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Sick Building Syndrome—A Case Study

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The problem of 'sick building syndrome' was investigated by carrying out a field survey on the library building of the Hong Kong Polytechnic. The environmental conditions, indoor air quality and species of common bacteria were measured for a period of five months. The library staff were interviewed to get their subjective feelings on the environment. Results of this case study were presented and the relationship between those occupants' subjective feeling, indoor environment and prevalence of symptoms was analysed. Measurement results indicated that indoor environmental conditions could generally be maintained up to widely acceptable standards. Yet, feedback from staff did not show the expected consistency.

INTRODUCTION

THE DEFINITION for 'sick building syndrome' has been a controversial topic over the past years. Lots of professionals have been trying to define the problem but an internationally accepted standard still has not been reached. On the other hand, symptoms of SBS are difficult to diagnose as they are dominated by sensory reactions about which only very little is known even from the medical point of view [1]. Researches in finding out the effects of SBS on human health are limited.

To simplify the situation, SBS may be described as a phenomenon that occurs in a building in which a proportion of occupants experience varying degrees of low level sickness or discomfort which are nonspecific in nature and are dominated by sensory reactions. Furthermore, symptoms brought into a building are not considered as symptoms of SBS unless they are developed after an occupant enters the building and disappear very quickly upon his subsequent departure.

The sensory reactions are broadly classified by the WHO [2, 3], World Health Organization, into:

- sensoric irritation in eye, nose or throat;
- skin irritation;
- neurotoxic symptoms;
- unspecified hyperreactions and
- odour and taste complaints.

The exact causes of SBS have not been identified. Various past researchers [4, 5, 6] provided varying and sometimes conflicting argument. Yet, the general consensus is that they are related to indoor environmental variables including physical factors like air temperature, chemical factors like pollutants, biological factors like pollen of mould, and psychological factors [2].

Effects of SBS on human health have not been rigorously reported. There have been arguments about the attribution of illnesses to SBS. Should absenteeism be a suitable guideline? Such persistent low level symptoms may lead to subclinical infection which may eventually be converted to a clinical condition and result in absenteeism. Nevertheless, the decrease in productivity of workforce is notorious and the impact of SBS is worth investigating [7].

As air-conditioned or sealed buildings such as offices, hotels and tertiary education institutions are potential traps in which unnoticed causes of SBS can exist, the library building of the Hong Kong Polytechnic was therefore chosen to be the subject of the case study. Objectives could be summarized as follows to find out:

- the prevalence of the low level symptoms that characterized SBS as experienced by the staff;
- the relationship between the degree of comfort expressed by the staff and the corresponding indoor environmental conditions and the comparison with various widely accepted standards; and
- the relationship between the prevalence of symptoms, degree of comfort experienced by occupants and indoor environmental conditions.

THE SURVEY

The survey consisted of two main components: subjective assessment and objective measurement. To obtain subjective feeling, questionnaires (shown in Appendix A) were distributed to library staff at the Circulation, Acquisition, Cataloguing, Serial, Special Collection and Audio-Visual Sections as shown in Fig. 1. Details about the low level symptoms such as dryness and irritation of eyes, nose, throat, skin, headache, lethargy, dizziness etc. as experienced by staff were assessed.

Objective measurement was carried out at the same time as subjective assessment was obtained to find out the environmental conditions and to determine the possible relationship between these variables. The survey ran from October 1989 to February 1990. Environmental parameters being measured included:

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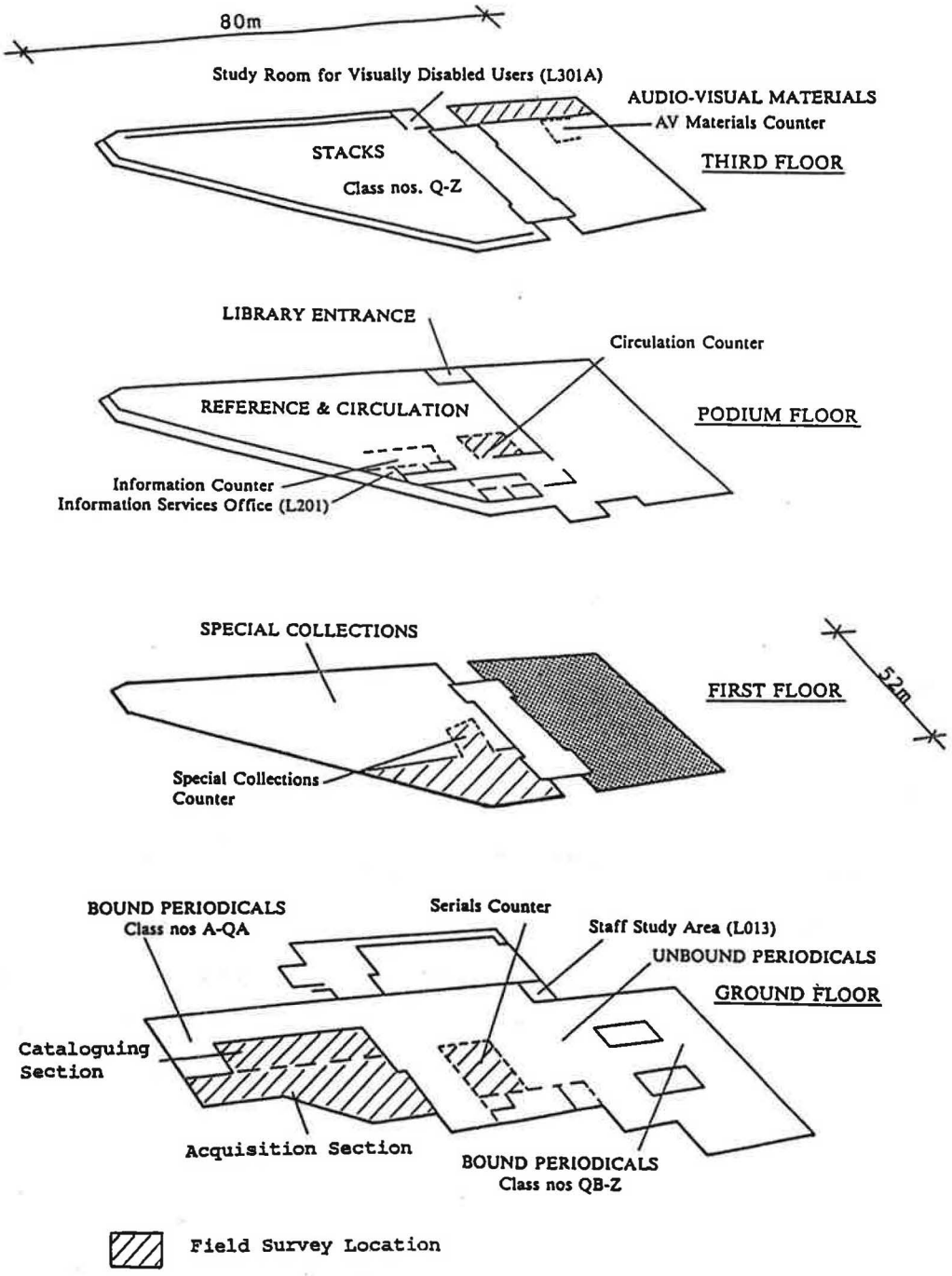


Fig. 1. HKP Library layout plan.

Physical aspects:
- —air temperature (D.B. °C, W.B. °C)
- —air velocity (m/s)
- —mean radiant temperature (°C)
- —surface temperature (°C)
- —illuminance level (lux)
- —noise level (dBA and the whole spectrum)
- —respirable dust particles ($\mu g/m^3$).

Chemical aspects:
- —THC (ppm)
- —NO (ppm)
- —NO_x (ppm)
- —SO_2 (ppm)
- —CO (ppm)
- —CO_2 (ppm)
- —Formaldehyde (ppb).

Biological aspects:
- —*Staph. epidermidis* (CFU/m^3 of air)
- —*Staph. aureus* (CFU/m^3 of air)
- —*Bacillus* (CFU/m^3 of air)
- —*Penicillium* (CFU/m^3 of air).

FINDINGS

The results of the survey are summarized in Tables 1(a) to 1(g) while Table 2 lists the recommended values for various indoor environmental parameters.

Prevalence of symptoms

Out of the total 253 responses from the five surveys carried out in the months stated with an average of 50 respondents per survey, 84% claimed that they experienced one or more symptoms during office hours. The average number of symptoms per respondent was three. The variation was greatest for Circulation and Serial Sections in January with one and six symptoms per respondent respectively. Figure 2 shows the number of work related symptoms experienced by staff members.

Lethargy and dry symptoms were most prevalent and

Table 1(a). Acquisition Section at G/F

Date	30 Oct.	27 Nov.	18 Dec.	22 Jan.	27 Feb.
Thermal environment					
D.B. temp (°C)	21.5	21	20	21.2	19
W.B. temp (°C)	18	17	16	16.5	15.3
R.H. (%)	72	69	69	63	70
Surface temp (°C)	18.5	20	19	20–21	17–18
Mean radiant temp (°C)	22	22	21	22	19.5
Air velocity (m/s)	0.1	0.17	0.1	0.1–0.35	0.1–0.5
Visual environment					
Task illuminance level (lux)	335–695	429	503	383–542	433–575
Ambient illuminance level (lux)	400–599	338	469	437–550	350–530
Audio environment					
dBA	52–58	45–48	50–58	50–52	47–53
Linear	80–81	78–80	80–84	82–84	82–84

Table 1(b). Serial Section at G/F

Date	30 Oct.	27 Nov.	18 Dec.	22 Jan.	27 Feb.
Thermal environment					
D.B. temp (°C)	22.5	22.5	21	22	19.8
W.B. temp (°C)	18.5	17.5	16.5	17.5	17.2
R.H. (%)	68	60	65	65	78
Surface temp (°C)	21–22	21–22	20–21	20–21	18
Mean radiant temp (°C)	23	23	21.5	22	18
Air velocity (m/s)	0.1	0.2	0.1	0.09	0.1
Visual environment					
Task illuminance level (lux)	380–520	320–510	420–528	432–545	413–513
Ambient illuminance level (lux)	350–560	331–565	368–555	400–584	480–600
Audio environment					
dBA	48–55	52–60	45–56	42–48	45–55
Linear	79–81	77–80	79–82	79–80	79–81

Table 1(c). Circulation Section at P/F

Date	30 Oct.	27 Nov.	18 Dec.	22 Jan.	27 Feb.
Thermal environment					
D.B. temp (°C)	22.3	21	20.5	20.8	19.5
W.B. temp (°C)	18	17	16.5	16	15.5
R.H. (%)	67	68	66	62	65
Surface temp (°C)	22–24	20–21	19–20	17–18	17–18
Mean radiant temp (°C)	22.8	21.7	21	21	19.5
Air velocity (m/s)	0.1	0.17	0.14	0.08	0.08
Visual environment					
Task illuminance level (lux)	450–650	400–470	350–410	366–411	471–533
Ambient illuminance level (lux)	400–700	453–533	390–419	353–424	470–500
Audio environment					
dBA	52–58	56–62	55–65	54–60	52–60
Linear	79–81	78–82	78–82	78–82	79–81

Table 1(d). Special Collection Section at 1/F

Date	30 Oct.	27 Nov.	18 Dec.	22 Jan.	27 Feb.
Thermal environment					
D.B. temp (°C)	21.5	21	20	19	19.5
W.B. temp (°C)	17	16	16	15	17.5
R.H. (%)	64	60	68	67	80
Surface temp (°C)	19–20	19–20	18–20	17–18	18
Mean radiant temp (°C)	22.8	21.5	20.5	20.2	18
Air velocity (m/s)	0.1	0.18	0.1	0.1	0.1
Visual environment					
Task illuminance level (lux)	410–470	396–445	400–450	405–428	576–598
Ambient illuminance level (lux)	313–400	265–450	310–420	350–400	490–625
Audio environment					
dBA	54	45–58	48–57	46–56	50–51
Linear	80	79–80	78–82	80–82	80–85

Table 1(e). Audio-Visual Section at 3/F

Date	30 Oct.	27 Nov.	18 Dec.	22 Jan.	27 Feb.
Thermal environment					
D.B. temp (°C)	22.5	21.3	21	18.5	19
W.B. temp (°C)	18	17.2	16.5	14.2	16
R.H. (%)	67	68	65	65	75
Surface temp (°C)	20	20	19–20	16–17	17–18
Mean radiant temp (°C)	29.2	22	21.5	19	19.2
Air velocity (m/s)	0.1	0.2	0.1	0.07–0.15	0.08
Visual environment					
Task illuminance level (lux)	476–636	465–629	480–622	500–648	520–630
Ambient illuminance level (lux)	440–630	430–720	420–680	400–800	420–650
Audio environment					
dBA	52	50–58	50–54	49–52	49–50
Linear	80	79–81	80–82	79–81	79–81

Table 1(f). Date: 27 February

Chemical contaminants and dust particles	THC		NO		NO_x	SO_2	
	(ppm)	(mg/m^3)	(ppm)	(mg/m^3)	(ppm)	(ppm)	(mg/m^3)
Serial	2.7	1.104	0.0684	0.084	0.07665	0.0015	0.004
Circulation	2.8	1.145	0.10175	0.125	0.1151	0.0015	0.004
A–V	2.7	1.104	0.0836	0.103	0.0973	0.002	0.005
S. collection	2.8	1.145	0.07925	0.097	0.09225	0.003	0.008

Chemical contaminants and dust particles	CO		Formaldehyde		CO_2		Respirable dust particles	
	(ppm)	(mg/m^3)	(ppb)	(mg/m^3)	(ppm)	(mg/m^3)	0.45–5 μm (mg/m^3)	>0.5 μm (count/ft^3/min)
Serial	0.2	0.229	300	0.375	594	1069	0.0071	177829
Circulation	0.3	0.344	850	1.063	88	158	0.05463	94490
A–V	0.3	0.344	200	0.25	61	99	—	52929
S. collection	0.3	0.344	1000	1.25	636	1145	—	38598

around 40% of the respondents experienced lethargy, 36% suffered dryness of eyes, 36% dryness of mucous membrane of nose and 34% dryness of skin. The other more common symptoms were sensoric irritations and problems with upper respiratory tract. Irritation of eyes and nose was in general below 40% while upper respiratory tract problems were more serious in the Circulation Section.

As suggested by past researchers [8], symptoms may be more prevalent at the beginning of a week which may be the result of switching off the central air-conditioning plant leading to the faster growth of micro-organisms. However, this survey did not support the proposition. Perhaps this may be explained by the fact that the library was still open on Saturdays and Sundays.

In order to investigate the relationship between preva-

Table 1(g). Serial Section at G/F. Bacterial count (CFU/m³)

Date Time	30 Oct. 12:00	30 Oct 19:00	27 Nov. 12:00	27 Nov. 19:00	18 Dec. 12:00	18 Dec. 19:00	22 Jan. 12:00	22 Jan. 19:00	27 Feb. 12:00	27 Feb. 19:00
Staph. aureus	72	19	34	29	39	29	22	12	19	6
Staph. epidermidis	22	15	19	21	14	5	15	3	16	4
Bacillus spp.	11	1	4	4	9	1	16	11	17	6
Penicillium spp.	0	4	20	9	5	1	6	4	7	6
Total	105	39	77	63	67	36	59	30	59	22

Table 2. Recommendation on indoor environmental conditions

A. Thermal Environment	ISO Standard		CIBSE Guide		ASHRAE Standard	
	Winter	Summer	Winter	Summer	Winter	Summer
Air temp. (°C)	21±2	24.5±1.5	19–20	20–22	20–23.6	22.8–26.1
R.H. (%)	—	—	40–70	40–70	—	—
Mean air speed (m/s)	<0.15	<0.25	0.1–0.15	0.1–0.24	<0.15	<0.25

B. Air Contaminant (mg/m³)	WHO	ASHRAE Standard (62-1989)
NO_2	0.32	0.1 (average 1 year)
CO	30	40 (1 hour) 10 (8 hour)
CO_2	1200	1800 (continuous)
Formaldehyde	0.12	0.12 (continuous)
SO_2	1.35	0.08 (1 year)
Particulates	—	0.075 (1 year) 0.26 (24 hour)

C. Visual Environment	CIBS Code	IES
Illuminance (lux) (General Office)	500	300–500–750

D. Audio Environment	CIBSE Guide
Noise level (General Office)	45 NR or 51 dB (A)

lence of symptoms and occupants' subjective feeling towards the environment, a subjective rating was devised according to their overall responses in the five areas: namely, thermal environment, air quality, visual environment, audio environment and psychological factors. Zero score was given for neutral feeling while higher scores were allocated for successive increase in discomfort. Negative score would be included when the occupant favoured the factor. The total score for the five areas would be the subjective rating that indicated the respondents' feeling towards the environment. The higher the total rating, the more will be the negative feeling.

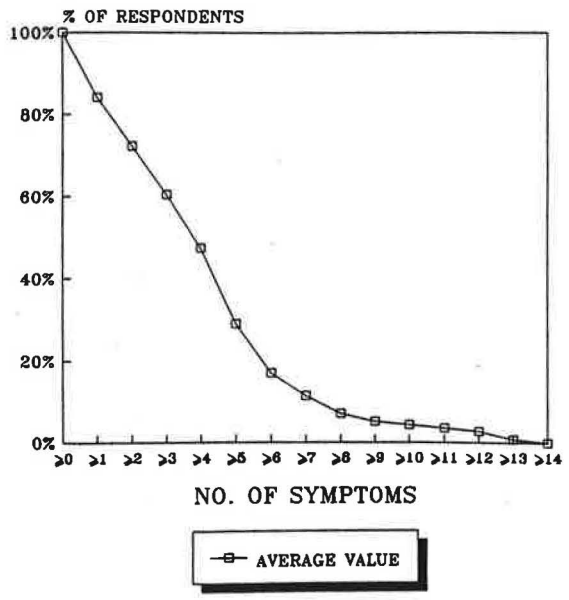


Fig. 2. Number of symptoms experienced by staff.

The relationship between the subjective ratings and the numbers of symptoms is shown in Fig. 3. A linear regression line is included to show the general trend. The slope of 0.7 indicates the positive relation between ill feeling and the number of symptoms experienced. The positive intercept indicates that symptoms will usually not emerge until certain degree of dissatisfaction with the environment is developed. As the sample size is small, the actual mathematical relationship has to be derived by future researches with much larger sample sizes.

Indoor environment and subjective feeling

The survey indicated that indoor conditions of the library generally were within acceptable standards except

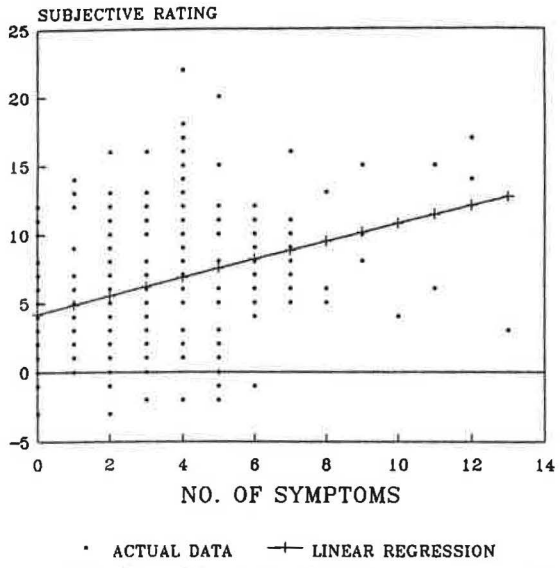


Fig. 3. Subjective rating vs no. of symptoms, October 1989–February 1990. Note: Each point represents the rating of each respondent and there is overlapping of points.

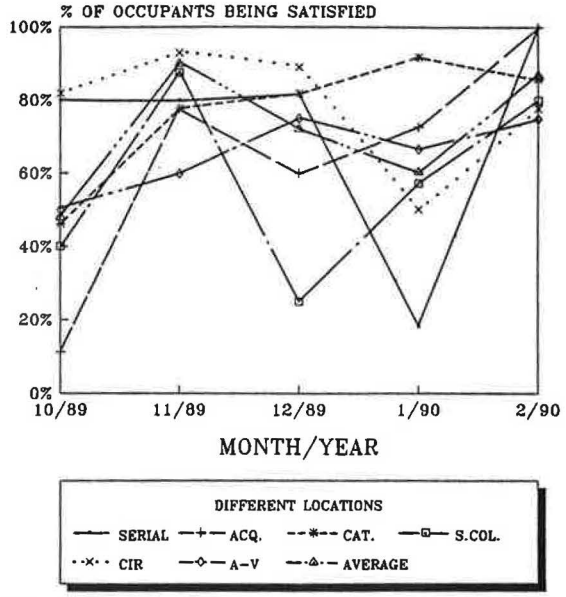


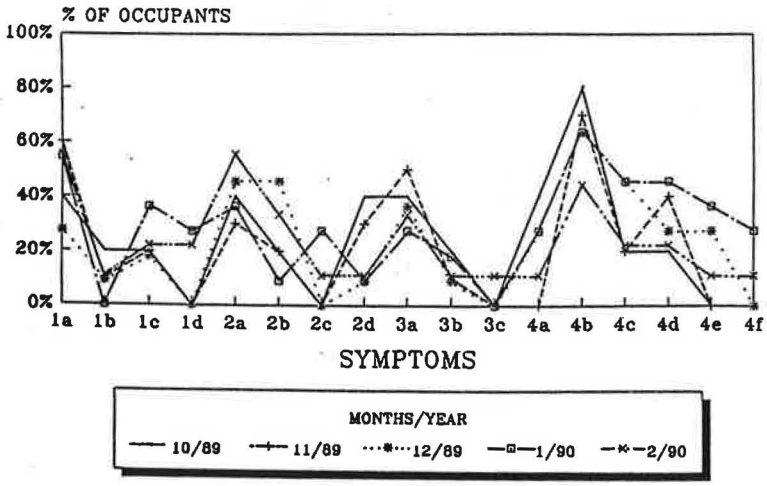
Fig. 5. Subjective rating for temperature (monthly variation).

the contamination level for formaldehyde. The variation in prevalence of symptoms with respect to the different indoor environmental conditions has been analysed by plotting the percentages of respondents with different symptoms during different periods throughout the survey. Figure 4 shows the monthly variation at the Serial Section of the library. It can be observed that the occurrence of symptoms generally follows a random pattern and no definite seasonal variation can be identified.

Thermal environment. From the analysis, it was found that the dry bulb temperature varied from 18.5°C to 22.5°C while the relative humidity varied from 60% to 80% in the months under consideration. The air velocity varied from 0.08 m/s to 0.2 m/s. Although these data lie within various standards, the respondents will be more satisfied if the indoor air temperature is lower in winter such as 19°C to 20°C and higher in summer. This may be due to the variation in the clothing worn by occupants in different seasons. Figure 5 shows the subjective rating in temperature as reported by occupants.

It is interesting to note that although the relative humidities recorded were all above 60%, nearly half of the respondents still felt that air was too dry and the problem was alleviated in February when the relative humidity was 70% to 80%. Figure 6 reveals the subjective feeling of occupants towards relative humidities throughout the months under consideration. Dry symptoms therefore do not appear to be related to relative humidity nor feeling of dryness by occupants. This agrees with Robertson about the loose relationship between sick building syndrome and the decrease in relative humidity [9].

Complaints of air stuffiness were higher when air velocity was considered slow. A linear regression line on this relationship is shown in Fig. 7. Occupants seem to be more satisfied when air velocity can be raised above



SYMPTOMS

1. Problems with nose
   - 1a. dryness
   - 1b. itching, stinging sensation
   - 1c. stuffy nose
   - 1d. runny nose
2. Problems with eyes
   - 2a. dryness
   - 2b. itching, stinging sensation
   - 2c. watering eyes
   - 2d. reddening of eyes
3. Problems with skin
   - 3a. dryness
   - 3b. itching, stinging sensation
   - 3c. reddening of skin
4. Neurotoxic symptoms
   - 4a. reduced memory
   - 4b. tired or sleepy feeling
   - 4c. reduced power of concentration
   - 4d. headache
   - 4e. dizziness, intoxication
   - 4f. nausea or feeling of vomiting

Fig. 4. Monthly variation of symptoms, Serial Section at G/F.

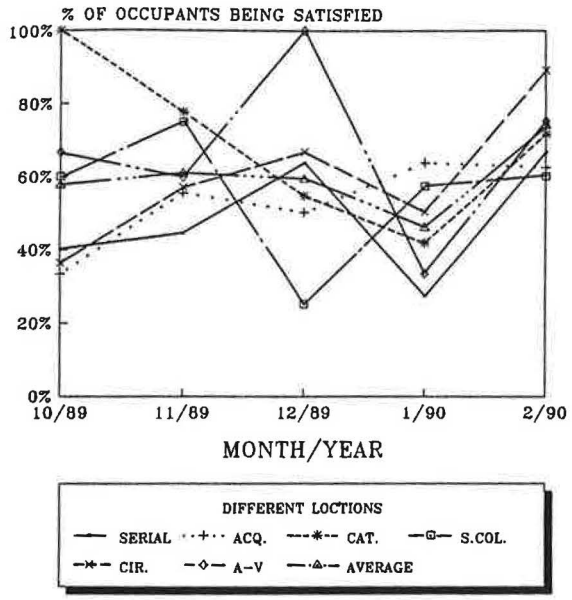


Fig. 6. Subjective rating for relative humidity (monthly variation).

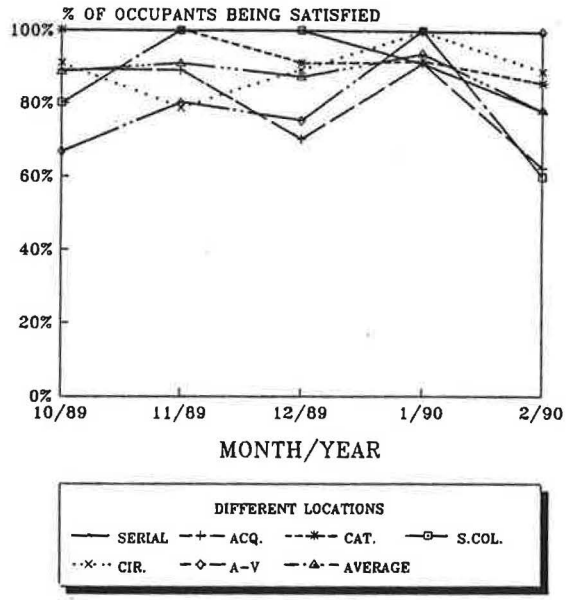


Fig. 8. Subjective rating for illuminance level (monthly variation).

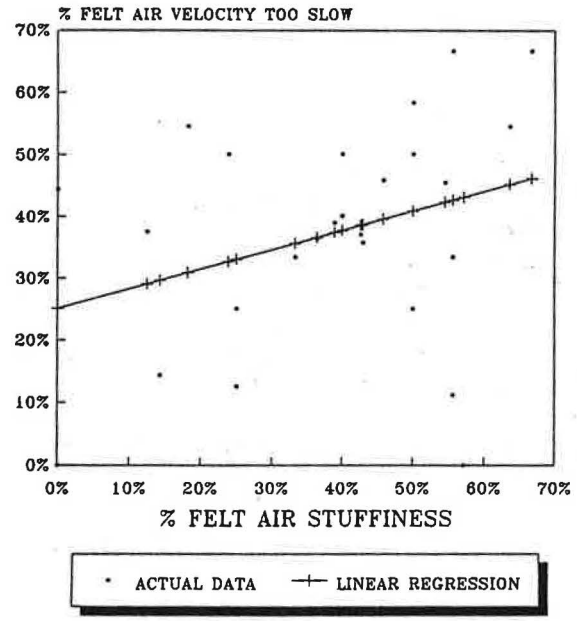


Fig. 7. Feelings on air velocity vs perception of stuffiness.

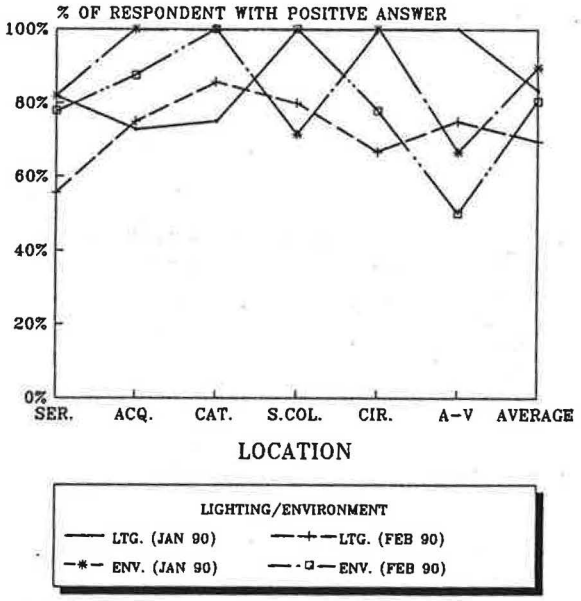


Fig. 9. Subjective rating for color perception, lighting/environment.

0.1 m/s. On the other hand, it is suggested by ISO and ASHRAE standards [10] that air velocity should be kept below 0.15 m/s in winter and 0.25 m/s in summer as design temperature in summer is slightly higher.

The phenomenon of having more complaints on air stuffiness when air temperature or relative humidity is high as suggested by some researchers [7] does not seem to occur in this case. Air stuffiness does not seem to bear any steady relationship with the sensation of air temperature or relative humidity.

Visual environment. The ambient and task illuminance levels in the offices of the library varied from around 320 lux to 700 lux. As indicated in Figs 8 and 9, more than 70% of staff were satisfied with the illuminance level while less than 20% complained about glare, and more than 80% appreciated the colour of lighting and colour scheme of the indoor environment. It may therefore be concluded that the visual environment is satisfactory despite some complaints about flickers from fluorescent lamps.

Audio environment. Noise level in the library varied from 42 dBA to 65 dBA at different locations throughout the survey period. In general, noise level increased by 6 dB to 10 dB when typing was carried out. On many occasions, the noise level exceeded the recommended NR45 value. Figure 10 shows the subjective feeling of library staff towards the audio environment and they would be more satisfied if the working environment could be quieter.

The identified disturbing noise was found pre-

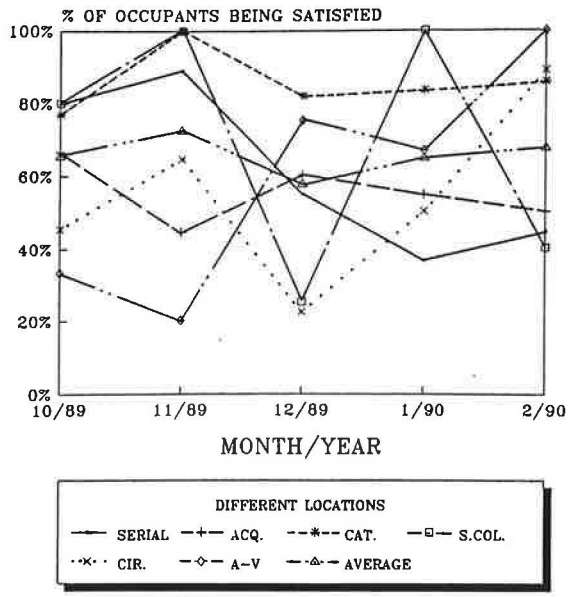


Fig. 10. Subjective rating for audio environment (monthly variation).

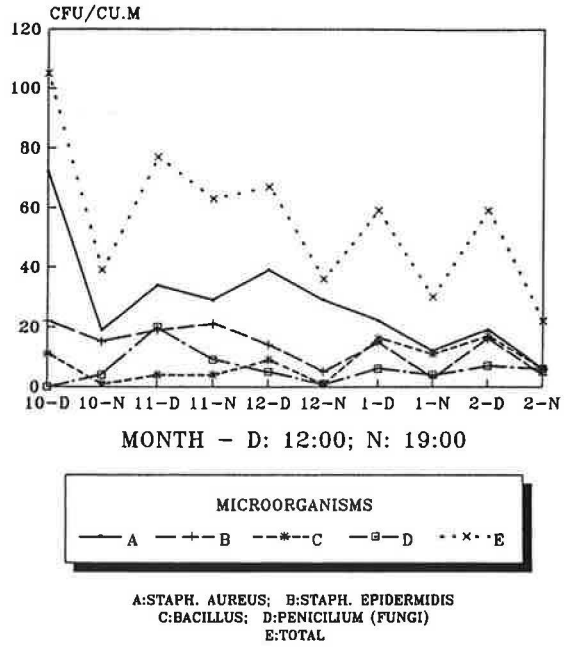


Fig. 11. Bacterial count in the air (October 1989–February 1990).

dominantly in the low frequency region which may lead to complaints of headaches, distraction of attention and difficulties with reading and writing.

Air quality—chemical contaminants. In general, contaminant levels of chemicals like CO_2, NO, SO_2 and CO etc. were all within the recommended values laid down in ASHRAE or WHO [10] except formaldehyde. The formaldehyde concentrations varied from 0.25 mg/m^3 to 1.25 mg/m^3 in the four locations where plywood boards, fabrics and carpets would be the potential sources. Eye irritation threshold is likely to be exceeded [11–13] and this may partly account for the irritation feeling on eyes. However, its effect on general respiratory health is at present still not very clear and it cannot be relied upon to explain the problems associated with upper respiratory tract. Besides, concentration of gases like ozone and total volatile organic compound (TVOC) was not assessed. The volatile organic compounds like toluene, methyl chloroform and carbon tetrachloride can be dissolved readily and absorbed by the lung and skin. Many of them are irritants and neurotoxic agents and if present in sufficient concentrations may pose threats to human health with respect to acute and chronic effects. The problem is further complicated by the combined effects of a mixture of VOC rather than those due to an individual compound alone [11]. As the combined effects of these low concentration contaminants are still a mystery, the answer to their possible impact on occupants has to be ascertained from future researches.

The CO_2 level in January in the Serial Section was about 1730 ppm which exceeded the ASHRAE recommended value of 1000 ppm for continuous exposure [12] and was equal to 2.7 times to 28 times the concentration in other areas where the CO_2 level varied from 61 ppm to 636 ppm. This indicates that the amount of fresh air was not enough and this may be one of the reasons for more complaints about air stuffiness in the Serial Section than others.

Air quality—dust particles. The amount of respirable dust particulates in the range of 0.45 μm to 5 μm in air was measured and was found to be on the average 42 μg/m^3 and 6 μg/m^3 in the Circulation and Serial Sections respectively. The recommended maximum concentration of particulates in the range of 0.1 to 100 μm by the National Primary Ambient Air Quality Standards [5] is 75 μg/m^3 for long exposure. It can therefore be imagined that the total respirable particulates in the Circulation Section would probably be quite high. It may be due to dusty books that a large portion of staff are required to handle. In fact, there were complaints by a number of staff in the open ended questions that the air was dusty. Dust particulates in the respirable particle class (<2.5 μm) will present a greater risk to health as they are readily breathed deep into the lungs, circumventing many respiratory defence mechanisms, and can deliver high concentrations of potentially harmful substances to body tissue. Particulates may themselves be chemically reactive or act as a carrier for other harmful chemical species such as polynuclear aromatic hydrocarbon [13]. Mucous membrane irritation and impairment of respiratory system is likely to result. This may therefore be one reason causing itchy, stuffy and runny noses as experienced by library staff. However, the problem of dryness of nose mucous membrane does not seem to be correlated with respirable particulates because of its prevalence in all locations.

Air quality—biological aspect. As shown in Fig. 11, the total number of the four types of micro-organisms, viz. *Staph. aureus*, *Staph. epidermidis*, *Bacillus*, and *Penicillium* in the Serial Section varied from more than 100 CFU/m^3 in October 1989 to only around 20 CFU/m^3 in February 1990. However, their relationship with the prevalence of symptoms cannot be found.

Some studies suggested that a level of viable particles in occupied space in office buildings in excess of about

1000 CFU/m^3 may need further investigation or improvement in hygienic conditions [11]. As only four types of micro-organisms were measured, this may not represent the actual total CFU/m^3 and so it cannot be concluded whether or not the concentration of micro-organisms in the air inside the library is acceptable.

Concentration of micro-organisms in air was in general higher in the afternoon than in the evening. This may be due to the fact that these micro-organisms are all commonly found and very often human bodies are being used as hosts. For example, *Staph. aureus* are found on the anterior nasal mucosa of 40% to 50% of healthy adults. *Staph. epidermidis* are found in large numbers all over human skin and on many mucous surfaces. The variation pattern of these micro-organisms may be due to a decrease in host number in the library in the evening.

No relationship between difficulties in breathing and the presence of *penicillium* in air is revealed.

Psychological factors. More than 80% of the respondents were satisfied with the colour of lighting and colour scheme of the indoor environment. Their effect on prevalence of symptoms can be eliminated.

From the response of the staff, the percentages of respondents that were satisfied with their working area in terms of ergonomics increased with increasing space per person. Besides, around 80% preferred to have windows nearby. Prevalence of symptoms was found to be higher if the working environment was completely sealed from the outside. However, the relationship between lethargy and enthusiasm about work could not be found.

CONCLUSION

Comparison between the measured environmental parameters and the generally accepted standards such as the ASHRAE Standard (62-1989) [5] and CIBSE guide [15, 16] reveals that the library building should be operating largely in a satisfactory condition. The identified problems were the high noise and relative humidity levels coupled with aggravated formaldehyde concentration. Yet, feedback from library staff does not show consistent arguments. The elements which are the most possible causes of SBS therefore cannot be identified. The major difficulty is that the environment is not under control and various parameters may vary at the same time. Nevertheless, it can be concluded that the prevalence of symptoms varies positively with the degree of dissatisfaction with the environment. It will be higher when occupants are more dissatisfied. The changes in ill feeling, however, will be less responsive to the changes in number of symptoms. Furthermore, it is not until a certain degree of dissatisfaction with the environment is developed that symptoms will appear. In order to minimize the occurrence of SBS, improvement to indoor environmental conditions will definitely be the proper starting point.

Dry symptoms and lethargy are the most prevalent symptoms with some minor symptoms which include irritation of skin, eye and nose and other neurotoxic ones like headaches which may be caused by the high formaldehyde concentration. Their occurrence does not exhibit any definite seasonality. Dry symptoms do not appear to be related to the feeling of dryness nor to the actual relative humidity. They exist despite the comparatively high relative humidity of over 60%. Respirable dust particulates may account for itchy, stuffy and running noses, but no direct correlation with dryness of nose mucous membrane can be inferred. Relationship cannot be found between the prevalence of lethargy and the enthusiasm of occupants about their work. Lethargy is non-specific and may be due to many reasons like inadequate sleep and after-lunch inactivity. Therefore, dry symptoms and lethargy are concluded to be caused by some other factors and probably due to TVOC which had not been measured in this study. Relationship between eye symptoms and visual environment also cannot be pin-pointed.

As already mentioned, CO_2 level in January in the Serial Section was highest. This is matched by the corresponding largest number of symptoms per person. Closer analysis reveals that complaints about air dryness, stuffiness and temperature were strong. Physical measurements indicate that air temperature, velocity and relative humidity were most extreme when compared with other locations on the same day. This may be the result of improper operation of the air-conditioning system with inadequate ventilation rate and fresh air. There will thus be another aspect that can be focused on to mitigate the problem of SBS: proper design, installation, operation and maintenance of building services, particularly the air-conditioning system.

The existence of numerous low level contaminants in the ambient air has long been confirmed. However, their effect on human beings is only surmised. The problem is further complicated by the fact that pollutants may act independently, antagonistically or synergistically. To further the analysis, research shall be carried out in controlled environments so that the effect on the prevalence of symptoms can be studied as far as possible by isolating one parameter from another. The cross-sensitization effect can be investigated by more extensive research so that the results obtained in problem areas can be compared to the results from those areas where no problems are perceived to exist. Subsequent critical synthesis of the data derived from controlled and uncontrolled environment may then pave the way to clarify the obscurity of sick building syndrome.

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APPENDIX A
QUESTIONNAIRE ON THE ANALYSIS OF SICK BUILDING SYNDROME FOR THE LIBRARY BUILDING AT THE HONG KONG POLYTECHNIC

I. GENERAL INFORMATION

1. Sex: _____ 2. Age: _____
3. Do you smoke?
( ) a. Yes ( ) b. No

II. NATURE OF WORK

1. What is your position?
_____
2. What types of work are you handling?
_____
3. Where is your location of work?
_____
4. Do you need to sit in the same area during office hours?
( ) a. Yes ( ) b. No
5. How many years have you been working in the present location?
_____
6. What is your rating for the stress in work?
( ) a. Very high ( ) c. Average
( ) b. High ( ) d. Low ( ) e. Very low
7. Do you like your work?
( ) a. Yes ( ) b. No

III. THERMAL COMFORT

1. How do you feel about the ambient air temperature?
( ) a. Very cold ( ) c. Cool ( ) e. Warm
( ) b. Cold ( ) d. Satisfactory ( ) f. Hot ( ) g. Very hot
2. Do you experience draughts?
( ) a. Yes ( ) b. No
3. How do you feel about the room air?
( ) a. Too dry ( ) b. Satisfactory ( ) c. Too wet
4. Do you have control over the air temperature for your working area?
( ) a. Yes ( ) b. No

IV. AIR QUALITY

1. What is your feeling towards the ambient air?
( ) a. Very Stuffy ( ) b. Stuffy ( ) c. Fresh ( ) d. Very Fresh
2. Do you sense the presence of any odour?
( ) a. Yes ( ) b. No
3. Where does the odour come from if it exists? (more than one answer is possible)
( ) a. Cigarettes ( ) e. Ceiling tiles
( ) b. Papers or books ( ) f. Furniture
( ) c. Other occupants ( ) g. Wall finishes
( ) d. Carpet ( ) h. Others (Please specify: _____)
4. How do you feel about the odour?
( ) a. Unacceptable ( ) b. Acceptable
5. What is your overall rating for the indoor air quality?
( ) a. Satisfactory ( ) b. Acceptable ( ) c. Unacceptable

V. VISUAL ENVIRONMENT

1. How is the lighting level at your task area?
   ( ) a. Too high ( ) b. Satisfactory ( ) c. Inadequate
2. Do you think that your performance of work may be improved at higher lighting level?
   ( ) a. Yes ( ) b. No
3. Is there any glare troubling you?
   ( ) a. Yes ( ) b. No
4. Where does the glare come from if it exists? (more than one answer is possible)
   ( ) a. Sun rays through window ( ) b. Luminaires ( ) c. Reflecting surface
5. Are you troubled by flicker from the fluorescent lamps?
   ( ) a. Yes ( ) b. No
6. Do you need to work with VDUs?
   ( ) a. Yes ( ) b. No
7. If you have to work with VDUs, what is the duration you normally spend per day?
   ( ) a. Duration <2 hours ( ) c. 3 hours ≤duration <4 hours
   ( ) b. 2 hours ≤duration <3hours ( ) d. 4 hours ≤duration <5 hours
   ( ) e. 5 hours ≤duration (Please specify: _____)
8. Is there any light reflected from the VDU screen?
   ( ) a. Yes ( ) b. No
9. Do you find the VDU screen visually comfortable?
   ( ) a. Yes ( ) b. No
10. Have you ever experienced the following symptom(s) when working with VDUs and the symptom(s) disappear quickly after not using it? (more than one answer is possible)
    ( ) a. Eye strains ( ) c. Dryness of eyes
    ( ) b. Running eyes ( ) d. Irritation of eyes

VI. AURAL ENVIRONMENT

1. How do you feel about the aural environment?
   ( ) a. Very noisy ( ) b. Noisy ( ) c. Quiet
2. What is the nature of the noise?
   ( ) a. High frequency ( ) b. Low frequency ( ) c. Cannot be identified
3. What are the noise sources if they exist? (more than one answer is possible)
   ( ) a. Ventilation system ( ) b. Typewriters ( ) c. Conversation
   ( ) d. Office machines (Please specify: _____)
   ( ) e. Noise from outside (e.g. street traffic, refurbishment work, aeroplane etc.)
   ( ) f. Others (Please specify: _____)
4. How do you rate the aural environment?
   ( ) a. Satisfactory ( ) b. Unsatisfactory ( ) c. Annoying

VII. ERGONOMICS

1. Is your working position constantly in the view of others?
   ( ) a. Yes ( ) b. No
2. Can you exercise some control over people entering directly into your working area?
   ( ) a. Yes ( ) b. No
3. How do you feel about your working area?
   ( ) a. Very spacious ( ) c. Neutral
   ( ) b. Spacious ( ) d. Tight ( ) e. Very tight
4. Do you find your working area comfortable?
   ( ) a. Yes ( ) b. No

VIII. HEALTH

1. What is the average number of days per year that you are absent because of illness?
   ( ) a. 0 ( ) b. 1–3 ( ) c. 4–6 ( ) d. >6
2. What type(s) of illness did you suffer in those absent days? (more than one answer is possible)
   ( ) a. Respiratory problems ( ) c. Problems with nose
   ( ) b. Allergic problems ( ) d. Problems with eyes
   ( ) e. Others (Please specify: _____)
3. Have you experienced the following symptom(s) during office hours only and they disappear or alleviate quickly after leaving the office? (more than one answer is possible)

   3.1 Problems with nose
   ( ) a. Dryness ( ) c. Stuffy nose
   ( ) b. Itching, stinging sensation ( ) d. Running nose

   3.2 Problems with eyes
   ( ) a. Dryness ( ) c. Watering eyes
   ( ) b. Itching, stinging sensation ( ) d. Reddening of eyes

   3.3 Problem with skin
   ( ) a. Dryness ( ) c. Reddening of skin
   ( ) b. Itching, stinging sensation

   3.4 Neurotoxic symptoms
   ( ) a. Reduced memory ( ) d. Headache
   ( ) b. Tired or sleepy feeling ( ) e. Dizziness, intoxication
   ( ) c. Reduced power of concentration ( ) f. Nausea or feeling of vomiting

IX. OVERALL SUBJECTIVE RATING FOR THE WORKING AREA

1. What is your feeling towards the working area?
   ( ) a. Very comfortable ( ) c. Acceptable
   ( ) b. Comfortable ( ) d. Uncomfortable ( ) e. Very uncomfortable
2. Do you like the internal environment?
   ( ) a. Yes ( ) b. No
3. Do you find that some/all of the symptoms you experienced as stated in VIII (3) above also occurred in the past during office hours?
   ( ) a. Very often ( ) c. Seldom
   ( ) b. Sometimes ( ) d. Never
4. Do you find that these symptoms are more obvious at the beginning of a week e.g. on Mondays and Tuesdays?
   ( ) a. Yes ( ) b. No
5. Do you have any other comments on the internal environment e.g. air temperature, air quality, lighting, noise etc?

Thank you for completing this questionnaire. EnCoQ(S)