

17th World Congress on Ergonomics

Winning Telebet Centre Design: Apply Participatory Ergonomics to Promote Work Health & Safety, Employee Wellness and Operational Efficiency

Justine, M Y, CHIM

Human Resources Manager (Employee Safety and Services), The Hong Kong Jockey Club

Peter, S G, NG

Head of Telebet Services, The Hong Kong Jockey Club

Stephen, T C, TAI

Telebet Manager (Tin Shui Wai), The Hong Kong Jockey Club

Keywords: Participatory ergonomics, work health and safety, telephone operator

The application of ergonomics and occupational health and safety principles has a strategic significance in developing new workplaces at the Hong Kong Jockey Club (“the Club”). At present, the Club has four telephone betting call (“Telebet”) centres with a total of 3,900 operator workstations and employs 9,000 operators to provide 24 hours and 7 days quality betting entertainment services to customers. The Club is developing the fifth call centre with a capacity of 1,000 operator workstations and will commence operations in 2009. The project team incorporated modern architectural designs at this new centre to elevate the occupational health and safety standards so as to meet the corporate commitments towards staff wellness, customer services and operational productivity. This paper summarizes the real case experience on participatory ergonomics to develop a new Telebet call centre.

Internal specialists, comprising Telebet management, occupational safety and health & ergonomics, building services, and Telebet staff representatives, an external architect and academic consultants were the key contributors to develop the overall design criteria for the new centre. In the preliminary design stage, direct observations and assessment methods were adopted to identify the key occupational safety and health, as well as ergonomics issues, interacting between the telephone operator and the task, workstation, computer accessories and overall work environment. Latest research papers and regulatory guidelines were reviewed for benchmarking. About 150 management staff and operators were also interviewed to collect user feedback on improvement needs for the existing Telebet centres. Six key areas of concern were identified: (1) operations’ hall design; (2) lighting and vision comfort; (3) ventilation and indoor air quality; (4) washroom and rest area facilities; (5) operator-workstation layout; (6) computer accessories and phone systems and (7) operator seating design. The outcomes were similar to the published research findings. According to the received feedback, ergonomics interventions were applied in the design, mock-up, and construction stages, focusing on advancement of the global centre design, operator workstation and operational efficiency.

In the design evaluation stage, concept mock-up workstations and fully configured pre-production mock-up workstations together with the relevant environmental set up were built to evaluate: (1) Ergo-design Workstation; (2) Operator Hall and (3) Global Centre Design. Six groups of male and female employees from large, medium and small body build were invited for the evaluation on operator-workstation fit and operator’s seating. Design specifications of the workstation height, workspace on desktop, height adjustability range of monitors and leg room were confirmed. Study participants were asked to evaluate the level of lighting comfort and illuminance at the workstation. Lighting fixtures and layout were assessed. A number of assessments were conducted to evaluate the acoustic features for room absorption, background noise effect and speech transmission. The benefits of progressive mockup evaluation were noted to determine the final design of the centre, fitting and fixtures for all components.

INTRODUCTION

Workplace health and safety is not confined to preventing injury and disease but aims to design the best workplace environment which promotes the employees' well-being and operations efficiency in an organization. The Occupational Safety and Health Ordinance ("OSH Ordinance") (Cap 509) came into effect in May 1997 which covered all workplaces in Hong Kong. The purpose of the OSH Ordinance is to ensure the safety and health of employees at work. In July 2003, the Occupational Safety and Health (Display Screen Equipment) Regulation ("OSH (DSE) Regulation") (Cap 509B) came into effect and the aims of the OSH (DSE) Regulation at protecting the safety and health of employees who use display screen equipment at work for prolonged periods of time.

According to the Occupational Safety and Health ("OSH") Statistics Bulletin published by the Labour Department of Hong Kong, there were 63 and 35 confirmed occupational diseases of employees suffered from tenosynovitis of hand or forearm in 2006 and 2007 respectively (OSH Branch, 2008). In the confirmed employees' compensation cases, the injured employees were cleaners, catering workers and clerical and other office personnel. The evidence of repetitive strain injuries of using computer has not been well identified from the confirmed occupational disease statistics in Hong Kong.

Work Environment in the Call Centre

Past research studies indicated that the telemarketing or telephone call centre operators reported a high rate of upper extremity musculoskeletal symptoms in association with computer use and psychological disorders (Ferreira and Saldiva, 2002). Telephone operators perform repetitive keyboard tasks in a prolonged sitting posture while requiring outstanding communication skills and efficient in response to the customer's request. The computer-telephone task requires highly repetitive movements under time pressure in a direct performance monitoring work environment.

Lin, Chen and Lu (2009) suggested that call centre operators who perceived higher job stress will have reported rate of eye strain, irritable stomach, hoarse or painful throat and musculoskeletal discomfort. The work environment in relation to staff's health and safety was noted.

Participatory Ergonomics and Work Health and Safety

The ergonomics application in the design of a new workplace is significantly important to the overall work health and safety, employee wellness and operational efficiency.

Participatory ergonomics is broadly defined as the sharing by stakeholders of their ergonomics knowledge and expertise on work method by contributing in the ergonomics initiatives. Wilson and Haines (1998) defined participatory ergonomics as: "The involvement of people in planning and controlling a significant amount of their own work activities, with sufficient knowledge and power to influence both processes and

outcomes in order to achieve desirable goals." There are two main benefits of using participatory ergonomics approach in the review of workplaces and work processes. They are (1) employees' involvement and unique knowledge and experience sharing to the project team; (2) employees having greater feeling of ownership of the suggestions and implementation of the changes, which will create a greater commitment as well. The outcomes of the participatory ergonomics include the enhancement of employee motivation and job satisfaction, employee health and safety as well as the reduction of musculoskeletal disorders.

The Hong Kong Jockey Club and Telebet Department

The application of ergonomics and occupational health and safety principles has a strategic significance in developing new workplaces at The Hong Kong Jockey Club.

The Hong Kong Jockey Club ("The Club") is one of the largest racing organisations in the world. Horse racing is the most popular spectator sport in Hong Kong and the Club is the only authorised operator of horse racing. The Club also operates the Mark Six Lottery and under Government authority offers betting on football matches held outside Hong Kong. The Club is the largest single taxpayer in Hong Kong – HK\$13,115 million in 2007/08, or about 6.5% of all taxes collected by the Government's Inland Revenue Department. In addition to the betting oriented business, the Club is one of the best membership clubs in Asia.

A unique feature of the Club is its not-for-profit business model whereby its surplus goes to charity. Through the past decade, the Club has donated an average of one billion Hong Kong dollars every year to hundreds of charities and community projects. The Club is also one of the largest employers in Hong Kong, with 4,800 full-time and 20,200 part-time staff.

In the occupational safety and health aspect, the Club won the "Best Workplace Health Practices Award" in the Hong Kong HR Awards 2008. This award recognised the Club with effective people strategies that promote and practise a healthy lifestyle for its human capital both inside and outside of the workplace.

The Telebet Department of the Club operates four telephone betting call ("Telebet") centres with a total of 3,900 service positions to provide quality betting services to a huge base of customer accounts as well as an integrated contact centre with 150 positions to provide customer care services to all betting and Club customers. The Department employs a workforce of over 9,000 operators and operates on a 7 days and 24 hours service model.

Tin Shui Wai Telebet Centre

In late 2007, a project was established to build the fifth Telebet centre with a capacity of 1,000 operator workstations, not only to further improve the demanding customer services

but to strengthen the community contribution by creating employment opportunities for 2,500 staff locally in the new town area at the Tin Shui Wai district.

This new Telebet Centre is located at an under-utilized car park building and occupies the lowest two floors with a total floor space of about 52,000 square metres. In addition to the various new technological infrastructures, the project team has decided to incorporate modern architectural designs at this new centre to elevate the occupational safety and health standards so as to meet the corporate commitments towards staff wellness, customer services and operational productivity. As a result, the following design requirements are established:

1. Modern, professional and hi-tech
2. Ergonomically-design workstation (“Ergo-design Workstation)
3. Operational and functional effective
4. Indoor air quality (“IAQ”) and OSH compliance
5. Employee environmental friendly

OBJECTIVES AND SCOPE OF STUDY

This paper summarizes the real case experience on participatory ergonomics to develop a fifth Telebet Centre of the Club at the Tin Shui Wai, Hong Kong. The major purpose of this paper is to identify the potential workplace health and safety and ergonomics risk factors of the telephone betting operators through task analysis and operators’ survey in the preliminary design stage and illustrated the solution of the workplace design in the fifth Telebet Centre. This study will be mainly illustrated the design requirements on ergonomically design workstation and workplace environment design, indoor air quality, illumination and acoustic of the new centre.

METHODOLOGY

Project Team for the New Centre Design

The Club was invited internal and external parties to participate in the preliminary design, architectural design and implementation of ergonomics and workplace health and safety management in the new workplace. Internal specialists, comprising Telebet management, occupational safety and health ergonomics, building services and Telebet staff representatives plus an external all-in architect were the key contributors to develop the overall design criteria for the new centre. Moreover, Telebet management has employed professionals and consultant to perform evaluation during the design stage and then operational certification after centre opening.

Preliminary Stage of the Telebet Centre Design Project

In the preliminary design stage, direct observations and assessment methods were adopted to identify the key occupational health and safety as well as ergonomics concerns, interacting between the telephone operator and the task,

workstation, computer accessories and overall work environment.

On the assessment of the operators’ task, videotaping, photo taking were used to assist the postural analysis and assessment of their interacting between the operators and the workstation setup and design. The assessment undertook in the main Telebet centre in Sha Tin Racecourse, Hong Kong. Operators were also interviewed to understand the task requirements and the operational needs during the horse race day and non race day. In addition, research papers, regulatory guidelines and internal operational manual were reviewed for benchmarking in the design of the new Telebet centre.

Telebet Staff Survey

Telebet management organized eleven focus groups of about 150 staff from three existing centres during February to April 2008. Through the brainstorming and feedback exercises, Telebet management collected the staff opinion and expectation to the new working environment as well as the improvement needs for the existing Telebet Centres.

Design Evaluations

Internal specialists, Telebet management, staff representatives and external consultants, were jointly organized the architectural design evaluation. Concept mock-up workstations and fully configured pre-production mock-up workstations together with the relevant environmental set up were built to evaluate the major design of the new centre. The evaluation was developed into three levels: (1) Ergo-design Workstation: Six groups of male and female employees from large, medium and small body build were invited for the evaluation on operator-workstation fit and operator’s seating design. (2) Operator Hall: Study participants were asked to evaluate the level of lighting comfort and illuminance at the work benches. Furthermore, a number of assessments were conducted to evaluate the acoustic features for room absorption, background noise effect and speech transmission. Project team and existing operators were also invited to give qualitative comments on the design. (3) Global Centre Design: Qualitative operators’ feedback on the mock-up site was collected.

TASK ANALYSIS

Task Description of Telebet Operators

The Telebet Services Assistants (“Operators”) are responsible to operate a betting terminal, an information terminal and automatic call distribution (“ACD”) console for selling and transferring in/out calls from betting customers. Customer services and operational efficiency are the key requirements of the operators who are required to fulfill standard instructions without any delay to completing the betting request by the customers.

At the start of the shift, Telebet supervisor will give a briefing to the operators and they will each setup their own workstation before the beginning of the shift. The sequence of serving a customer is as follows:

- Receive phone calls from account holders through the ACD console
- Input betting details through a betting terminal by using custom made keyboard and/or mouse according to the standard operating procedures
- Echo to the account holders according to the information displayed on the screen of the betting terminal before executing the transaction
- Answer account holders' enquiries on account balance and betting details efficiently as required
- Process Telebet account fund withdrawals as requested by account holders

Operators' Work Pattern and Task Demand

Operators are required to sell three betting products. On a horse racing day, operators spend about 95% of their time handling horse betting and about 5 % for handling football betting and customer enquiries. Operators are required to place horse betting orders for customers in a fast and accurate manner and they handle about 350 to 500 calls in a 6 to 8 hours shift. The horse race runs every 30 minutes and usually, the operators receive more calls within the last 15 minutes and starting from the third race.

During the non race day, the call pattern is different. Operators receive highest number of calls for placing football betting orders (50%) and about 37% for Mark Six betting. Only 6% of incoming calls are for placing the horse betting orders and 7% for enquiries. The average number of calls is less during non horse race day which is about 160 to 220 calls in a 5 hours shift.

The work schedule of the operators for three betting products is summarized as follows:

Betting Products	Work Schedule
Horse Races	<ul style="list-style-type: none"> ➤ Racing season from September to July ➤ On Wednesday night (8 races) ➤ On Saturday/Sunday (10 to 11 races) ➤ 6 to 8 hours per shift ➤ Take about 1 to 2 minutes per call
Mark Six	<ul style="list-style-type: none"> ➤ On every Tuesday, Thursday and Saturday or Sunday of all year round ➤ 5 to 8 hours per shift ➤ Take about 2 minutes for placing 2 bets in average
Football Matches	<ul style="list-style-type: none"> ➤ No fixed schedule depending on the football matches frequently in the night time due to time zone differences ➤ 5 to 8 hours per shift ➤ Take about 5 minutes per call

Operators work on roster shift basis. Because of volatile customer demands, the on-site deployment will be arranged to fit the actual business needs. Usually, operators can take short

breaks of a few minute in between the races while operators on longer shifts will be entitled to long breaks of 20 to 30 minutes. Regular and small breaks allow the operators to conduct stretching exercise and rest.

OPERATOR WORKSTATION AND EQUIPMENT

In the Tin Shui Wai Telebet Centre design, each workstation is equipped with two computer terminals for betting services and information platform separately. Due to the security reason of protecting the betting system and customer's information, two computers shall be separated. Two individual sets of input devices are required in each desk. It is estimated that about 80% of time required manipulating the betting terminal and 20% of time for using information platform terminal. ACD console is connected with a headset. Operator workstation is assigned in each shift so a personal storage cabinet is required for each workstation. The workstation desk is fixed height and height adjustable office chair are available in each workstation.



Figure 1: Operator workstation and operator hall in Sha Tin Telebet Centre

For the betting orders input systems, operators are required to use different input devices to place the orders for different betting products. The proportions of using different input devices for placing the orders are illustrated as follows:

Betting Products	Custom-made Keyboard	Mouse
Horse Races	97%	3%
Mark Six	100%	0%
Football Betting	7%	93%

Custom-made keyboard is the key input device for entering the horse races and mark six betting requests to the betting system. However, mouse is the major input device for entering the football betting requests to the terminal.

PRELIMINARY DESIGN STAGE

Telebet Staff Survey

Staff involvement in designing a new work environment is valuable to create the best suitable workplace to the staff. Valuable feedbacks on existing centres and recommendations for new centre design were collected from 150 participants

during the eleven focus group sessions. Feedbacks on physical environments are summarized as below:

Physical Environment	Feedbacks
Work Environment	<ul style="list-style-type: none"> ➤ Avoid noise interruptions to operators from rest & drinking areas ➤ Request larger locker size for keeping personal belongings ➤ Use energetic and soft color
Workstations	<ul style="list-style-type: none"> ➤ Require sufficient space for mouse movement and desk space ➤ Provide comfortable palm rest and space on the desk ➤ Require more knee space and legroom ➤ Orderly bench design for easy supervision
Telephone System	<ul style="list-style-type: none"> ➤ Control unexpected loud and high-pitched sounds from customer ➤ Eliminate/reduce noise interference from other operators
Lighting and Indoor Air Quality	<ul style="list-style-type: none"> ➤ Require brighter and natural lightings ➤ Require better thermal comfort and ventilation system ➤ Prefer natural and soft colour in the work area
Rest Area Facilities and Washroom	<ul style="list-style-type: none"> ➤ Provide sufficient drinking and rest area at different working zone for easy staff management ➤ Request extra hot water machine and microwave oven to reduce waiting ➤ Provide sufficient washroom facilities meeting needs at peak hours

The above task analysis and operators feedback highlighted the key design factors of the new centre as well as the operator workstation. The task is characterized by screen-based nature which is relatively repetitive of requiring fast and accurate keyboard and mouse inputting in sedentary work position. Operators access the second computer for checking the betting information relatively infrequently.

According to the task analysis and operators' feedback, six key areas of concern were identified: (1) operations' hall design; (2) lighting and vision comfort; (3) ventilation and indoor air quality; (4) washroom and rest area facilities; (5) operator-workstation layout; (6) computer accessories and phone systems and (7) operator seating design.

International Standard and Guidelines

International guidelines, code of practices and standard of workplace design were reviewed. Guidelines were formed to ensure the centre is built in consistent approach to design, quality, cost and health and safety issues with the basis of the task design of the operators.

1. *Ergo-design Workstation*: The operator workstation design guidelines provided the useful basis for project team to formulate the acceptable range of furniture dimension and design which used in the development of concept mock-up workstations. The major criteria for the design of furniture are highlighted below:

Components	Ergo-design Workstation Guidelines
Work Surface	<ul style="list-style-type: none"> ➤ Should be large enough to accommodate the screen and input devices and for the resting of hands and arms in proper posture* ➤ At least 650mm (D) x 1000mm (W)
Workstation Height	<ul style="list-style-type: none"> ➤ Should be between 680mm and 720mm* ➤ Ensure the minimum of 30 mm knee space in a neutral sitting posture (Stevenson, 2003) ➤ Minimize the needs of using footrest
Leg Space	<ul style="list-style-type: none"> ➤ Free leg movement without obstruction* ➤ At least 550mm (D) x 800mm (W)*
Chair	<ul style="list-style-type: none"> ➤ Seat height: Adjustable with the range of 485 to 550mm from the floor ➤ Seat pan depth: Preferable adjustable; if fixed, at least 460mm ➤ Seat Width: Minimum of 470mm ➤ Sufficient backrest support and adjustable in height and forward & backward direction** ➤ Softly padded cushioning and Rounded seat pad** ➤ Swivel chair with five wheels on base**

References:

- * AS 3590.2-1990 Australian Standard, Screen-based Workstations Part 2: Workstation furniture
- **National Occupational Health and Safety Commission (1991) Ergonomics Principles and Checklists for the Selection of Office Furniture and Equipment, Australia.

2. *Indoor Air Quality*: Occupational Safety and Health Regulations of Hong Kong define the ventilation requirements on providing adequately ventilated fresh air in every workplace. Good IAQ brings ultimate benefits to our employees who can increase the productivity by maintaining a pleasant indoor environment.

The Hong Kong Special Administrative Region (“HKSAR”) Government launched a voluntary IAQ Certification Scheme (“Scheme”) for Offices and Public Places since 1st February 2008. Two-level IAQ objectives (i.e. Excellent Class and Good Class) are provided to assess the IAQ objectives in 12 parameters for eight hours average standard (Indoor Air Quality Management Group, 2003). The project team reviewed the scheme requirements and set out the target of acquiring the “Good Class” certification at the Tin Shui Wai Telebet Centre.

External consultants were hired who worked closely with our internal Building Services team to review and comment the design criteria of the Mechanical Ventilation and Air Conditioning Systems (“MVAC”), fresh air supply rate, air side equipments, fresh air intake points and the development of long term MVAC maintenance program. The selection of furniture and fitting-out as well as renovation materials are significantly important to ensure the indoor pollutant emission level within the limit during manufacturing process and centre commissioning.

IAQ measurements will be conducted upon centre commissioning to confirm compliance with the IAQ objectives

as specified on the Scheme. Telebet Management requires continuous effort to maintain the good standard of IAQ level.

3. *Illumination:* Operators work in a screen-based environment so sufficient and comfortable lighting can prevent the glare and visual fatigue of the operators. The workstation top should not reflect the light sources at the ceiling and avoid the indirect glare effect.

Labour Department of HKSAR published a “Guidelines for Good Occupational Hygiene Practice in a Workplace” and it recommended the optimum levels of lighting in different areas (Table 1) (Occupational Safety and Health Branch, Labour Department of HKSAR, 2000). The project team considered the recommendations in the lighting design and illumination level.

Task Position or Area	Optimum Average Illumination
Computer Work Stations	500 lux
General Offices	500 lux
File Storage and Reception	300 lux

Table 1: Recommended optimum average illumination level

DESIGN EVALUATIONS

According to the design criteria and design proposed by the external architect, concept mock-up workstations and fully configured pre-production mock-up workstations together with the relevant environmental set up have been built for the project team and operators’ evaluation. The design evaluation was separated into three levels: (1) Ergo-design Workstation; (2) Operator Hall and (3) Global Centre Design.

(1) Ergo-design Workstation

1. *Selection of Sample Operators:* Six groups of male and female employees with the total number of 48 operators from large, medium and small body builds were invited for the evaluation on worker-workstation fit, operator’s seating as well as illumination and lighting environment. Selection of three body build groups in stature dimension and body weight was reference to the anthropometric data (Table 2) which was published in Pheasant and Haslegrave (2006).

	Stature and Body Weight		
	5 th Percentile (Small)	50 th Percentile (Medium)	95 th Percentile (Large)
Men	1585mm, 47kg	1680mm, 60kg	1775mm, 75kg
Women	1455mm, 39kg	1555mm, 47kg	1655mm, 62kg

Table 2: The anthropometric data of the Hong Kong Chinese Population

External consultants were explained to the study participants on the objectives of the mock-up workstation assessments and were introduced to the design of the mock-up workstation model (Figure 2).



Figure 2: Prototype workstation in mock-up site

2. *Desk Height:* To determine the appropriate height for the workstation, Stevenson (2003) proposed the considerations of the 95th percentile male knee height, shoe height, knee room clearance space and desk top thickness. A total of 48 participants participated in the users’ evaluation for the mock-up desktop height of 700mm. The results showed that males in large body build group had the narrowest knee room clearance space of 30mm whereas widest clearance (160mm) was from the female small body build group (Table 3).

	Knee Space Clearance (mm) (Vertical Clearance Beneath the Desktop)		
	Small	Medium	Large
Men	80-110 (N=5)	65-160 (N=7)	30-110 (N=7)
Women	60-160 (N=9)	70-115 (N=11)	50-150 (N=9)

Table 3: Vertical clearance beneath the desktop of different genders and body builds with the desktop height of 700mm

According to the result in Table 3, external consultants recommended that with minimum clearance of 50mm, the desktop height of 700mm could accommodate a total of 99.3% of the existing employees of the Telebet Department. It is estimated that the desktop of 700mm could minimize the need for footrests. However, if employees could not achieve a comfortable knee clearance of 50mm, the operator-workstation fit will be arranged by the internal occupational safety and health team after assessment.

Ten height adjustable desk-top workstations were fitted for employees’ with special needs. Barrier-free access and disabled toilets were installed for wheel chair employees.

3. *Arm Reach Distance and Workspace on Desktop:* For each workstation, a modular design is planned for standardisation and operational effectiveness. As compared to the existing Telebet centres, the new dimension for Tin Shui Wai Telebet Centre will be enlarged by at least 40 per cent not only to improve operator comfort but to house a second monitor to cope with the future knowledge management applications.

In the mock-up evaluation, after the external consultant explained the study details, participants were asked to arrange the positions of the input devices according to their own preferences. The external consultants measured the maximum

and comfortable distances of arm reach of the participants. The locations of the two keyboards and mouse were taken which measured from participant's acromion.

The result was noted that the study participants did not tend to place the input devices within their comfortable reaches so they maintained an awkward posture of extending their forearms and hands to input the betting orders. The operators were not normally keeping arms and elbows relaxed and close to body. The result also showed that 23 out of 48 participants arranged the second keyboard in a position beyond their maximum reach so they tended to overly extend their arms when accessing to the second set of input devices. The posture of maintaining forearm at about 90 degree to arm was not normally adopted.

When determining the operator's workspace on desktop, McCormick's sequence-of-use and frequency-of-use principles were considered (Pheasant and Haslegrave, 2006). According to the task analysis result, importance principle, frequency of use principle and function principles should be adopted. The recommended desktop layout is given below:

McCormick's Principles	Desktop Layout
Frequency of Use Principle	The first keyboard and mouse should be placed in the most accessible locations within comfortable reach than the second keyboard and the mouse. The monitor and input devices should also be placed right in front of the operator to provide a proper sitting posture.
Importance Principle	The first keyboard should be put within the comfortable reach of the operator. If the operator mainly places the football betting, the first mouse will become the most important item at the comfortable reach zone on the desktop.
Function Principle	The main and secondary input devices should be grouped separately as they have similar function individually.



Figure 3: Recommended desktop layout arrangement of monitors and input devices. Input devices shall be arranged according to the frequency of use in their shifts

4. Size and Height of Monitors: In the new workstation design, the first monitor (in 17") will display the betting platform and the second monitor (in 13") will be used for betting information platform. It was estimated that only about 20% of the time requiring accessing the second computer so in order to save up more desk space, the smaller monitor was selected operators were advised to place two monitors at an angle with equidistant from eyes and the screen background colour and fonts displayed on the monitors that should be similar in order to reduce the visual adjustment when looking between two monitors.

In the monitor sourcing process, most monitors were not height adjustable or the adjustability ranges were very minimal which could not able to satisfy the needs of diverse body builds at different eye height level at sitting up straight posture as proposed. A study was undertaken by the external consultant for the same group of participants on calculating the desirable lowest and highest range of monitor height which measured at the top of the screen level.

The eye levels of 38 participants in six groups were measured, representing the small, medium and large body builds in both genders. The result in figure Table 4 shown that the lowest eye level was the women in small body build of 970mm whereas the highest eye level was the men in large body build of 1260mm.

	Body Build/Sitting Eye Levels (mm)		
	Small	Medium	Large
Men	1060-1120 (N=5)	1170-1220 (N=7)	1180-1260 (N=7)
Women	970-1080 (N=9)	1000-1120 (N=11)	1110-1220 (N=9)

Table 4: Eye levels of participants of different genders and body builds measured when sitting in the mock-up workstation.

The consultant was advised in the procurement process, the monitor height of the maximum of 1200+/-30mm and minimum of 1015+/-30mm were desirable. Due to the product availability, the best suitable in market of two sizes of monitors (Table 5) were specified as follows:

	Monitor Height Range with Stand	Total Height Including Desk Height of 700mm
1st Monitor in 17 inch	365 to 470mm	1065 to 1170mm
2nd Monitor in 13 inch	320 to 465mm	1020 to 1165mm

Table 5: Procured monitor height of first and second monitors

5. Selection of Operators' Chair: The project team conducted two phases of evaluation on the selection of the swivel office chair for the operators. Basic selection criteria had developed in the preliminary stage of the study. Eight chairs were initially evaluated by the evaluation panel composed of seven members from the consultancy team and the management of the Telebet Department as well as the internal occupational safety and health & ergonomics specialist. According to the 5 point Likert scale with "1" indicating "Extreme Discomfort" and "5" indicating "Extreme Comfort" on the backrest and overall chair individually, two chairs (Chair B and Chair D) obtained the same score of total 25 points with weighted 35% of backrest and overall chair conformability of 65%. The dimensions of each evaluated chair were measured for further evaluation in the same exercise. The Chair B has the best height adjustability among eight chairs which the seat height ranging from 490 to 570mm. The dimension of seat pan depth is 440 to 500mm and seat width is 480mm. The panel finally shortlisted Chair B for user's evaluation in the second phase.

Three new office chairs were sourced together with Chair B for further review. In the operators' review, participants were asked to rate the level of comfort against a 10-point Likert scale with "1" indicating "Extreme Discomfort" and "10" indicating "Extreme Comfort". In this phase, 30 out of 48 participants were invited for evaluation. The dimensions of evaluated operators' chair and the rating of overall level of comfort for 30 participants are shown below (Table 6).

	Seat Pan Depth (mm)	Seat Height (mm)	Seat Width (mm)	Overall Level of Comfort (N=30)
I	420 (Min)-495 (Max)	425 (Min) - 570 (Max)	475	236 ①
J	440-490	460-545	475	194
K	420-460	420-500	440	192
B	440-500	490-570	480	234 ②
H	400	400-525	480	145

Table 6: Dimensions of six evaluated operators' chair and the rating of overall level of comfort for 30 participants.



Figure 4: Appearance of Chairs I (left photo) and B (right)

The ratings of 30 participants concluded that Chair I (score of 236) and Chair B (score of 234) scored the top two highest among five chairs. As the centre will be hired over 2000 operators, the seat pan and height with wider range could provide a better flexibility and suitability for most operators of different body build. The "User checklist for ergonomics design of adjustable chairs" (National Occupational Health and Safety Commission, 1991) prepared by WorkSafe Australia were used to assess the ergonomics functionality of chairs. In the end, Chair I was finally selected by the project team considering the following characteristics:

- Excellent range of back-height, seat-depth and seat-height
- Firm and comfortable lumbar support in curved seat and back
- Easy and quick seat adjustment while seated
- Seat cushion effectively distribute pressure with water fall edge design for smooth blood circulation
- Braille user adjustment instructions under levers for ease understanding and visible
- Obtained GREENGUARD Indoor Air Quality certification by the GREENGUARD Environmental Institute
- Compliance with all requirements of (1) Business and Institutional Furniture Manufacturer's Association (BIFMA) which the BIFMA were adopted by the American National Standards Institute (ANSI); (2) Australian/New Zealand Standard AS/NZS 4438:1997
- 15 years warranty to provide long service support

In the project team discussion, the team concluded that the Chair I without armrests was adopted. There were several reasons for choosing the model without armrests. Firstly, operators are required to key-in the betting orders to the keyboard with frequent hands movement instead of sitting in a normal typing posture, therefore the forearms are supported by the desk and the armrests deemed not necessary. Secondly, operators are advised to leave the seat and perform stretching exercise during break time so the armrests would not bring extra benefits while taking rest. Thirdly, operators are assigned to different workstation in every shift so the proper adjustment of armrests in each work shift may create logistic problems to the management.

(2) Operator Hall

1. *Workplace Atmosphere:* In order to cope with the low headroom of the car park building, the project team has innovatively used "safety" glass partition between workstations to create a spacious feeling and alternate raised floors to house the data and power cables to optimise space utilisation. Eye relaxing feature walls and lively multi-colour pillars, Oasis (i.e. the rest area) and operator chairs were selected to create a warm and relaxing work environment in the new centre.

Alternate and lateral seating (Figure 5) were designed to improve acoustics and staff comfort.

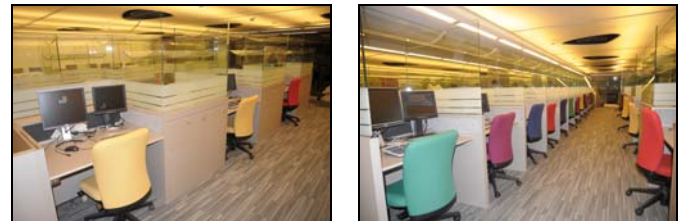


Figure 5: Operator hall in alternate seating (left photo) and lateral seating (right)

The workbenches are schematically configured with efficient corridors to facilities traffic flow and distributed communal zones acting as staff rest areas and relationship building points.



Figure 6: Illustration of workbenches design for efficient staff circulation

2. *Illumination*: Four operators were invited to evaluate the illuminance level and users' level of comfort on the illumination of the mock-up work benches. Participants' qualitative comments and external consultants highlighted the concerns of the intensity of the illuminance level and glare for workstations at different orientation and layout. A number of solutions were considered in the evaluation process.

Because of low ceiling height site constraint, a stretch ceiling system was adapted. With integration of a compact Barrisol ceiling system, light sources were covered to reduce glare effect and created a unique luminous atmosphere on ceilings, walls and workstations to the implementation of a homogeneous working environment.

To attend to glare concerns of glass partition between workstations, the design team has tried various designs including opaque film, frosted glass and opaque pattern. After the follow up staff survey, a special strip opaque pattern was selected because of the least disturbance and glare.

At the same time, for cost effectiveness, a zoning approach has been deployed so that the various building facilities can be individually controlled to meet operational needs. The lighting intensity at different locations at the mock-up sites were measured to ensure compliance with the lighting level recommended by the Labour Department of HKSAR.

3. *Acoustics*: In the existing Telebet centres, operators can hear distorted sounds and the voices of operators nearby causing difficulty in hearing for both customers and operators. In this situation, the operator may need to increase their concentration and listen more attentively, causing mental fatigue and increased muscle tension.

According to the design, an overhead curved glass was installed to serve as an acoustic barrier to reflect the noise within a single workstation. An alternate seating pattern was used to reduce noise influence to other operators (Figure 7).

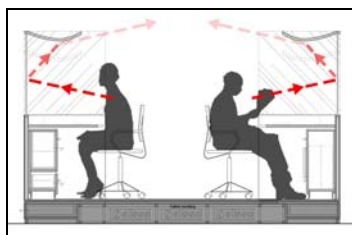
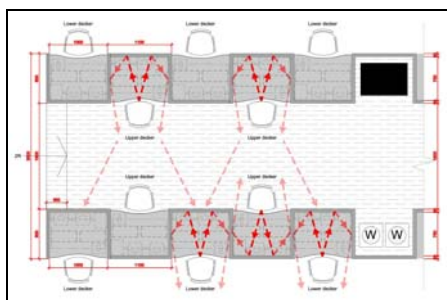


Figure 7: Illustration of the alternate seat and overhead curved glass Telebet workbench design to minimize noise influence

Furthermore, acoustic partition panels (Figure 8) are built around the workstation and a special acoustical coating is applied on the concrete ceiling for further sound absorption.



Figure 8: Three-side Australian acoustics panel with outstanding sound absorption in open and reverberating spaces

Per assessment by external acoustics consultant, the speech transmission characteristics within the mock-up site were good to excellent indicating the participants communicated without obvious problems, i.e. noise generated from one participant did not seem to interfere with others in the surrounding area. That meant, in normal working circumstance, operators would not be able to overhear the conversations of other operators taking customer orders.

(3) Global Centre Design

In order to meet the new requirements and the unique site layout, new workstation design and new operator bench configuration were developed. Following extensive reviews with the lead construction consultant & architect, Telebet management adopted a “City-in City” theme to represent the new Telebet centre. As Tin Shui Wai is a city in Hong Kong, the Telebet centre has a huge workforce which in fact is one of a community within the district.

Telebet management and external architect considered the operators' feedback and comments in the existing centres and mock-up site. As a result, the following design concepts were adopted for respective functional areas:

- Centralised lobby for high volume staff arrival and departure at the same time
- Four operating zones for flexible management
- Decentralized washrooms for efficient staff flow
- Scattered rest areas for staff relationship and traffic regulation (Figure 9)
- Centralized drinking water distribution system
- Leisure corner with sofa, internet access, magazines and snack vending machines
- Multi-purpose Cafeteria installed with natural light
- Indoor garden - Green Room decorated with artificial plantations

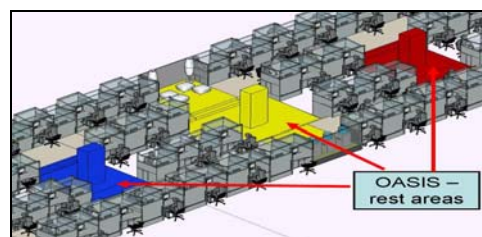


Figure 9: Illustration of colourful scattered Oasis – rest areas in the centre

CONCLUSION

Application of participatory ergonomics approach provided useful value on collecting the knowledge and feedback of the Telebet operators in this study.

Whilst concept mock-up workstations were manufactured for evaluation, the project team and operators performed detailed assessments and trial operation on a module of fully configured pre-production mock-up workstations with exact dimensions, finishing and materials plus the relevant environmental set up including ceiling and lighting.

The design specifications of the workspace on desktop, height adjustability range of monitors, workstation height, and the selection of operators' chair were concluded through a series of studies and reviews by project and external experts. All centre facilities such as lighting, temperature, air quality and workstation ergonomics were specially designed to meet or exceed the various local or international guidelines on occupational safety and health. A high level of indoor environmental quality was one of the aims for this new centre. Operators' occupational safety and health training will be provided in the Tin Shui Wai Telebet Centre on advising the desktop layout and the appropriate sitting posture.

This process ensured the new Telebet workstations would cope with the auditorium environment in meeting the expectations of the Telebet management especially on aesthetics, practicality, functionality, ergonomics as well as indoor environment quality. At the same time, this process established the exact manufacturing process and standards for the future production workstations before the mass production of the 1,000 Telebet workstations. The participants of the ergonomics study suggested that the new design of the mock-up workstation would enhance a healthy working environment and will result in better occupational safety and health.

Telebet management has also planned to use this new design as the model for upgrading the existing Telebet centres.

AREAS OF FURTHER STUDY

Assessment of the operators' satisfaction on new workplace environment and operators' workstation could provide valuable feedback on the new centre design. Evaluation of the psychosocial factors and potential for occupational stress of the supervisors and operators in the Telebet operations can contribute added value of providing a safer and healthier work environment.

ACKNOWLEDGEMENTS

The project was highly supported by the Telebet Department, Human Resources Department and Property Department of the Club. We would like to offer our thanks to the Management and staff who have been supporting this study and occupational safety and health as well as ergonomics promotion in the Club. Appreciation is also given to external

architect, Barrie Ho Architecture Interiors Ltd and the external consultants from the Hong Kong Polytechnic University and the Hong Kong Productivity Council who provided high standards of design and recommendations to the development of the Tin Shui Wai Telebet Centre.

REFERENCES

- Ferreira Jr., M. & Saldiva, P. H. N. (2002). Computer-telephone interactive tasks: predictors of musculoskeletal disorders according to work analysis and workers' perception. *Applied Ergonomics*, 33, 147-153.
- Haines, M. C. and Carayon, P. (1998). Theory and practice for the implementation of "in-house", continuous improvement participatory ergonomic programs. *Applied Ergonomics*, 29(6), 461-472.
- Indoor Air Quality Management Group (2003). *A Guide on Indoor Air Quality Certification Scheme for Offices and Public Places*. Hong Kong.
- Lin, Y. H., Chen, C. Y. & Lu, S. Y. (2009). Physical discomfort and psychological job stress among male and female operators at telecommunication call centres in Taiwan. *Applied Ergonomics*. 40(4), 561-568.
- National Occupational Health and Safety Commission (1991). *Ergonomics Principles and Checklists for the Selection of Office Furniture and Equipment*. Australia.
- Occupational Safety and Health Branch, Labour Department (2000). *Guidelines for Good Occupational Hygiene Practice in a Workplace*. Hong Kong
- Occupational Safety and Health Branch (2008). *Labour Department, Occupational Safety and Health Statistics Bulletin*, Issue No. 8. Hong Kong.
- Pheasant, S., & Haslegrave, C. M. (2006). *Bodyspace: Anthropometry, Ergonomics and the Design of Work (3rd edition)*. Boca Raton, FL: Taylor & Francis
- Stevenson, M. G. (2003). *Notes on the principles of ergonomics, Mike Stevenson Ergonomics*. Australia
- Wilson, J. R., & Haines, H. M. (2001). Participatory Ergonomics. In W. Karwowski, *International Encyclopedia of Ergonomics and Human Factors*. Boca Raton, FL: Taylor & Francis