. CLASSROOM RESULTS

A number of iterative design scenarios have been investigated to try find the best solution in preventing overheating without the need for installing mechanical cooling.

Each scenario was tested assuming that the lecture halls were occupied all through the summer, making allowance for potential summer schools or other activities which may use the space. It has been confirmed with the design team that this is a realistic usage pattern for the spaces, and so the assessment must span the entire cooling season.

It should be noted that the Criteria 1, 2 & 3 values need to be lower than the target values listed in the below table.

Table 3 - TM52 criteria target values

Criteria 1 (%Hrs Top-Tmax>=1K)	Criteria 2 (Max. Daily Deg.Hrs)	Criteria 3 (Max. DeltaT)
3	6	4

4.1 Scenario 1 - As currently proposed

In this scenario the occupancy levels modelled are the proposed numbers.

Results for this analysis is.

Analysis on the current design proposal shows that all the rooms tested are failing all criteria by a considerable margin, and therefore are at high risk of overheating.

Table 4 - Scenario 1 results

Room Name	Criteria 1 (%Hrs Top-Tmax>=1K)	Criteria 2 (Max. Daily Deg.Hrs)	Criteria 3 (Max. DeltaT)	Criteria failing	Pass/Fail
G.32 - Classroom 35 Desks	24.8	43	8	1 & 2 & 3	Fail
G.31 - Classroom 56 Desks	35.6	53	9	1 & 2 & 3	Fail
1.26 - Classroom 28 Desks	18	36	7	1 & 2 & 3	Fail

4.2 Scenario 2 - Reduced occupancy

As the current design proposals are failing to meet TM52 criteria further measures will be investigated to try find a solution. In this instance the largest contributor to internal heat gains is from the number of occupants in the lecture theatres. Therefore, the proposed number of occupants has been reduced by half to the following values:

- Classroom 56 Desks - reduced to 28 Desks
- Classroom 28 Desks - reduced to 14 Desks
- Classroom 35 Desks - reduced to 18 Desks

This has reduced the margin of failure, however none of the spaces are achieving a pass.

Table 5 - Scenario 2 results

Room Name	Criteria 1 (%Hrs Top-Tmax>=1K)	Criteria 2 (Max. Daily Deg.Hrs)	Criteria 3 (Max. DeltaT)	Criteria failing	Pass/Fail
G.32 - Classroom 35 Desks	19.1	63	7	1 & 2 & 3	Fail
G.31 - Classroom 56 Desks	29	77	8	1 & 2 & 3	Fail
1.26 - Classroom 28 Desks	11.1	45	6	1 & 2 & 3	Fail

4.3 Scenario 3 - Internal Shutters Always Closed

The next biggest contributor to the internal heat gains is through the sun's solar radiation. As this is a listed building, solutions such as installing higher performance glazing and adding external shading is likely to prove problematic. To reduce the solar gains from heating the lecture theatres internal shutters or blinds could be utilised.

If using internal shading devices, it is recommended that louvred shutters are used as they allow airflow into the space. It would need to be confirmed if this method was acceptable due to the historic nature of the buildings. Blinds will reduce the air flow into the space which removes the cooling effect of opening the windows. On this basis, it has been assumed that shutters will be used. In this scenario it has been assumed that the shutters will be closed at all times when there is a risk of overheating.

The occupancy levels are assumed to be half the proposed values as stated in Section 4.2

Under these conditions 1 lecture theatre is passing, however Classroom - 35&56 Desks are still failing to meet any criteria, and are failing by a considerable margin.

Table 6 Scenario 3 results

Room Name	Criteria 1 (%Hrs Top-Tmax>=1K)	Criteria 2 (Max. Daily Deg.Hrs)	Criteria 3 (Max. DeltaT)	Criteria failing	Pass/Fail
G.32 - Classroom 35 Desks	10.9	29	5	1 & 2 & 3	Fail
G.31 - Classroom 56 Desks	16.3	36	6	1 & 2 & 3	Fail
1.26 - Classroom 28 Desks	3	20	4	2	Pass

Further analysis was undertaken to see if the occupancy of 01 - Room-28 Desks could be increased and still achieve a pass. Increasing in the number of people in the room by 1 results in a failure, therefore the limit has already been reached 14 occupants for this scenario 01 - Room-28 Desks

Table 7 - Occupancy increased to 15 for 01 - Room-28 Desks

Room Name	Criteria 1 (%Hrs Top-Tmax>=1K)	Criteria 2 (Max. Daily Deg.Hrs)	Criteria 3 (Max. DeltaT)	Criteria failing	Pass/Fail
1.26 - Classroom 28 Desks	3.1	20	4	1 & 2	Pass

4.4 Scenario 4 - Internal Shutters With Night Time Cooling

Inward swinging louvred shutters could be fitted with hinges and locks located on the inside. This would allow the louvres to be securely closed while the glazing was left open. This means the windows can be left open over night without causing a security risk, and also allowing air flow into the room throughout the night. As a result, the rooms will start the day cooler than if they had not been open in the night, helping reduce risk of overheating. This solution would need to be confirmed feasible due to the heritage nature of the building.

The occupancy levels are assumed to be half the proposed values as stated in Section 4.2

Night time cooling has reduced the values of all criteria but not enough for Classroom - 35&56 Desks to achieve a pass.

Table 8 Scenario 4 results

Room Name	Criteria 1 (%Hrs Top-Tmax>=1K)	Criteria 2 (Max. Daily Deg.Hrs)	Criteria 3 (Max. DeltaT)	Criteria failing	Pass/Fail
G.32 - Classroom 35 Desks	5.7	22	4	1 & 2	Fail
G.31 - Classroom 56 Desks	10.2	27	5	1 & 2 & 3	Fail
1.26 - Classroom 28 Desks	2.4	19	4	2	Pass

4.5 Future Weather Files

Due to the effects of climate change the UK temperatures, especially in London, will rise in the coming years. There are weather files which allow the simulation of potential future temperature scenarios. No future weather files have yet been tested, however they should be considered in any new build or refurbishment. It is recommended that to prevent more costly retrofits further down line, further analysis is conducted and preparation for the hotter climates is considered now.

5. MEETING ROOM AND OFFICE RESULTS

At this stage in the design the meeting rooms and offices have only been analysed with the current proposed design and no mitigation measures have been explored.

All windows have been assumed to have 50% openable area as is currently uncertain how much/far each window opens. This can be reviewed once the window opening strategy has been determined.

5.1 Meeting Rooms

Table 9 shows that both the meeting rooms analysed are failing TM52 criteria without any mitigation measures.

Table 9 Meeting rooms results

Room Name	Criteria 1 (%Hrs Top-Tmax>=1K)	Criteria 2 (Max. Daily Deg.Hrs)	Criteria 3 (Max. DeltaT)	Criteria failing	Pass/Fail
1.20 - Meeting/Small Classroom	4.4	22	4	1 & 2	Fail
1.22 - Meeting/Small Classroom	4.9	24	5	1 & 2 & 3	Fail

Offices

Table 10 shows that all the rooms on the top floor are at no risk of overheating.

Table 10 Fourth floor offices results

Room Name	Criteria 1 (%Hrs Top-Tmax>=1K)	Criteria 2 (Max. Daily Deg.Hrs)	Criteria 3 (Max. DeltaT)	Criteria failing	Pass/Fail
4.07 - Office (1P)	0	0	0	-	Pass
4.08 - Office (1P)	0	0	0	-	Pass
4.27 - Tutorial	0	0	0	-	Pass
4.28 - Office (2P)	0	0	0	-	Pass
4.29 - Office (2P)	0	0	0	-	Pass
4.30 - Tutorial	0	0	0	-	Pass

6. CONCLUSION

Detailed analysis has been completed in line with TM52 and produced indicative results for how the Gordon Square refurbishment will perform in terms of overheating for a variety of rooms types. The studies conducted so far indicate that the classroom and meeting spaces will overheat to an unacceptable degree without specialist design measures being undertaken.

In the classrooms passive design approaches were not able to prevent overheating in the spaces, and even at reduced occupancy levels the majority still did not achieve a pass. In order to operate these rooms in line with the occupancy assigned in the brief only way to prevent unacceptable overheating would be to install dedicated cooling.

The provision of cooling would necessitate external cooling units being installed onsite. There are a number of potential approaches which could be considered, including the installation of local cooling units in the lightwells/ basement bunkers dependent on impact assignments, or provision of a centralised cooling compound. These options are detailed in a number Hydrock documents.

For the classrooms the scenarios analysed are as follows with a results summary shown in Table 11 - Classroom results summary table:

- Scenario 1 - As currently proposed
- Scenario 2 - Reduced occupancy
- Scenario 3 - Internal Shutters Always Closed
- Scenario 4 - Internal Shutters Night Time Cooling

Table 11 - Classroom results summary table

Room Name	Scenario 1	Scenario 2	Scenario 3	Scenario 4
	Baseline Natura Ventilation Proposal	Baseline proposal + Reduced occupancy	Shutters + Reduced occupancy	Shutters + Reduced occupancy + Night-time cooling
G.32 - Classroom 35 Desks	Fail	Fail	Fail	Fail
G.31 - Classroom 56 Desks	Fail	Fail	Fail	Fail
1.26 - Classroom 28 Desks	Fail	Fail	Pass	Pass

The design as it is currently proposed also shows a high risk of overheating in the meeting rooms. Further passive measures could be explored, however if other areas require mechanical cooling then these rooms could also benefit from this solution. The fourth floor offices have no risk of overheating with the proposed design and modelling assumptions.