



TECHNICAL EDUCATION AND SKILLS DEVELOPMENT AUTHORITY
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DEVELOPMENT OF WELDING HEAD CAP WITH REPLACEABLE MASK

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EXECUTIVE SUMMARY

This research study aimed at developing a viable head cap with replaceable mask for welding trainees of TESDA Women's Center (TWC).

The trainer and trainees of Shielded Metal Arc Welding (SMAW) NC II observed that it took more than the headgear and the usual PPE to protect oneself during the welding process. Masks were to protect the nostrils and mouth from fumes while welds and spatter were also potential hazard on the head. Trainees used scarves, old t-shirts and mask to improvise a head cap.

The conceptual framework utilized was the Product Development framework, a systematic, commercially oriented research to develop products and processes satisfying a known or suspected consumer need. The Dressmaking NC II qualification spearheaded the product development process. Factors considered in the design include the need for a washable mask, protection of the head that should be made of durable and fire-proof material, comfort in wearing, and low cost to produce.

After the initial idea generation, screening and development of product prototype, product test was with a controlled group consisted of one (1) TWC faculty and nineteen (19) trainees. An evaluation sheet using the five-point Likert scale (Annex) was devised for the conduct of testing to establish the overall preference and satisfaction with the welding head cap with replaceable mask from the respondents.

The results of the product tests showed that more than half of the respondents were satisfied with the product they tested. 65% of the respondents were very satisfied on the following attributes of the welding head cap with replaceable mask: comfort, safety, ease of use, appearance and overall quality. 35% of the respondents were satisfied with the safety, ease of use and appearance,

Based on the results of the product test, it was concluded that the welding head cap with replaceable mask could be a viable product as personal protective equipment. The overall quality was acceptable and satisfied the needs of the intended consumers. Recommendations were the manufacture and sales of the product at TESDA Women's Center. Likewise, the conduct of a feasibility study to determine the viability of commercializing the product was suggested.



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INTRODUCTION

Background of the Study

In 2013, a total of 49,118 occupational injuries were reported in the country based on the Integrated Survey on Labor and Employment (Philippine Statistics Authority, 2015). This figure is higher compared to the 2011 survey where there was only 48,975 posted workplace injuries. Among those industry groups with the highest number of cases include manufacturing and construction. This is evidence that the workplace can be a hazardous environment for people, especially the workers. Hence, there is a need to control and prevent accidents from happening through constant monitoring of occupational health and safety standards.

Welding is one of the prominent aspects involved in the construction sector. Among the many health hazards of welding include “smoke” which is a mixture of very fine particles (fumes) and gases. Many of the substances in welding smoke, such as chromium, nickel, arsenic, asbestos, manganese, silica, beryllium, cadmium, nitrogen oxides, carbon monoxide, cobalt, copper, lead, selenium and zinc, can be extremely toxic. Exposure to welding smoke may have short-term and long-term health effects (AFSCME, 2017).

Personal Protective Equipment (PPE) should always be used along with safe work practices, including welding for construction. Eye protection should be used for all welding operations to protect the eyes from bright light, heat, ultraviolet light and flying sparks. For protection, face shields or helmets and goggles are commonly worn. Aside from this, protective clothing should also be worn during welding including fire resistant gauntlet gloves, high-top, hard toed- shoes, leather apron, face shield, flame-retardant coveralls and safety glasses (AFSCME, 2017). Protective clothing should be made of wool, which does not ignite easily, or specially-treated cotton fabrics. With regards to respiration, masks or respirators must be specific to the hazard and fitted, cleaned, stored and maintained in accordance to the standard. There are instances when a self-



contained breathing apparatus should be worn when welding in confined spaces because welding may reduce the oxygen concentration in the air.

Statement of the Problem

The Department of Labor and Employment has issued Department Order No. 13 series of 1998 providing the guidelines governing occupational health and safety in the construction industry. Section 6 in particular refers to the provision of personal protective equipment to employees as part of the responsibility of employers, including specialized PPE for those involved in welding(philconstruct.com, 2017).

TESDA Women's Center envisions to be the lead TVET institution of excellence in empowering Filipino Women. Among the qualifications offered at TWC are Gas Metal Arc Welding (GMAW) NC II and Shielded Metal Arc Welding (SMAW) NC II. Both the trainer and the trainees have observed that it takes more than the headgear and the usual PPE to protect oneself during the welding process. Fumes are also produced which require masks to protect the nostrils and mouth. At the same time, welds are also potential hazard on the face. At present, trainees use scarves, old t-shirts and mask to improvise a head cap. This process takes time to prepare and does not ensure protection since most are made from light materials. In the market, there are available head gears usually used by motorcycle riders but also covers the nostrils and mouth along with the head. Along this line, the trainer of Dressmaking NC II has stepped out to develop and design a head cap most suited for the needs of the welding trainees.



Objectives of the Study

The objective of this research is to design a specialized head cap appropriate for welding trainees. Factors considered in the design include the need for a washable mask, protection of the head that should be made of durable and fire-proof material, comfort in wearing, and low cost to produce. The developed product is expected to provide trainees as well as those in the industry a better alternative for PPE in welding.

Scope and Delimitation

The research was focused on the design and development of a head cap with replaceable mask as personal protective equipment of TWC welding trainees. Acceptability of the product developed was determined by conducting product test survey with 20 Shielded Metal Arc Welding NC II former and current trainees of TWC, Taguig City.

Both quantitative and qualitative data were gathered. Quantitative data were obtained from the results of the consumer survey and evaluations conducted with the participants. Qualitative data were gathered also from the group discussion and feedbacks of participants during the product testing. The conduct of consumer survey was limited to 20 participants because of limited number of available trainees.



CONCEPTUAL FRAMEWORK

Review of Related Literature

According to the Philippine Occupational Health and Safety Brief, the OSH situation in the country is far from being admirable, to say the least. More and more workers are suffering from poor working conditions, with no protection whatsoever.

The 2000 to 2002 data showed that occupational accidents resulting to death increased by 69.7%(anroev.org, 2017). Although the exact figures have declined year on year, it might have included under-reporting which is prevalent in developing countries.

Philippine laws are seen as not responsive to the problems of workers, specifically occupational health and safety concerns. DOLE issued an order in 2004 no longer requiring inspection for companies with more than 200 workers and do a self-assessment report on their respective working conditions.

The brief also stated that information on OHS among workers is very low. The dominant understanding is wearing personal protective equipment (PPE), wherein workers thought they were already safe from working hazards. For welders, head cap is one of the personal protective clothing which provides protection against metal splashes, flames and sparks. It is worn before they put their face shield and it protects the upper part of the body.



Conceptual Framework

Product and Process Development (commonly referred to as Product Development) is systematic, commercially oriented research to develop products and processes satisfying a known or suspected consumer need. Product development is a method of industrial research in its own right. It is a combination and application of natural sciences with the social sciences into one type of integrated research whose aim is the development of new products. The most widely referenced normative product development models are those of Booz, Allen and Hamilton Inc. (1982) and that of Cooper and Kleinschmidt (1986). There are essentially four basic stages in these models for every product development process. These are:

- product strategy development;
- product design and development;
- product commercialization;
- product launch and post-launch.

Each stage has activities that produce outcomes (information) upon which management decisions are made. In practice, some of the activities performed in the product development process can be truncated, or some stages can be omitted or avoided based on a company's accumulated knowledge and experience. Having defined product development, it is now necessary to examine the issue of what constitutes a new or innovative product. Newness of a product may be judged differently according to those who perceive it. In the context of consumer goods such as clothing, there are three groups of actors: consumers, distributors, and producers. Each may have a different view of whether or not a product is new.

Crucial to the discussion of product development is to recognize that "innovation" is contextual. The consumers' perception of product newness depends on the location of the consumer and the types of clothing currently on the market.



The challenge for product development is to develop a product, which is acceptable to the target consumer. The specific size, comfort and safety provided are significantly some of the factors that target customers are concerned about.

New Product Development Process

Idea Generation

Basic survey questionnaire are utilized in this process to identify the needs of the intended clients and describe the problems that might occur when these needs are not addressed. Ideas from other members of the organization are also generated as a significant part of this process that will take on affordability, accessibility and other specifics of the product development.

Idea Screening

This step is crucial to ensure that unsuitable ideas, for whatever reason are rejected as soon as possible. Ideas are considered objectively; ideally by a group or committee focusing mainly on the needs of the intended clients as a result of the survey done. Shortlists of ideas were documented.

Concept Development and Testing

Once the ideas have passed the screening stage, a small group discussion is conducted. The idea is now a concept, with enough in-depth information that the consumer can visualize it. A sample of the products is pre-tested by the group.

Aside from patent research, design due diligence, and other legalities involved with new product development, knowing where the product will be work best - who are the consumer? How will the consumer accept the new product? Do they really want or need it? This stage will be a chance to develop the concept further.



Product Development

In this process, the trainer involved used various raw materials for product development. Number of products were produced and presented initially to a small group.

Product Testing (Internal Clients)

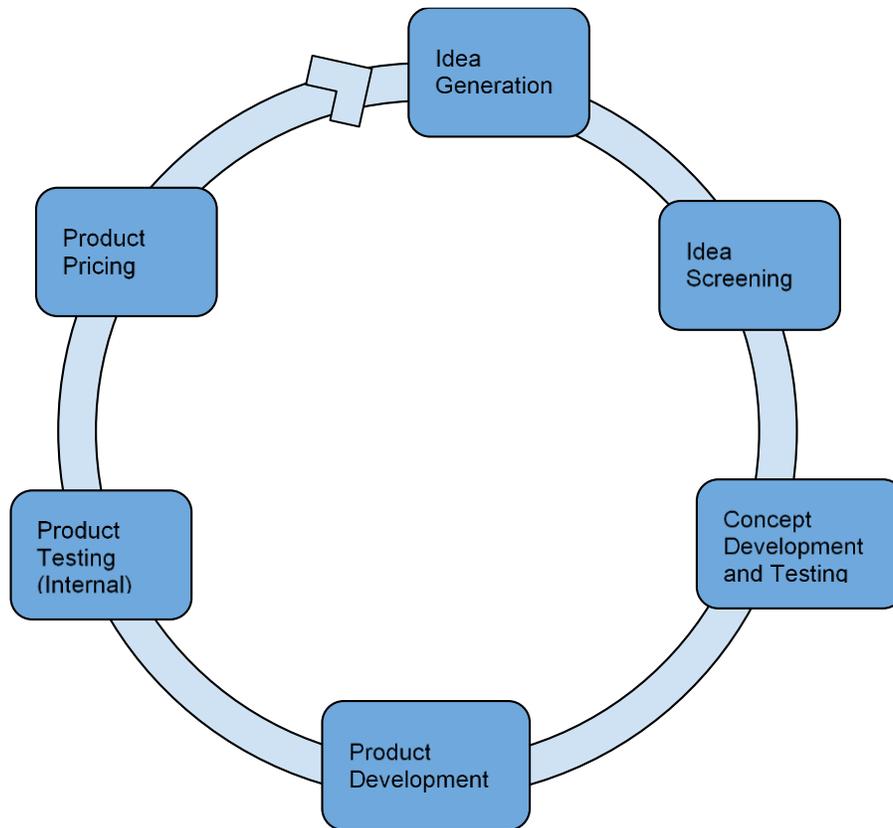
Product testing were participated by selected members of TWC staff and trainees with the consideration that this group have experience in welding. This process aims to gather feedbacks on the design, comfort and protection of the product.

Product Pricing

At this stage, new product developed have gone mainstream. Once the consumers are purchasing the products, it should be at a reasonable cost.



Figure 1. Conceptual Framework of New Product Development



METHODOLOGY

Idea Generation and Screening

The experimental stage involved crafting of different designs and exploration of the most suitable materials to be used for the head cap. The research team was composed of the TESDA Women Center (TWC) trainer in Dressmaking who led the conduct of design development with assistance from TWC Shielded Metal Arc Welding (SMAW) expert. The TWC Center Chief provided technical guidance in the research design and methodology while the team of TWC Research provided assistance in the conduct of consumer survey and technical writing.

An important consideration in the experimental stage was the material. Since welding is prone to splatter that can damage clothing, the design team needed to use materials that are fire-retardant but also comfortable enough for everyday use during training. Crucial to the design is the replaceable mask that can be washed because this part covers the nose and mouth and will need to be clean for hygienic purposes.

The team looked at the available head caps in the market and found that most are used by motorcycle riders which are made of light materials which can catch fire. Fire retardant cloth used by firefighters was then canvassed and bought at Divisoria Manila. The design used was based on those available from the internet to cover the head and neck areas.



Concept Development and Product Development

After looking at all available designs in the market, the research team then developed the design of the product. This was led by the Dressmaking NC II trainer in consultation with the SMAW NC II trainer. The next step was the pattern of the parts of the head cap were drawn on tracing paper. Annex 1 shows the photos of the pattern used for the product development. After that, the pattern were drawn on the fire-retardant fabric. These parts were then sewed together. The prototype covers the head including the back of the head. The head cap has an opening for the face. When the mask is placed, the cheeks, nose and mouth of the wearer gets covered, except for the eyes.



Sideview photo of welding head cap

Additional cloth is provided to cover the upper chest and shoulders. The head part has a Velcro tape where the left ear is covered while on the right ear a strip of fire

retardant cloth is attached. The other end of the strip also has Velcro tape and this will be used to tighten or loosen the mask on the head.



Backside view of welding head cap

The main feature of the welding head cap is the removable mask made from the same material. On the end of both sides are Velcro tapes to attach on the inner lining of the head mask. The left side has an additional Velcro tape in case of adjustment. The back side of the removable mask is lined with net and is open on both ends. This will be the pocket to place a piece of cloth such as handkerchief, towel or disposable mask and prevent it from getting pulled down. The removable mask is also washable which makes it ideal for everyday use. The proponents can sell two of the removable mask per set so that one of a removable mask that can be used while one is being washed and dried.



Inside view of welding head cap

The inside of the welding head cap is lined with net. This is to let the air flow inside the mask. For the purpose of the research, two prototype samples were made by the trainer from Dressmaking NC II.

Product Evaluation and Respondents of the Study

The next step involved was conducting product test with a controlled group consisted of one (1) TWC faculty and nineteen (19) trainees. An evaluation sheet using the five-point Likert scale (Annex) was devised for the conduct of testing to establish the overall preference and satisfaction with the welding head cap with replaceable mask from the panelists. The panelists used a check mark in the appropriate scale to express their feeling of how much they satisfied or dissatisfied with the product.



Conduct of Product Test

Product Testing

To determine the acceptability and preference of the welding trainees, consumer testing of the prototype samples were conducted to a total of twenty (20) welders including one trainer from TESDA Women's Center, Taguig City. The product evaluation was conducted on December 14 and 15, 2017. Two (2) members of the research team facilitated the consumer survey. The panelists were asked to wear the head cap and perform a number of positions in welding including the overhead position. The acceptability test could forecast buying intent from the trainees. Questions were asked to see if they would use the head cap again and if they would recommend the product to other people.



TWC Welders testing the head cap on the various positions including overhead

Product Costing

Product costing of the welding head cap with replaceable mask was computed to determine its affordability and compare the cost with prices of other head caps in the market.



RESULTS AND DISCUSSION, CONCLUSION AND RECOMMENDATION

Results of Product Evaluation

Two prototypes of the product were produced by the research team and were subjected for testing with twenty (20) respondents. The survey was conducted to determine the over-all acceptability of the welding head cap with replaceable mask by the trainer and trainees of SMAW NC II.

Tables 1 and 2 show the profile of respondents who participated in the product testing. There were more female welders (85.0%) compared to male welders (15.0%) with age ranging from 16 to 40 years old. More than one third of the respondents belong to the 21-25 age group while one fourth of the respondents are aged 26-30.

Table 1. Profile of Students by Sex

Class Section	Male	Female
Total	3	17
%	15.0	85.0

Table 2. Profile of Students by Age

Age Range	Quantity	%
16-20	2	10.0
21-25	7	35.0
26-30	5	25.0
31-35	4	20.0
36-40	2	10.0
Total	20	100.0



Table 3 shows the results of evaluation of the prototype for welding head cap with replaceable mask that was tried by the research team in terms of percentage (%) of responses in liking of the respondents/panelists.

Table 3. Percentage (%) Satisfaction of Respondents/Panelists

Description of Preference	% Satisfaction				
	Comfort	Safety	Ease of Use	Appearance	Overall Quality
1 – Very Satisfied	65.0 %	65.0 %	65.0 %	65.0 %	65.0 %
2 – Satisfied	20.0 %	35.0 %	35.0 %	35.0 %	35.0 %
3 – Neutral	15.0 %	-	-	-	-
4 – Unsatisfied	-	-	-	-	-
5 – Very Unsatisfied	-	-	-	-	-

The 5-point Likert scale was considered as the most appropriate to use in this study because of its usefulness in planning. The goal here was not to compare the comparative degree of liking but merely to register whether a product under study was liked well enough based on quality attributes. The judgments were more absolute than comparative.

It can be inferred from Table 1 that more than half of the respondents are satisfied with the product they tested. 65% of the respondents were very satisfied on the following attributes of the welding head cap with replaceable mask: comfort, safety, ease of use, appearance and overall quality. 35% of the respondents were satisfied with the safety, ease of use and appearance, while 20% of the welders were satisfied with the comfort the product provided. On the other hand, 15% of the respondents were neither satisfied nor dissatisfied with the comfort of product. This result can be due to the limited time they were able to use the product to confidently determine if they can wear the head cap comfortably.



The general comments of the panelists and photos taken during the conduct of the product test are presented below.

Welding Head Cap with Replaceable Mask
<ul style="list-style-type: none">• Mas maganda siya hindi siya masyado mainit• Everything is perfect• Hindi napapasukan ng spatter, safe gamitin at comfortable.• Mas nasusunog pa ang gloves kaysa sa head cap• Mas ligtas gamitin• Mas maganda po siya gamitin at safe unlike sa ibang mask• Very satisfied• Thank you for this welding head mask because it is easy to use• Comfortable and easy to use• Good job• This welding mask is easy to use• Comfortable to use and safe• Comfortable to use

When asked to compare the other head PPE available that they use and the prototype sample, all of the respondents remarked that the welding head cap with replaceable mask is a much better product. The respondents were also asked if they would use the product if it is available and 75.0% answered “Definitely” while the remaining 25.0% responded “Probably”. On the other hand, 70.0% of the respondents answered that they will definitely recommend the product to other welding trainees or workers.

Product Costing

The cost of materials, supplies, labor and miscellaneous expenses of the welding head cap with replaceable mask was computed based on the current market price. Table 4 presents the summary of costing with suggested selling price.



Table 4. Summary of Costing with Suggested Selling Price

Material	Quantity	Unit	Unit Cost, Php	Total Cost, Php
Fire retardant fabric, navy blue	1	Yard	250.00	250.00
Net, black	0.25	Yard	60.00	15.00
Velcro	0.50	Yard	40.00	20.00
Thread	1	Spool	10.00	10.00
			Sub-total	295.00
Labor cost				64.00
Overhead cost (electricity, transport)				43.75
			Sub-total	107.75
Yield	1	Piece		
Cost per piece				402.75
Selling Price				600.00

Conclusion

Based on the results of the product test, it is concluded that the welding head cap with replaceable mask could be a viable product as personal protective equipment. The product provides ample safety from spatter and burns especially during overhead welding, is comfortable enough to wear for hours and limits the inhalation of fumes. The design allows welders to save time in wearing multiple covers for their face. The replaceable mask is washable and cost efficient compared to buying disposable masks. The overall quality is acceptable and satisfies the needs of the intended consumers.



Recommendations

The result of the study proved that the developed welding head cap with replaceable mask was generally satisfying and acceptable for the intended clients. Hence it is recommended that the product be manufactured and sold at TESDA Women's Center and have the design patented or certified. Furthermore, it is recommended that the Dressmaking NC II together with the TWC research team conduct a feasibility study to in to determine the viability of commercializing the product. There is a possible market catering to other training centers offering SMAW and other related program qualifications. The opportunity to establish another income-generating project for the institution should be backed up by thorough research.



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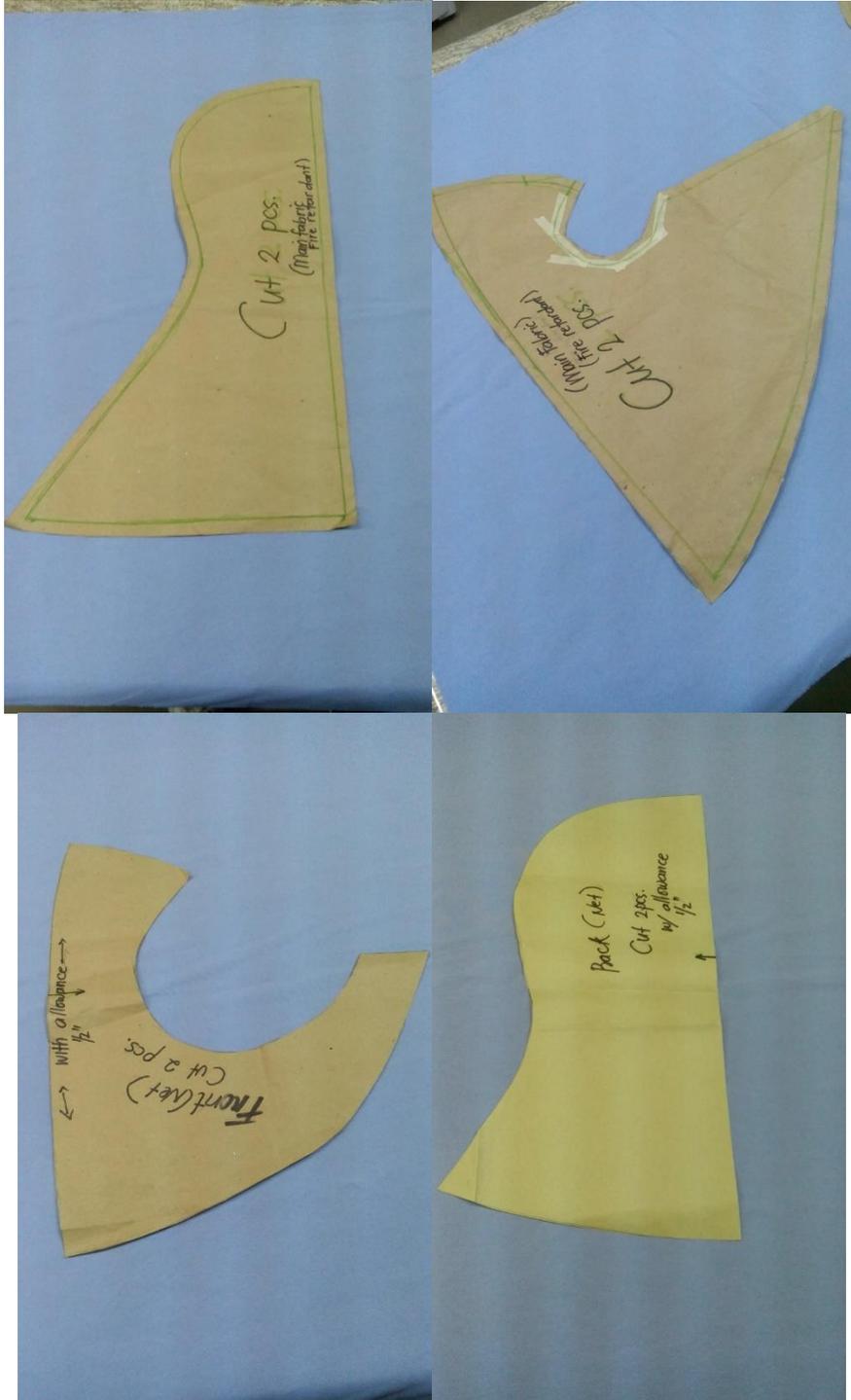
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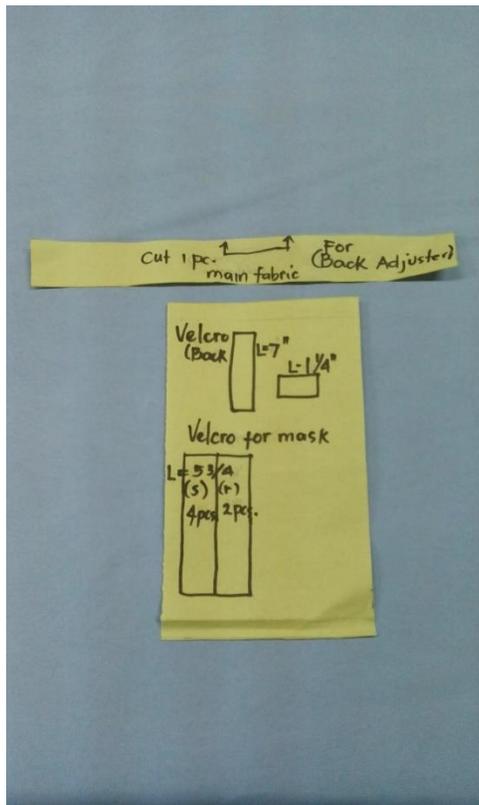
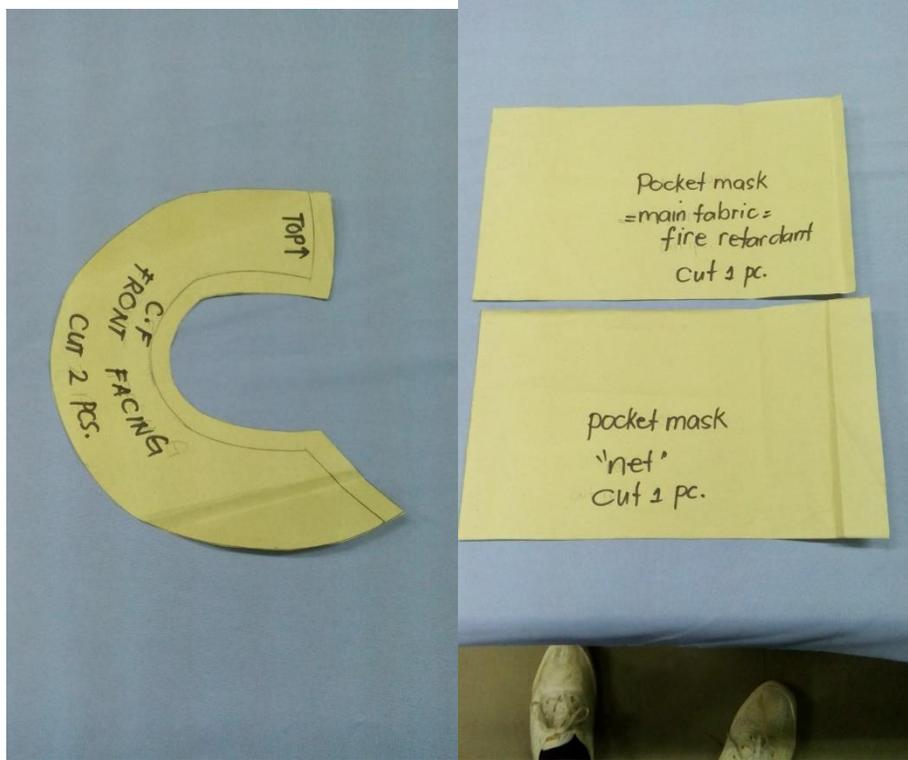


ANNEXES



ANNEX 1- PATTERN OF WELDING HEAD CAP WITH REPLACEABLE MASK





ANNEX 2

PRODUCT TEST SURVEY FOR WELDING HEAD CAP WITH REPLACEABLE MASK
SURVEY FORM

Name of Panelist (Optional): _____ Date: _____

Sex: _____ Age: _____

Instruction: After testing the product, please evaluate and complete the survey below by checking the appropriate box.

1. The following is a list of product items. How satisfied are you with the Welding Head Cap with Replaceable Mask based on the criteria below?

	Very Satisfied	Satisfied	Neutral	Unsatisfied	Very Unsatisfied
Comfort					
Safety					
Ease of use					
Appearance					
Overall Quality					

2. Compared to other head caps that are available, would you say that the Welding Head Cap with Replaceable Mask is:

<input type="checkbox"/>	Much better
<input type="checkbox"/>	Somewhat better
<input type="checkbox"/>	Almost the same
<input type="checkbox"/>	Somewhat worse
<input type="checkbox"/>	Much worse

3. If it is available now, will you use the Welding Head Gear with Replaceable Cap again?

<input type="checkbox"/>	Definitely
<input type="checkbox"/>	Probably
<input type="checkbox"/>	Might or might not
<input type="checkbox"/>	Probably will not
<input type="checkbox"/>	Definitely will not

4. Would you recommend the Welding Head Cap with Replaceable Mask to other welding trainees/workers?

<input type="checkbox"/>	Definitely, will recommend
<input type="checkbox"/>	Probably will recommend
<input type="checkbox"/>	Not sure
<input type="checkbox"/>	Probably will not recommend
<input type="checkbox"/>	Definitely, will not recommend

5. Comments:





