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The benefits of using 3D CAD software to modify clothing virtual prototype

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Abstract

Automated garment pattern making system has an important role in increasing development efficiency and achieving sustainable environment. In the traditional method, the operations must be repeated to prepare three-dimensional clothing samples several times, and this leads to an increase in time, effort, and costs .The problems of this research were: What is a clothing sample, what are the requirements for its implementation, and what are its types? How well does CLO 3D program perform the prototype sample efficiently? How can we combine the Gerber pattern program with the CLO 3D program to get the best garment sample? The significance of this research is keeping pace with the great technological growth in the applying the latest technologies in the field of advanced products, reducing wasted time, effort and money by using the traditional methods through the use of 3D technologies. This research aims to identify the garment sample, its requirements and types, achieve the maximum benefit from 2D program and 3D software to obtain garment virtual sample, and overcome any errors resulting from not adjusting the prototype sample using only CLO 3D software program. Research hypotheses are the possibility to combine between the Gerber pattern software with the CLO 3D program to get the best garment sample; the use of 2D - 3D software reduces the occurrence of costly errors before executing the garment. Two complex models were chosen for the experimental work. A Question form containing four basic axes was designed to investigate the assessment of the research factors and validate the hypotheses. The basic axes included 10 sub-inquiries spread in four axes to assess the achievement of the main axes. Results were statistically analyzed using the statistics Program (SPSS). The high evaluations of the basic axes prove the success of the questionnaire axes and execute the research hypotheses.

Keywords

Garment virtual prototype, Apparel industry, Gerber program, CLO 3D program

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Introduction

Despite the tremendous technological progress in the apparel industry, traditional methods are still used in some departments, and we have not yet been able to use these technologies optimally, for example the "3D technologies", which depend on designing three-dimensional virtual environments. These technologies can be used in developing the marketing of clothing products through techniques that allow the customers, through the program, to choose the offered products and try them easily and quickly, as the customer coexists with them, which increases the purchasing power of the products. Beside that it can also be used in other applications such as marketing, workers training, and making virtual fashion shows.

The 3D programs allow making virtual 3D samples for designs instead of actually making them from real fabrics, with the possibility of modification and change in design, sizes, colours, to suit customers' desires quickly, which helps in reducing production costs and increasing competition in the apparel markets. Also the use of 3D programs increases flexibility and reduces consumption of production resources.

The pattern preparation stage is considered one of the most important stages on which the success of the design implementation depends on. The more efficient the pattern is the higher the production efficiency and obtaining the required design with the specified sizes (Ahmed, 2014).

To keep up with the tremendous technological advances, it has become essential to move towards the development of new technologies through which the defects of the traditional methods in preparing the first sample can be overcome. Among the defects of the traditional methods are the following:

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- Waste a lot of time, effort and money in executing the prototype sample.
- Iinability to imagine the final shape of the product without executing a complete sample with the required specifications (modeling).

Research Problem:

Using CAD technology in apparel manufacture has been extensively used in pattern making, it still based on personal experience in the manufacture and only designers who have experience in making patterns can be relied upon.

From to the 2D flat pattern, designers cannot instinctively consider the 3D product forms; the usual process is to make 3D prototype through the plain and then change it to the flat pattern, but this process has to be repeated many times, which is tiring and expensive.

The CLO 3D program is considered one of the most popular programs used in designing. The use of the CLO program is not limited to designing clothes only, but rather it is used to design accessories. But CLO 3D has not been known as a pattern construction program, so the research seeks to answer the following questions:

1- What is a clothing sample, what are the requirements for its implementation, and what are its types?
2- How well does CLO 3D program perform the prototype sample efficiently?
3- How can we combine the Gerber pattern program with the CLO 3D program to get the best garment sample?

Research Significance:

The importance of this research is due to:

1- Keeping pace with the great technological growth in the applying the latest technologies in the field of apparel manufactory.
2- Reducing wasted time, effort and money by using the traditional methods through the use of 2D and 3D technologies.

Research objectives:

This research aims to:

1- Identification of the garment sample, its requirements and types.
2- Achieving the maximum benefit from 2D and 3D software to obtain garment virtual sample.
3- Overcoming any errors resulting from not adjusting the prototype sample using only CLO 3D software program.

Research Hypotheses:

1- It is possible to combine between the Gerber pattern software with the CLO 3D program to get the best garment sample.
2- The use of 2D and 3D software reduces the occurrence of costly errors before executing the garment.

Methodology of the Research:

In this study the descriptive method was applied, as it describes and analyses the phenomenon that the researcher wishes to study. The applied method aims to utilize modern scientific techniques, which are needed by scientific research to increase production, and improve performance by using technical methods, and this is shown in the applied procedures that were represented by combining between the Gerber pattern software with the CLO 3D program to get the best garment sample.

Research Limits:

The research limits are: Designing the garment prototype sample using the software programs, Gerber 10 and CLO 10.

Previous Studies:

Advanced techniques have laid a good technical basis for pattern constructing with the permanent progress of digital knowledge, professional systems, apparatus knowledge, and other simulated applications. It is obvious that the future of digital pattern making is based on computer acknowledgment and perceptive of piece type, with the computer analysis and adjusting the pattern making and the worker dependable for evaluating and modifying. For this reason, recently, many studies have been concerned with the smart production of sample.

A variety of programme software are used to recognize the digital pattern making of apparel has mostly transformed the needs of people for usual garment pattern making, and to develop the production efficiency of factories and supplied new information for the field of smart clothing manufacture.

In order to solve the problems of wasting resources and at the same time costing time and labour due to making usual patterns in the clothing field, (Jin, et al, 2023) have proposed a method of for automatically generating clothing patterns based on a parametric formula and the Python language.

(Mohsen, 2020) aims to provide students with the skills of drawing and grading a skirt pattern using the Gerber program, and thus raising the efficiency of the pattern and keeping pace with the labour market.

(Farag, et al., 2017) aims to identify the effectiveness of 3D programs in drawing the basic model for the production of women's trousers through comparison with the manual method of drawing the model to reach fully-adjusted samples in less time and less cost.

(Jevsnik, et al., 2015), (Stjepanovic, et al., 2015) emphasized that virtual prototypes are a talented

technology that has the ability to replace traditional clothing prototypes. However, it can only be successful when it is taken into account all the specific characteristics of the fabric and the model of the virtual body to simulate the fit of the clothes.
With the increasing use of 3D clothing modeling technology and with the availability of technologies such as virtual modeling and virtual draping have become new methods for the objective assessment of clothing simulation
(Wanger, et al., 2019), (Ahmed, 2014).
Study by (Abdo; Aborady, 2020) concerned with applying the CLO 3D program to take advantage of the capabilities of the three-dimensional simulation programs in evaluating the Aldrich model for girls in adolescence by knowing the extent of its control and its applicability to the mannequin attached to the program and trying to make some modifications to it to reach the optimum degree of control for it.
This research concerns with the capability to achieve the maximum benefit of 2D and 3D software technologies in clothing factories, using two 2D and 3D software programs (Gerber and CLO).

Theoretical framework:

1- Garment Sample in Apparel Industry:

The sample department is the research and development department in the apparel industry, as the sample serves to conceptualize the design idea, and is used as a tool for product development, evaluation of the design, performance and expected production of the product, as well as test results.

The concept of garment sample:

- It is the focus of planning for new products in terms of development and change in the form of textiles by changing colors, lengths or patterns, as well as introducing improvements in designs and models.
- it predicts the quality of the product, determines the processes it goes through during production, production requirements and costs, the price of the piece to the consumer, and determines the time it takes to produce the order based on the available capabilities of the factory.
- The importance of the sample is that it represents the reality agreed upon by all those responsible for the design in the factory (Ahmed, 2014).

Garment sample types:

There are different types of sample whose name differs from one customer to another. Some customers request one sample while others request more than one sample. These types are:

1- **Prototype:** Defined as the appropriate form for evaluating the design, performance and expected production of the product.
2- **Fit Sample:** Sample is often measured in factories on a person or a mannequin of the same size and then adjusted by means of pins.
3- **Wash Sample:** The factory washes the sample if the customer requests it, to ensure that its dimensions and colour are preserved.
4- **Final Sample:** After approval of the first sample, this sample is made with the same stages as the first sample, but on the actual fabric, and after confirming its conformity, it is sent to the production department.
5- **Preproduction Sample:** Sample is sent from the sample department to the production department to be executed with all the details (fabrics, accessories, operation, packaging, care labels, and others).
6- **Presentation Sample:** Sample is displayed in the meeting room in the presence of: (production manager, sample workmanship, designers, quality assurance manager, engineering department official), where the techniques used in implementation are clarified, as well as an explanation of the parts of the model and its assembly method.
7- **Sales Sample:** A number of samples are made and distributed to retailers, as production orders are based on actual sales of samples.
8- **Top of Production:** It is the best sample that was produced with the highest quality, as it is an example of what the production will be like, and it has a label with all the information related to the sample written on it. (Lee, Steen, 2010), (Regan, 2008), (Ahmed, 2014).

Main Requirements in Sample Making:

- **Sample Design Steps:** The design process is subject to a number of steps and specifications, for example: Identifying consumers' desires, putting the initial design in the form of sketches or proposals, producing the prototype of the product... etc.
- **Preparing the Technical File for the Sample:** The sample file includes the steps that follow to produce the sample in the garment industry.
- **Sample Preparation:** The sample maker assembles the garment's complementary pieces, the stitches and techniques used must be suitable for the cutting process that will be used in the regular production process.
- **Cut The Sample:** The process of cutting the sample is one of the most important stages that must be examined to ensure the efficiency and effectiveness of the cutting process before producing the sample of clothing.
- **Sample Production Methods:** Sample production methods differ according to the

number of samples produced per day (Ahmed, 2014).

2- Virtual Reality (VR) in the Product Development:

Definition of Virtual Reality (VR):

Virtual Reality (VR) is one of the most important design techniques today, and the word virtual reality or virtual reality means the semi-realistic representation of things, bodies, people, and their environments, in addition to the idea of permanent interaction between the computer user and the digital graphics and images that he deals with. It also means the use of computers in modeling and interactive simulation to enable a person to interact with synthetic and other sensory or visual three-dimensional products or environments, by making the user use them, live with them and between them in a three-dimensional way, and deal with them in real-time as if they were real things, exist on the ground (Nofal, 2010).

Advantages of Virtual Reality:

1- Providing a virtual environment in which to navigate through a 3D- space that permits wandering, looking, rapid classified, and facing the actuality.
2- The virtual creation is existing with actual measures and a normal shape that is commensurate with a person image of the dimensions.
3- It displays fake images that make the user feel that he is engrossed in a simulated realm.
4- It achieves security for its user.
5- Providing expenses for establishing real systems and products (Waheed, 2009).

Disadvantages of virtual reality:

It may have harmful effects on its users, and these effects include:

1- Some applications that create a state of peripheral virtual reality lead to a state of addiction to being inside it.
2- A state of inability to differentiate between what is real and what is hypothetical, and here the designer may lose the ability to distinguish between what is actually required in the product he designs and what is a fantasy (Waheed, 2009).

Virtual garment simulation:

Simulation applications have clearly and effectively contributed to the development and progress of the field of design and manufacture of ready-made garments. The structure of the simulation work system in clothes is as follow: the flat (two-dimensional) pattern is inserted, the fabrics used are entered, taking into account their mechanical properties, and the assembly data is set (stitch type - knitting). ....., etc.) as well as putting the basic data of the mannequin (sizes), then running the simulation program used, after that we get a simulation of the piece of clothing (Ahmed, 2014).

3- Gerber Program:

The Accumark Gerber system is considered one of the best and most powerful systems used in the industry, due to the great experience of this company in this field and its wide spread around the world. It also contains many features and specialized programs as well as any specialized system that both work on a specific part of the pattern drawing.

Gerber advantages:

1- Great accuracy in adjusting the pattern between the parts.
2- The possibility of making an exact copy of the pattern, which gives a high quality.
3- The appearance of arrows in each piece to determine the places of the pieces as evidence to prevent an error from occurring during the work of the pattern
4- Ease and flexibility in the way of moving the parts, which works to complete the pattern in the least time.
5- It is suitable for all matching methods, whether by blocking or distorting, and it is suitable for all individual methods, whether face-to-face, face-up, or bent over.
6- The use of modern technology in the production of clothing gives the producer the opportunity to be at the forefront of competitors and introduces the electronic computer in the production processes of clothing.
7- Early detection of existing errors.
8- Dealing with all raw materials while minimizing errors in samples.
9- Determine the areas that are not suitable for the material in order to avoid errors to improve the quality (https://www.lectra.com).

4- ClO 3D Fashion:

CLO It is a fashion design program that reproduces the process of making actual clothes in typical 3D modelling programs. A 3D mesh surface is sculpted to create a costume, and on the other hand, it creates 2D pattern pieces and sews them to produce 3D fashion clothes.

CLO 3D program advantages:

- Speeds up the production process
- Minimizing sample making costs
- Helps reduce waste
- Ensures a better sizing fit
- Clothes can be sold before they are produced
- Virtual fashion shows can be held

CLO program provides a conversant, easily line which aids to imagine the design with fast and stress less. Design with simulated clothing

decreases prototype making, delivery and unused fabric https://www.clo3d.com/en/.

Experimental work:

a. Description of Practical Experiments:

To investigate the research problem, 2 complex models were chosen for the experimental work. The main objective of the research is to design and execute the garment prototype using the capabilities of Gerber program and CLO 3D program. To get the best results, the pattern is drawn on the Gerber program, and then the adjustments are made according to the measurements on the ClO 3D program. The Goal is to achieve the best for of the prototype without real production.

Operation Stages:

1- The pattern is quickly drawn on the CLO 3D program (a sketch drawing to illustrate the idea only) to test the shape of the Fitting
2- The pattern was drawn on Gerber program.
3- To confirm the precision of the design pattern and to see the modelling and the final shape of the design, the parts of the pattern were transferred to the ClO 3D program,
4- The main screen of the program is divided into two sides, where the 2D flat pattern is placed on the right side of the screen, while the left side is where the 3D mannequin is placed.
5- The parts of the patron are moved from the right side to the left side next to the mannequin, then the parts of the patron are stacked next to the places designated for them on the mannequin.

In the case that there is more than one part in the design, the upper part is finished first, then the lower part, or vice versa.

In first design, the upper part (the blouse) was implemented first, as the icons for assembling were pressed in the program to sew the parts together on the mannequin, and the sewing takes place according to the logical sequence of the production stages.

1- After that, the stage of adjustments is done with the pattern after placing it on the mannequin to adjust the size and see the fitting from the front, back and all sides.
2- After making sure that the pattern matches the size of the mannequin and verifying the required design, the materials are selected and placed on the mannequin, then accessories, printing and embroidery, if any.
3- Then nesting the parts of the pattern is done on Gerber software, and then the actual sample is executed.

One of the advantages of the ClO 3D program is to create more than one idea for a complete collection of up to 40 designs without the need to implement any of them, and create a virtual fashion show in this program without any costs, and customers choose designs and then implement them according to demand.

It is a modern way to display fashion and its accessories clearly in the smallest details, which helps attract customers to buy fashion. It is also possible to see the shape of the accessories (buttons, zippers, etc.) and change their size and shape to reach the best alternatives. The goal of the program is to clearly see the final shape of the design without the need for actual implementation, where the sample was previously executed more than once to reach the desired final form, but by using the program, time, effort and money are saved, as adjustment, modification and vision of the final form are done without the need to implement more than one sample. Then the final sample is executed.

To get the best results, the pattern is drawn on the Gerber program, then the adjustment and adjustment are made according to the measurements on the ClO 3D program.

For sizes that do not conform to the standard size table, the measurements are set on the mannequin, then the pattern is placed and adjusted to see the final shape of the design.

Stages of Implementing the First Design

Figures from (1) to (10) show the operation stages of Design 1.

First stage: Developing the idea of a pattern and testing the form of implementation (dressing) on the CLO 3D program

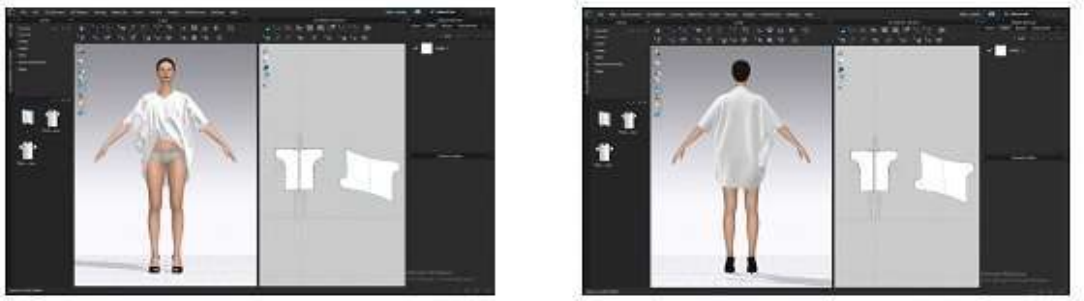


Figure 1: First stage (Design 1)

Second stage: Make the desired modifications to the pattern of the initial idea on the Gerber program

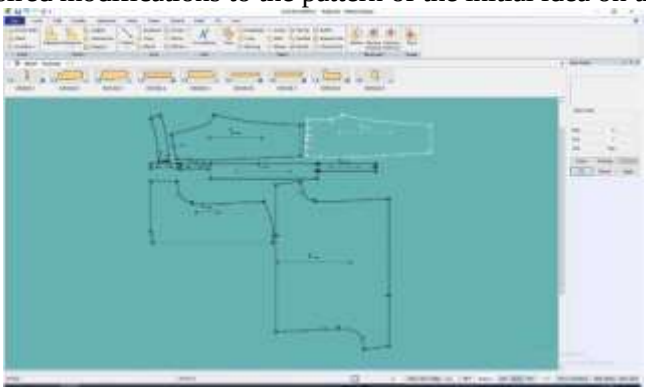


Figure 2: Second Stage (Design 1)

Third stage: Entering the pattern on the CLO 3D program: The upper part of the design: Steps to implement the blouse: Placing the parts of the pattern on the mannequin (weaving the pieces)

Figure 3: Third Stage: Implementing of the blouse (Design 1)

Fourth stage: Entering the pattern on the CLO 3D program: The lower part of the design: Steps to implement the pants: Placing the parts of the pattern on the mannequin (sewing the pieces)

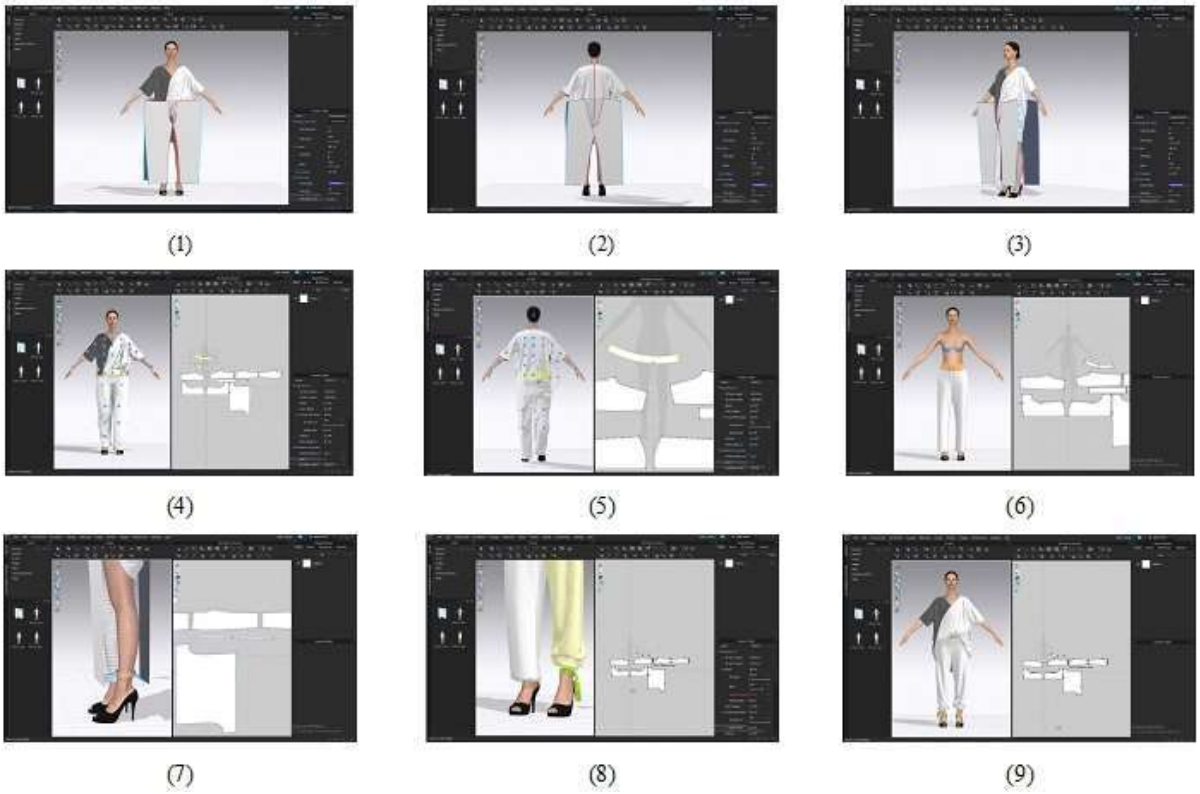


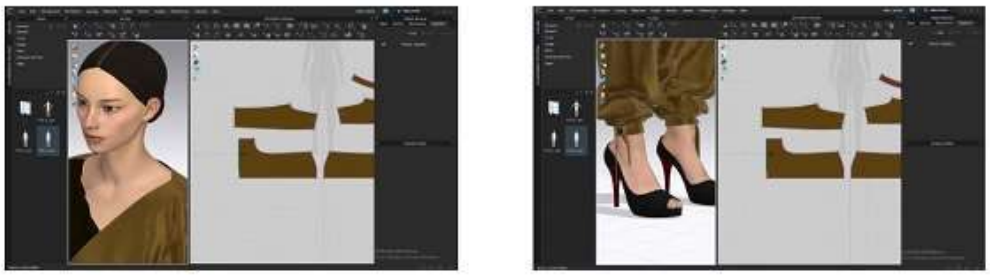
Figure 4: Fourth Stage: Implementing of the pants (Design 1)

Fifth stage: Selection of the fabrics:

(1) (2) (3)

Figure 5: Fifth Stage: Selection of the fabrics (Design 1)

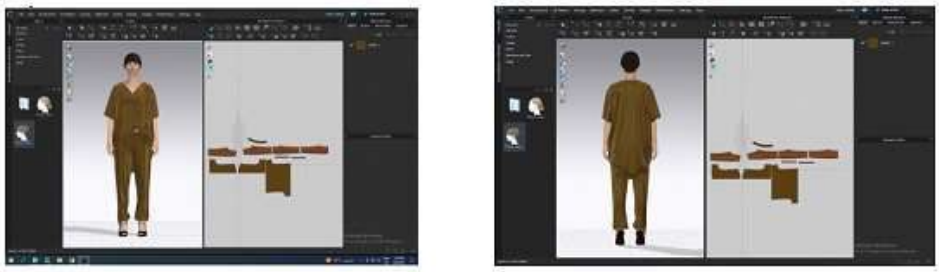
Sixth stage: Execution of visible seams:



(1) (2)

Figure 6: Sixth Stage: Execution of visible seams (Design 1)

Seventh stage: Make the bliss effect for the pants, then hide the back of the fabrics, any stage of the work steps and choose a hair and shoe style to complete the final look



(1) (2)

Figure 7: Seventh Stage: Give the bliss effect and Choose hair and shoes (Design 1)

Eighth stage: Final look

Figure 8: Eighth Stage: Final look (Design 1)

Ninth stage: Sample preparation

Tenth stage: Marker making (pattern nesting) by using Gerber program

Figure 9: Ninth Stage: Sample preparation (Design 1)

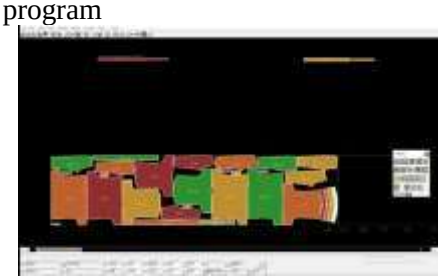


Figure 10: Tenth Stage: Marker making (Design 1)

Stages of Implementing the Second Design

Figures from (11) to (19) show the operation stages of Design 2.

First stage: Developing the idea of a pattern and testing the form of implementation (dressing) on the CLO 3D program

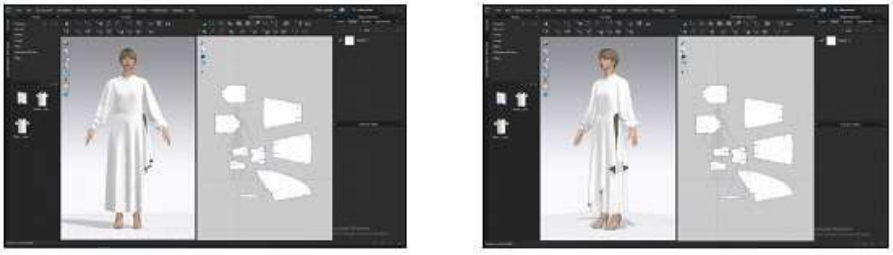


Figure 11: First stage (Design 2)

Second stage: Make the desired modifications to the pattern of the initial idea on the Gerber program

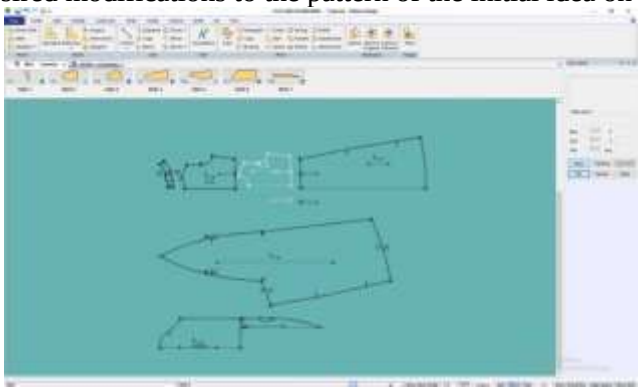


Figure 12: Second Stage (Design 2)

Third stage: Entering the pattern on the CLO 3D program: Placing the parts of the pattern on the mannequin (sewing the pieces together)

(1) (2) (3)

(4) (5) (6)

(7) (8) (9)

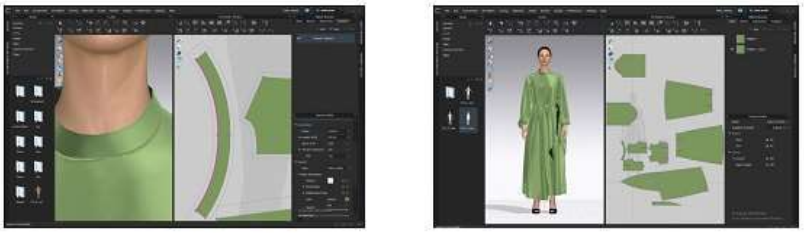
(10) (11)

Figure 13: Third stage: Entering the pattern on the CLO 3D program (Design 2)

Fourth stage: Choosing fabrics and installing sleeve cuffs

Figure 14: Fourth Stage (Design 2)

Fifth stage: Execution of visible seams:



(1) (2)

Figure 15: Fifth Stage (Design 2)

Sixth stage: choose a hair and shoe style to complete the final look

Figure 16: Sixth Stage (Design 2)

Seventh stage: Final look

Figure 17: Seventh Stage (Design 2)

Eighth stage: Sample preparation

Ninth stage: Marker making (pattern nesting) by using Gerber program

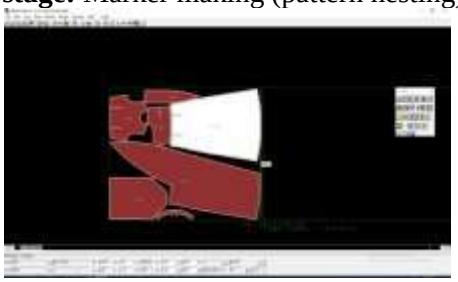


Figure 18: Eighth Stage: Sample preparation (Design 2)

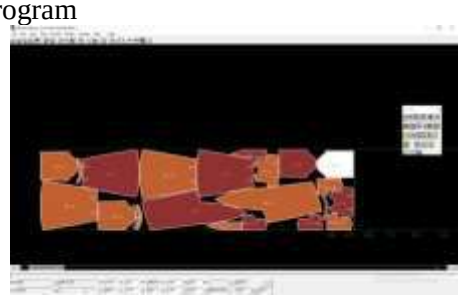


Figure 19: Ninth Stage: Marker making (Design 2)

b. Designing the Questionnaire

The hypotheses of this study state that "It is possible to combine between the Gerber pattern software with the CLO 3D program to get the best garment sample" and "The use of 3D software reduces the occurrence of costly errors before executing the garment". To investigate these hypotheses a questionnaire was considered. It contains four basic axes to investigate the assessments of the subject of the study and validate

the research hypotheses. The basic axes included 10 sub-inquiries to judge the basic axes. 18 university members evaluated the executing stages of (2) different complex designs. Results were statistically analyzed using the statistics Program (SPSS), and the statistical analyzes were as follows:

The questionnaire variables

The questionnaire included 10 sub-inquiries spread in four axes, the basic axes are:

Axis 1: Precision and mastery: It covers 3 inquiries, concerning with the ability to change measurements of sizes, doing more experiments, easy level to transfer the pattern between the two programs.

Axis 2: Quality of seams, fitting & finish: It covers 3 inquiries, concerning with executing of the visible seams, ability to change the colours, hair styles, fabrics textures and shoes types.

Axis 3: Save time, effort & costs: It covers 3 inquiries, concerning with the ability to save time, effort and costs.

Axis 4: Use of technology in product developing: it contains one inquiry concerning with the ability to benefit from the advantages of special programs in sample prototype developing with less costs and best precision.

Results & discussion:

Reliability Statistics:

The (Alpha Crownbach) was calculated on a total taster (18) judged members. Table (1) represents the stability of questionnaire

Table 1: Alpha Cronbach's

Questionnaire axes	N of Inquiries	N of Designs	N of Items	Alpha Cronbach's
Axis 1: Precision and mastery	3	2	6	0.814
Axis 2: Quality of seams, fitting & finish	3	2	6	0.741
Axis 3: Save time, effort & costs	3	2	6	0.754
Axis 4: Use of technology in product developing	1	2	2	0.844
General stability of the questionnaire	10	2	20	0.788

N of Items	Cronbach's Alpha
20	0.788

Results in table (1) clears that, the stability factor of the axes is suitable, recording (0.788) for all inquiries, although the stability of the separate axes stands between (0.844) and (0.741). This indicates that the questionnaire categorized with acceptable degree of stability, since the value is between 0.7 and 0.8, which enables to rely on it in the actual application of the study.

Analysis of the Correlation:

The degree of linear correlation and the direction of this linear relationship between the variables under study were assessed. The correlation matrix was calculated between the four evaluation axes of the questionnaire under study using Pearson's correlation coefficient.

The statistical hypothesis:

(H0): $P = 0$ (H1): $P \neq 0$

(H_0): is the null hypothesis, which means that the coefficient of linear correlation between variables is not significant and there is no relationship between them.

(H_1): is an alternative hypothesis, which means that the coefficient of linear correlation between the variables is significant and not equal to zero and there is a relationship between them.

(P): is the correlation coefficient

Table 2: Correlations Matrix

Questionnaire axes		Axis 1	Axis 2	Third axis	Axis 4
Axis 1: Precision and mastery	Pearson Correlation	1	.896**	.728**	.715**
	Sig. (2-tailed)		.000	.000	.008
Axis 2: Quality of seams, fitting & finish	Pearson Correlation	.896**	1	.733**	.708*
	Sig. (2-tailed)	.000		.001	.032
Axis 3: Save time, effort & costs	Pearson Correlation	.728**	.733**	1	.884**
	Sig. (2-tailed)	.000	.001		.002
Axis 4: Use of technology in product developing	Pearson Correlation	.715**	.708*	.884**	1
	Sig. (2-tailed)	.008	.032	.002	

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

It is evident from table (2) that there is a strong direct correlation, varying in degrees and strength, between each pair of the four study axes. By studying the relationship of each of the four axes, we find that the correlation was strong and positive between each of the four axes of the study. The

value (P-value) between each pair of the axes was less than 0.01. That is, it was important, and therefore we discard the null hypothesis that adopts "there is no correlation between the axes, and we take the hypothesis that the correlation of the study differs from zero". That is, the correlation of the elements under study was strong and remarkable. This means that the axes of the questionnaire are added to each other and do not differ from each and reach the success of the possibility of combine between the Gerber pattern software with the CLO 3D program to get the best garment sample" and "The use of 3D software reduces the occurrence of costly errors before executing the garment.

Descriptive Statistics:

Evaluations of questionnaire of executing of 2 complex designs were done. The Results of axes were denoted and evaluated distinctly. Table 3 shows the relative weight of designs evaluation.

Table 3: Evaluation the questionnaire axes

	Axes of the Questionnaire									
Design Nr.	Axis 1			Axis 2			Axis 3			Axis 4
	1st Inquiry	2nd Inquiry	3rd Inquiry	4th Inquiry	5th Inquiry	6th Inquiry	7th Inquiry	8th Inquiry	9th Inquiry	10th Inquiry
Design 1	92.22	96.67	90.00	93.33	90.00	93.33	95.56	91.11	97.78	98.89
Design 2	96.67	96.67	86.67	91.11	96.67	93.33	98.89	96.67	97.78	96.67

Figure 20: Evaluation of precision and mastery

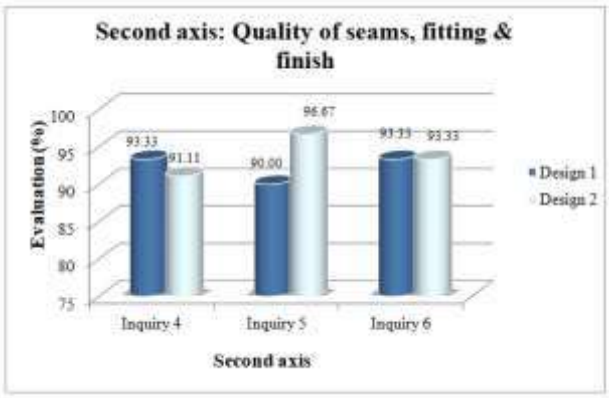


Figure 21: Evaluation of quality of seams, fitting and finishing

Figure 20 represents the evaluation of the first axis. It can be found that the inquiry 2, which concern with "the possibility of making several attempts to obtain a more accurate sample, has the best evaluation (96.67 %). The overall evaluation of the first axis (precision and mastery) is 93.15 %.

Figure 21 shows that the evaluation of the second axis. It indicates that, the three inquiries (4, 5 and 6) had similar results. The overall evaluation of the second axis "Quality of seams, fitting & finish" is 92.96 %.

Figure 22: Evaluation saving time, effort and costs

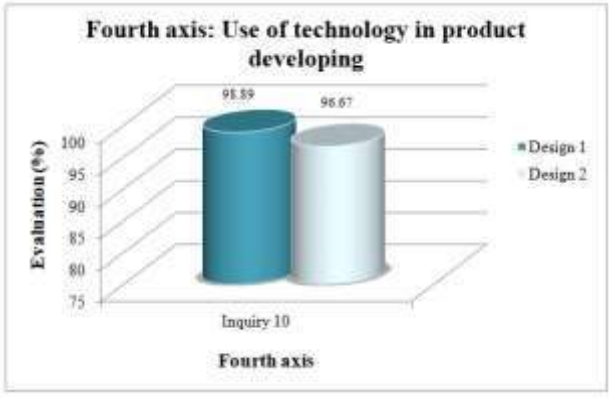


Figure 23: Evaluation of using technology in product developing

In figure 22, the evaluation of the third axis "Save time, effort & costs" is presented. It is obviously that the inquiries 7 and 9, which concern with "the possibility of saving time and costs, record the best evaluation (97.78 % %).The overall evaluation of the third axis is 96.30 %.

Result in figure 23 confirms that, the fourth axis "Use of technology in product develops", which

consider the main goal of the research, has the best evaluation. The value of the evaluation is 97.78 %. The overall evaluation of all questionnaire axes is 95.05%. These high values confirm the achievement of the questionnaire axes that fulfill the research hypotheses.

Summary:

This research aims to identify the garment sample, its requirements and types, achieve the maximum benefit from 2D program and 3D software to obtain garment virtual sample, and overcome any errors resulting from not adjusting the prototype sample using only CLO 3D software program. Research hypotheses are: It is possible to combine between the Gerber pattern software with the CLO 3D program to get the best garment sample; the use of 2D - 3D software reduces the occurrence of costly errors before executing the garment. Results confirmed that:

- The questionnaire characterized with acceptable degree of stability, since the value is between 0.7 and 0.8, which enables to rely on it in the actual application of the study.
- There is a strong direct correlation between questionnaire axes.
- The overall evaluation of the first axis (precision and mastery) is 93.15 %.
- The overall evaluation of the second axis "Quality of seams, fitting & finish" is 92.96 %.
- The overall evaluation of the third axis "Save time, effort & costs" is 96.30 %.
- The value of the evaluation of the fourth axis "Use of technology in product developing" is 97.78 %.
- The overall evaluation of all questionnaire axes is 95.05%.
- These high values confirm the achievement of the questionnaire axes that fulfill the research hypotheses.

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