

DESIGN OF MULTIFUNCTIONAL MANUAL SCREEN PRINTING TOOL

1,2,3,4) Mechanical
Engineering, Politeknik Negeri
Bali, Denpasar, Indonesia

Corresponding email ^{1*)}:
nengahludraantara@pnb.ac.id

**I Nengah Ludra Antara^{1*)}, I Nyoman Sutarna²⁾, I Putu Darmawa³⁾,
I Nyoman Gunung⁴⁾**

Abstract. Screen printing is the simplest and most likely done manually. This screen printing technique is also an effective and efficient way to develop small industries. The advantage of this screen printing business is that the capital is not too large, and you also don't have to have special skills. This research method is to redesign the manual screen printing tool by combining two screen printing tools to get more effective and efficient results for the screen printing operator. The research results show that the advantage of redesigning this screen printing tool is that it can produce precise print results and can print several screen-printed objects that previously could only produce plastic screen prints. After adding a design, the function of the tool will increase to be able to filter glass, cardboard, plastic bags, etc.

Keywords: screen printing, stickers, cup molding, multifunction.

1. INTRODUCTION

Along with the growth of the screen printing business, stickers, plastic and glass screen printing have become a necessity for entrepreneurs so that the brand or identity of a beverage and convection product can be recognized by people. Therefore, screen printing stickers, plastic and glass are in great demand for entrepreneurs who want to market their products in a wider range. According to my survey, the author did in Gianyar Regency, Singapadu Village, there are many convection businesses and sales of boba drinks. So it requires a fast printing process. The existing screen printing process in Singapadu Village uses a separate screen printing tool in the sense that the sticker and plastic bottle screen printing tools are separate, so it takes a relatively long time. In addition, screen printers also feel uncomfortable. As the times progress, there are various types of tools that can simplify the screen printing process. Because the existing screen printing tools at Delivory Konveksi are less efficient due to the limitations of the print media. Therefore, in order to compete with screen printing tools that are still very expensive on the market, we have an initiative and an idea to design a multifunctional manual screen printing tool so that the middle class can open a business with limited capital. So that the thought arose to design a tool, namely the design of a multifunctional manual screen printing tool, and the author hopes that with this tool, it can help the screen printing business in the process of printing. And more economical so that it can be reached by convection and young people who start a screen printing business in Singapadu Village.

Design is the engineering of a construction or structure that realizes the concept of being an item or tool [1], [2]. The activity of planning or designing a construction must consider the following criteria, easy and simple, easy to make or common components on the market, economical is a service that has the best quality at the smallest possible price level and aesthetic is a sense that arises from how beautiful or dazzling an object is seen and the tool must be aesthetic in shape and appearance, and appropriate in a technology that is discovered or created with the aim of further improving or making human work smoother. This can then increase economic value as well, the technology is not just made but made precisely according to human needs [3]–[5].

Manual Screen Printing Tools The word screen printing comes from the Dutch language, namely "scablon", in the language of absorption into screen printing. Screen printing is part of the science of applied graphics that is practical. Screen printing is the simplest print and is likely to be done manually. This printing technique is also an effective and efficient way of developing small industries. The advantage of this screen printing business is that the capital is not too large, and also does not have to have special skills. With willingness and practice, anyone will be able to do this job. Furthermore, with perseverance and good processing, it will

produce good results, so many people make screen printing tools with limited use of screen printing media on their own. The idea of redesigning my manual screen printing tool came from problems at Delivory Konveksi. The purpose of designing this screen printing tool is to add 1 cup bottle screen printing tool to get more effective and efficient results.

Screen printing screen is an item that is needed as one of the equipment for screen printing [6]. There are two parts to the screen printing screen, namely the main part, namely the frame and the screen cloth or gauze. Where the frame used on the screen printing screen can be made of aluminum or wood. The frame functions to give shape and hold the screen printing ink to stay on the screen printing field [7]. Screen printing frames are usually made in various sizes, adjusted of course to the needs of the screen printing to be carried out (the size of the image to be screened). Screen printing frame materials can be made of wood, aluminum, or sometimes also hollow iron [8].

Based on the design and purpose of using the screen. screens that are generally used to make screen printing on fabric as a whole can be divided into several categories [9], [10]. Namely starting from a coarse screen (48 T-90 T), medium screen (120 T-150 T), to a fine screen (165 T-200 T). The letter T listed in front of the number is usually termed Thick which is then abbreviated as T. The size of T in the screen printing world is commonly used to indicate the level of density in the woven screen threads [11]. The bigger the number, the tighter the yarn.

In the design of a multifunctional manual screen printing tool, the author only discusses how to design/make a multifunctional manual screen printing tool. In this design, the author uses problem boundaries so that the discussion does not get out of the existing objectives. The problem limitation used is how to design or make a multifunctional manual screen printing tool and the community easily uses the designed tool so that it can increase productivity for convection and screen printing workers. Increasing worker productivity is very necessary for small and medium industries [12], [13].

The objectives of the research of the design of a multifunctional manual screen printing tool are: 1) To find out how to design or make a multifunctional manual screen printing tool, 2) With the design of this multifunctional manual screen printing tool, it can increase productivity for convection and screen printing workers.

2. METHODS

The type of research taken uses the type of design research. Design is planning, designing, engineering calculations of materials and components, simulation tests, and modeling of a tool [14], [15]. In the design the author took the title "Design of Multifunctional Manual Screen Printing Tools". The completion of this design uses an exploratory method that aims to find a new solution to solve the problems faced by convection and screen printers. The first step in this exploratory research is to add a cup bottle screen printing tool that once screen printing gets a lot of screened cup bottles faced by screen printers, by conducting a survey in the field. After obtaining the required data then design, calculate, select the materials to be used. And solve existing problems by realizing a design [16].



Figure 1. Plastic screen printing tools

Employees who work in screen printing or convection, located in Singapadu Banjar Negari Village, Sukawati District, Gianyar Regency, Bali Province, as in Figure 1, still use simple tools in doing a job of printing plastic, stickers, shopping bags by using separate tools, causing the production process to be longer and the area used is more.

In every design, of course, there are pictures of components and their arrangement so that later it will make it easier when working or realizing the design made, as well as in the design of this multifunctional manual screen printing tool. In designing images using the *Professional Autodesk Program Inventor Drawing Design 2018*. As in Figure 2.

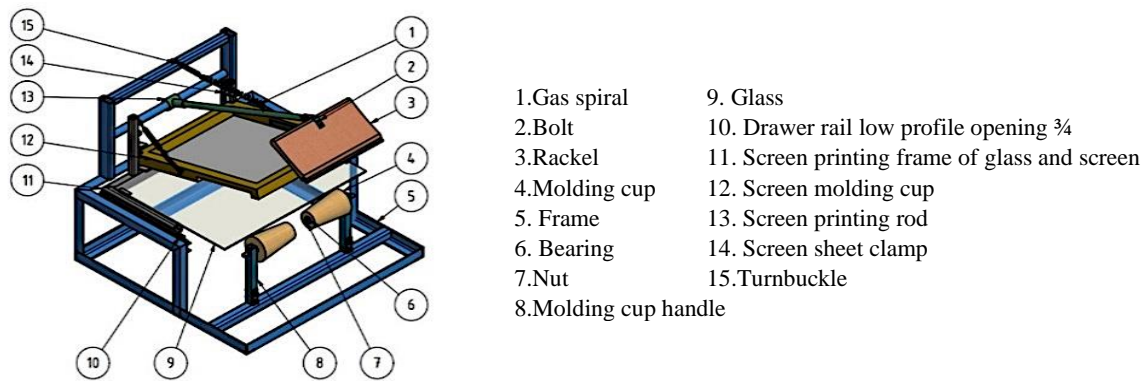


Figure 2. Design Of Multifunctional Manual Screen Printing Tool

Some of the tools and materials used in this study, namely:

2.1 Tools

To support the work of "Design of Multifunctional Manual Screen Printing Tools", using some of the following equipment: Welding machine, hand grinder, compressor, drilling machine, lathe, vernier, steel bar, and elbow.

2.2 Materials

To realize the process of multifunctional manual screen printing tools, the following materials are needed:

Table 1. Materials

No	Component name	Quantity (pieces/cm)
1	Racker	1
2	Screen and frame	30cm x 40cm
3	Glass	30cm x 50cm
4	Moulding cup	2
5	Screen sheet clamp	2
6	Drawer rail low profile opening ¾	2
7	Spiral spring	2
8	Turnbuckle	2
9	Spiral spring	3cm x 3cm
10	Iron pipe	Ø 8mm
11	Bolts and nuts	10
12	Hollow iron	3cm x 3cm
13	Bearings	4

The procedure research with the following stages :

- 1) Conducting observations or research in the field to find problems in the field so that later the tool can be appropriate.
- 2) Determining the needs of the tool to determine the concept of the tool so that it is effective and efficient.
- 3) Making drawings or designs to determine the shape and mechanism of the sketch design of the tool to be made.
- 4) Determining the cost details needed to make the tool to be made.
- 5) The process of making or working on tools according to the working drawings.
- 6) The process of assembling, finishing and testing the results of the design.

3. RESULTS AND DISCUSSION

3.1 Design Results

The resulting design is as follows.



Figure 3. Multifunctional manual screen printing tool

Deck 1, flat surface screen printing (paper bag and sticker screen printing)

- a) Prepare tools and materials before performing the screen printing process.
- b) Install the glass mat for the placement of the product to be screened.
- c) Place the screen above the product to be screened.
- d) Setting the distance of the racker from the screen.
- e) Pour screen printing paint into the screen and mix a little with m4.
- f) Rub the screen that has been painted using the racker.
- g) Lift the screen and replace the product, do it repeatedly.

Deck 2, screen printing the surface of round objects or tubes (cup screen printing)

- a) Prepare tools and materials before the screen printing process.
- b) Remove the glass mat.
- c) Install the screen on the sliding track.
- d) Setting the racker and the position of the holder for the product.
- e) Pour the screen printing paint into the screen.
- f) Slide the screen back and forth with the handle.
- g) Lift the screen and replace the product, do it repeatedly

3.2 Materials used

The materials used in this design are shown in Table 2.

Table 2. Materials Description

Name	Specification	Quantity	Description
Hollow Iron	3mm x 3mm	1 pc	made
Iron plate	3mm	1 pc	made
Iron pipe	O 1- inch	1 pc	made
Angle iron	3mm x 3mm	1 pc	made
Racker	wood and rubber	2 pcs	bought
Screen	30 cm x 40 cm	2 pcs	bought
Glass	40cm x 50cm	1 pc	bought
Turnbuckle	stainless	2 pcs	bought
Spiral spring	steel wire	2 pcs	bought
Low profile drawer rails	opening ¾	2 pcs	bought
Moulding cup	wood	2 pcs	bought
Screen clamp	steel	2 pcs	bought
Bolts and nuts	steel	8 pcs	bought
Couplers	steel	8 pcs	bought
Bearings	steel	4 pcs	bought

3.3 Manufacturing Process of Multifunctional Manual Screen Printing Tool Frame

The process for making a multifunctional manual screen printing tool frame is as follows.



Figure 4. Welding process



Figure 5. Smoothing process

3.3.1 Cup molding process

1) Tools used: lathe (wood chisel), wedge, sandpaper.

2) Materials used: panis wood

3) Working process

- a) Pay attention to the work drawings carefully.
- b) Prepare the tools and materials used.
- c) Take measurements and markings according to the working drawings, after that just do the turning on the material that has been marked.
- d) After molding the cup according to the size or working drawing, then make a hole in the center of the molding cup for the bearing and shaft so that it can rotate.
- e) After finishing turning and making holes then smooth the molding cup with sandpaper to make it smooth.
- f) Finish the new smoothness to do the painting process.



Figure 6. Turning process

3.3.2 Painting Process

The painting process uses the following tools and materials

- 1) Tools used: 280 grit sandpaper and 800 grit putty, kapi
- 2) Materials used:
- 3) The steps of caulking process on the frame
 - a) Leveling the uneven surface of the iron and smoothing the welding marks.
 - b) The process of caulking on the frame is carried out to flatten the welding connection and flatten the surface of the iron that is accidentally exposed to burrs.
 - c) Then smooth the parts that have been putty with 280 grit sandpaper and 800 grit.

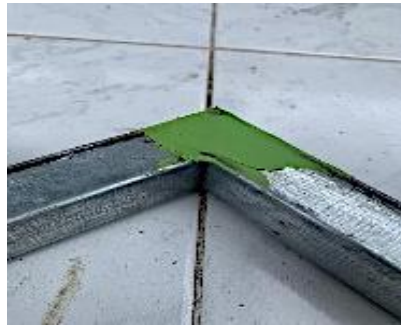


Figure 7 Putty process

- 4) Painting process with primer (*epoxy*)
 - a) Sand the iron surface using 200 grit sandpaper.
 - b) Wash with soap until clean.
 - c) Wipe and dry until the frame, glass holder and molding cup holder are completely dry.
 - d) dry completely.
 - e) Epoxy all parts of the frame, glass holder and molding cup holder. Repeat 2x basic bonding (epoxy).



Figure 8 Primer

- 5) Painting process with blue paint
 - a) Sand the surface that has been epoxied with 800 sandpaper.
 - b) Wash with soap until clean.
 - c) Wipe and dry until the frame, glass holder and molding cup holder dry completely.
 - d) Paint using blue sapire colored paint to all parts of the frame.



Figure 9 Blue color painting

3.4 Testing Process

Based on the results of tests carried out 5 times on (deck 1, flat screen printing for sticker, paper bag, and plastic screen printing) and tests carried out 10 times on (deck 2, surface screen printing of round objects or tubes for cup screen printing). Observation data was obtained in the form of a comparison of the use of ordinary screen printing tools with multifunctional manual screen printing tools. Based on the data analysis carried out, the advantages and disadvantages of multifunctional manual screen printing tools are obtained as in Table 3.

Table 3. Test Results

Parameter	Sticker screen printing tools and paper bag	Cup screen printing tool	Manual screen printing tool multifunction
Screen printing result	Less neat, because it is not equipped with a sturdy frame and it takes time to position and lock the object to be screened.	Expression is difficult to achieve, Precision, because the frame is made strong to be set up and tested before use.	keep the object being screened from moving (Deck 1, flat surface screen printing for sticker, paper bag, plastic screen printing) and the screen printing point according to the design is not tilted or defective. (Deck 2, surface screen printing of round objects or tubes for cup screen printing)
Usage	Long process, need time to set the tool for precision screen printing results with the object.	Long process, cannot screen print quickly and neatly, slippery cup holder cannot lock well. lock well.	Practical, and easy to operate according to the object to be screened.
Operator	1 operator, to screen 1 type of object.	1 operator, for printing 1 type of object.	1 operator with dual-function tools.
Place	A table is required for the work process because the object being screened must be on a flat surface.	A table is required for the work process due to the small size of the tool.	Minimalist in shape, it takes up little space and does not require a table.

4. CONCLUSION

Based on the results of the trial use of a multifunctional manual screen printing tool, a significant difference was obtained compared to the usual tool. In terms of cost, time and workplace requirements. In terms of cost, the multifunctional manual screen printing tool can cut operator costs and tool procurement costs, while in time the multifunctional manual screen printing tool is easier to operate and more efficient because of its multifunctional features, while from the needs of the production site the multifunctional manual screen printing tool is more compact and takes up less space.

The screen printing results obtained by the multi-function manual screen printing tool are considered more precise because the frame and body of the tool are strong to maintain the stability of the object when screened, especially when the cup screen printing process. The operator required to operate the tool is only 1 person with experience and skills in printing plastic and cup screen printing. Some of the advantages of multifunctional manual screen printing tools:

- 1) This tool can screen different objects with 1 tool.
- 2) This tool is easy to operate because it is only set once.
- 3) The shape of the tool is easy to move.

- 4) The cost of the tool is cheaper than before.
- 5) To increase the life of the tool, periodic maintenance should be carried out and after use is always cleaned.
- 6) In the design of this multifunctional manual screen printing tool there are still many shortcomings, therefore it is hoped that in the future this tool can be analyzed and redesigned (redesign) so that it can be developed for its improvement.

5. REFERENCES

- [1] P. L. Dhar, "Chapter 7 - Introduction to Optimum Design," P. L. B. T.-T. S. D. and S. Dhar, Ed. Academic Press, 2017, pp. 385–407.
- [2] J. Wickert and K. E. Lewis, *Mechanical Engineering, An Introduction to Mechanical Engineering*, Third Edit. Canada: Nelson Education Ltd., 2013.
- [3] A. Parrish and F. J. Camm, *Mechanical engineer's reference book*, 11th Editi. London: Butterworths, 2011.
- [4] B. Kaur, "A Study : Working Conditions Of Small Scale Weaving Units," *Int. J. Mech. Eng.*, vol. 7, no. 1, pp. 1375–1379, 2022.
- [5] I. G. Santosa and M. Yusuf, "Ergonomic Multifunctional Building Tool Design to Increase Work Productivity of Msmes Employees," *Am. J. Sci. Eng. Technol.*, vol. 8, no. 4, pp. 189–193, Oct. 2023.
- [6] J. Cao, "Research on the Fusion of Art Design and Screen Printing Process," in *Proceedings of the 2021 Conference on Art and Design: Inheritance and Innovation (ADII 2021)*, 2022, vol. 643, no. Adii 2021, pp. 311–316.
- [7] K. Dölle, "Original Research Article Paper for Screen Printing Applications – A Paper Development Study," *J. Eng. Res. Reports*, vol. 21, no. 9 SE-Original Research Article, pp. 45–63, Dec. 2021.
- [8] V. Cazac, J. Cîrja, E. Balan, and C. Mohora, "The study of the screen printing quality depending on the surface to be printed," *MATEC Web Conf.*, vol. 178, pp. 1–6, 2018.
- [9] J. Lavanya and N. Kishore, "Different Textile Printing Techniques-Hand Block Printing, Screen Printing, And Digital Printing," *Webology*, vol. 19, no. 2, pp. 787–802, 2022.
- [10] U. Boda, J. Strandberg, J. Eriksson, X. Liu, V. Beni, and K. Tybrandt, "Screen-Printed Corrosion-Resistant and Long-Term Stable Stretchable Electronics Based on AgAu Microflake Conductors," *ACS Appl. Mater. Interfaces*, vol. 15, no. 9, pp. 12372–12382, Mar. 2023.
- [11] U. Hasni, M. E. Piper, J. Lundquist, and E. Topsakal, "Screen-Printed Fabric Antennas for Wearable Applications," *IEEE Open J. Antennas Propag.*, vol. 2, pp. 591–598, 2021.
- [12] M. Yusuf, L. Sudiajeng, K. A. Suryawan, and I. M. Sudana, "Redesign of Ergonomic Worktables in Reinforced Concrete Sheet Works Reduce Ergonomic Risk Level," in *Proceedings of the 5th International Conference on Applied Science and Technology on Engineering Science iCAST-ES*, 2022, pp. 370–374.
- [13] T. Budiyanto and M. Yusuf, "Improvement of Wok Molding Station Increases Work Comfort and Productivity of the Workers," *Int. J. Psychosoc. Rehabil.*, vol. 24, no. 4, pp. 8883–8892, 2020.
- [14] C. Qiu, J. Tan, Z. Liu, H. Mao, and W. Hu, "Design Theory and Method of Complex Products: A Review," *Chinese J. Mech. Eng.*, vol. 35, no. 1, p. 103, 2022.
- [15] D. Mourtzis, "Simulation in the design and operation of manufacturing systems: state of the art and new trends," *Int. J. Prod. Res.*, vol. 58, no. 7, pp. 1927–1949, Apr. 2020.
- [16] I. G. O. Pujihadi, I. K. G. J. Suarbawa, I. M. Arsawan, and M. Yusuf, "Coffee Roasting Machine Model Design 3Kg Capacity to Boost Craftsman Work Productivity," *Am. J. Appl. Sci. Res.*, vol. 8, no. 4, pp. 83–87, 2022.