

**EDITORS**

ERRY YULIAN TRIBLAS ADESTA

MOHAMMAD YEAKUB ALI

AKM NURUL AMIN

**DESIGN FOR MANUFACTURE**

Towards Improved Manufacturability



**IIUM Press**

# DESIGN FOR MANUFACTURE

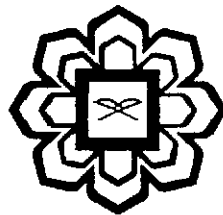
## Towards Improved Manufacturability

### EDITORS

ERRY YULIAN TRIBLAS ADESTA

MOHAMMAD YEAKUB ALI

AKM NURUL AMIN



**IIUM Press**

Published by:  
IIUM Press  
International Islamic University Malaysia

First Edition, 2011  
©IIUM Press, IIUM

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without any prior written permission of the publisher.

Perpustakaan Negara Malaysia

Cataloguing-in-Publication Data

ISBN: 978-967-418-159-8

Member of Majlis Penerbitan Ilmiah Malaysia – MAPIM  
(Malaysian Scholarly Publishing Council)

Printed by :  
**IIUM PRINTING SDN.BHD.**  
No. 1, Jalan Industri Batu Caves 1/3  
Taman Perindustrian Batu Caves  
Batu Caves Centre Point  
68100 Batu Caves  
Selangor Darul Ehsan  
Tel: +603-6188 1542 / 44 / 45 Fax: +603-6188 1543  
EMAIL: iiumprinting@yahoo.com

# CONTENTS

## Preface

---

### PART I: DESIGN

---

#### Chapter 1 - Design of a Simple and Affordable Electric Bicycle ..... 04

Tasnim Firdaus Ariff<sup>1</sup>, Goey Ewing<sup>2</sup> and Kam Yee Wah<sup>3</sup>  
1 Faculty of Engineering – International Islamic University Malaysia  
2,3 School of Technology, Tunku Abdul Rahman College  
✉ : tasnim@iium.edu.my

---

#### Chapter 2 - Design of Bicycle Helmet Using FEA ..... 10

Tasnim Firdaus Ariff<sup>1</sup> and Lau Ken Tick<sup>2</sup>  
1 Faculty of Engineering – International Islamic University Malaysia  
2 School of Technology, Tunku Abdul Rahman College  
✉ : tasnim@iium.edu.my

---

#### Chapter 3 - Mould Design for Handphone Casing Using Moldflow ..... 18

Tasnim Firdaus Ariff<sup>1</sup> and Law Siah Yong<sup>2</sup>  
1 Faculty of Engineering – International Islamic University Malaysia  
2 School of Technology, Tunku Abdul Rahman College  
✉ : tasnim@iium.edu.my

---

#### Chapter 4 - Improvement of Typical Hip-Joint Design for Gripping and Fixing ..... 26

Siti Norbadiyah Binti Mohamad Badari<sup>1</sup> and Erry Adesta<sup>2</sup>  
1, 2. Faculty of Engineering – International Islamic University Malaysia  
✉ : eadesta@iium.edu.my

---

#### Chapter 5 - A Surgical Training Model Manufacture Using Fused Deposition Modeling ..... 44

Hasanudin Hafis Mohamad Ali, Md. Amir Hamzah Md. Shukri, WAY Yusoff  
Faculty of Engineering – International Islamic University Malaysia  
✉ : hasan.ma86@gmail.com; mdamirhamzah87@gmail.com

---

**Chapter 6 - Reverse Engineering for Rapid Prototyping of Automotive Components ..... 50**

WAY Yusoff<sup>1</sup>, Muhammad Ridhuan Kamarudin<sup>2</sup> and Noor Hiana Mohd Salimi<sup>3</sup>  
1, 2, 3 Faculty of Engineering – International Islamic University Malaysia  
✉ : yusmawiza@iium.edu.my; wan\_ching05@yahoo.com.my; nuriliana@yahoo.com

---

**Chapter 7 - Design and Fabrication of Industrial Welding Robotic Arm ..... 58**

Syed Idros Syed Abdullah<sup>1</sup>, Mohamad Syatbi Mahamad Puzi<sup>2</sup>, and WAY Yusoff<sup>3</sup>  
1,2,3. Faculty of Engineering – International Islamic University Malaysia  
✉ : yusmawiza@iium.edu.my

---

---

**PART II: QUALITY**

---

**Chapter 8 - Application of Statistical Quality Control for Quality Improvement ..... 66**

Tasnim Firdaus Ariff<sup>1</sup> and Yap Yee Seng<sup>2</sup>  
1 Faculty of Engineering – International Islamic University Malaysia  
2 School of Technology, Tunku Abdul Rahman College  
✉ : tasnim@iium.edu.my

---

**Chapter 9 - The Development of Cost Estimation for Quality Assurance System in Die-Casting Processes ..... 72**

Nur Hanisah A Hamzah<sup>1</sup> Nurhafizah Azmi<sup>2</sup> and Erry Yulian Tribblas Adesta<sup>3</sup>  
1, 2, 3 Faculty of Engineering, International Islamic University Malaysia  
✉ : eadesta@iium.edu.my

---

**Chapter 10 - Study the Adherence of the Values in The ISO 9001:2000 Certified Companies in Malaysia ..... 84**

Dr. Mohd Radzi Bin Haji Che Daud<sup>1</sup> and Rusdi Bin Mat Song<sup>2</sup>  
1, 2. Faculty of Engineering – International Islamic University Malaysia

---

**Chapter 11 - Cost Comparison Analysis between Strip to Coil for Support Brake Pedal at Suria Component (M) Sdn. Bhd ..... 92**

Dr. Mohd Radzi Bin Haji Che Daud<sup>1</sup>, Shamin Asyrani Bt Alies<sup>2</sup>, Norhayati Bt Saleh<sup>3</sup>  
1,2,3. Faculty of Engineering – International Islamic University Malaysia

**Chapter 12 - Performance Measurement of SMEs Manufacturing Sector in Malaysia ..... 98**

WAY Yusoff<sup>1</sup>, Muhammad Fauzan Md Noraini<sup>2</sup> and Mohd Norazrul Ismail<sup>3</sup>  
1, 2, 3 Faculty of Engineering - International Islamic University Malaysia  
✉ : yusmawiza@iium.edu.my

---

**Chapter 13 - The Introduction of Fit Manufacturing as a Performance Measuring Approach towards Sustainability of Selected Manufacturing Companies in Malaysia ..... 105**

WAY Yusoff<sup>1</sup>, Aziatul Ashikin Mohd<sup>2</sup> and Siti Maznah Abdul Rahim<sup>3</sup>  
1, 2, 3 Faculty of Engineering - International Islamic University Malaysia  
✉ : yusmawiza@iium.edu.my

---

**Chapter 14 - The Study of the Implementation of OHSAS: 18001 at Kulliyah of Engineering ..... 113**

WAY Yusoff<sup>1</sup>, Muhammad Fakhrani Hayyun<sup>2</sup> and Mohd Fairus bin Abdullah<sup>3</sup>  
1, 2, 3 Faculty of Engineering - International Islamic University Malaysia  
✉ : yusmawiza@iium.edu.my

---

**Chapter 15 - Implementation of FMECA on Fixed Assembly Cell (FAC) ..... 121**

WAY Yusoff<sup>1</sup> and Paul Roberts<sup>2</sup>  
1. Faculty of Engineering - International Islamic University Malaysia , 2. Warwick Manufacturing Group- Warwick University, United Kingdom  
✉ : yusmawiza@iium.edu.my

---

**Chapter 16 - Implementation of FMECA on Computer Integrated Manufacturing (CIM) ..... 129**

WAY Yusoff<sup>1</sup> and Azmil Soleh<sup>2</sup>  
1,2 Faculty of Engineering – International Islamic University Malaysia  
✉ : yusmawiza@iium.edu.my

---

---

## **PART III: MATERIALS**

---

**Chapter 17 - The Effect of Stucco System in Ceramic Shell Investment Casting ..... 139**

Siti Norbahiyah Binti Mohamad Badari<sup>1</sup> and Erry Adesta<sup>2</sup>  
1, 2. Faculty of Engineering – International Islamic University Malaysia  
✉ : eadesta@iium.edu.my

---

**Chapter 18 - Casting Investigation of Heat Treated Biocompatible Materials  
for Total Hip Bone Replacement ..... 151**

Siti Norbahiyah Binti Mohamad Badari<sup>1</sup> and Erry Adesta<sup>2</sup>  
1, 2. Faculty of Engineering – International Islamic University Malaysia  
✉ : [eadesta@iium.edu.my](mailto:eadesta@iium.edu.my)

---

**Chapter 19 - Pultrusion of Pineapple Leaf Fibre (PALF)-reinforced Vinyl Ester  
Composites: Water Absorption Property ..... 162**

Mohamed Abd. Rahman, M. Kamarul Helmi M. Nawawi  
Faculty of Engineering – International Islamic University Malaysia  
✉ : [mrahman@iium.edu.my](mailto:mrahman@iium.edu.my)

---

**Chapter 20 - Effects of Austempering Treatment on Mechanical Properties of  
Ductile Iron ..... 170**

Belal Ahmed Ghazal<sup>1</sup> and Erry Yulian Triblas Adesta<sup>2</sup>  
1, 2 Faculty of Engineering – International Islamic University Malaysia  
✉ : [belalghazal88@gmail.com](mailto:belalghazal88@gmail.com) ; ✉ : [eadesta@iium.edu.my](mailto:eadesta@iium.edu.my)

---

**Chapter 21 - Microwave Sintering of Metallic Materials ..... 179**

Tasnim Firdaus Ariff  
Faculty of Engineering – International Islamic University Malaysia  
✉ : [tasnim@iium.edu.my](mailto:tasnim@iium.edu.my)

---

**Chapter 22 - Microwave Sintering of Ceramic Materials ..... 185**

Tasnim Firdaus Ariff  
Faculty of Engineering – International Islamic University Malaysia  
✉ : [tasnim@iium.edu.my](mailto:tasnim@iium.edu.my)

---

---

**PART IV: MODELLING**

---

**Chapter 23 - Numerical Analysis to Characterize Triaxiality Value of Adhesive Joint  
due to Particular Load Configuration. Part 1: Butt Joint ..... 194**

Irfan Hilmy  
MME Dept., Faculty of Engineering – International Islamic University Malaysia  
✉ : [ihilmy@iium.edu.my](mailto:ihilmy@iium.edu.my)

**Chapter 24 - Numerical Analysis to Characterize Triaxiality Value of Adhesive Joint due to particular Load Configuration. Part 2: Cleavage and Scarf Joint ..... 202**

Irfan Hilmy  
Faculty of Engineering – International Islamic University Malaysia  
✉ : [ihilmy@iium.edu.my](mailto:ihilmy@iium.edu.my)

**Chapter 25 - Metabolic Energy of Manual Lifting in Manufacturing Industry ..... 213**

Mohammad Iqbal<sup>1</sup>  
1. Faculty of Engineering – International Islamic University Malaysia  
✉ : [mohammad\\_iqbal@iium.edu.my](mailto:mohammad_iqbal@iium.edu.my)

---

**PART V: MANAGEMENT**

---

**Chapter 26 - Value Stream Mapping: an Important Footstep for Value Analysis and Value Engineering ..... 223**

A. N. Mustafizul Karim and Nurul Husna Binti Azon  
Faculty of Engineering, International Islamic University Malaysia  
Email: [mustafizul@iium.edu.my](mailto:mustafizul@iium.edu.my)

---

**Chapter 27 - The Project Management Challenges in Technology Innovation ..... 231**

Mahmood Hameed Mahmood<sup>1</sup> and Erry Yulian Triblas Adesta<sup>2</sup>  
1, 2. Faculty of Engineering – International Islamic University Malaysia  
✉ : [mahmoodfattah@yahoo.com](mailto:mahmoodfattah@yahoo.com) / ✉ : [eadesta@iium.edu.my](mailto:eadesta@iium.edu.my)

---

**Chapter 28 - Critical Chain in Project Management ..... 239**

Erry Yulian Triblas Adesta<sup>1</sup>, Asfana Banu Mohamad Asharaf<sup>2</sup>, Nur Atiqah Abdul Rahman Azmil<sup>3</sup>  
1, 2, 3 Faculty of Engineering – International Islamic University Malaysia  
✉ : [eadesta@iium.edu.my](mailto:eadesta@iium.edu.my)

---

---

**PART VI: MACHINING**

---

**Chapter 29 - Engineering Project Management in Automotive Industry ..... 247**

Mohamed Konneh<sup>1</sup>, and Abdul Halim  
Faculty of Engineering - International Islamic University Malaysia



**Chapter 30 - Surface Study when Finish Grinding Silicon using Resin Bonded Diamond Cup Wheel..... 257**

Mohamed Konneh<sup>1</sup>, and Muhammad Mukhtar  
Faculty of Engineering, International Islamic University Malaysia  
✉: mkonneh@iium.edu.my

---

**Chapter 31 – Surface Roughness Studies in Die-sink EDM of Tungsten Carbide using Copper Tungsten Electrode ..... 264**

Mohamed Konneh<sup>1</sup>, and Abdul Halim  
Faculty of Engineering - International Islamic University Malaysia  
✉: mkonneh@iium.edu.my

---

**Chapter 32 – Study of the Effect of different Electrodes on Material Removal Rate, Electrode Wear Rate and Surface Roughness in the EDM of S-STAR ..... 272**

Mohamed Konneh<sup>1</sup>, Nur Jannah Shad and Noor Fazlin Saharudin  
Faculty of Engineering - International Islamic University Malaysia  
✉: mkonneh@iium.edu.my

---

**Chapter 33 – Kerf in Micro Wire Electro Discharge Machining ..... 279**

Abdus Sabur<sup>1</sup> and Mohammad Yeakub Ali  
Department of Manufacturing and Materials Engineering  
Faculty of Engineering, International Islamic University Malaysia  
✉: asbur72@yahoo.com

---

**Chapter 34 - The Effect of Deep Cryogenic Treatment on the Properties of AISI D2 Tool Steel ..... 286**

Belal Ahmed Ghazal<sup>1</sup> and Erry Yulian Triblas Adesta<sup>2</sup>  
1, 2. Faculty of Engineering – International Islamic University Malaysia  
✉: belalghazl88@gmail.com; ✉: eadesta@iium.edu.my

---

**Chapter 35 - Effect of Welding Process on Formability of Tailor Welded Blanks ..... 294**

Umer Mushtaq<sup>1</sup> and Erry Yulian Triblas Adesta<sup>2</sup>  
<sup>1, 2</sup> Faculty of Engineering – International Islamic University Malaysia  
✉ : mirkaz9@hotmail.com ; mirkaz9@yahoo.com / ✉ : eadesta@iium.edu.my

---

**Chapter 30** Surface Roughness Studies in Die-sink EDM of Tungsten Carbide using Copper Tungsten Electrode ..... 257

Mohamed Konneh<sup>1</sup>, and Muhammad Mukhtar  
Faculty of Engineering, International Islamic University Malaysia  
✉: mkonneh@iium.edu.my

---

**Chapter 31** - Study of the Effect of different Electrodes on Material Removal Rate, Electrode Wear Rate and Surface Roughness in the EDM of S-STAR..... 264

Mohamed Konneh<sup>1</sup>, and Abdul Halim  
Faculty of Engineering - International Islamic University Malaysia  
✉: mkonneh@iium.edu.my

---

**Chapter 32** - Kerf in Micro Wire Electro Discharge Machining..... 272

Abdus Sabur<sup>1</sup> and Mohammad Yeakub Ali  
Department of Manufacturing and Materials Engineering  
Faculty of Engineering, International Islamic University Malaysia  
✉ : asbur72@yahoo.com

---

**Chapter 33** - Engineering Project Management in Automotive Industry ..... 279

Mohammed Kaleemullah<sup>1</sup>, Erry Yulian Triblas Adesta<sup>1</sup>, Waleed F. Faris<sup>1</sup>  
<sup>1</sup> Faculty of Engineering, International Islamic University Malaysia  
mkalim@gmail.com, eadesta@iium.edu.my, waleed@iium.edu.my

---

**Chapter 34** - The Effect of Deep Cryogenic Treatment on the Properties of AISI D2 Tool Steel ..... 286

Belal Ahmed Ghazal<sup>1</sup> and Erry Yulian Triblas Adesta<sup>2</sup>  
1, 2. Faculty of Engineering – International Islamic University Malaysia  
✉: belalghazl88@gmail.com; ✉: eadesta@iium.edu.my

---

**Chapter 35** - Effect of Welding Process on Formability of Tailor Welded Blanks ..... 294

Umer Mushtaq<sup>1</sup> and Erry Yulian Triblas Adesta<sup>2</sup>  
<sup>1, 2</sup> Faculty of Engineering – International Islamic University Malaysia  
✉ : mirkaz9@hotmail.com ; mirkaz9@yahoo.com / ✉ : eadesta@iium.edu.my

---

# Casting Investigation of Heat Treated Biocompatible Materials for Total Hip Bone Replacement

Siti Norbahiyah Binti Mohamad Badari<sup>1</sup> and Erry Adesta<sup>2</sup>  
1, 2. Faculty of Engineering – International Islamic University Malaysia  
✉ : eadesta@iiu.edu.my

---

## 1. Introduction

Hip joint is a very important part in a human anatomy. The hip bone is used in our daily life activities such as walking, climbing, sitting and running. The human hip is designed to withstand a lifetime of strenuous activity.

Previous studies faced problem with major thought in making decision in selecting biocompatible material which cause less contamination in tissue body and provide no harm. ASTM F75 cobalt base alloy has been proven to satisfy the requirements. Simultaneously, this alloy has a large amount of carbide content which gives rise to brittleness as the main problem for this alloy (Bedolla, 2009). This phenomenon has brings out the study on the effect of heat treated of Co-Cr-Mo alloy on the mechanical properties and microstructures. In this study, the researcher aims to investigate the hardness and microstructure change due to heat treatment.

## 2. Biocompatible Material for Total Hip Replacement

Successful joint surgery requires the replacement joint be painless, stable and freely mobile with an acceptable service lifetime. Ideally, the new joint must exactly match the geometry and performance of the natural hip. In any joint replacement surgery, there are three key variables: geometry, choice of material and operative procedure. Implants fabricated to be inserted into human body by replacing bones, such as artificial hip joints, bone plates, and dental implants. Implants will absolutely used under severe cyclic loading conditions.

Today, the demands on orthopedics alloys are high. The alloy must have excellent strength, low stiffness, and biocompatible. Thus, metals with high strength, ductility, good resistant corrosion and toughness are preferable for implants. Fracture toughness of the implant after critical of infection period determines the reliability of the biomaterial. Even though some pure metals have excellent