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# Ergonomic design and evaluation of a new VDT workstation chair with keyboard–mouse support

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**Abstract**

A new-concept VDT workstation chair with an adjustable keyboard–mouse support was proposed to minimize the physical discomfort and the risk of cumulative trauma disorders (CTDs) at work sites. A three-dimensional human modeling tool (SAFEWORK ®) was used to design the new chair which satisfies the anthropometric specifications of the Korean population. Based upon the result of 3-D graphical simulations, a mock-up chair was constructed with an adjustable keyboard/mouse support directly attached to the chair body. An experiment was conducted to compare the new workstation chair to a conventional computer chair without a keyboard–mouse support by measuring muscle fatigue and subjective discomfort. Six volunteer subjects participated in six 1-hour word-processing sessions with two different chairs and three different work postures. Statistical results indicated that the new-concept VDT chair generally improved subjective comfort level and reduced fatigue in the finger flexor/extensor and the low back muscles. Implications of the new design and suggestions for further development are addressed.

**Relevance to industry**

The proposed VDT chair in this study can be used by certain VDT users such as telephone operators who are potentially exposed to CTDs. Since the number of computer users has greatly increased, the market share of better-designed VDT chairs is expected to increase rapidly. Moreover, the new VDT chair can impact design and manufacturing industries that make new products and accessories which support the new VDT environment.


*Keywords:* VDT chair; CTDs; 3-D human modeling

## 1. Introduction

Recent advancement of computer-related technology has contributed to rapid communication advances and an increase of productivity among individuals and organizations. But such a frequent and prolonged use of computers in a conventional working environment creates occupational and physical problems, or the so-called cumulative trauma disorders (CTDs), which often result from repetitive keyboard work for prolonged periods of time.

It was reported that millions of workers have complained of CTDs, and the cost of compensation for CTDs was exorbitant (NIOSH, 1997).

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In Korea, CTDs were first recognized as an occupational disease in 1986 (Korea Industrial Safety Corporation/Korea Welfare Corporation, 1996), and several case studies were reported among bank tellers and telephone operators (Lim et al., 1997). Since the number of CTD cases is increasing, without effective ergonomic prevention, CTD problems can negatively affect Korean industry and the well-being of Korean workers.

Many ergonomic studies for VDT workstations have been conducted to reduce the incidence of CTDs. For example, Villanueva et al. (1997) found that a backward-leaning trunk decreased the trapezius muscle activity in VDT tasks. Tougas and Nordin (1987) showed that a chair should maintain 105° angle between the trunk and the thighs to prevent users from experiencing back problems. Grandjean et al. (1984) indicated that an adjustable VDT workstation chair could decrease the risk of back problems resulting from excessive static load and an uncomfortable posture. A study by Saito et al. (1997) also demonstrated that non-adjustable VDT devices could cause poor posture resulting in visual and musculoskeletal problems.

A recent study with a quite different chair design concept was conducted by Hedge and Shaw (1996). Using 12 subjects, they assessed the effects of a chair-mounted split keyboard on user performance involving typing and cursor positioning tasks, as well as work posture and comfort, by comparing it to a conventional keyboard arrangement. The chair-mounted split keyboard (floating arms keyboard) system consists of a conventional keyboard layout that is split into two separate sections and mounted to the arms of an office chair. Each section is fully articulated and adjusts laterally, vertically, and twists and/or tilts into almost any position. It was found that this new type of keyboard significantly reduced average ulnar deviation but slightly slowed typing speed without affecting typing accuracy. The video motion analysis showed that the chair-mounted split keyboard significantly reduced the elbow angle and increased the shoulder/neck angle. However, this study did not use objective EMG measures to assess the fatigue of shoulders and arms in spite of user fatigue due to increased muscular activity during VDT tasks.

Based on the previous research, most studies have focused primarily on a static sitting posture to solve visual and musculoskeletal problems during VDT work. But what has been missing is that most computer users are in fact changing their sitting or working postures frequently. Therefore, ergonomic suggestions from the previous studies may be insufficient to accomplish a realistic ergonomic improvement for VDT users. Furthermore, the recent development of a remote entry device, such as a wireless keyboard and/or a mouse (Korea ET news, 1996; Tagishi et al., 1998), has begun to provide users with a more individually controllable working environment which will increase spatial and postural freedom.

Therefore, the goal of this study is to propose a new design of the VDT chair with a keyboard–mouse support table and to evaluate by experimentation, whether or not, by using subjective and biomechanical measures, the new chair can actually provide more physical comfort.

## 2. Method

First, a computer model of the new VDT workstation was designed, based upon Korean anthropometric data. Second, a mock-up chair was constructed using 3-D human modeling. Finally, the safety and efficiency of the chair was verified through both objective and subjective evaluations by using electromyography and a subjective rating scale. Fig. 1 shows how this study has progressed, and details of each step are described in the following sections.

### *2.1. Modeling of new VDT workstation chair*

Major design specifications of the new VDT workstation chair were determined based upon the design recommendation (Korea Industrial Safety Corporation/Korea Labor Corporation, 1996) and the Korean anthropometric data (KRISS, 1992) installed in the 3-D modeling software, SAFEWORK® (GENICOM, 1998). It can simulate a human body and various work environments in