

UNI

VERSITI

THE 11TH INTERNATIONAL INNOVATION, INVENTION & DESIGN COMPETITION INDES 2022

EXTENDED ABSTRACTS BOOK



© Unit Penerbitan UiTM Perak, 2023

All rights reserved. No part of this publication may be reproduced, copied, stored in any retrieval system or transmitted in any form or by any means; electronic, mechanical, photocopying, recording or otherwise; without permission on writing from the director of Unit Penerbitan UiTM Perak, Universiti Teknologi MARA, Perak Branch, 32610 Seri Iskandar Perak, Malaysia.

Perpustakaan Negara Malaysia

Cataloguing in Publication Data

No e-ISSN: e-ISSN 2756-8733



Cover Design : Nazirul Mubin Mohd Nor Typesetting : Wan Nurul Fatihah binti Wan Ismail

EDITORIAL BOARD

Editor-in-Chief

Wan Nurul Fatihah binti Wan Ismail

Editors

Nor Hazirah Mohd Fuat Noor Fazzrienee J Z Nun Ramlan Dr Nuramira Anuar Dr Shazila Abdullah Halimatussaadiah Iksan Iza Faradiba Mohd Patel Jeyamahla Veeravagu Mahfuzah Rafek Nor Nadia Raslee Nurul Nadwa Ahmad Zaidi Peter Francis Zarinatun Ilyani Abdul Rahman Zarlina Mohd Zamari

The 11th International Innovation, Invention and Design Competition 2022

Organised by

Office of Research, Industrial Linkages, Community & Alumni Networking (PJIM&A) Universiti Teknologi MARA Perak Branch

and

Academy of Language Study Universiti Teknologi MARA Perak Branch



FEASIBLE JIG FOR COORDINATE MEASURING MACHINE

Aziurah Mohd Shah, Muhammad Faez Ammar Faizal, Lesairuamin Leiahs, Siti Mardini Hashim

Universiti Teknologi MARA Pulau Pinang Branch

Email: Aziurah623@uitm.edu.my

ABSTRACT

The aim of this project is to design a feasible fixturing jig for a Coordinate Measuring Machine (CMM) to easily hold, support and clamp a workpiece. The CMM is one of the precision equipment that uses a probe to measure the dimensions and geometries of a physical workpiece. Currently, the jig used contains several components that can be troublesome if one of the components is missing. The number of components can go as high as hundreds, depending on the size, and shape of the workpiece. Moreover, additional accessories are required to facilitate the measurement of the workpiece consisting of complex geometry. Therefore, the objective of the design is to reduce the number of jig components and increase the flexibility of the jig to hold a complex workpiece without being required to change any components. According to the feedback acquired from customer surveys, interviews and benchmarks, three designs of the jig; designs 1, 2 and 3 have been evaluated using conceptual selection. Design B is selected as the definitive design, based on the evaluation result in the selection process by using the screening method. The result shows that design B gave the highest net score. The selected design is drawn and analyzed using SolidWorks software. PLA is selected as a material and undergoes the 3D printing process to produce the final product. In conclusion, a cheap and feasible fixturing jig is produced to facilitate the measurement of a specific workpiece.

Keywords: jig, design, Coordinate Measuring Machine (CMM), conceptual design.

1. INTRODUCTION

Parts' dimensions and geometric characteristics are very important in the manufacturing of prototypes or real parts of all products. Any dimension errors can threaten an entire production process. Therefore, to eliminate that, a high tolerance measuring machine like CMM is required. Applications in process control, quality assurance of manufactured components, and product verification are fields that require the most of CMM (Gaha et al., 2021). A "magic finger" of CMM is a probe that serves as one of the most important elements of the dimensional measuring instrument. The probe is in contact with the workpiece and is responsible for the coordinate measurement precision (Hocken & Pereira, 2017). The probe moves along X-, Y- and Z-axis, sending an electrical signal for the computer to map out. The method of movement for the probe depends on the type of CMMs. The probe system can be in a conventional touch-trigger or scanning system. As the name suggests, the earlier system acquired measurements through a low trigger force that contacted a selected points on the workpiece. Meanwhile, the latter system can operate the same as the earlier system or in continuous touch to capture the measurements (Bastas, 2020). Thus, the high precision and system of the probe CMM required a fixturing jig to stabilize the workpiece through the measuring process. In the manufacturing



industry, jigs are an essential tool used to assist workers in holding the workpiece for welding (Ordieres et al., 2019), machining (Kumar et al., 2019) and measuring (Hazra et al., 2001). The general factors to be considered when designing a jig are geometry, state of work part, material, type of processes and the machine tools used, workpiece handling, ergonomics and safety considerations. In addition, the gripping ability can be considered as an important factor that affected the clamping and holding of the work part perfectly during operations.

2. METHODOLOGY

The development of the conceptual design started with defining the problem statement, gathering information, generating concepts, evaluating, and selecting concepts. Survey input from industries has been collected to identify the current problems. Brainstorming was done to obtain rough ideas for the design through benchmarking with related products. The design criteria were set and used as a guideline to generate and select the concept as shown in Table 1.

Concepts Variants			
Characteristics	Design 1	Design 2	Design 3
Geometry Flexibility	0	+	0
Weight	-	0	0
Portable part	-	+	-
Less replaceable part	+	+	+
Durability	+	0	+
Safety	+	+	+
Sum +'s	3	4	3
Sum 0's	1	2	2
Sum – 's	2	0	1
Net score	1	4	2
Rank	3	1	2
Continue?	No	Yes	No

Table 1 Concept Selection

The evaluation of concept selection was done by using the rank concept. The concept is to sum of all the 'better than', 'same as' and 'worse than'. The net score is determined by the score from subtraction of Sum +'s with Sum -'s. Conceptual selection methods are widely used to deduce the best selection. The previous researcher stated the best decision marking to evaluate the design is using the Pugh Chart (Deininger et al., 2017; Varun & Rino Nelson, 2022)

3. FINDINGS

Design 2 scored the highest net value in the screening process. Thus, it is decided as the best design among the three designs that have been proposed. The design model of the jig is drawn



by using 3D CAD design software, SolidWorks Ver. 2021. The software can analyze the applied total pressure on regions where the clamp and work part contact each other (Rajesh et al., 2021). Besides, the consistency, reliability and accuracy factors that can be offered by this software give an upper hand when compared to manual drafting. Figure 1 shows the drawn draft designs 1, 2, and 3 after the concept generation process. Meanwhile, the list of parts and features in the final concept of design is shown in Table 2.



Figure 1 Draft of Design 1, 2 and 3

Item	Part name	Description of features	
1.	Base	Flat surface to put specimen during the inspection and	
		adjustable base for clamping stand.	
2.	Clamping Stand	To hold and adjust the raise of working height.	
3.	Clamp	Adjust and tighten to hold the specimen.	

Table 2 List of Parts and Features

4. CONCLUSION

This paper illustrates the design of a jig for CMM to reduce the number of pieces or components that is currently used, thus, increasing the flexibility of the jig without having to constantly change the pieces to hold and measure the complex geometry of a workpiece. Conceptually, Design 2 shows a high net score. Since PLA is used for the material selection, the jig can only hold small workpieces. Therefore, further improvement in material selection and actual experiments needed to be done to improve the usage of the design.



REFERENCES

Bastas, A. (2020). Comparing the probing systems of coordinate measurement machine: Scanning probe versus touch-trigger probe. *Measurement*, *156*, 107604.

Deininger, M., Daly, S. R., Sienko, K. H., & Lee, J. C. (2017). Novice designers' use of prototypes in engineering design. *Design Studies*, 51, 25–65. https://doi.org/10.1016/J.DESTUD.2017.04.002

- Gaha, R., Durupt, A., & Eynard, B. (2021). Towards the implementation of the digital twin in CMM inspection process: opportunities, challenges, and proposals. *Procedia Manufacturing*, 54, 216–221.
- Hazra, L., Kato, H., Kuroda, T., Hashimoto, Y., Tsuchiya, Y., & Sakuma, I. (2001). Practical inspection system of drill point geometry by using simple measurement jig and image processing. *Precision Engineering*, 25(3), 206–211.
- Hocken, R. J., & Pereira, P. H. (2017). Coordinate measuring machines and systems (2nd ed.). CRC Press.
- Kumar, S., Campilho, R. D. S. G., & Silva, F. J. G. (2019). Rethinking modular jigs' design regarding the optimization of machining times. *Proceedia Manufacturing*, 38, 876–883.
- Ordieres, J., Rodríguez, E., Bayón, A., Caixas, J., Barbensi, A., & Guglielmi, P. (2019).
 Improvement of manufacturing jigs design for reduction of welding distortion in Vacuum
 Vessel PS1 through finite element analysis. *Fusion Engineering and Design*, 146, 2168
 2171.
- Rajesh, S., Vijaya Ramnath, B., Parswajinan, C., Vishnu, K., & Sridhar, R. (2021). Multi Component Drill Jig for Brake Lining Component. *Materials Today: Proceedings*, 46, 3903–3906.
- Varun, T., & Rino Nelson, N. (2022). Design of tool employed in dissimilar micro-friction stir welding. *Materials Today: Proceedings*, 62, 3617–3623.

Pejabat Perpustakaan Librarian Office

Universiti Teknologi MARA Cawangan Perak Kampus Seri Iskandar 32610 Bandar Baru Seri Iskandar, Perak Darul Ridzuan, MALAYSIA Tel: (+605) 374 2093/2453 Faks: (+605) 374 2299





Prof. Madya Dr. Nur Hisham Ibrahim Rektor Universiti Teknologi MARA Cawangan Perak

Tuan,

PERMOHONAN KELULUSAN MEMUAT NAIK PENERBITAN UITM CAWANGAN PERAK MELALUI REPOSITORI INSTITUSI UITM (IR)

Perkara di atas adalah dirujuk.

2. Adalah dimaklumkan bahawa pihak kami ingin memohon kelulusan tuan untuk mengimbas (*digitize*) dan memuat naik semua jenis penerbitan di bawah UiTM Cawangan Perak melalui Repositori Institusi UiTM, PTAR.

3. Tujuan permohonan ini adalah bagi membolehkan akses yang lebih meluas oleh pengguna perpustakaan terhadap semua maklumat yang terkandung di dalam penerbitan melalui laman Web PTAR UiTM Cawangan Perak.

Kelulusan daripada pihak tuan dalam perkara ini amat dihargai.

Sekian, terima kasih.

"BERKHIDMAT UNTUK NEGARA"

Saya yang menjalankan amanah,

Setuju.

PROF. MADYA DR. NUR HISHAM IBRAHIM REKTOR UNIVERSITI TEKNOLOGI MARA CAWANGAN PERAK KAMPUS SERI ISKANDAR

SITI BASRIYAH SHAIK BAHARUDIN Timbalah Ketua Pustakawan

nar