

복사기의 HCI관점에서의 개선과 복사자들의 자세개선

Improvement of Copy-Machine in terms of Human-Computer Interface and
Posture Improvement of Copy-Workers

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Abstract

Work-related injuries have become the issue in the twentieth century. Musculoskeletal disorders are the most common work-related injuries and the most frequent form of work-related ill-health (more than 50% of total work-related injuries (BLS 1990)). The workers at copy shops have complained of pain in their back, legs, and shoulders. Most of them work for more than 8 hours a day. They have claimed that their pains were associated with repetitive and continuous work over a long term. The purpose of this research is to suggest an ergonomically comfortable redesign of the copy machine. This study was performed by conducting a survey of copy shop workers who have complained of job-related physical pain, and analyzing their working postures. The copy machine was ergonomically modified to reduce the workers' pain. The VISION 3000 software was used to analyze the posture. The analysis showed significant differences in the ranges of back and neck motion ($p < 0.05$).

1. INTRODUCTION

Work-related injuries are a major concern to industries, academic researchers, and public and government agencies. Industries are interested in reducing high worker compensation for work-related injuries, costs of medical payments, and costs resulting from lost work time. Health and safety researchers and practitioners are constantly endeavoring to control workplace injuries by trying to understand the causal mechanisms underlying workplace injuries, and by designing safer working conditions through job, equipment and workplace design, educating employees, and matching employees to particular jobs.

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The total cost of occupational injuries continued to increase between 1972 and 1994 in the United States. The sudden and significant increase in the total cost in 1992 (nearly \$60 billion), from 1991, indicated a change in injury reporting and recording practices. The total cost of occupational injuries in the United States in 1996 was slightly more than \$120 billion. The back was the most affected body part in work injuries (Mital, 1999). Since Ramazini (1713), the health effects of simple repetitive motions (which he called "Clerk's palsy") have been studied by only a few researchers. The ILO (International Labor Organization) recognized the importance of musculoskeletal disorders in the 1960's. Their significance was subsequently considered after the sudden increase in cumulative trauma disorders (CTDs) in the United States in 1992. Also the BLS (Bureau of Labor Statistics) reported that musculoskeletal disorders were over 50% of total occupational injuries in 1990. The motions of copy shop workers are so repetitive that they are complaining of back, leg, and shoulder pain. Therefore, it is necessary to study the musculoskeletal disorders and back injuries related to working in a copy shop.

2. METHODS

This study was conducted in four stages: 1) conducting a pilot study, 2) conducting a survey and recording the working postures of copiers, 3) analyzing the postures, and 4) modifying the design of copy machines to make them more comfortable to the workers. Figure 1 shows the procedures in this study

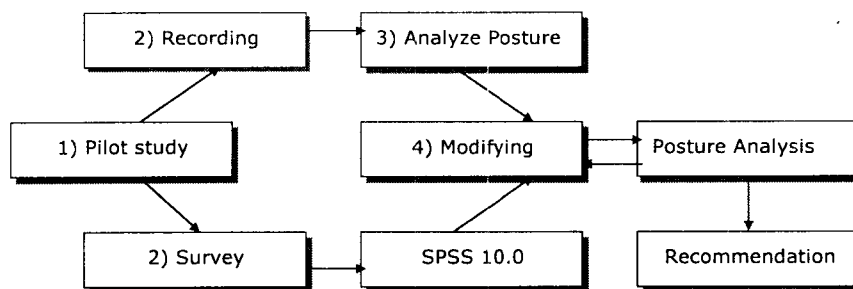


Figure 1. Procedures in this study to recommend a comfortable design of a copy machine

A pilot-study was performed to make a reasonable questionnaire. This questionnaire was used to conduct the survey, and recording the motions of copiers was simultaneously conducted with the survey. SPSS 10.0 was used to analyze the responses to the survey. A camcorder (8mm Video camera, VM-1300, SAMSUNG) was used to record the postures of the subjects, and the video frames were analyzed using VISON 3000 software. Posture analysis was performed in four stages: when copying using the common design and when copying using the modified design in both standing and sitting positions (2 X 2). Three stages of posture are shown in Figure 2.

3. RESULTS

Total subjects for this survey were 40. The subjects consisted of 29 male and 11 females. Most of them usually worked for over 8 hours a day. The copiers had been complaining of leg pain (16, 40%), back pain (10, 25%), and shoulder pain (4, 10%). Eighty-two point five percent of the subjects (33/40) showed a positive response for pains which had been job-related.

Figure 2 shows three types of representative frames of copying task.

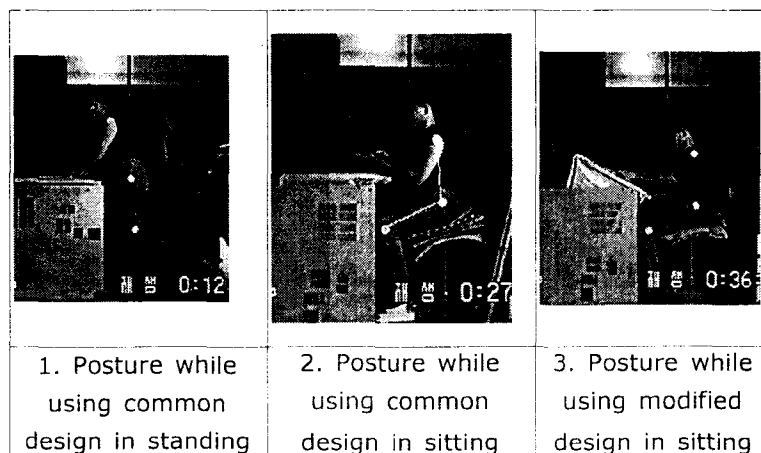


Figure 2. Postures while using copy machine.

Table 1 shows the results of the posture analysis. N (=30) means the number of frames, which are grouped as one period of a copying task. STD means 'standing', SIT means 'sitting' (P=common design, S=modified design, N=shoulder, B=back). The range and SD of 'SIT-' motion is smaller than 'STD-', and '-S-' is smaller than '-P-'.

Table 1. Results from the posture analysis of copying motions [angle °]

	STDPN	STDSN	STDPB	STDSB	SITPN	SITSN	SITPB	SITSB
N	30	30	30	30	30	30	30	30
Mean	34.00	31.00	3.30	-12.43	13.90	27.27	71.17	60.70
Std. Deviation	8.78	5.59	12.61	2.91	3.75	2.46	9.73	3.44
Range	34	17	35	11	16	12	29	15

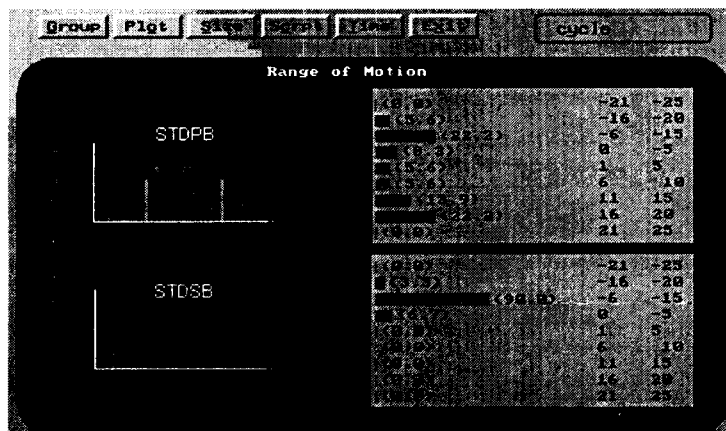
Table 2 shows the results of paired-samples t-test. There is a statistical significance (Sig.<0.05) between each pair except 'STDPN-STDSN (Sig.>0.05)'. This means that there is a difference and in short, an ergonomically modified design is effective.

Figure 3 shows the comparison of the range of copying motion when using the common design and using the modified design in standing position. The range of motion of STDPB is bigger than STDSB. Therefore, STDSB is more comfortable than STDPB.

Table 2. Paired-samples t-test [angle °]

	Paired Differences						t	df	Sig. (2-tailed)
	Mean	Std. Devi.	Std. Error Mean	95% Confidence					
				Lower	Upper				
STDPN - STDSN	3.00	10.97	2.00	-1.10	7.10	1.497	29	.145	
STDPB - STDSB	15.73	12.50	2.28	11.07	20.40	6.897	29	.000	
SITPN - SITSN	-13.37	3.68	.67	-14.74	-11.99	-19.889	29	.000	
SITPB - SITSB	10.47	8.18	1.49	7.41	13.52	7.007	29	.000	
STDPN - SITPN	20.10	8.25	1.51	17.02	23.18	13.342	29	.000	
STDSN - SITSN	3.73	6.79	1.24	1.20	6.27	3.013	29	.005	
STDPB - SITPB	-67.87	8.39	1.53	-71.00	-64.73	-44.283	29	.000	
STDSB - SITSB	-73.13	3.86	.70	-74.57	-71.69	-103.849	29	.000	

Figure 3. The results from the posture analysis



4. DISCUSSION

This paper has analyzed the postures of copiers while using a copy machine and has tried to find a more ergonomically comfortable design to reduce the pain felt in the legs, back, and shoulder of the workers. To design the most comfortable copy machine, some factors that should be considered are as follows: the range of the copying motion, comfort, costs, etc.

This study, however, did not consider the costs for modifying the design but only considered the level of comfort while copying. To reduce back and shoulder pain, the copy machine was modified by giving its copy table a 30-degree slope. To reduce leg pain, a proper chair with a height adjustment feature was given to the copier.

According to the data in Table 1 and Table 2, it is possible to design a more comfortable copy machine by creating a slope on the copy table and providing an adjustable chair to the worker. Figure 2-c shows the most comfortable working posture, and Figure 3-STDSB confirms this fact (the range of 'SIT-' motion is smaller than 'STD-', and '-S-' is smaller than '-P-').

In conclusion, this paper suggests that the design of the copy-machine should be modified to reduce the pain that copy workers experience during copying tasks and to protect the copiers from musculoskeletal disorders.

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