

Wireless 3D Chocolate Printer

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Abstract - This study is for the BSHRM Students of Batangas State University (BatStateU) ARASOF for the researchers believe that the Wireless 3D Chocolate Printer would be helpful in their degree program especially on making creative, artistic, personalized and decorative chocolate designs. The researchers used the Prototyping model as procedural method for the successful development and implementation of the hardware and software. This method has five phases which are the following: quick plan, quick design, prototype construction, delivery and feedback and communication. This study was evaluated by the BSHRM Students and the assessment of the respondents regarding the software and hardware application are all excellent in terms of Accuracy, Effectiveness, Efficiency, Maintainability, Reliability and User-friendliness. Also, the overall level of acceptability of the design project as evaluated by the respondents is excellent. With regard to the observation about the best raw material to use in 3D printing, the chocolate is good to use as the printed material is slightly distorted, durable and very easy to prepare; the icing is also good to use as the printed material is not distorted and is very durable but consumes time to prepare; the flour is not good as the printed material is distorted, not durable but it is easy to prepare. The computation of the economic viability level of 3d printer with reference to ROI is 37.14%. The recommendation of the researchers in the design project are as follows: adding a cooling system so that the raw material will be more durable, development of a more simplified version and improving the extrusion process wherein the user do not need to stop the printing process just to replace the empty syringe with a new one.

Keywords: BatStateU-ARASOF, HRM Students, Wireless 3D Chocolate Printer

I. INTRODUCTION

Nowadays, more and more people are reliant upon the usage of technology as it helps in shaping one's modern life. With the advancement of the technology and the benefits that it provides, people at home, in a company, in an industry, and especially in schools and universities has the eagerness to support and promote it in their everyday lives. Recent technological advancements, including the computers, printing press, telephones, mobile phones, personal digital assistant (PDA), handheld gaming devices, wireless gadgets and the Internet, have greatly made human's life better by providing easier ways of doing things.

Technology continues to evolve with the new invention being made across the globe. The change has touched every human's life – be it directly or indirectly and because of this, they need to be more competitive for them to be able to cope up with the fast pace of technology. Everyday new ideas and discoveries are being raised to the changing world of technology in which it includes but not limited to computers, printers and wireless technology.

With more and more technological advances around the corner, a lot of new innovations will continue to arise which focuses on the trends of the technology. Many people, expert or not, creates different inventions through the use of modern technology which became very useful in the different fields of the industry.

The researchers came up with the idea of proposing a study entitled “Wireless 3D Chocolate Printer” because they are fascinated about what they have watched and read over the

internet. The researchers are challenged that if they can make one with an attempt of adding a feature of wireless technology, they are indeed good information technology students of BatStateU ARASOF- Nasugbu. Also, they are motivated to pursue doing the study because there are no existing third dimensional (3D) printers in their university so they are honoured that if they will finish this study, they will be the first researchers who have conducted a study about 3D printers.

The researchers got the idea of making a 3D wireless printer based on the ideas and information they have obtained from library. They found out that there is a study about “Wireless Printer” conducted by Dimafelix et. Al. who were BSIT 2010 students, According to these researchers, when it comes to offices, a wireless printer is more convenient to a wired printer because the user do not have to go through the hassle of saving files to a compact disk (CD) or flash drive and run where the printer is located just to do printouts. So the researchers decided to make their 3D printer wireless so that they do not need to use those bulky wires of printers just to be connected and do the printing jobs.

The researchers named their project, “Wireless 3D Chocolate Printer”, because they will use chocolate instead of plastic in printing out 3D objects. They realized that it will be helpful in some of the degree programs of the BatStateU ARASOF - Nasugbu particularly in the Hotel and Restaurant Management in making their lovely chocolate designs.

This study had been commenced and pursued to create a wireless 3D printer, using the Wi-Fi technology as a means of

connection between the 3D printer and the personal computer which will be utilized to create and design 3D objects.

II. OBJECTIVES OF THE STUDY

This study aimed to develop a “Wireless 3D Chocolate Printer” for BatStateU ARASOF- Nasugbu. Specifically, this study was guided by the following objectives: to determine which is the best raw materials to use in 3D printing among chocolate, flour and icing in terms of distortion of printed figure, durability of the printed figure and easiness in terms of raw material preparation; to determine the economic viability level of 3d printer and to determine the acceptability level of the proposed 3d printer in terms of accuracy, effectiveness, efficiency, maintainability, reliability and user-friendliness.

III. METHODS

In beginning a new project, there are several steps and procedures to follow especially in the designing process. The design process gives a quick overview of what the project will look like and helped in achieving better results.

In this study, the researchers used the System Development Life Cycle (SDLC) method in which the activities and functions that the systems developers typically performs. It follows a series of steps from systems planning, systems analysis, systems design, systems implementation and systems support and security (Shelly and Rosenblatt).

The SDLC method has several types such as waterfall model, prototyping, spiral model, agile, iterative enhancement model and 4GT. Among the given types, the prototyping type was used as the procedural method for the successful development and implementation of the present study.

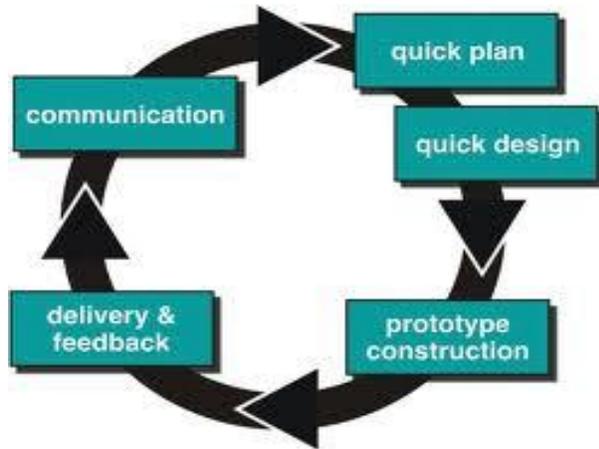


Figure 1. Prototyping Model(Pressman)

Figure 1 shows the Prototyping Model which serves as a paradigm of their study. The first step is to gather requirements about the study wherein it signals the start of the development process. Once the requirement analysis is done and design for the prototype is made, it goes to the evaluation process. Then refining the prototype based on the evaluation. In this model, going back from the previous phase to modify something as

well as proceeding to the next phase even if the previous phase is not yet finished is allowed.

Instrumentation

The researchers used different references such as books, magazines, news articles and the internet in searching for the needed data and information about their study. The data gathered served as their basis while developing the design project.

For the purpose of knowing if what is the best raw material to use in 3D printing among chocolate, icing and flour, the researchers are about to conduct observation regarding it while focusing on the durability and the possibility of distortion of the printed material. The easiness of preparation of the raw material is also one factor that the researchers have considered. Also, the researchers are about to compute for the economic viability level of the design project using the return on investment (ROI).

In order to gather more reliable data and information, the researchers developed questionnaires that will serve as their instrument in information gathering. The researchers believe that survey questionnaires are one of the most effective methods in getting the response from the respondents.

The questionnaires were given to the respondents to evaluate the proposed system. The respondents were chosen based on random sampling which will be given to HRM students only.

In terms of determining the economic viability level of the design project, the researchers compute first for all the costs of the materials needed in the development and then compute for the benefits.

To determine the Net Benefit, we have the formula:

$$Net\ Benefit = TotalPresent\ Value\ Benefits - Total\ Present\ Value\ Costs$$

The formula for ROI:

$$ROI = \frac{TotalPresent\ Value\ Benefits - Total\ Present\ Value\ Costs}{Total\ Present\ Value\ Costs} \times 100$$

(Silber)

Before disseminating the survey forms to the respondents, the researchers developed questionnaires for the evaluation process and the said questionnaires were checked and validated by their adviser and members of the panel. Moreover, they used the Slovin’s formula in getting the number of their respondents. For the preparation process, they also had to setup their project so that they can demonstrate well to the respondents of what output does their project produce.

After they had gathered information from the respondents, they are about to compute if the design project is acceptable on the perception of the respondents.

To determine the interval between rankings in the questionnaires evaluation of the Acceptability Level of the project, the researchers used the Likert Scale:

$$i = \frac{h - l}{t}$$

Where in:

- i = interval
- h = highest value in the questionnaires acceptability level
- l = lowest value in the questionnaires acceptability level
- t = total number of present options in the questionnaires acceptability level(Kirk).

Applying the formula to the study, the researchers have:

$$i = \frac{5 - 1}{5} = 0.8 \text{ interval}$$

Table 1. Guideline Interval for Questionnaire

Interval	Descriptive Equivalent
4.21 – 5.00	Excellent
3.41 – 4.20	Very Good
2.61 – 3.40	Good
1.81 – 2.60	Fair
1.00 – 1.80	Poor

Table 1 presents the guideline interval in determining the statistics of Acceptability Level of the proposed study. The interval in each class is 0.8 which is based on what the researchers got when they used the Likert scale formula with 5 as the highest value in the questionnaires acceptability level and 1 as the lowest.

Table 2. Scale of Value and Descriptive Equivalent (Stewart and Rao)

Scale of Value	Descriptive Equivalent
5	Excellent
4	Very Good
3	Good
2	Fair
1	Poor

Table 2 shows the qualitative description of the weighted mean of the scale of value and the descriptive equivalent. It presents that if the respondents rate the system 5 - it means excellent, 4 - very good, 3 - good, 2 - fair and 1 - poor. This will help in determining the perception of the respondents with regard to the study.

Sampling Procedure

The researchers used the Slovin’s formula in getting the number of their respondents. In order to determine the effects of the researches study to the respondents, survey forms or questionnaires were used.

In order to get the sample size, the researchers used the formula shown below:

$$n = \frac{N}{1 + Ne^2}$$

Table 3. Raw Material Observation

Raw Material	Level		
	Distortion	Durability	Easiness of Preparation
Icing Chocolate	Not Distorted Slightly Distorted	Very Durable Durable	Slightly Difficult/ Takes 15mins Very Easy/ Takes 2-3mins
Flour	Very Distorted	Not Durable	Very Easy/ Takes 3-5mins

Where:

- n = sample size
- N = population size
- e = desired margin of error (percent allowance for non – precision because of the use of the sample instead of the population) (Pagoso, Garcia and Guerro)

The Formula for Weighted Mean:

$$WM = \sum f(v) = \frac{f_1v_1+f_2v_2+\dots+f_nv_n}{N}$$

Where:

- WM = Weighted Mean
- f = Frequency
- v = Value of scale
- N = Population or Total No. of Respondents(Ybañez)

Evaluation

In the evaluation phase, the researchers had prepared the needed materials and followed the instruction of how the raw materials should be process for it to be place on the syringe and be ready on the printing and observation process. The researchers had also started the computation of the economic viability level of 3D printer after getting all the necessary data needed on the calculation process.

In this phase, the researchers had also distributed evaluation questionnaires to evaluate the quality of service as well as the level of acceptability of the “Wireless 3D Chocolate Printer”. The respondents of the study were the students of CABEIHM particularly HRM Students. The sample size of the respondents was obtained by the Slovin’s Formula:

$$n = \frac{N}{1 + Ne^2}$$

Where:

- n = sample size
- N = population size
- e = desired margin of error (percent allowance for non – precision because of the use of the sample instead of the population) (Pagoso, Garcia and Guerro)

Applying the formula, the number of respondents was:

$$n = \frac{N}{1 + Ne^2}$$

$$n = \frac{427}{1 + 427(0.05)^2}$$

$$n = \frac{427}{1 + 1.0675}$$

$$n = \frac{427}{2.0675}$$

$$n = 206.5 = 207 \text{ respondents}$$

In determining the best raw material to use in 3d printing, the researchers observed that:

Table 3 shows the result of researchers' observation regarding the best raw material to use in 3D printing. For determining the economic viability level of 3D printer, the researchers had conducted a short study about it.

Calculation of Financial and Economic Viability

Financial and economic appraisal is an important component of any project without which it is incomplete. Increasing awareness about the use of scarce resources and the returns obtainable from it makes the issue more important. Financial analysis is used to describe the commercial viability of the project and shows its strength from financial angle. The concept of economic analysis can be considered as an

extension of the financial analysis. In economic analysis the concern is on the developmental effect on the society/economy as a whole as against the financial analysis that bothers the interest of the specific entity.

In order to assess the financial viability of the project, Return on Investment (ROI) of the project has been worked out with reference to total cost of future and present value and total benefits of future and present value from the first year to the fifth year.

The formula for getting the difference between the total benefits over total costs is:

$$Net\ Benefit = Total\ Present\ Value\ Benefits - Total\ Present\ Value\ Costs$$

Table 4. Economic Viability Computation

Costs		Current Year (CY)	CY+1	CY+2	CY+3	CY+4	CY+5	
1	Extruder (1pc)	Php4,582.17						
2	RAMPS1.3 with 4 genuine Black Edition Pololu A4988 stepper drivers (1pc)	Php4,794.08						
3	endstops with cables (3pcsx80.48)	Php241.43						
4	stepper motors (4pcsx824.31)	Php3,297.22						
5	T2.5-16T pulley (2pcsx275.92)	Php551.84						
6	T2.5 belt (2mx241.43)	Php482.86						
7	608ZZ bearing (2pcsx68.98)	Php137.96						
8	LMS1U bearings (10pcsx137.96)	Php1,379.59						
9	Plastic Material (1set)	Php2,948.73						
10	Arduino Mega 2560 (1pc)	Php2,900.00						
11	Wood	Php200.00						
12	Fasteners and rods	Php950.00						
13	Shipping Fee	Php10,534.12						
14	Other Miscellaneous Expenses Chocolate, Electricity etc.	Php37,000	Php37,000	Php37,000	Php37,000	Php37,000	Php37,000	
Total Costs (Future Value)		Php70,000	Php70,000	Php70,000	Php70,000	Php70,000	Php70,000	
Total Costs (Present Value)		Php70,000.00	Php68,627.45	Php67,307.69	Php66,037.74	Php64,814.81	Php63,636.36	Php400,424.06
Benefits								
	Rent of 3D printer and Income from Printed 3D Chocolate Object	Php96,000	Php96,000	Php96,000	Php96,000	Php96,000	Php96,000	
Total Benefits (Future Value)		Php96,000	Php96,000	Php96,000	Php96,000	Php96,000	Php96,000	
Total Benefits (Present Value)		Php96,000	94,117.65	92,307.69	90,566.04	88,888.89	87,272.73	549,152.99
Present Value Discount Rate		2%						
PV Denominator		1	1.02	1.04	1.06	1.08	1.1	

Table 4 shows the computation of the total costs and the total benefits of the project which are data needed for the ROI computation.

Result:

Total Costs Present Value :Php 400, 424.06
 Total Benefits Present Value: Php 549,152.99

The Cost Benefit Analysis is:

$$Net\ Benefit = Php549,152.99 - Php400,424.06$$

$$Net\ Benefit = Php148,728.94$$

The ROI would be:

$$ROI = \frac{Total\ Present\ Value\ Benefits - Total\ Present\ Value\ Costs}{Total\ Present\ Value\ Costs} \times 100$$

$$ROI = \frac{Php549,152.99 - Php400,424.06}{Php400,424.06} \times 100$$

$$ROI = \frac{Php148,728.94}{Php400,424.06} \times 100$$

$$ROI = 0.37143 \times 100$$

$$ROI = 37.14\% \text{ on year 5}$$

In year 5, the return of investment of the design project “Wireless 3D Chocolate Printer would be 37.14%. The ROI is obtained in this project to measure the performance of the design project– if it will be successful or not when it is out in the market.

Through the economic viability computation, the financial assessment of the design project was projected. This is also used to evaluate the efficiency of the investment.

Table 5. Evaluation of Wireless 3D Chocolate Printer

Criteria	5 Excellent (5.00-4.21)	4 Very Good (4.20-3.41)	3 Good (3.40-2.61)	2 Fair (2.60-1.81)	1 Poor (1.80-1.00)	WM	VI
Accuracy	122	70	15	0	0	4.52	Excellent
Effectiveness	112	81	14	0	0	4.47	Excellent
Efficiency	119	66	21	1	0	4.46	Excellent
Maintainability	118	62	25	2	0	4.43	Excellent
Reliability	109	71	27	0	0	4.40	Excellent
User-friendliness	122	55	27	3	0	4.43	Excellent
					Average	4.45	Excellent

Table 5 shows the result of the evaluation using the Likert Scale. With this the researchers were able to determine the design project’s quality factor.

After conducting observation, tests and evaluation, the study yielded the following findings:

- The chocolate as a raw material in 3D printing is good as the printed material is slightly distorted and is durable. In terms of easiness in its preparation, it is very easy as it takes 2-3 minutes to prepare.
- The icing as a raw material in 3D printing is good as the printed material is not distorted and is very durable. In terms of easiness in its preparation, it is slightly difficult as it takes 15 minutes to prepare.
- The flour as a raw material in 3D printing is not good as the printed material is distorted and is not durable. In terms of easiness in its preparation, it is very easy as it takes 3-5 minutes to prepare.
- The economic viability level of 3d printer with reference to ROI is 37.14%.
- The level of acceptability of the design project in terms of Accuracy, Effectiveness, Efficiency, Maintainability, Reliability and User-friendliness are all excellent.
- The overall level of acceptability of design project as evaluated by the respondents is excellent.

IV. CONCLUSIONS AND RECOMMENDATIONS

The best raw material to use in 3D printing in terms of durability and distortion of the printed material is icing but in terms of easiness in preparation is chocolate. 3D printing business is economical. The respondents simply denote that the developed system conforms to standards of the five criteria, which means that the design project has a high level of acceptability.

The developed Wireless 3D Chocolate printer is hereby recommended for use with the user’s manual for user’s reference and information.

The researchers suggest the improvement of the following aspects of the design project: adding a cooling system on the design project so that the raw material will be more durable; development of more simplified version of the design project; and improving the extrusion process wherein the user do not need to stop the printing process just to replace the empty syringe with a new one.

Further studies should be conducted regarding 3D printing technology to enhance the design project including additional features and enhancement of program design.

The design project may serve as a reference for future researchers.

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