

Design Development and Evaluation of Working Clothes for Fitting Process of Shipbuilding Enterprise⁺

Park Hyewon · Bae Hyunsook · Park Ginah · Kim Jiekwon*

Prof., Dept. of Clothing & Textiles, Changwon National University
Prof., Dept. of Industrial & System Engineering, Changwon National University*

Abstract

The purpose of this study was to develop and evaluate working clothes for shipbuilding workers who work in one of the poorest work environments among national strategic industries that are playing pivotal roles for the Korean economy. For the study method, requirements collected through interviews and field surveys were incorporated to directly weave the fabrics for working clothes. The colors were then selected and the woven fabrics were dyed with the selected colors. Using these, the designs of working clothes were planned from the construction and design aspects and four winter clothes and four spring and fall clothes were produced. Afterwards, the workers dressed in these clothes and workers and managers evaluated them in terms of appearance, color satisfaction, design satisfaction, and safety mind harmony on a five point scale. This study found that the new working clothes offered better functionality, design, and safety compared to existing working clothes.

Key Words : Working Clothes for Fitting Process of Shipbuilding Enterprise, Working Clothes Design

I . Introduction

The purpose of this study was to develop and evaluate working clothes for shipbuilding workers who work in one of the poorest work environments

among national strategic industries that are playing pivotal roles for the Korean economy. Shipbuilding is characterized by complex processes and a very poor work environment. The shipbuilding processes can be divided into

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Corresponding author; Park Hyewon, +82-55-213-3494
E-mail: hwpark@changwon.ac.kr

those that require workers to wear special clothes (e.g., painting, welding, grinding) and those that require workers to wear general working clothes. The scope of this study was limited to the fitting process that requires the workers to wear general working clothes and the designs appropriate for this process were developed and evaluated. It was believed that this study would confirm the need for the subdivision of the production and distribution of working clothes based on the characteristics of the processes and contribute to the development of clothing studies by suggesting a more systematic and rational process of working clothes design development.

In past studies on working clothes, the wearing performance and motion functionality were studied¹⁾, and the colors and construction elements were studied²⁾, but no studies were centered on the shipbuilding industry. Prior studies on the working environment of shipbuilding workers in relation to clothing³⁾ focused on the wearing condition of working clothes and a color state survey for integrated environmental planning, or investigated the awareness on the colors of the workers' clothes. Now, we need a study to produce and evaluate actual working clothes based on the findings of these studies.

The Korean shipbuilding industry is a national strategic industry that boasts a very high foreign currency earning rate and a very high degree of contribution to the national trade balance. In 2008 the shipbuilding recorded a higher growth rate than any other industry in Korea, growing at 21.1% from the previous year with 12.47 million CGT (compensated gross tonnage) and the number of shipbuilding workers reached over 130,000⁴⁾. The shipbuilding business is a large-scale general industry that processes

materials and assembles parts from various industries such as steelmaking, machinery, electronics, and chemistry, and standardization is difficult because its processes are very complex. Furthermore, as most works are carried out outdoors due to their sizes⁵⁾, appropriate working clothes are urgently needed for the safety of workers.

The shipbuilding processes are largely divided into design, hull construction, equipment, and painting. More specifically, after steel materials are selected, cut and processed according to the designs, the hull is assembled from blocks through manual, medium, and large assemblies. The hull is then mounted, the engine is installed, and equipment work and painting work are carried out before the ship is launched.

According to the Collection of Serious Disaster Cases in Shipbuilding Industry(2008) by the Korea Occupational Safety and Health Agency (KOSHA), disasters are decreasing since 2003, but the disaster rate of the shipbuilding industry is 1.76%, 2.48 times higher than the disaster rate of all industries which is 0.71%⁶⁾.

Among the typical shipbuilding works, the painting, welding, and grinding works which require special clothes, but the fitting work, which is to fit equipment and pipes and perform temporary welding during processing, is done in general working clothes. In the case of special clothes, there is a limit to the application of design elements such as personal satisfaction of workers, explicitness, attention, and visibility because the selection of fabrics and the aspects of construction are very important due to the specialness of fabrics (leather or special fabrics). Thus, in this study, the scope of design and evaluation of working clothes was restricted to the fitting work in which the workers must actively move their bodies while

frequently traveling between steel beams and pipes.

A study on the consciousness of the working environment and the colors of working clothes for the machinery, automobile, and shipbuilding companies⁷⁾ found that the main colors of the workplaces were predominantly achromatic (60%). Particularly for the shipbuilding industry, 257 respondents or 78.8% of total 326 subjects answered "gray workplace," indicating very dry and desolate work sites⁸⁾. Furthermore, 241 respondents or 73.9% indicated that not only the work environment is gray, but the color of the work in clothes of the workers in this environment was also gray. Thus, we can see that it is difficult to distinguish between the background and workers.

50.9% of the workers felt "monotonous and boring" and on the question about the color plan of working clothes, 65.1% answered that the colors of working clothes should be changed. Moreover, the respondents answered that changing the colors will have a positive effect on workers and also help improve safety since it will heighten mood and enhance recognition.

Therefore, we need to go beyond such simple clothing management considerations of adequacy for motion and protection of workers from contamination, and approach it from new perspectives. Designs must be developed with considerations of colors because colors affect the satisfaction, efficiency and safety of workers.

According to a study on the environment and the color of working clothes for each shipbuilding process, the fitting process was characterized by low explicitness due to many shadows from outdoor work, very low chroma, and no change of colors although the brightness of working clothes was medium or higher. As a

result, the distinction between workers and background is vague and the overall attention is very low. Due to concerns about contamination, however, workers showed a contradictory attitude because they actually preferred gray, beige, and dark blue in this order while wanting improvement of colors. Thus, if we use sub colors and accent colors while using the preferred colors as main colors considering contamination, we could design much better working clothes.

II. Methods and Process

1. Subjects and content of study

The subject of this study was 'C' Company in Gyeongnam Province where there are many shipbuilding companies, which was also recommended by the KOSHA. Through an interview with the safety management team leader of C Company, fitting workers including the chief of the fitting workplace were recommended with whom we conducted three interviews and performed field surveys. Requirements collected through interviews and field surveys were incorporated to directly weave the fabrics for working clothes. The colors were then selected and the woven fabrics were dyed with the selected colors. Using these, the designs of working clothes were planned from the construction and design aspects and four winter clothes and four spring and fall clothes were produced. Afterwards, the workers dressed in these clothes and workers and managers evaluated them.

2. Study method and procedure

1) Field survey and interview

Four researcher(composed with specialists : industrial & safety system, clothing environment, clothing construction and clothing design) visited the site and took the fitting process with a digital camcorder and a digital camera, and interviewed the two safety team leaders and one managers, and two fitting workers. Based on the results of the field survey and interviews, a checklist for the working cloth design elements was prepared. The interview questions were about the dissatisfactory and preferred elements of the fitting work clothes, preferred colors, and safety problems. The field survey and interviews were conducted between October 11 to 14, 2009 by an occupational safety engineering professor, a clothing environment professor, a clothing construction professor, a clothing design professor, and a master's degree and doctorate degree holder in fashion design. The images and voices were recorded simultaneously.

2) Production and analysis of fabrics for working clothes

Fabrics appropriate for the fitting process were produced by referring to the results of field surveys and the results of prior studies. The production of fabrics was commissioned to S Company in Daegu. The colors of the working clothes were divided into three parts: main colors, sub colors, and accent colors, and appropriate colors were selected. For the main colors, the preference survey results of the previous studies (Park Hyewon 2009; Park Hyewon 2010), field survey results, and the background color were taken into consideration. For the sub colors, harmonious colors of the same color line were selected. For the accent colors, colors with high brightness and chroma harmonizing with the main color and sub color

were selected. Since colors are not enough for increasing explicitness, retro-reflective fabrics were actively used. Finally, ten colors were selected by a clothing design professor, and a master's degree and doctorate degree holder in clothing design using Pantone color chips. Beaker test (BT) was conducted for the finally decided color chips by a fabric production company. For the first test samples of the 10 colors, three variations of each color were chosen. Among the 30 colors in total, 10 colors which were judged to be close to the presented Pantone color chips were selected and the second samples were tested before the final dyeing. For color measurement, a measuring cabinet was used with the D65 basic beam.

For the fabrics of working clothes, one fabric for winter clothes and one fabric for spring and fall clothes were selected, which were then dyed with the selected colors. The basic processing of working clothes was then performed. The colors of the finally produced fabrics were analyzed with color measurements to check the color elements. The production of fabrics for working clothes began in December 2009 and finished in February 2010.

3) Design development of working clothes

For the construction design of the working clothes, the design state investigation and preference survey results were taken into consideration. Furthermore, the shape, adjustment, pocket positions, lengths of top and bottoms, and the tightness of waist and sleeves were determined, which were illustrated as diagrams on the work order sheet. Eight sets of clothes (4 sets of winter clothes and 4 sets of spring and fall clothes) were produced in L size (waist: 82-86 cm, chest size: 105) in accordance with the work order sheet by applying the main colors,

sub colors, and accent colors to the presented shape in consideration of the feelings of seasons.

4) Design evaluation

The produced working clothes for test were applied to the field and evaluated. We visited C Company twice to evaluate the design of the winter clothes. The design evaluation was performed separately with workers and with their managers. Four fitting workers wore the test clothes and their front, side, and back were evaluated. The workers performed fitting work at the field for one day and they were asked to write their opinions on the evaluation sheets for workers and managers. The evaluation sheets consisted of questions related to the satisfaction for the overall appearance, satisfaction for colors, satisfaction for safety, and psychological satisfaction. They evaluated them on a five point scale, and they were asked to freely write their opinions.

III. Results and Discussion

1. Field survey results of design checklist

The checklist was made from visual analysis by researcher's field study and worker's interview. Four researchers visited the site for this study and check the values as two areas

(ergonomics and colors) and added two areas(clothing environmental and construction) by interview with workers , leaders and manager. The ergonomics and color areas investigated subjectively by visual decision and interviews were processed in free group discussion. The interview was recorded and wrote. After finishing the field study, four researchers had discussion and made final checklist.

The shipbuilding site was a vast outdoor field, so large that it was difficult to find a place without a guide <Fig. 1>. As the design elements of the working clothes for the fitting process of a shipbuilding enterprise, ergonomic elements, clothing environment elements, clothing construction elements, and color elements were checked <Table 1>. It was found that the fitting process had very high torsion elements of the upper body, lower body, and the trunk. For clothing environment elements, moisture absorption, penetration, material quality, pressure, and moistness were elements that needed to be considered. Furthermore, for the construction elements, the adjustment part needed improvement and the buttocks part needed more room due to repeated sitting and standing during work. For the color elements, a very high degree of explicitness, a high esthetic level, very high brightness, and high color and tone were required. <Table 1> summarizes the aforementioned survey results.



<Fig. 1> Fitting process working field, taken by researcher

<Table 1> Checklist for design factors

<L: Low, M: Medium, H: High, VH: Very High>

categories	factors	evaluation
ergonomics	upper body	VH
	lower body	VH
	torso twist	VH
clothing environmental	moisture absorption	H
	penetration	H
	easy put on-off	M
	material quality	H
	pressure	H
	moistness	H
	body movement	H
construction	neck/pocket fastening	VH
	front sleeve fastening	H
	front pocket	M
	waist band	L
	hip	VH
color	value control	VH
	chroma control	H
	tone control	H

2. Results of interviews with workers and managers regarding their needs for the design of working clothes

To review the prior studies related to the design needs of workers, a study on the design state and preferences for working clothes of workers in seven companies in machinery, automobile, transportation, and shipbuilding industries (Hye-Won Park and Ginah Park, 2008), the needs for colors and designs varied by the area of work. The workers whose work was toughest had greater need for protection from contamination reflecting safety than for esthetic characteristics such as corporate image or fashion trends. Furthermore, the workers requested an inside pocket, cell phone pocket,

ball-point pen holder, reflective fabric, and a different lining for each season for the top, and additional waist belt rings, button fixing for waist adjustment, and improvement of side pockets for the bottoms.

The workers were dissatisfied with the edge of sleeves, pocket type, and colors in this order for the top of the clothes, and waist belt, rear pocket, and edge in this order for the bottoms. Field workers also suggested improvement of safety by the use of reflective and fluorescent fabrics.

They also requested dark colors, which can cover contaminations due to work in poor environments. For colors of the top, they preferred basic colors of shirts, and convenient snap types for the sleeve design. For pants,

they preferred simple types such as suit pants rather than casual or gym clothes styles.

A study on the work environment and colors of working clothes of shipbuilding companies (Park Hyewon 2010) showed that the yellow line colors appeared often in fitting process. For brightness, medium or higher brightness was dominant excluding shadows. The chroma was very low due to the dominance of achromatic gray colors. The results of the interviews in this study were similar. Nine persons including workers and safety management team leaders were interviewed at a shipbuilding site. In these interviews, they requested identification and safety functions for securing the view of the managers and supervisors to ensure that the workers are not exposed to dangerous situations. They also said that the explicitness and attention of workers were needed, and fluorescent and reflective functions were essential for dark or closed spaces. The fitting process is characterized by many movements during work and contamination of working clothes was a serious problem due to the use of steel, pipes, and tools.

The workers stated that they experienced psychological change by colors, and suggested

that explicitness of shoulders, arms, and legs was needed. They demanded that a higher priority should be given to protecting the body and safety.

3. Design planning and fabric production

1) Design planning

The design of working clothes appropriate for fitting process was planned by referring to the field survey, interviews, and prior studies. The directions of the design planning for the fitting process working clothes in shipbuilding industry are summarized in Table 2.

2) Fabric production results

The fabrics appropriate for the fitting process were selected by considering the clothing environment aspects found from the field survey. The fabrics for winter clothes and spring and fall clothes were woven separately. For the yarns of the fabrics, cotton and polyester Coolon yarns were used, with 2/2 twill weave and weighed 220g/m² for spring and fall clothes and 300g/m² for winter clothes. Before post-processing finishing, antistatic, water absorption and fast















































<Table 2> Design planning

working condition		design factors		design development
outside working	→	consider weather	→	fastener, easy put on -off, fabric considered
pollution	→	dark color	→	main color
need explicitness and attention	→	bright color for safety	→	sub, accent color
high body movement	→	body functional construction (arm, leg etc.)	→	darts, fastener, snap, jacket length, waist elastic band
need shoulder protection	→	shoulder protection	→	design shoulder protection

<Table 3> Fabric production results

fabric	weave	weight(g/m ²)	density(1inch)	density(yarns/5cm)	width(in grey)
for summer & fall	2/2 twill	220	130*84	260*168	66inch(167cm)
for winter -1	2/2 twill	300	91*66	180*132	66inch(167cm)
for winter -2	2/2 twill	300	100*70	200*140	66inch(167cm)

<Table 4> The results of color selection

	Pantone	1st samples	modification	2nd samples
brown		 A  B	⇒ choice B: more dark	 A  B(✓)
grey		 A  B	⇒ more greyish	 A(✓)  B
purple		 A  B	⇒ more blueish more dark	 A(✓)  B
red		 A  B	⇒ more vivid	 A(✓)  B
yellow green		 A  B	choice A	
sky blue		 A  B	choice A	
blue		 A  B	choice A	
light grey		 A  B	choice A	
light brown		 A  B	choice B	
mustard yellow		 A  B	more mustard	 A(✓)  B  C

drying functions were added. For the special processes of post-processing finishing, waterproof, water-repellant, vapor-permeable, flame-retardant, and anti-biotic functions were added. The details of the woven fabrics are summarized in Table3.














3) Selection process and results of dye colors for the woven fabrics

The main colors, sub colors, and accent colors of the working clothes for fitting process were selected by referring to the findings from field survey, interviews, and prior studies. For main colors, brown, gray, violet, and blue were

selected; for sub colors, bright brown, bright gray, and sky blue; for accent colors, vivid red, yellowish green, and mustard yellow. The colors were finally determined through discussion after selection of Pantone color chips by three researchers.

The selected color chips were sent to a fabric production company and beaker test (BT) was conducted for the first dyeing. Two colors were sampled as test colors for each color. Among them, the samples that were judged to be most similar to the Pantone color chips presented by the research team were selected and the second BT was conducted before final selection.

<Table 5> The color measure results of the selected fabric

Material		Color Values					
		L	a	b	H	V	C
	PET+ Cotton	26.87	7.32	1.23	1.3R	2.62	1.32
	PET+ Cotton	48.89	5.70	3.22	6.4R	4.74	1.42
	PET+ Cotton	42.70	57.57	35.15	6.2R	4.14	13.85
	PET(Polar fleece)	26.87	11.63	11.00	2.2YR	2.62	2.82
	acrylic(rib knit)	19.55	7.31	4.35	0.1YR	1.90	1.52
	reflective material	53.46	-0.42	-2.74	2.8PB	5.19	0.73
	PET+Cotton	72.52	-2.05	-21.53	3.7PB	7.10	5.71
	PET+Cotton	69.92	1.94	7.88	8.8YR	6.83	1.26
	PET+Cotton	79.95	-21.35	38.45	5.5GY	7.86	6.04
	PET+Cotton	34.72	16.71	-40.19	7.3PB	3.38	9.53
	Mesh	72.60	2.62	-19.94	6.3PB	7.11	5.27
	Coolon Mesh	76.09	0.48	10.56	1.3Y	7.46	1.48
	reflective material	53.46	-0.42	-2.74	2.8PB	5.19	0.73

The results of color selection are shown in Table 4.

The woven fabrics for working clothes were dyed with the final samples of the color test. The completed final fabrics and the Pantone colors were compared, and the selected colors of the final fabrics were measured to check the color values. It was determined that the colors with particularly high chroma would be used as the accent colors, and the colors with medium or high brightness would be used as the main colors and sub colors for the spring and fall clothes <Table 5>.

4. Production results of working clothes

The working clothes were produced after design planning and fabric production. The designs were drawn as diagrams separately for winter clothes and spring and fall clothes, and eight sets were produced in total, four for each.

1) Winter clothes

For the top of winter clothes, cuttings were added to the shoulders, elbows and body for convenient motion, and accent colors were inserted with a bias cut between the cuttings to improve explicitness and convenience. The back length of the top was longer than that of existing working clothes so as to prevent exposure of underwear and protect the waist when workers stoop down. For pants, rubber was added to the waist belt for convenience and flexibility in waist size. For front and rear rooms and convenience of knees, darts and curved cutting lines were added. For adjustment, metal snaps were added and for the waist adjustment of pants, hook and eye were used together with buttons. For colors of the top, gray was used as the main color and brown as

the sub color which was arranged to the edges of sleeves which are easily contaminated. As a point color, vivid red was arranged. Two little thick reflective bands were added from the back of the neck to the waist on the front and back, and the same bands were horizontally arranged below the waist. Dangerous situations that may occur at the backside of workers which cannot be seen by them were taken into consideration. The shoulders were protected by multiple lines of backstitching with two layers of cloths on the shoulder. Considering the cold weather in the winter, the circumference of neck, the edges of sleeves, and the waist end part were doubled and warm fabrics were added to the inside <Table 6-a>.

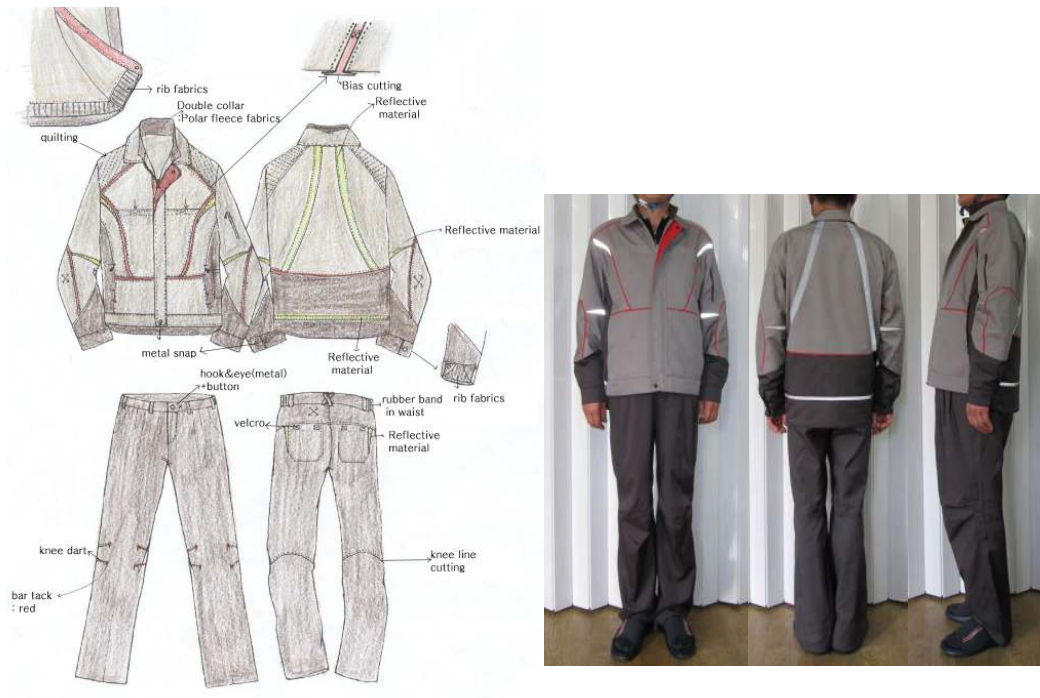
2) Spring and fall clothes

The spring and fall clothes followed the basic design of the winter clothes, except for fabrics, colors, and the lining for which a mesh fabric was used. For fabrics, the light and thin one of the two fabrics that were produced was selected (weight: 220g/m²), and for the colors, generally bright and light colors were used with higher brightness and chroma. Sky blue was used as the sub-color for the top and beige as the sub color for top and bottoms. For the point color, bright yellowish green(5.5GY) was used(Table 6-b).

6. Evaluation of working clothes designs by workers and managers

The designs of the 4 sets of winter clothes and 4 sets of spring and fall clothes were evaluated. We visited C Company again twice (May 11, June 16) and let workers wear the clothes and work for 2-3 days in them <Table 7>. The degree of satisfaction on the designs

<Table 6-a> Production results and design details of working clothes : winter



Concept	<ul style="list-style-type: none"> · Convenient working motion · Visual attention + soil prevention · Cold protection
Color	<ul style="list-style-type: none"> · Jacket : grey+brown · Trousers : brown
Jacket	<ul style="list-style-type: none"> · To use reflective material for visual attention, 3 dimensional sectioning and color arrangement of red color · Bias cutting of sleeve elbow for motion convenience · Double collar for cold protection, patching the rib fabrics on sleeve and lower end of jacket
Trousers	<ul style="list-style-type: none"> · Convenient working motion, bias treatment on knee dart, waist rubber band, bottom yolk of pants · Reflective material on pants pocket for visual attention
Fastenings	<ul style="list-style-type: none"> · Sleeve, placket : snap(metal) · Trousers : hook&eye(metal) +button

<Table 6-b> Production results and design details of working clothes : spring and fall



Concept	<ul style="list-style-type: none"> · Convenience of working action · visual attention · ventilation
Color	<ul style="list-style-type: none"> · Top: sky blue+yellow green+beige+blue · Bottoms: beige
Top	<ul style="list-style-type: none"> · Using a reflection band for visual attention, yellow-green coloration · shoulder pleats and back pleats for convenience of action · to use mesh in shoulder and armpit region for ventilation
Bottoms	<ul style="list-style-type: none"> · Knee dart on pants for convenience in movement, rubber band in waist · to use coolon mesh on the crotch of pants for ventilation
Fastenings	<ul style="list-style-type: none"> · sleeve, pocket, placket: (snap) metal · pants: hook&eye (metal)+button

was then evaluated with workers and managers <Table 8 and Table 9>. The evaluation items were appearance, colors, harmony with the work site, safety, and psychological satisfaction <Table

10>. The five point scale was used and the mean and standard deviation were calculated down to the second decimal point.

As a result, the workers showed 3.5 or higher

satisfaction in all items. The satisfaction level was relatively high for the designs of the top and bottoms at 4.00 and 4.33, respectively. Color satisfaction levels for top and bottoms were also high at 3.25, respectively. The improved explicitness and attention of harmony, safety, and psychological satisfaction was evaluated at 3.75. Managers showed a little higher satisfaction than workers. Their satisfaction level was 4.25 for the overall appearance and the design of top, and 3.33 and the color satisfaction level was 3.33 and 3.25 among the workers and managers, respectively. The satisfaction

levels for harmony, safety, and psychological aspects were 3.75, and the satisfaction level for explicitness and attention was 3.5. The highest score was received in the item that the new working clothes are more helpful than the existing working clothes in terms of safety. The satisfaction level for ease of management and supervision was 3.75, which is relatively high <Table 10>.

Four workers and three managers participated in the evaluation of spring and fall clothes <Table 9>. The satisfaction levels for spring and fall clothes were a little higher than those for

<Table 7> Workers worn new clothes for evaluation



<Table 8> Assessor characteristics for winter clothes

	Gender	Career(year)	working time/day		Position	Gender	Career (year)
	workers	M	17		8	managers	subcontractor
M		23	8	safety	M		20
M		5	8	subcontractor	M		20
M		40	8	health manager	F		1

winter clothes. The same evaluation items for the spring and fall clothes were identical to those of the winter clothes. The satisfaction levels for the designs of bottoms and top were 4.00 and 4.33 among workers, and the satisfaction levels for overall appearance and design

were higher than 4.00 among managers. The satisfaction level for explicitness and attention was the highest at 4.67, indicating that the test clothes were designed with high explicitness and attention. The satisfaction level for safety management was also high <Table 10>.

<Table 9> Assessor characteristics for spring/fall clothes

	Gender	Career(year)	working time/day		Position	Gender	Career (year)
	workers	M	9		9	managers	subcontractor
M		9	9	safety	M		17
M		5	9	subcontractor	M		20
M		8	8				

<Table 10> The results of satisfaction for winter and spring/fall clothes

		contents	winter		spring/fall		
			mean	SD	mean	SD	
workers	appearance	total appearance was improved	3.75	0.96	3.75	0.50	
		jacket design was improved	4.00	0.82	4.00	1.15	
		pants design was improved	4.33	0.58	4.33	1.15	
	psychological satisfaction	harmony/ safety/	harmonious with work environment	3.75	0.96	3.25	1.26
		explicit with working background(color explicitness effects)	3.75	1.50	3.75	0.96	
		safety is satisfied	3.75	0.96	3.50	1.29	
		awareness of colleague is helpful	3.75	0.96	3.25	0.50	
	satisfied with good feeling	3.75	0.96	3.00	0.82		
managers	appearance	total appearance was improved	4.25	0.50	4.33	0.58	
		jacket design was improved	4.25	0.50	4.67	0.58	
		pants design was improved	4.00	0.82	4.33	0.58	
	color	color is satisfied	3.25	0.50	4.00	0.00	
	psychological satisfaction	harmony/ safety/	harmonious with work environment	3.75	0.50	4.00	0.00
		explicit with working background(color explicitness effects)	3.50	0.58	4.67	0.58	
		easy attention by far distance (color attention effects)	3.50	0.58	4.67	0.58	
safety is satisfied		4.25	0.50	4.33	0.58		
	helpful for manage and supervision	3.75	0.50	4.33	0.58		

V. Conclusion

The purpose of this study was to develop and evaluate working clothes for fitting process workers in a shipbuilding company who work in one of the poorest work environments among national strategic industries that are playing pivotal roles for the Korean economy. The scope of this study was limited to C Shipbuilding Company which was recommended by the Gyeongnam branch of KOSHA. A checklist of design elements for working clothes was prepared through a field survey and interviews with the workers of C Company. The fabrics for working clothes were then woven and the colors were selected by incorporating the requirements collected from the field survey and interviews and then the woven fabrics were dyed with the selected colors. Using these, the designs of working clothes were planned from the construction and design aspects and four winter clothes and four spring and fall clothes were produced. Afterwards, the workers dressed in these clothes and workers and managers evaluated them.

To sum up the results of this study, it was found that the fitting process had very high torsion elements of the upper body, lower body, and the trunk. For the color elements, a very high degree of explicitness, a high esthetic level, very high brightness, and high color and tone were required.

The workers requested coverage of contaminations for safety more than esthetic elements such as corporate image or fashion trends. The main colors, sub colors, and accent colors for the working clothes for fitting process were selected. For main colors, brown, gray, violet, and blue were selected; for sub colors, bright brown, bright gray, and sky blue; for

accent colors, vivid red, yellowish green, and mustard yellow. The selected color chips were sent to a fabric production company and BT was performed for the first and second dyeing before the final selection was made.

The evaluation results for the produced working clothes are as follows.

For the winter clothes, all workers medium or higher satisfaction levels for all items. The satisfaction level for design was high and the color satisfaction level for the top was above medium. The improved explicitness and attention of harmony, safety, and psychological satisfaction was medium and lightly above. Managers showed a little higher satisfaction than workers. However this evaluation result was interpreted as a not outstanding improvement than before.

The satisfaction levels for spring and fall clothes were a little higher than those for winter clothes. The satisfaction levels for the designs of bottoms and top were above 4.00 among workers, and the satisfaction levels for overall appearance and design were higher than among managers. The satisfaction level for explicitness and attention was the highest at 4.67, indicating that the test clothes were designed with high explicitness and attention.

This study confirmed the need for subdivision of the production and distribution of working clothes by the characteristics of processes, and proposed a more systematic and rational design development process for working clothes. If more studies are conducted on the working clothes of industrial sites, it will not only improve the quality of life of workers but also contribute to the development of clothing studies.

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