Building Performance Evaluation

Reid Textile Dye Lab and Print Room monitoring

Surabhi Saran

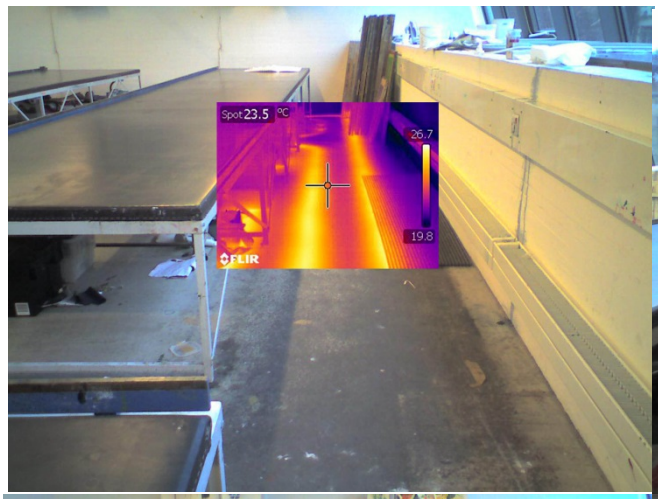
Msc. Environmental Architecture

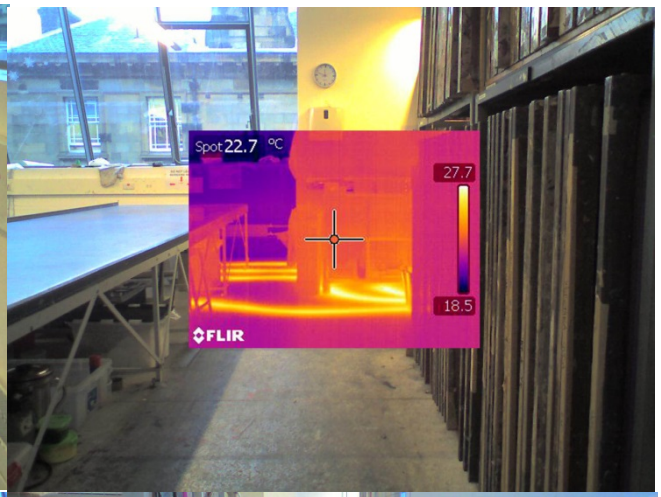
Introduction

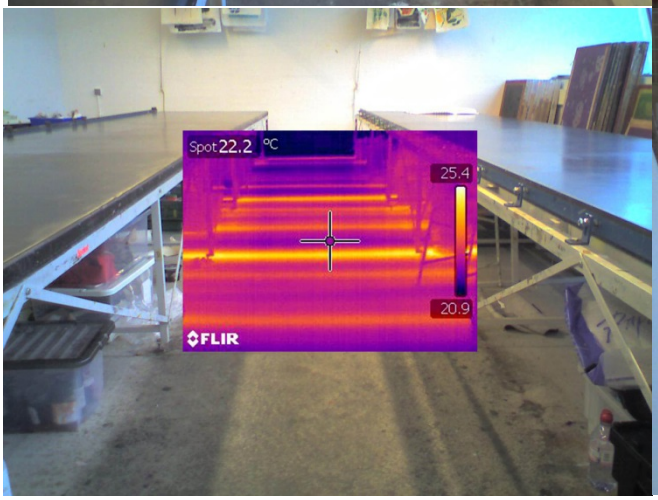
Print room and dye lab

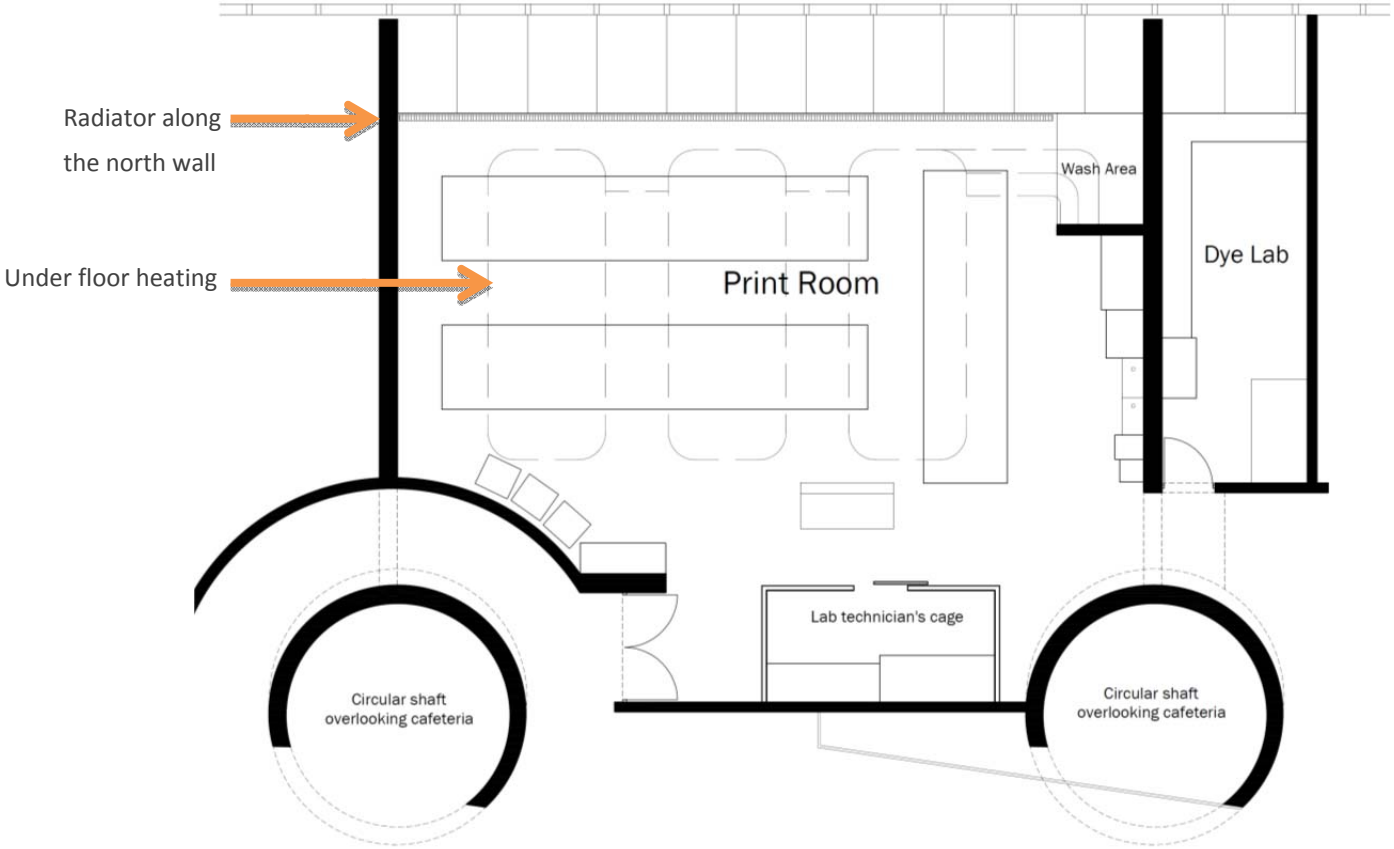
The GSA textile print room and the adjoining Dye lab located on the third floor of the Reid building, were to be monitored. The print room is used by textile design students to dye cloth pieces using screen printing method. The print room is located in the north facade of the building with large top hung windows running through the entire length. The south east corner of the print room opens into the circular hollow shaft.

The print room had an under-floor heating system that drains under the wash area floor. It also has a radiator running along the north wall as seen in the picture below. The occupants only have manual override control over the radiator but no control over the underfloor heating. Also, the heat press which is located right outside the technician's cage is regularly used for drying screens and has a temperature of approx. 180'C.









Complaints

The lab technician requested for the monitoring project. There were complaints from the occupants, saying that the room was overheating and got quite hot, humid and claustrophobic when it was busy. Some complained about too much noise coming from the Reid cafeteria below through the shaft. A survey was conducted engaging 10 users of the print room and dye lab shown in table 1. The results are analyzed later in this report.

Aim of Monitoring

- Temperature, carbon dioxide and relative humidity sensors were installed in order to measure the indoor temperature as well as understand the indoor air quality in the print room.
- Also, the Dye lab was separately monitored for the Levels of TVOCs, Formaldehyde and Particulate matter and how the activities in the room affect the indoor air quality and if it is under safe limits.
- Understanding the cause behind the overheating of the print room.

PEOPLE	1	2	3	4	5	6	7	8	9	10
AGE	24	26	30	29	22	20	41	20	19	20
GENDER	F	F	F	F	F	F	F	F	F	M
YEAR	M.DES	M.DES	M.DES	M.DES	YEAR 3	YEAR 4	TECHNICIAN	YEAR 2	YEAR 2	YEAR 3
Time per week	13-24	5- - 13	5- - 13	5- - 13	5- - 13	>24	>24	13-24	13-24	Varies
Time of the day	All the time	Morning / afternoon	Morning / afternoon	Mornings/ afternoon	afternoon/ evenin	afternoon/ evening	All the time	Mornings/ afternoons	Mornings/ afternoons	Varies
Proportion of time spend in Print Room to Dye lab	80%-20%	100%-0%	50%-50%	80%-20%	80%-20%	80%-20%	80%-20%	80%-20%	80%-20%	80%-20%
Kind of activities performed	Heat press mainly	Heat press mainly	Sampling, printing, painting	Flocking	Printing, washing, mixing chemicals	Printing, washing, mixing ,heating	Printing, washing, mixing ,heating, Teaching	Printing, washing, Dyeing , cleaning	dyeing	Printing, Dyeing , mixing
Kinds of dyes used	Plastics , mix dyes	foil		Procion , Hocking	Procion , Pigments	Binders/ Puff/ glues/ foil/disperse	Reactive dyes/ alluminium sulphates	Procion, Pigment	Procion, Pigment	All kinds
Comfort levels in terms of Temperature (1- 5: cold to hot)	5	3	4	4	3	4	4	3	3	3
Comfort levels in terms of Humidity (1-5: dry to humid)	5	3	4	2	3	3	3	3	3	4
Need to open the window (1-5 - Always to never)	1	5	3	3	2	4	1	4	4	2
What do they like about the space	Size, Ease of movement	High ceilings, natural light, big windows	The size	The light from Windows	Clean , tidy , good facility	Large table space	When there is a buzz	Spaciousness	Openness , big windows	You can print and be messy
What would they change about the space?	Heat, Noise from the void	Disco ball	Bigger washing area, stronger hoses	strip lighting	stronger washers for screens and bigger wash space	more storage	More ventilation , better air quality, no noise from void	No	No	More space
Would they like more control over the cooling? How?	Yes, Temperature Guages	Yes, sometimes it gets warm	Yes	Yes, turn heat down	No	Maybe	Yes, control of underfloor heating	No	No	No
Would they like more control over the heating? How?	Yes, Temperature Guages	No	Yes, too hot	No	No	Maybe	Yes,	Maybe	No	No

Table 1 : Results of the survey

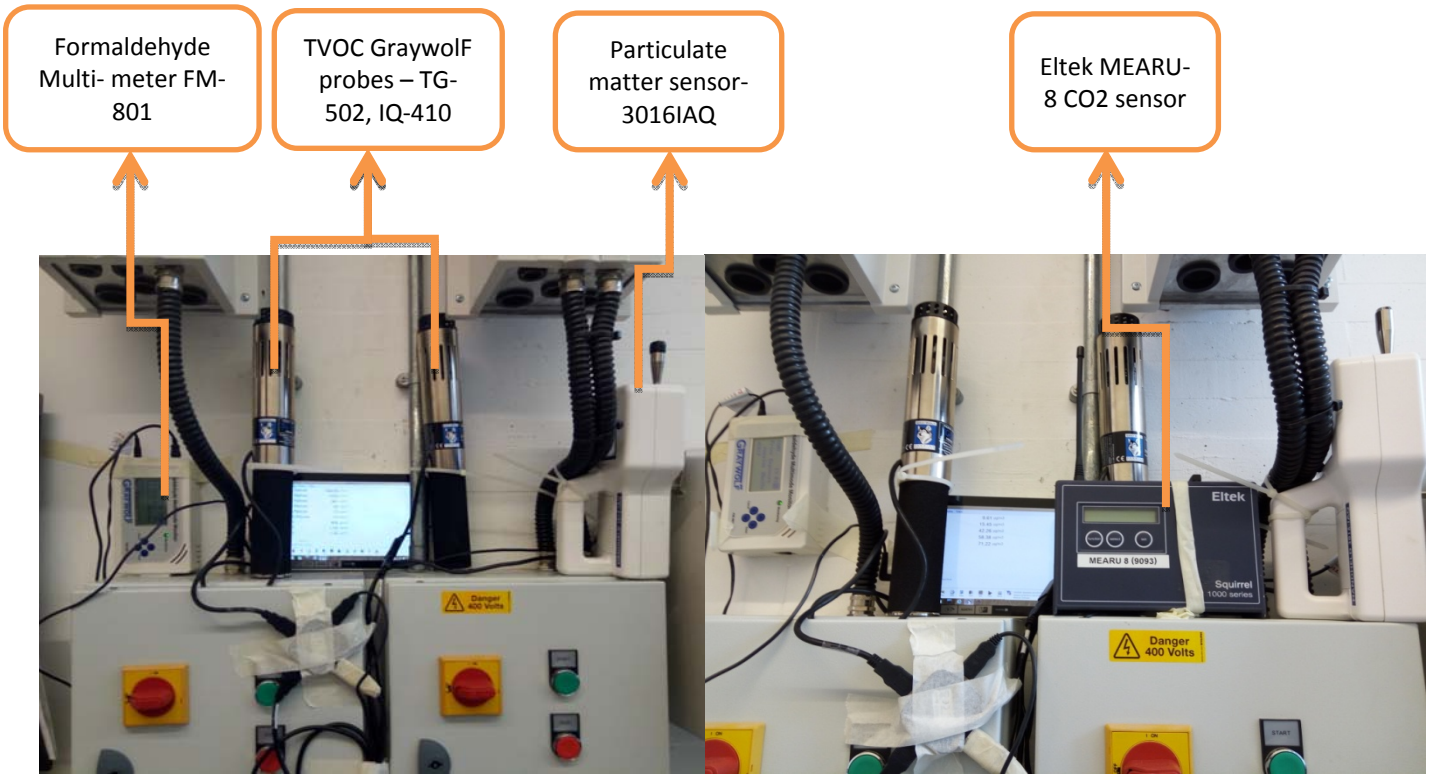
Figure1 : Lab Technician's cage has a door opening on the longer side. The heat press is directly placed opposite this entrance

Figure 2 : Screen wash Area is located on the north east corner of the room with the underfloor heating drain directly below it.

Figure 3:Heat press with overhead exhaust system. They are planning to shift it against the wall in place of the shelf due to its inconvenient location.

The **Dye lab** is used for mixing, heating and disposing dyes. It has burners to heat the dyes, along with sinks to wash off dyes. The dye lab does not have dedicated heating systems, but does have hot water delivery pipes for the underfloor heating system in the print room running under the sink on two adjacent walls.

Equipment installed



Installation at 11.15am

Adjustments made to setup at 3.30pm

START DATE : Monday, 14/11/16 11.30pm

The equipment was installed on top of the electrical boxes, as this was the only spot where the equipment would not be disturbed by the occupants working in the lab. The equipment was installed between 11.15 and 12pm on 14th November 2016. The following equipments were installed in the Dye lab.

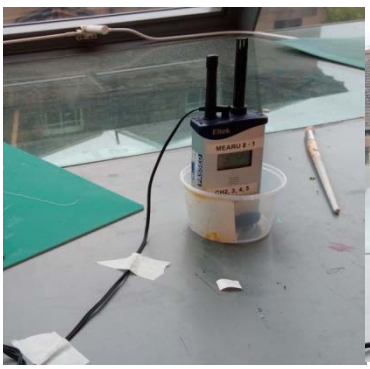
- Formaldehyde Multi- meter FM-801
- TVOC Graywolf probes – TG-502, IQ-410
- Particulate matter sensor- 3016IAQ
- Eltek MEARU-8 CO2 sensor

All three sensors were connected to the tablet with the Wolfsense program, where a log had been set up to record the data, using a 4 port USB Connector. The connector was taped to the front of the electrical box. The Tablet was tucked behind the two TVOC probes.

The Particulate meter and TVOC probes were secured to the electrical conduit using plastic cable ties. The Formaldehyde meter was pasted onto the wall using double sided velcro tape and masking tape was used to secure it firmly.

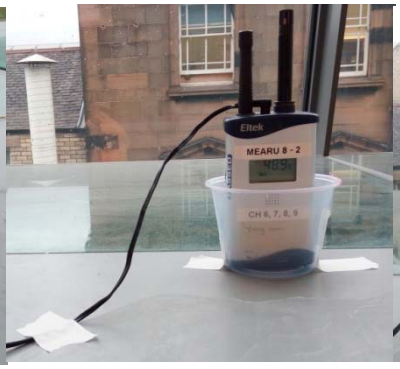
At 3.30pm some alterations were made to the formaldehyde meter. It was lifted above from the surface of the box, as the sensor was being blocked off. The cap on the particulate meter sensor was removed. Also an Eltek MEARU 8 was installed and secured using a loop of masking tape around it. All the equipment except the TVOC probes had power cables connected to a spike chord.

Four Carbon dioxide sensors were also installed in the Print room. Three were installed along the north wall on the deep window sill. One was installed adjacent to the technician's cage.



CO2 Censor - 1

Channel 3,4,5



CO2 Censor - 2

Channel 6,7,8,9

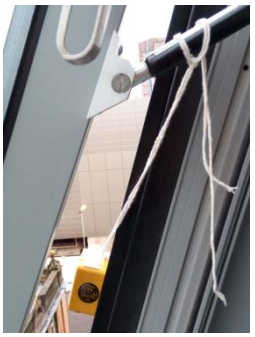
CO2 Censor - 4

Channel 14,15,16,17

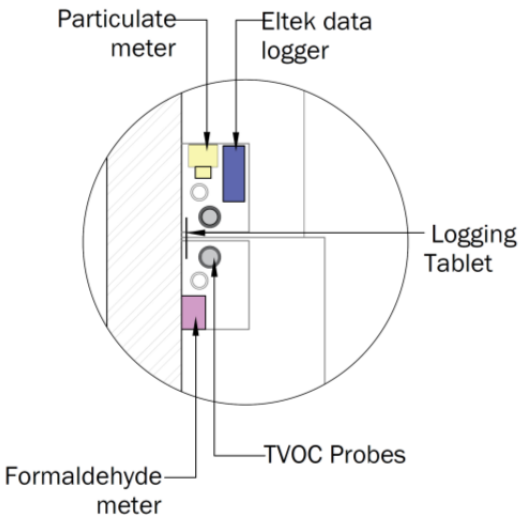
CO2 Censor - 5

Channel 18,19,20,21

The three sensors were placed in plastic containers stuck to the sill using double sided tape, in order to avoid damage that may be caused due to spillage of dyes. The wires were secured to the sill using masking tape. The sensor near the cage was fixed over a plastic channel and was secured to the wall using masking tape.



A tiny tag was attached as well to the outer surface of the window using a double sided Velcro tape. It was secured using a thread to the shutter support. It was



installed on the 16th of November, two days after the initial installation.

The equipment was checked again on the 22nd November 2016 at about 11.15am. Since the Wolfsense on the tablet was not logging the data properly, the log was stopped and started again in a new file location.

STOP DATE : 02/12/2016 3.30pm

The lab technician was also asked to keep a brief record number of occupants using the space on a daily basis. The below table shows the activity in the print room and dye lab in the mornings and the afternnons.

Date			YEAR	AM	PM
14	Week 1	MON			Disposal of Dyes
15		TUE	MDES. PRINT BASIC	11.30-4pm - 9people in Print room	Dye room-1 person, Reactive and Metal dyes
16		WED		11-11.30 - 1person mixing	2people using heat press in print room
17		THURS			
18		FRI			
21	Week 2	MON		10am-1pm 1 person using spectrum binders	
22		TUE	MDES. PRINT ADVANCE	8 students +technician	
23		WED		3-4 peple mixing	
24		THURS		3-4 peple mixing	
25		FRI	MDES. PRINT ADVANCE	6+3 persons	
28	Week 3	MON	TECHNICAL WORKSHOP	11 people	11 people
29		TUE		People in and out	People in and out
30		WED		People in and out	People in and out
1		THURS	TECHNICAL WORKSHOP	12 people	12 people
2		FRI	TECHNICAL WORKSHOP	11 people mixing reactive dyes	11 people in dye lab

Setbacks and Limitations

- At the end of the three week monitoring period it was found that, the log on the Wolfsense tablet failed to record the data in the log, presumably due to a loose connection in the USB connector.
- The Eltek data logger was also misbehaving during the monitoring period and the data gathered is sporadic and incomplete.
- There was incomplete record of the window opening schedule. It was only known that the window remained closed in the last week of the monitoring period. Hence, its effects IAQ could not be gauged.
- **Due to the lack of data, the monitoring of the Print room had to be eliminated from the scope of the project and report.**
- The data obtained from the particulate meter, was in terms of the particle count instead of the density and had to be converted to ug/m^3. This was done using an equation detailed under the section on Particulate matter.

The data collected for the Dye Lab was salvaged directly from the Formaldehyde monitor, the Particulate meter and the Tin tag.

Survey results

The initial feedback from the survey was mixed.

Temperature : Five out of the ten respondents stated that they felt that the room was warmer than their comfort levels, while five other respondents said that they were comfortable with the room temperature.

When they were asked if they wanted more control over the cooling, five of the occupants responded positively, actively stating that it gets warm and they would want to turn down the heat.

There was also a mixed reaction on the need to open windows in the space

Humidity : 6 of the 10 respondents felt that they were relatively comfortable in terms of the humidity. While 3 others stated that the humidity was on a higher level.

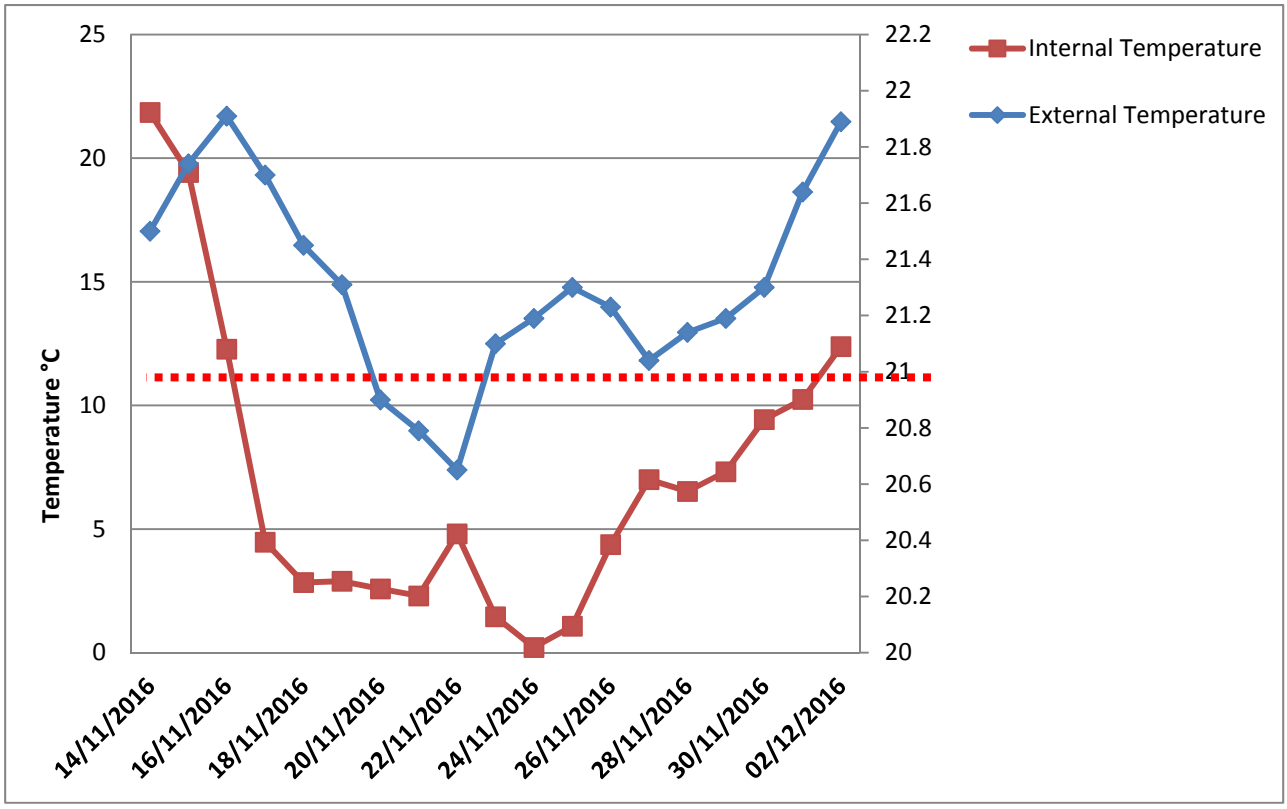
Design Intent and performance

It is probable that underfloor heating was provided by the designers due to the north facing design element in order to keep the space warm as there is limited solar gain on this facade. However, the occupants require a mildly cooler temperature in order to keep their dyes from drying quickly while they are working on the screens.

Data Analysis

Temperature

The chart below shows the indoor temperature plotted along with the outdoor temperature.



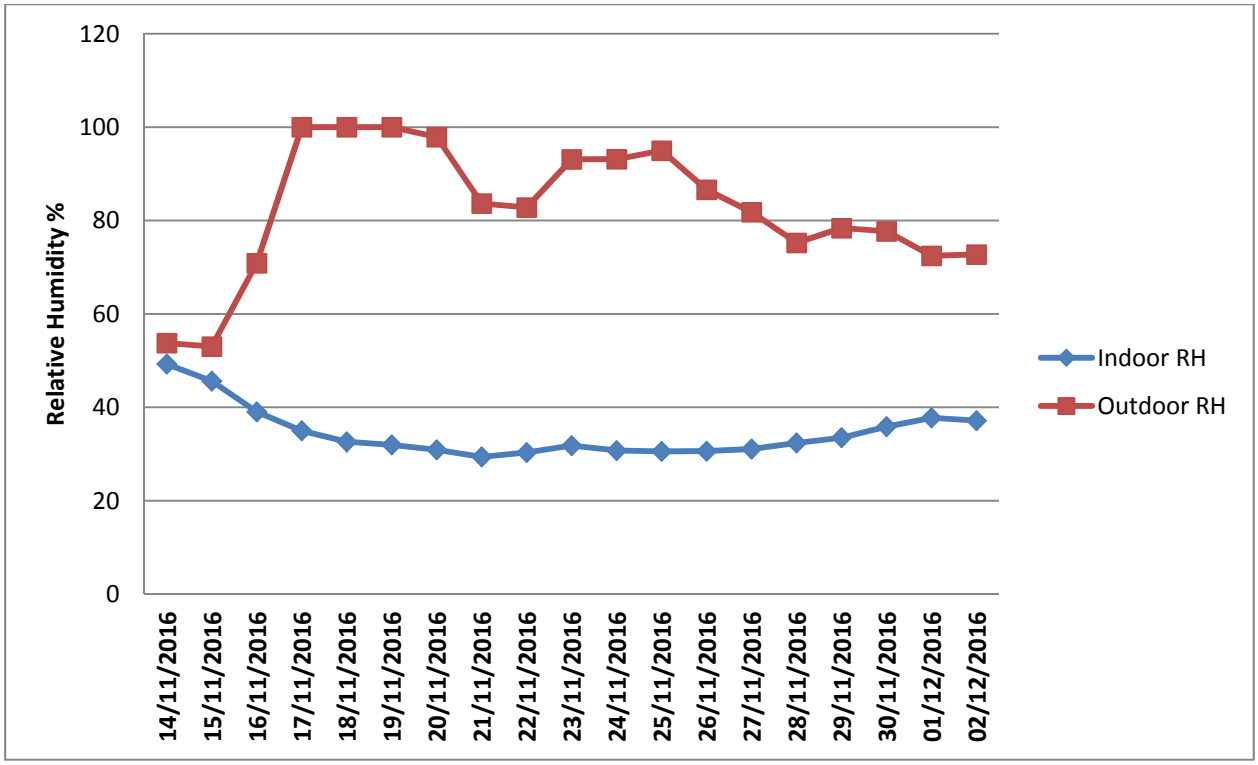
Since, the tiny tag was installed after two days, the accurate measure of outdoor temperature can be observed from 16/11/2016. According to the CIBSE guide A, the recommended comfort criteria for a teaching/exhibition spaces during the winter is 19-21 °C.[i] The red line on the graph marks the upper limit of the comfort range. **Clearly, the space is over-heating, as the temperature stays within the comfort limit only for a period of 3 days(between 20/11 to 23/11).**

The Mean temperature reaches a maximum of 21.91°C on the 16th of November.

Since we do not have accurate data about the window opening schedule, it cannot be predicted what effects it had on the indoor air temperature.

Humidity

The following graph shows the comparison between external RH and indoor RH. The indoor Relative Humidity is relatively low, and is in the range of 30% to 50%. However, the mean relative humidity has been significantly lower than 40% on 16 out of the 19 days that the Dye lab was monitored.



The CIBSE guide A states that in heated buildings in the UK "the humidity can remain below 40% RH during periods of sustained cold weather." However, precautions must be taken to prevent generation of dust or air-borne particles. [ii]

Particulate Matter

The data received from the particulate meter was converted to ug/m^3 and was only monitored from 22nd November.

PM2.5 and PM10 were monitored for the project.

The following equation was used to convert the data with a sample size of 1336.

PM2.5 $y=3.11+5.7E\text{-}3x+(-7.34E\text{-}8\ x^2)+3.04E\text{-}13x^3$

Mean = 10453.25

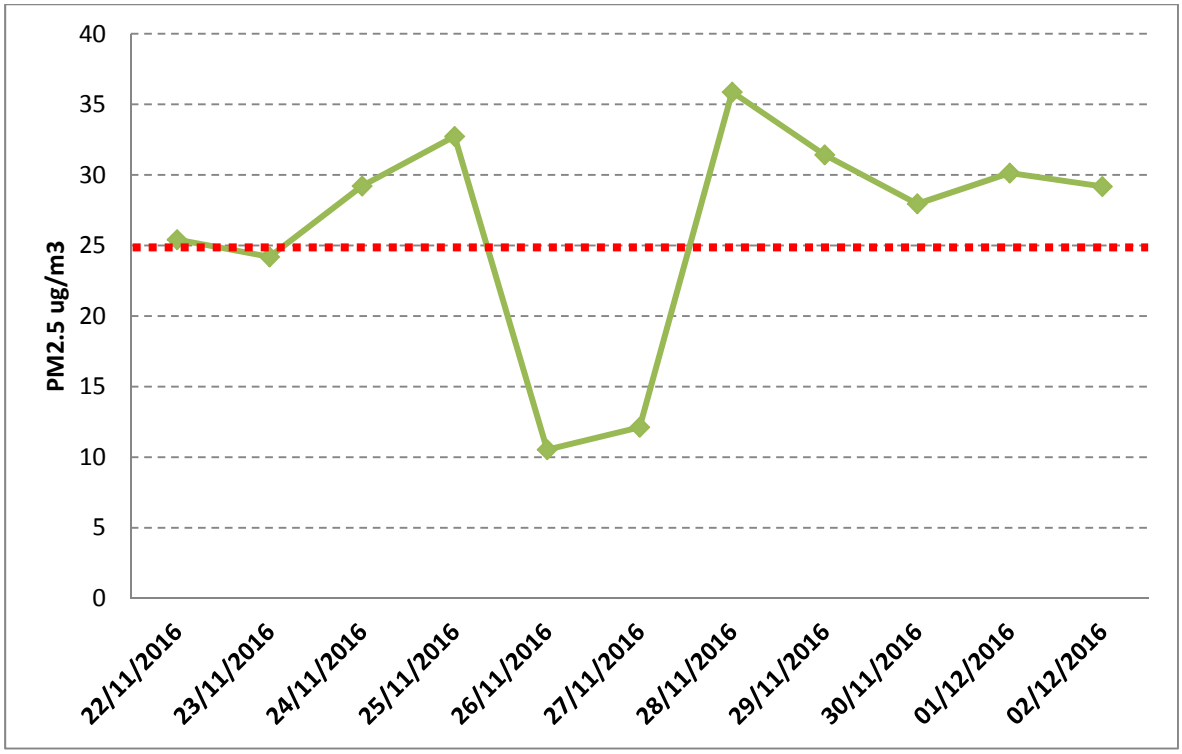
Standard Deviation = 103.748

PM10 $Y=4.96+2.96x+(-0.02x^2)+4.34E\text{-}5x^3$

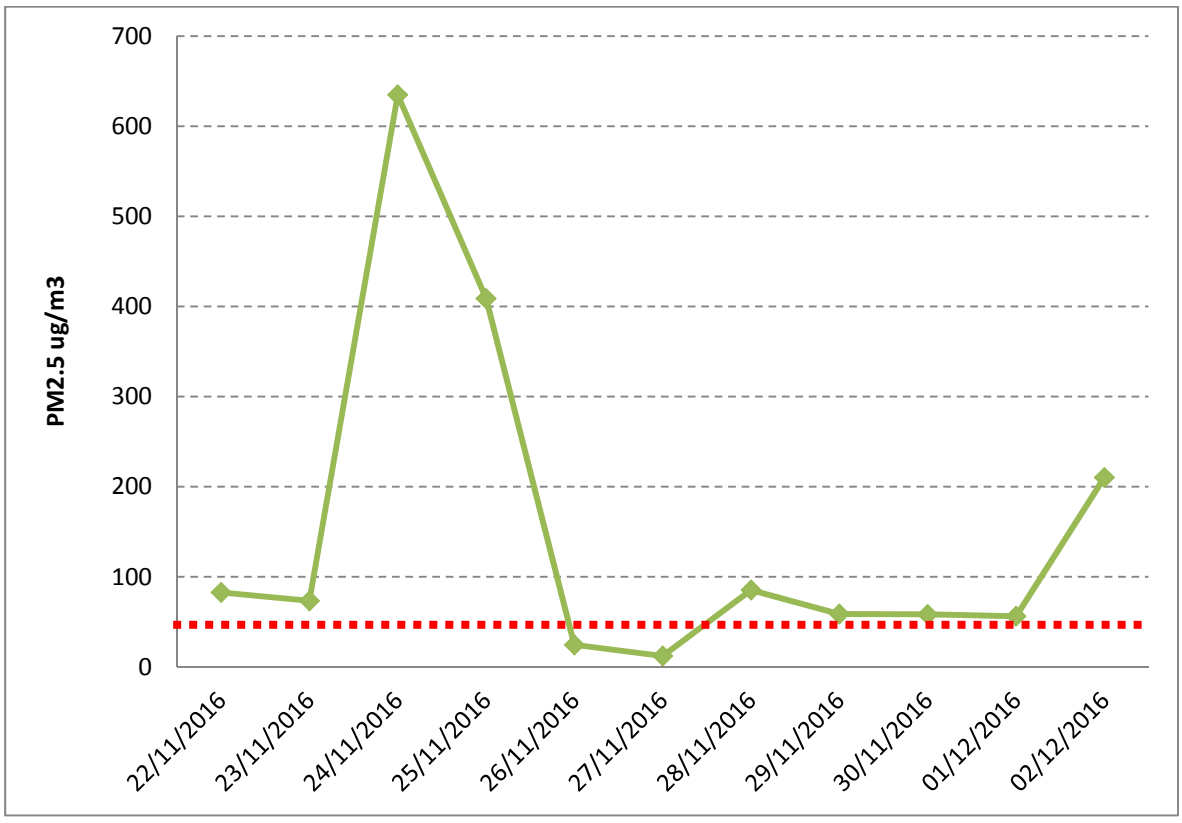
Mean = 74.34

Standard Deviation = 103.748

The WHO prescribes a limit of 25 ug/m^3 for PM2.5 particles and a limit of 50 ug/m^3 for PM10 particles for 24 hour mean. [iii]



Graph showing levels PM2.5 Particles in air



Graph showing levels PM10 Particles in air

The levels of PM 2.5 are significantly above the permissible limit on 7 out 11 days of monitoring with the highest average concentration going up to 35.87ug/m^3.

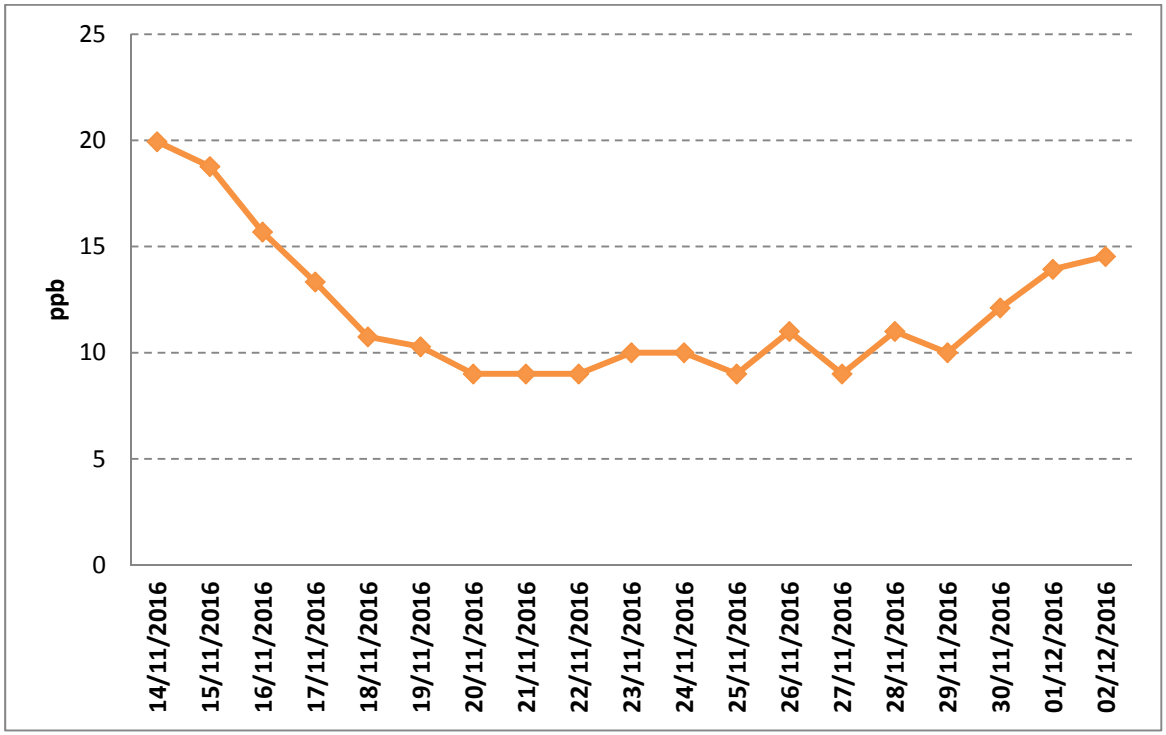
The levels of PM10 are above the prescribed limit on 9 out of the 11 days and shoot up to alarming levels of up to 634 ug/m^3 and 408 ug/m^3 on the 24th and 25th respectively.

This can be a serious health hazard and can cause cardio-vascular diseases and lung cancer as well. This needs to be addressed by the management of the educational institution.

The most common activity performed on the 24th and the 25th was the mixing of dyes and this could be a source of high particulate content in the air. The use of specific dyes must be further checked into**.**

Formaldehyde

Formaldehyde meter measured the levels of formaldehyde in the Dye Lab and they were found to be significantly lower than the WHO prescribed limit of 80ppb by mass.[iv] Sometimes the levels would dip below the detectable limit of 10ppb. Hence all values of less than 10ppb were assumed to be 9ppb in the data tables.



Conclusions and Suggestions

Since, it is established that the space is overheating, it is suggested that the controls of the underfloor heating must be provided locally. This will allow the occupants to control the temperature of the space.

The heat press could be moved to the corner of the space, to prevent it from obstructing the central path.

Since the humidity is relatively low, opening the window more often or adding a small humidifier might have a positive effect on the reduction of particulate matter.

The air change rate of the exhaust system must be increased while mixing dyes. Although masks are to be used while heating dyes, this rule must be thoroughly enforced due to the high particulate content.

[i] Table 1.5, pg.1-8, Recommended comfort criteria for specific applications , CIBSE Guide A – Environmental Design Criteria

[ii] Section 1.3.1.3 Humidity, Pg.1.4 CIBSE Guide A – Environmental Design Criteria

[iii] Table8.2, pg.8-8, Guideline values for individual substances, CIBSE Guide A – Environmental Design Criteria

[iv] Table8.2, pg.8-8, Guideline values for individual substances, CIBSE Guide A – Environmental Design Criteria