Ergonomical Comparison of Different VDT Workstations for Physically Disabled Wheelchair Users

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Abstract

This study presents a comparison between different workstations for physically disabled wheel chair users and their reach from wheel chairs based on anthropometric data and reach dimensions and clearance dimensions on the basis of various parameters such as stature, eye height, shoulder height, popliteal height, etc. Three workstations of VDT (Visual Display Terminal) workstations are considered to determine whether they are appropriate for use by wheelchair users. The study finds that presently available computer desks have difficulties, in terms of both design and reachability of peripheral devices, to wheelchair users. Some VDT tasks result in awkward body postures in virtual subjects. New VDT workstations are designed and recommended to solve the shortcomings found. The aim of the workstation analysis was to obtain maximum postural efficiency, bearing in mind environmental, manufacturing and marketing constraints.

Keywords- VDT, wheelchair users, anthropometric data, postural analysis

I. INTRODUCTION

Wheelchair users nowadays have to perform daily and professional activities exclusively in their wheelchairs. Therefore, wheelchair users should be considered as integral with their chairs [1]. Visual display terminal (VDT) tasks are becoming increasingly common in modern workplaces, and, due to their work characteristics, they are often performed by wheelchair users. However, interaction between the operators (with the chair) and workstation components is an important issue when VDT tasks are operated by wheelchair users. The potential worker who cannot 'fit' into the workstation is significantly disadvantaged in workplaces in terms of employability, decreased productivity and increased risk of injury [2]. Ashworth et al. [3] considered the extent to which older and disabled people are being 'designed out' of workplaces. The suitability of existing VDT workstation designs and the appropriate or best design for wheelchair users are interesting topics for study. VDT workstations have been extensively studied recently, with most studies focusing on occupational hazards such as perceived fatigue, visual discomfort and musculoskeletal stresses for normal VDT operators (e.g., [4-10]). Ergonomics issues for the physically challenged individuals, e.g., wheelchair users, have also been studied, as have anthropometric measurements for wheelchair users [1-2, 11-14]. However, the interaction between wheelchair users and specific workstations has not often been considered. Feeney [15] conducted a survey on the reach capabilities of disabled people, and studied the design of automatic teller machines (ATMs). Tilley [16] demonstrated the anthropometric requirements of facilities such as lavatories, drinking fountains, urinals, toilets and telephone booths for wheelchair users. Wheelchair users can perform VDT tasks, as recommended by Taiwanese governmental authorities and private enterprises. Many training courses for skills in operating computers and software applications, as well as specific assistant devices to help physically challenged individuals operate computers, have been designed and developed [17]. However, VDT workstations for wheelchair users have rarely been systematically studied in Taiwan. Products and facilities, e.g., VDT workstations, must be tested by operators at the final stage of design and manufacture. Inadequate design may reduce work efficiency, increase human error and lead to awkward postures, resulting in poor productivity and reliability, and musculoskeletal disorders. However, ergonomics information about users cannot easily be incorporated into the design processes of workplaces and products, since it is often poorly presented and evaluated [18]. Conventional methods of evaluating human-machine compatibility involve the use of flat cardboard manikins and layout drawings, or constructing a prototype or physical mockup with evaluation by live subjects [18-19]. With the rapid development of information technology, computer-aided ergonomics offers the assistance in the creation, modification, presentation and analysis of design [18, 20]. The design can be modified at an early stage once problems are identified. The development of three-dimensional computer-modelling systems to construct 3D objects/equipment and human models with specific anthropometric measurements, and to evaluate the human- machine interaction, has been frequently studied in the literature [15, 18-21]. This study presents a novel simulation system to evaluate the effectiveness of VDT workstations. The objects used with 3D graph forms included presently available, widely-used models of personal computers, peripheral equipment, and wheelchairs. The study focuses on how wheelchair users perform their work. The adequacy, as well as the advantages and disadvantages of currently available workstations, are investigated with computer simulation. Moreover, the design and evaluation of new models of VDT workstations is explored, in the hope of providing a reference for designing and selecting workstations for wheelchair users.

II. METHODOLOGY

A. Comparision of a VDT Computer Workstations

This study compares for VDT workstations. Specification information about currently available and widely-used models of personal computers (PCs) and peripheral equipment such as CPU system units, monitors, color printers, scanners and desks was first collected and summarized from some large PC supermarkets in India. Discussions and comparisons were then made to select some kinds of PC components according to their specification differences in order to build three different VDT workstation. The desktop PC components and three commercial desks selected were all built as three-dimensional graphs using AutoCAD 2000. The major dimensions and models of desktop PC components used in the study Ergonomic Study of VDT Workstations for Wheelchair Users Int. J. Appl. Sci. Eng., 2007. 5, 2 99 were shown in Table 1. The PC components were then arranged to build three VDT workstations due to the dimensional constraints of PC components and desks selected. Figure 1, Figure 2, Figure 3 shows the three VDT workstation setups, and Table 2 lists their major dimensions. The ergonomic features to access, reach and posture were demonstrated for these three simulated environments.

Fig. 1: Configuration of VDT workstation1 [22]

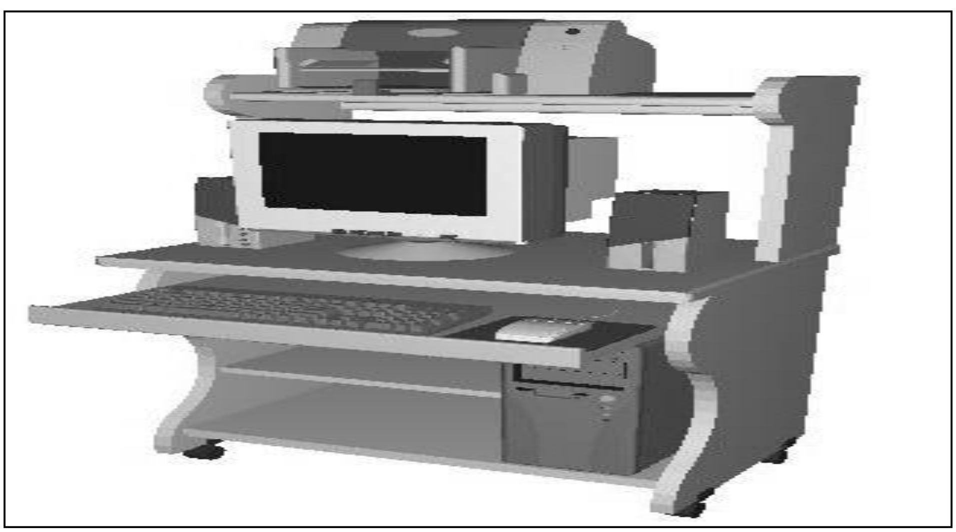

Fig. 2: Configuration of VDT workstation2 [22]

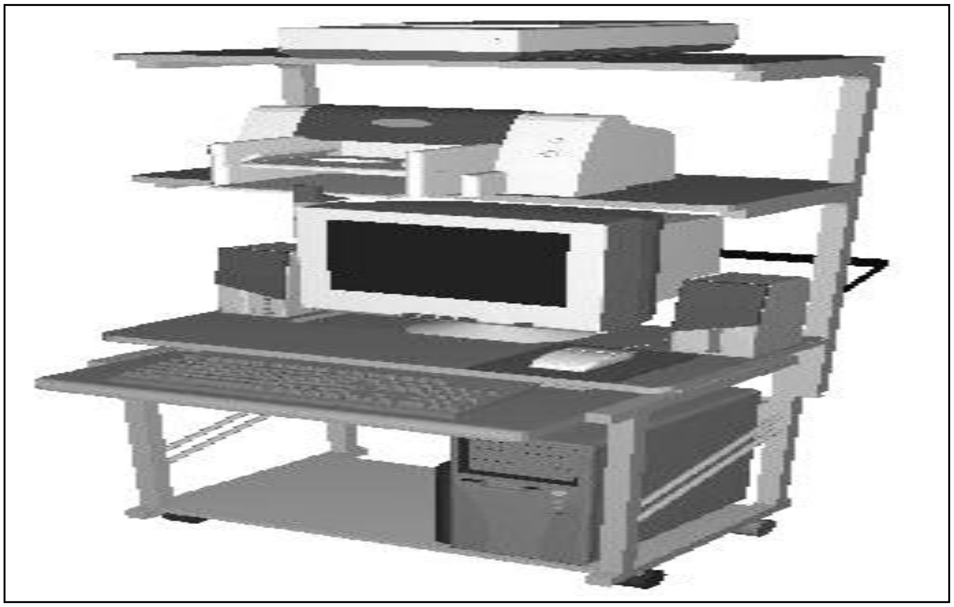

Fig. 3: Configuration of VDT workstation3 [22]

Table 1: The dimensions and models of PC components applied in the study

Components	Models	Specifications (cm) (total breadth×total depth×total height)
Monitor	View Sonic 17"	40.5×41.0×42
PC case	5.25" drive bays: 3 3.5" drive bays: 3	19×43×43
Color printer	HP Deskjet 640c	43.6×40.5×20
Scanner	Micro Tek	28×48×9
Keyboard	Standard 104	45×18×4
Mouse	LogiTech	6×12×3
Speakers	AS-480	10×14×25

Table 2: Major dimensions of the three commercial desks studied (in mm)

	WS* I	WS II	WS III
Total height	1175	1300	1600
Total breadth	1080	800	660
Total depth	600	600	450
Desk height	740	800	745
Surface height for keyboard	640	680	670
Surface height for monitor	680	800	720

B. WS: workstation

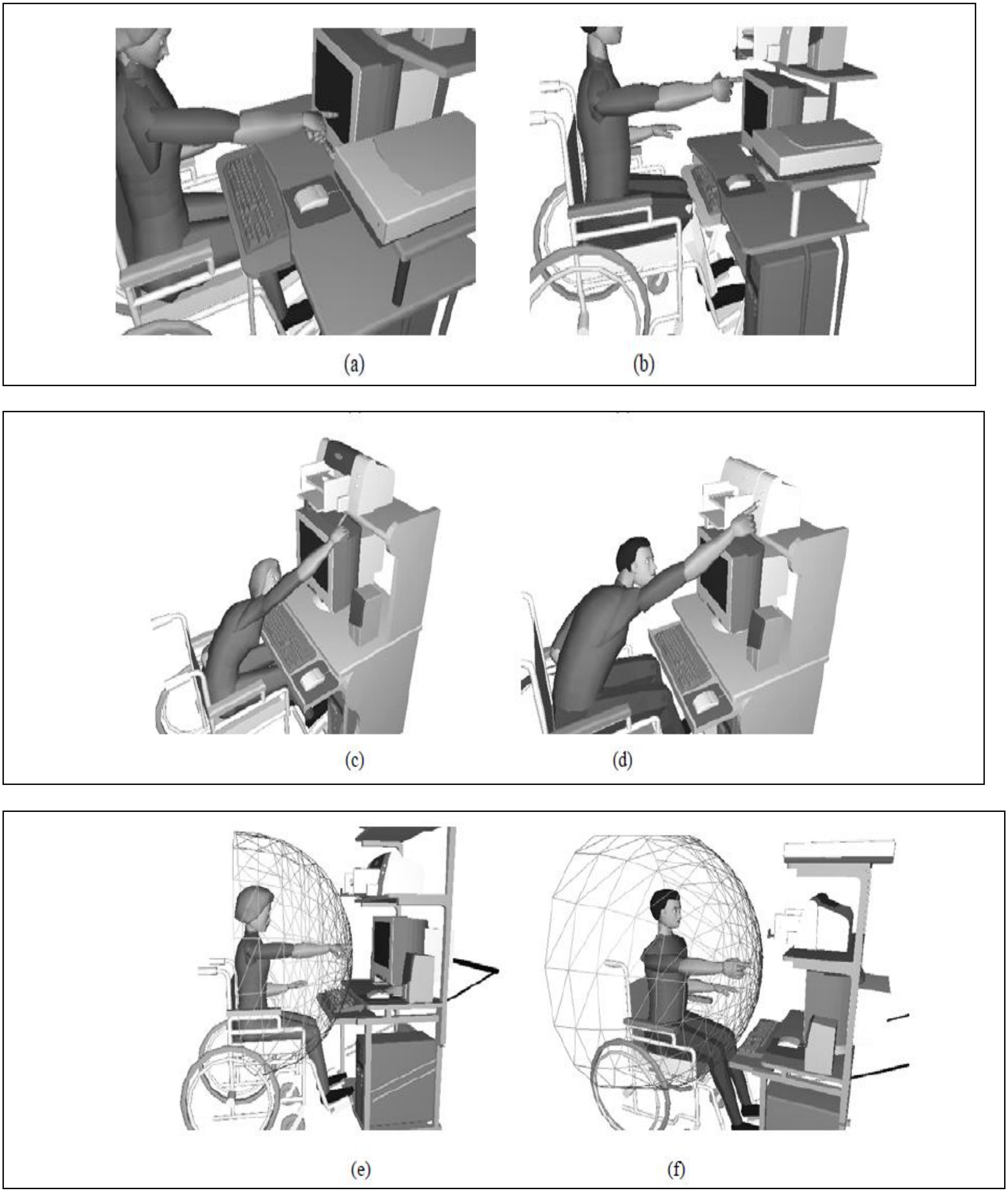

Fig. 4: Some simulation examples: (a) 5%ile female in WS I (easy to access desk); (b) 95%ile male in WS I (hitting the keyboard tray); (c) 5%ile female in WS II (hard to operate the printer); (d) 95%ile male in WS II (reachable to the printer), and (e) and (f) the reach envelope of 5%ile and 95%ile subjects with normal upright posture in WS III, respectively

Table 3: Accessibility and reachability of subjects operating at three workstations

	WS I		WS II		WS III	
Workstation elements	95%ile male	5%ile female	95%ile male	5%ile female	95%ile male	5%ile female
Desk*	×	O	×	×	×	×
CPU system unit	⊖	⊖	⊖	⊖	⊖	⊖
Printer	⊖	⊖	⊖	×	⊖	×
Monitor	O	O	O	O	⊖	⊖
Mouse	O	O	O	O	⊖	⊖
Keyboard	O	O	O	O	O	O

*: easy to access to VDT workstation (i.e. without desk-hitting)
O: easy to reach (i.e., performing with erect back in sitting posture)
⊖: reachable
×: incapable of reach

III. Conclusion

Three VDT workstations have been simulated and assessed with selected commercial desks in this study. It has been found that the commercial workstations have some drawbacks the work space and reach are insufficient, and working postures become awkward and have to be redesigned, when wheelchair users perform VDT tasks. Two new computer desks have been designed and obtained to solve the above shortcomings of three commercial desks and to meet the design guidelines proposed in the study. With the above comparison, the commercial and newly designed workstations have been examined for subjects' postural risks. It has been shown that the postural risks of the modified workstations can be reduced to a mild level. The simulation technology applied in the study indeed offers the assistance in the creation, modification, presentation and analysis of VDT workstation design before the prototype is manufactured and evaluated. Figure 4 shows the analysis of reachability.Table:3 shows the final conclusion of the analysis.

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