ICONIET 2020
INTERNATIONAL CONFERENCE ON INNOVATION, ENTREPRENEURSHIP AND TECHNOLOGY

ICONETSI
International Conference on Engineering and Information Technology for Sustainable Industry 2020

Certificate of Participation

Number : CERT/ICONETSI/PRES/16/IX/2020

This is to Award:

Dr. Ary Syahriar, DIC.

as a Presenter

with paper title:

"Analysis and Simulation of Short Shot Defects in Plastic Injection Molding at Multi Cavities"

in International Conference on Engineering and Information Technology for Sustainable Industry (ICONETSI 2020) in conjunction with International Conference on Innovation, Entrepreneurship and Technology (ICONIET 2020)

held in Indonesia, on 28 -29 September 2020

ICONIET

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Chairman of ICONIET 2020
Swiss German University

ICONETSI

Dr. Tanika D Sofianti, ST, MT
Chairperson of ICONETSI 2020

Organized by:
SGU SWISS GERMAN UNIVERSITY
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PROCEEDING

ICONETSI

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28 - 29 September 2020

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MESSAGE FROM RECTOR

Swiss German University (SGU) has been established for 20 years. As a university committed to striving for quality education, SGU organizes its annual event, the International Conference on Innovation, Entrepreneurship and Technology – ICONIET to give a platform for researchers, practitioners, government officials to present and discuss their works. The ICONIET 2020 consists of two sub-conferences, namely "International Conference on Engineering and Information Technology for Sustainable Industry 2020 (ICONETSI)" on Monday & Tuesday, 28-29 September 2020 and "International Conference on Global Innovation and Trend in Economy (INCOGITE 2020)" on Thursday, 5 November 2020.

The conference has the same theme as the 20th anniversary of SGU, "Transforming Digitally, Empowering Globally". Digital transformation is a must. It connects technology specialists across all sectors and fields in order to meet business needs and market requirements. It builds innovation and high-tech know-how to assist business initiatives or to upgrade technology for future growth. SGU has also participated in education for empowering communities globally. By lifting up individuals within communities, SGU encourages and supports sustainable community and economic development. Good quality of education and research will generate technology, innovation and entrepreneurship which will eventually improve quality of life and the prosperity of societies, nations and the world as a whole.

This year, the ICONIET is conducted in the midst of pandemic Covid-19 and hence, will be fully virtual using video conferencing. I'd like to take this opportunity to welcome all honorable guests, speakers, presenters and participants, who have come not only from Indonesia, but also from different countries such as Germany, Japan, Malaysia, the United Stated, Singapore, Egypt and Taiwan.

I'd like to personally thank the Committee of ICONIET 2020, including the committee of ICONETSI and INCOGITE 2020, who have put their utmost efforts into organizing this event. I wish to express my gratitude to the Ministry of Research, Technology and BRIN for their continuous support to our research. I would also like to thank SGU's University partners, the South Westphalia University of Applied Sciences and the University of Applied Sciences Jena in Germany, as well as the International Management Institute (IMI) in Switzerland.

We do hope that the conference will be beneficial and mind-opening for all participating parties. Let us use this event to exchange ideas and to extend our networking virtually, with the aim of empowering the wider global community.

Respectfully yours,

Dr. rer. nat. Filiana Santoso
Rector of Swiss German University

MESSAGE FROM CONFERENCE CHAIR

I would like to welcome you to the 2020 1st International Conference on Engineering and Information Technology for Sustainable Industry, Tangerang, Indonesia. ICONETSI 2020 provides a scientific platform for both local and international researchers, engineers and technologists who work in all aspects of Engineering and Information Technology for Sustainable Industry to exchange their latest research results. In addition to the contributed papers, internationally well-known experts are also invited to deliver keynote and plenary speeches at ICONETSI 2020. We are honored to have the distinguished keynote speakers: Prof. Bambang PS Brodjonegoro, Ph.D of the Minister of Research and Technology – BRIN, INDONESIA; and also Prof. Dr. Engg. Koichi Murata of Nihon University, Japan; Prof. Dr. Eng. Agus Purwanto of Universitas Sebelas Maret, Indonesia; Assoc. Prof. Dr. Waseem Haider of Central Michigan University, USA; Dr. Anto Satriyo Nugroho of Agency for Assessment and Application of Technology – BPPT, Indonesia; Assoc. Prof. Yudi Fernando PhD M.LogM of Universiti Malaysia Pahang, Malaysia; and Dr. Charles Lim, BSc., MSc. of Swiss German University, Indonesia as our invited speakers.

The conference is organized as a set of tracks in Sustainable Energy and Environment, Production and Operation Management, Logistics and Supply Chain, Ergonomic and Human Factors, Automation, Mechatronics and Robotics, Cyber Security and AI, and Software Engineering.

In this first event of ICONETSI 2020, we have received 125 paper submissions from Germany, Japan, Taiwan, Singapore, Egypt and Indonesia. To ensure the high quality of papers in ICONETSI 2020, each submission is reviewed by no less than three reviewers through a blind review process. In addition, we also carefully check the similarity rating to avoid plagiarism, and the writing format according to the conference proceedings template for each submission. After a careful review process, the program committee accepted 76 high quality full papers for presentation in ICONETSI 2020.

The successful organization of ICONETSI 2020 has required strong support from Indonesia Honeynet Project, Industrial Engineering Higher Education Organizing Cooperation Agency (BKSTI), Pusat Unggulan Iptek (PUI) Baterai Lithium Universitas Sebelas Maret, and Indonesian Association for Pattern Recognition (INAPR).

Most of all, I thank you, the participants, for enriching this conference by your presence. I am thankful to the conference organizing committee members, the track chairs, the session chairs, and the numerous volunteers, without whose generous contributions, this conference would not have set a record number of presentations and number of participants, higher than our expectation, especially considering some difficulties that happened during the Covid-19 pandemic. We truly believe the participants will find the discussion fruitful, and will enjoy the opportunity of setting up future collaborations.

Warm Regards,
Assoc. Prof. Dr. Tanika D Sofianti
ICONETSI 2020 General Chair

Keynote Speaker

Prof. Bambang Permadi Soemantri Brodjonegoro, Ph.D

Minister of Research and Technology - The National Research and Innovation Agency of the Republic of Indonesia

Short Biography:

Prof. Bambang Permadi Soemantri Brodjonegoro, Ph.D is the Minister of Research and Technology and Head of the National Research and Innovation Agency of the Republic of Indonesia. Previously, he was the Minister of National Development Planning of the Republic of Indonesia from 2016 to 2019 and also the Minister of Finance from 2014 until 2016. He has also worked in various roles in the Ministry of Finance. The opportunities to contribute as the Minister of Research and Technology, Minister of National Development Planning, and Minister of Finance have established Prof. Brodjonegoro's career in integrating Indonesia's research, technology, innovation, development planning, financing, and economic stabilization. Prof. Brodjonegoro earned his Ph.D in Urban and Regional Planning from the University of Illinois at Urbana–Champaign, United States in 1997. Afterward, he started his academic career as a lecturer in Universitas Indonesia and became Dean of the faculty of economics, Universitas Indonesia from 2005 to 2009. His research mostly focuses on Economics. He has also been actively involved in various local and international organizations and Indonesian companies, including being the director-general of the Islamic Research and Training Institute (IRTI), Islamic Development Bank Group, Jeddah, The Kingdom of Saudi Arabia in 2010. He was also awarded several honor and awards, including Bintang Maha Putra Utama from President of Indonesia and Bintang Bhayangkara Utama from the Indonesian National Police.

Invited Speaker 1

On the Role of Industrial Engineering in the COVID-19 Era

Prof. Dr. Eng. Koichi Murata
Nihon University, Japan.

Abstract:

The purpose of this study is to consider the role of industrial engineering in the era of COVID-19. This paper is divided into three parts. Firstly, the history of industrial engineering is reviewed to confirm the richness and compensation of life brought by the division of labor. The second part describes the exchange that should be paired with the division of labor, and what it is likely to be, and then explains that the integration of the division of labor and its exchange is a future issue for humanity. The third part, regarding the touch strategy that is the first step of exchange, reviews the concept of visual management, which is a precedent case, and tries to systematize the three touch strategies that were tried in the early stages of the spread of COVID-19 in Japan. The results obtained from this survey show that it is important for industrial engineering, which has been trying to understand management resources from various perspectives, to engage not only in the division of labor, but also in their exchange. Also, in an era where environmental destruction and digitalization are progressing at a speed that humanity does not notice, the findings can be considered as a problem in order to produce human resource workers whose value is higher than ever.

Short Biography:

Koichi Murata is the head of operations & production management laboratory and a professor at the Department of Industrial Engineering and Management, College of Industrial Technology, Nihon University. He previously worked in industry as an industrial engineer at the flagship factory of Murata Manufacturing Co., Ltd., which is a global leader mainly in the manufacturing of electronic components. His research interests include operations & production management, kaizen, lean management, visual management, technology transfer, knowledge management, sustainable supply chain and others. Dr. Murata has published articles in international academic journals such as International Journal of Production Research, Sustainability, Journal of the Operations Research Society of Japan, and others. He was interviewed for NHK and the Associated Press (AP) about the prospects for the manufacturing industry.

Invited Speaker 2

Honeynet Threat Sharing – One step closer to Cyber Situational Awareness

Dr. Charles Lim, BSc., MSc., CTIA, CHFI, EDRP, ECSA, ECSP, ECIH, CEH, CEI
Swiss German University; Indonesia Honeynet Project

Abstract:

As organizations are digitally transforming their business, they are encountering security risks to slow down their intent. A collection of honeypots, i.e. honeynet, are often deployed in their infrastructure to detect the early cyber security attacks into the infrastructure, allowing the organization to be more aware of the emerging threats. Organizations may forge to stay relevant, timely and accurate in assessing these threats when they are willing to share these threats to the community of interest, providing the first step to cyber situational awareness.

Short Biography:

Charles Lim is a Cyber Security Researcher and Lecturer at Swiss German University, an independent researcher who works closely with Badan Siber dan Sandi Negara (BSSN) and a professional IT security related consultant and trainer. He is one of the recipients of the 2019 ISIF Asia Network Operations Research Grants and 2020 Internet Operations Research Grants. He also holds a few security professional certifications in the area of incident response, threat intelligence and security analyst, from ECCOUNCIL. He has a Doctorate degree in Electrical Engineering from Universitas Indonesia, Master of Science in Electrical Engineering from University of Hawaii, USA and his research includes Malware Analysis, Digital Forensics, Cloud Security, and IT Security Architecture. He is actively involved with many cyber security communities, such as Indonesia Honeynet Project (IHP), ACAD CSIRT (Academy Computer Security Incident Response Team), Indonesia Digital Forensics Association (AFDI), and others.

Invited Speaker 3

Recent Trends in 3D Printing

Assoc. Prof. Dr. Waseem Haider
Central Michigan University, USA

Abstract:

Additive manufacturing or 3D printing of metals is emerging and rapidly growing manufacturing technique from prototyping to large production runs. This process involves the fusion of metal powder bed by selectively melting above the melting temperature and building layers on top of each other. The imminent advantages of producing complex geometries, unprecedented manufacturing flexibility, product customization and at the same time economically viable process makes it a potentially disruptive technology for different industrial applications. The huge interest of industries for adapting this technology also brought the attention of research community to work in this area with full potential. The changed melting and solidification dynamics during additive manufacturing, results into striking differences in the microstructural evolution in comparison to the one obtained through conventional casting process. The microstructure variation strongly impacts the other structural properties of the material, e.g. mechanical, electrochemical etc. and this provides different avenues for the research community. Our group is working to elucidate the electrochemical response and the nature of passive oxide film formed on the additively manufactured 316L stainless steel for varying applications (biomedical, petrochemical and food industries).

Short Biography:

Dr. Waseem Haider is a tenured associate professor at School of Engineering and Technology, Central Michigan University, USA. He earned his PhD in Mechanical Engineering from Florida International University in 2010. He got a post-doctoral fellowship in materials science and engineering at Pennsylvania State University. Afterwards, he joined orthopedic research labs as a research scientist at State University of New York. Soon after that, he joined University of Texas as tenure track assistant professor where he served for three years. Dr. Haider's research focuses on Materials Science and Biomedical Engineering with special emphasis on Biomedical Materials Surface Chemistry, Electrochemistry, Bulk Metallic Glasses, and Nanomaterials. His research is supported by National Science Foundation and Department of Defense.

Invited Speaker 4

Engineering Design and Blockchain Technology for Sustainable Industry: A Circular Economy Perspective

Assoc. Prof. Yudi Fernando PhD M.LogM
Universiti Malaysia Pahang, Malaysia

Abstract:

The manufacturing industry is an essential sector, especially in developing countries, and significantly contributes to a nation's economy. These significant contributions are due to the availability of vendors with capabilities supporting low-cost production with quality materials. These significant contributions should not overlook other outputs from this industry as one of the largest emitters of greenhouse gasses, pollution, and waste that contribute to negative environmental impacts. These externalities are due to waste from the energy and material resources required to be processed into finished products. While the manufacturing industry has contributed enormously to wealth and job creation, thus improving quality of life, this is happening at the expense of delivering unsustainable amounts of solid waste and pollution. Due to many competing factors, the manufacturing industry is transforming from a linear economy model (make, use and discard) to a global circular economy in which the components of products are fed back to production after their service life. Yet, scanty evidence exists on how the manufacturing firms report on the success story of the remanufacturing process of leftover materials, return products and scrap. In the past, environmental concerns were mostly neglected in the manufacturing and supply chain processes. Circular economy, a term which used to be known as the remanufacturing of scrap, is an alternative method to counter this issue. The engineering redesign needs to be adopted with the proper integrity platform. Blockchain technology can be used to improve visibility, transparency and the accurate computation of the production and overall supply chain's carbon footprint. Blockchain technology has a high level of security and cannot be hacked. It can be used to support the integration of energy production, utilization, transmission, and storage so that every carbon footprint activity and carbon trading transaction can be tracked and no data can be manipulated. In regard to the importance of engineering design using circular economy concept and industrial revolution 4.0 enabler technology like blockchain, I will be presenting a remanufacturing model for sustainable industry that will assist the industry and academia to find alternative solutions to turn waste into value-added products.

Keywords: remanufacturing; design; circular economy; blockchain technology; industrial revolution 4.0; sustainability

Short Biography :

Yudi Fernando is an Associate Professor and holds a PhD. He is the Editor-in-Chief Industrial Management: An International Journal and Managing Editor of Journal of Governance and Integrity at the Faculty of Industrial Management, Universiti Malaysia Pahang. He is a Research Committee Chair and founding member of the Malaysian Association of Business and Management Scholars (MABMS). He is also a member of the Society of Logisticians, Malaysia/Pertubuhan Pakar Logistik Malaysia (LogM). Prof. Yudi is involved actively as the assessor for ABEST21 (Alliance of Business Education and Scholarship for Tomorrow) program-based accreditation system. His research interest is in the areas of sustainable supply chain; circular economy 4.0 and blockchain technology and he has supervised 9 PhDs, 11 ongoing, and more than 70 Master theses. His works can be found in the top tier journals such as: Journal of Cleaner Production, *Resources, Conservation* & Recycling, Sustainable Production and Consumption; tourism management International Journal of Information Management; Food Control, Journal of Energy Policy and others.

Invited Speaker 5

Biometrics Technology for Better Public Services

Dr. Eng. Anto Satriyo Nugroho
Center for Information and Communication Technology,
Agency for Assessment and Application of Technology (PTIK BPPT)

Abstract:

Kartu Tanda Penduduk Elektronik (KTP-el) is a National electronic ID card which is issued by the Indonesian government. The goal of KTP-el is to develop an accurate national population database, and ensure a single identity number (SIN) for the citizens. The unique identity of each citizen is verified using biometrics data: ten fingerprint scans, two iris scans and a face scan. More than 190 million citizens have had their biometrics data taken. The scale of biometrics data is the second largest biometrics data in the world after those collected by Unique Identification Authority of India (UIDAI). The data opens various applications such as biometrics authentication for banking, forensic identifications, and electronic voting. In this presentation, we will discuss several topics including biometrics testing of KTP-el Reader, the usage of KTP-el and biometrics for public services, and the future of biometrics data.

Short Biography:

Anto Satriyo Nugroho works for the Center of Information & Communication Technology, Agency for the Assessment & Application of Technology (PTIK BPPT), Indonesia. He completed his B.Eng. (1995), M.Eng. (2000) and Dr.Eng. (2003) in Electrical and Computer Engineering from Nagoya Institute of Technology, Japan. From 2003 to 2007, he was working as visiting professor at School of Life System Science & Technology, Chukyo University, Japan. His research interest is on pattern recognition and computer vision with applied field of interest in Multimodal biometrics Identification and Computer Aided Diagnosis for Malaria Detection. He is the 1st president of Indonesian Association for Pattern Recognition (INAPR), and an Indonesian Governing Board member of International Association of Pattern Recognition (IAPR). Dr. Anto Satriyo Nugroho is a member of IEEE, Indonesian Association for Pattern Recognition (INAPR), Indonesian Association for Computational Linguistics (INACL) and Indonesian Society of Soft Computing.

Invited Speaker 6

Recent Progress of Lithium Ion Battery for Electric Vehicles

Prof. Dr. Eng. Agus Purwanto, ST. MT
Lithium Battery Research and Technology Centre,
Universitas Sebelas Maret, Surakarta, Indonesia

Abstract:

At the end of 2019, the Nobel prize in chemistry was awarded for the advancement of Li-ion batteries considering its discovery promotes the current technology and lifestyle. Li-ion batteries (LIBs) are considered as a vital and predominant power source for various wireless and portable electronics, and have even been applied to high performance Electric Vehicles, especially BEV and HEV. It is predicted by 2030, the largest Li-ion Batteries market will be electric vehicles, mainly cars. As it progressed, current problems found during the development of LIBs were addressed and needed to be overcome such as performance, cost, weight and size. However, cell chemistry and thermal management became the main focus. Cell chemistry considers not only the electrochemical performance, but also its availability to avoid material shortage in the future. It appears that $LiFePO_4$ and graphite system was selected due to its safety properties. However, future trends tend to use nickel rich cathode and silicon-graphite anode for high voltage (up to 5 V) and high energy density batteries. However, high energy density results in high thermal runaway risk, thus making thermal management and failure mechanisms equally as important as cell chemistry. Failure mechanisms of LIBs have been extensively studied. From the material level, challenges such as undesired side reaction, particle breakage and passivation and metal dissolution are often found. However, the current technology of morphology control, nano-layer coatings and structural modification can be used to solve these problems. At the cell level, extensive safety tests, i.e. a mechanical test, thermal test and electrical abuse test are necessary to assure the safety of LIB cells for EVs. With good battery cell design, safety issues can still emerge due to the use of liquid electrolyte which is often flammable and unstable at elevated voltage and temperature. This phenomenon has initiated the development of solid electrolytes for high safety all-solid-state batteries (ASSB). In conclusion, LIBs bring numerous advantages for civilization, however, during worldwide EV application, intrinsic and extrinsic challenges still remain under investigation. With excellent efforts, high safety electric vehicles will undoubtedly be achieved in the near future.

Short Biography:

Agus Purwanto is recognized as an Indonesian developer of Lithium Ion Batteries (LIBs) [i] and the leader of the Centre of Excellence for Electrical Energy Storage Technology

(CEFEEST) Universitas Sebelas Maret. His current work is developing LIBs active material and design. He is the author of over 100 scientific papers, co-inventor of 14 inventions and a Professor in Chemical Engineering.

Agus Purwanto was born in Sragen, Indonesia in 1975 and currently lives with his family in Solo. He obtained his bachelor and master degree in Chemical Engineering from Institut Teknologi 10th November 1998 and 2002 respectively, and his Doctoral degree from Hiroshima University. He is taking a faculty position in the Chemical Engineering Department of Universitas Sebelas Maret.

Agus Purwanto has collaborated with many organizations and industries such as Indonesian Endowment Fund for Education (LPDP), Indonesian Institute of Science (LIPI), the National Nuclear Energy Agency (BATAN), PT Pertamina and Toyota. Agus Purwanto has received multiple awards including: Outstanding Lecturers of Universitas Sebelas Maret (2011), Academic Leader in Technology by Ministry of Research and Technology and Higher Education (2017), and Science and Technology Award by ITSF (2020).

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Analysis and Simulation of Short Shot Defects in Plastic Injection Molding at Multi Cavities

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ABSTRACT

This radiator cover mold has been made and has gone through the first pre-production trial stage (T0). However, the product experienced a short shot defect in the 1st cavity. After testing using Moldflow, there is a difference in injection time that is quite long between the 1st cavity and 2nd cavity. There is a need for a new design on the feeding system that can speed up injection time in 1st cavity, so differences in injection time can be minimized. The analysis is done by making variations of the size of the feeding system, which is: runner diameter, width, and thickness of the gate using Taguchi and ANOVA method. The analysis shows that the optimal design of the diameter runner is 8 mm while the size of the wide gate is 10 mm and the thick gate is 0.8 mm. The validation process is repeated using Moldflow with the result of a concise injection time difference is 0.001 s. The new design of feed system able to eliminate the difference in filling time in this product.

CSC Concepts

•Computing methodologies~Modeling and simulation~Model development and analysis~Model verification and validation

Keywords

Injection time, Feed system, Short shot

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1 Introduction

The use of plastic is now increasingly massive, marked by the amount of plastic production currently reaching more than 230 million tons/year, and continues to increase this year to 400 million tons with a growth rate of around 5% per year [1,2]. There is a study that states the consumption of raw material is based on weight, when compared with other materials, such as aluminum, steel, rubber, copper, zink, etc. It is reasonable, because plastic is easy to form and low processing costs [3]. Plastic are increasingly varied, because of the nature of being easily constrained, cheap production processes, and increasing physical properties.

Mold Cover Radiator is a type of multi-cavity. After going through the pre-production test phase, several problems were found in the mold. One of the biggest problems is the significant injection time difference between 1st cavity and 2nd cavity. Injection time difference affects one product that is not fully loaded while on the other hand the product is fully charged [4].

An incomplete part in a plastic product is considered a short shot. The problem is easily recognized as a part that is not fully loaded, one of which is influenced by some processing parameters that are not set properly. This might include transfer points, melt or mold temperatures, packing pressures and other variables. However, it can also be influenced by the design of the gate which was not ideal [5]. Short shot defects that occur in the radiator cover product as shown in Figure 1:

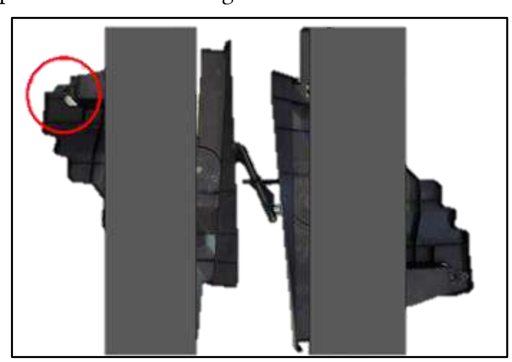

Figure 1 Short shot defects in radiator cover

Feeding system is a feeder system that regulates the distribution of plastic material flow from the machine into a mold consisting of a sprue system, runner system and gate system [6]. Redesign of feeding system aims to improve the injection time difference in plastic products [5]. So, in order to optimize the feeding system design, it is necessary to conduct a study of optimizing the feeding system design of the runner and gate system to produce a product without short shot defects in the 1st cavity and 2nd cavity.

2 Research Methodolgy

2.1 Steps for Testing the Feeding System

The stages of the testing process carried out in this study are explained through the following flowcharts as shown in Figure 2:

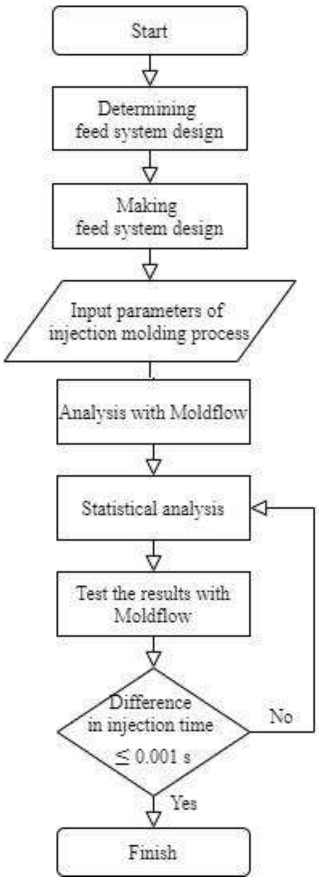

Figure 2 Flow chart of Optimization Feeding System to Injection Time in Radiator Cover Mold

2.2 Injection Process Parameters

These parameters are needed to be able to see the filling phase using Moldflow. Parameters for simulation of filling time are determined as demonstrated in Table 1.

Table 1 Parameter simulation filling time of radiator cover

Parameter	Value	Unit
Melt Temperature	220	°C
Mold Temperature	50	°C
Flowrate	145	cm^3/s
Injection Pressure	60	MPa
Packing Pressure	84	MPa
Packing Time	10	s

2.3 Feeding System Testing Response

Simulation of injection time response is divided into three categories, that is injection time at 1st cavity (v1), 2nd cavity (v2), and difference between the two (d). The following is the result of filling analysis in the initial conditions as shown in Figure 3:

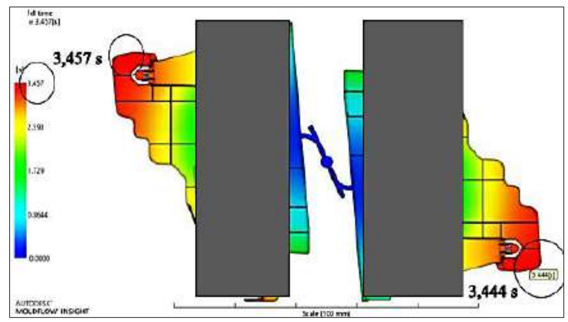

Figure 3 The initial simulation of injection time on the radiator cover

Injection time at (v1) is 3,457 s while at (v2) is 3,444 s. These results indicate at (d) is 0.013 s. To be optimal, if the injection time between (v1) and (v2) approaches nominal 3.444 s and (d) approaches or equals 0 s (d ≤ 0,002 s).

2.4 Testing Materials

2.4.1 The cover radiator mold material

The mold material used is P-20 type material in AISI standard. This type of material is commonly used for tool steel, following the specifications of the material as demonstrated in Table 2.

Table 2 Specifications of P-20

Characteristics	Value	Unit
Mold Density	7,8	g/cm^3
Mold Specific Heat	460	J/kg°C
Mold Thermal	29	W/m°C
Elastic Modulus (E)	205.000	MPa
Poissons ratio (v)	29	%

2.4.2 The cover radiator material

The radiator cover material is a type of polypropylene (PP) with the following material characteristics as shown in Table 3.

Table 3 Specifications of polypropylene

Characteristics	Value	Unit
Melt Flow Index	38	g/10min
Mold Shrinkage, MD	0.015	mm/mm
Mold Shrinkage, TD	0.017	mm/mm
Density	900	kg/m³
Tensile Strength at Yield	23.05	MPa
Tensile Strength at Break	50	MPa
Flexural Modulus	1150	MPa
Rockwell Hardness	R 86	-
DTUL @ 66 psi	122	°C

Source: Injection Molding Handbook, Rosato, 2000

3 Simulation and Experimental Results

3.1 Determination design of the diameter runner

The diameter of the runner taken is the largest diameter of the advice given in table 4, which is 9.525 mm which is then rounded to 10 mm. Table 4 shown recommendations of runner diameters.

Table 4 Recommended diameter of runners for several types of plastic material

Plastic Material	Range Diameter [Inch]		Range Diameter [mm]	
ABS, SAN	0,187	0,375	4,750	9,525
Acetal	0,125	0,375	3,175	9,525
Acrylic	0,312	0,375	7,925	9,525
Cellulosic	0,187	0,375	4,750	9,525
Ionomer	0,093	0,375	2,362	9,525
Nylon	0,062	0,375	1,575	9,525
Polycarbonate	0,187	0,375	4,750	9,525
Polyester	0,187	0,375	4,750	9,525
Polyethylene	0,062	0,375	1,575	9,525
Polypropylene	0,187	0,375	4,750	9,525
PPO	0,250	0,375	6,350	9,525
Polysulfone	0,250	0,375	6,350	9,525
Polystyrene	0,125	0,375	3,175	9,525
PVC	0,125	0,375	3,175	9,525

Source: Injection Molding Handbook, Rosato, 2000

3.2 Determination design of the diameter runner

The gate is the entrance of melting material to plastic products, this has the direct effect of controlling the flow process in the plastic mold cavity which ensures the product is fully filled so that mechanical properties, dimensional stability, and product appearance can be achieved as desired. [7]. One type of gate that is simple and uses quite a lot is the edge gate. The edge gate has a rectangular cross-section by taking into the width and height as calculated [8]. So, it is very important to determine the dimensions of the gate itself. Calculations for edge gates through Eq. (1) and (2) [4].

$$w = \frac{n\sqrt{a}}{30} \quad (1)$$
$$w = 10\ mm$$

Note:
W = *Width of the gate [mm],*
n = *Constant of Polypropylene*
a = *surface area of the plastic product section [mm²]*

$$h = nt \quad (2)$$
$$h = 0{,}8\ mm$$

Note:
h = *Gate height [mm]*
t = *Average thickness of product [mm]*

Based on the calculation results of the gate, the obtained size for the edge gate that has a width of 10 mm and a height of 0.8 mm.

3.3 Taguchi Method

The diameter of the runner taken is the largest diameter of the advice given in table 4, which is 9.525 mm which is then rounded to 10 mm. Table 4 shown recommendations of runner diameters.

3.3.1 Selection of the control factors

Analysis for design changes was made based on the Taguchi method. The Taguchi method is a comprehensive quality strategy that carries out a number of experiments using orthogonal arrays and building endurance during the design phase [9-11].

There are three main stages namely system design, parameter design, and tolerance design. System design is to identify the basic elements of the design itself, which will produce the desired output. Design parameters are used as the most optimal parameter determinant by considering the design elements of each parameter in order to obtain product targets. Then, design tolerance is used to identify design components that affect product quality and set tolerance limits at the level of design variation. [12].

3.3.2 Selection of the level factor in the design parameter

These three factors are analyzed in this study there are: runner, gate width, and gate thickness. Following are shown in Table 5.

Table 5 Factor level

Level	Control Factor		
	Diameter runner (A) [mm]	Wide gate (B) [mm]	Thick gate (C) [mm]
1	8	8	0,6
2	10	10	0,8
3	12	12	1

Orthogonal arrays can be used as a medium to organize matrix experiments, to evaluate the effects of a factors together and are an effective tool [13]. The use of orthogonal array includes all parameters with a minimum of experiments, allocation of control parameters and design variables to the column and transfers the results of the experiment to the real parameter settings [10,14].

3.3.3 Selection of the orthogonal array

Based on method for orthogonal array L9 or 33. The pattern shown on Table 6, as follows:

Table 6 Design variations of feeding system based on orthogonal array

Exp. No	Control Factor		
	A (mm)	B (mm)	C (mm)
1	8	8	0,6
2	8	10	0,8
3	8	12	1
4	10	8	0,8
5	10	10	1
6	10	12	0,6
7	12	8	1
8	12	10	0,6
9	12	12	0,8

3.4 Signal to noise (S/N) ratio approach

The signal to noise ratio (S/N) is used to determine the quality characteristics of each problem. The S/N ratio has three phases: the smaller the better, the best nominal, and the bigger the better [10].

3.5 Simulation Results Data Using Moldflow

The design that has been made is then tested again using Moldflow. The result of simulation injection time response on the 1st and 2nd cavity shown on Table 7, as follows:

Table 7 The results of simulation injection time

Exp. No	At 1st cavity (v1)		At 2nd cavity (v2)	
	Exp. Result (S)	S/N 3,444 Better	Exp. Result (S)	S/N 3,444 Better
1	3,446	53,979	3,475	30,173
2	3,446	53,979	3,445	60
3	3,46	35,918	3,438	44,437
4	3,481	28,636	3,505	24,293
5	3,496	25,68	3,488	27,131
6	3,471	31,373	3,519	22,499
7	3,529	21,412	3,539	20,446
8	3,524	21,938	3,551	19,412
9	3,532	21,11	3,539	20,446

The result of injection time response on the difference between 1st cavity and 2nd cavity shown on the Table 8, as follows:

Table 8 Difference injection time at 1st cavity and 2nd cavity

Exp No	Difference (d)	
	Exp. Result (s)	S/N 0 better
1	-0,029	30,752
2	0,001	60
3	0,022	33,152
4	-0,024	32,396
5	0,008	41,938
6	-0,048	26,375
7	-0,01	40
8	-0,027	31,373
9	-0,007	43,098

The results of each sub feeding system in 1st cavity against injection time indicated the best level marked in blue with an injection time of 3,446 s and the worst level marked in red with an injection time of 3,532 s. While, the results on 2nd cavity are shown the best level with injection time of 3,445 s and the worst level with injection time of 3,551 s.

In this study using the S/N-type of nominal better is the highest S/N shows the most optimal nominal injection time.

3.5.1 Analysis of the effect of runner diameter on the difference of injection time

Figure 4 shows the results of calculations of the influence of runner diameter on differences in injection time in 1st cavity, 2nd cavity, and between cavities.

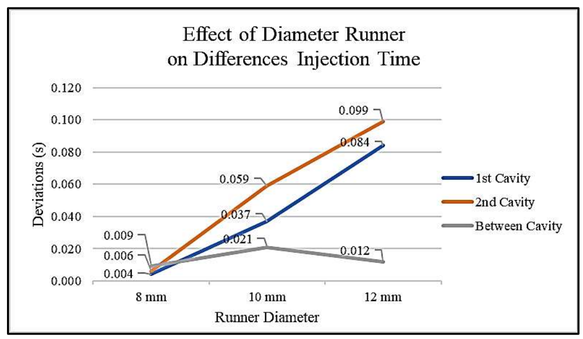

Figure 4 Modelling of Effect of Diameter Runner on Differences Injection Time

3.5.2 Analysis of the effect of gate width on the difference of injection time

The effect of gate width on the difference of injection time in 1st cavity, 2nd cavity, and between cavities are shown in Figure 5 as follows:

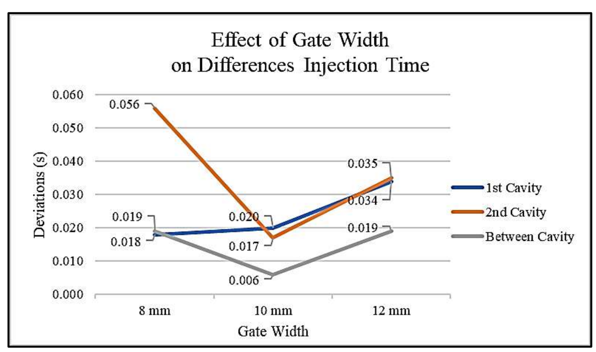

Figure 5 Modelling of Effect of Gate Width on Differences Injection Time

3.5.3 Analysis of the effect of gate thickness on the difference of injection time.

Figure 6 shows the result calculation of the effect of gate thickness on the difference of injection time in the 1st cavity, 2nd cavity, and between cavities.

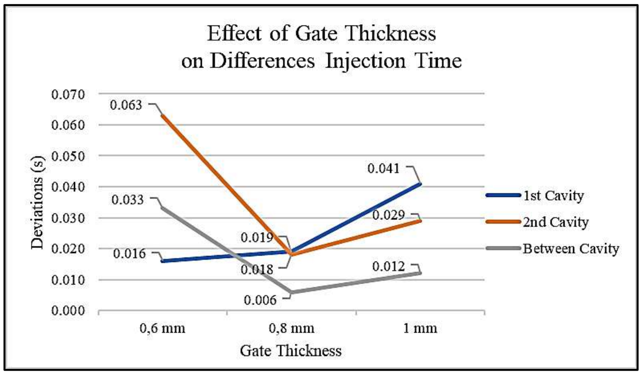

Figure 6 Modelling of Effect of Gate Thinckness on Differences Injection Time

3.6 Analysis of variance (ANOVA Method)

ANOVA method is used to determine the level of influence of changes or factor effects of each sub feeding system on each response. This method is also used to test whether variations are acceptable or not.

3.6.1 Determination of nominal variation test

It is assumed that in the data analysis of the results of this test the importance level of 98% was chosen, α = 0.02. This means that if the P value of a sub feeding system is less than 2%, it is assumed that there are variations due to changes in the sub feeding system can be ignored. In the ANOVA method ignoring a control factor is usually called accepting H0 and rejecting H1, and vice versa if receiving a control factor is usually called accepting H1 and rejecting H0.

3.6.2 Factor effect on injection time in 1st cavity, 2nd cavity, and between cavities

The results of the factor effect (*P*) can be calculated with degrees of freedom (*DoF*), number of squares (*SoS*), or number of squares between groups (*SSG*) and mean squares (*MSG / V*) [4]. The formula used is shown by Eq. (4), (5), (6), and (7), as follows:

$$DoF = k - 1 \quad (4)$$

$$SSG = \sum_{i=1}^{k} ni(\bar{x}_i - \bar{x})^2 \quad (5)$$

$$MSG = \frac{SSG}{Dof} \quad (6)$$

$$P = \frac{SSG}{\sum SSG} \cdot 100\% \quad (7)$$

Note:
k = Number to be examined on the independent variables
ni = Sample size of population *i*, x_i *is i - i* measurement
x = Overall mean (of all data values)

Factor effect is the level of influence of a control factor on a response. These are the influence factors on injection time in each cavity. The results of the factor effects on injection time at 1st cavity is shown in Table 9, as follows:

Table 9 Factor effect on injection time on 1st cavity

Factor Effect on Injection Time in 1st Cavity							
Control Factor	Level 1	Level 2	Level 3	DoF	SoS	V	P
Runner	8	10	12	2	376	188	87%
Gate width	8	10	12	2	16	8	4%
Gate thickness	0,6	0,8	1	2	38	19	9%

The results of the factor effects on injection time at 2nd cavity is shown in Table 10, as follows:

Table 10 Factor effect on injection time on 2nd cavity

Factor Effect on Injection Time in 2nd Cavity							
Control Factor	Level 1	Level 2	Level 3	DoF	SoS	V	P
Runner	8	10	12	2	348	174	75%
Gate width	8	10	12	2	56	28	12%
Gate thickness	0,6	0,8	1	2	60	30	13%

The results of the factor effects on injection time difference between cavities are shown in Table 11, as follows:

Table 11 Factor effect on injection time differences between cavities

Factor Effect on Injection Time in Between Cavities							
Control Factor	Level 1	Level 2	Level 3	DoF	SoS	V	P
Runner	8	10	12	2	30	15	14%
Gate width	8	10	12	2	68	34	31%
Gate thickness	0,6	0,8	1	2	124	62	55%

3.7 Calculation of variation of optimal control factors

Data analysis of responses from the 1st cavity, 2nd cavity, and between cavities can be determined by Pareto calculation. The following is the result of Pareto filled with data on the number of S/N ratios for each level of the sub feeding system. Table 12 as shown the result of calculation of Pareto optimal conditions, as follows:

Table 12 Calculation of Pareto optimal conditions

	Respon of Control Factor	Injection Time v1	Injection Time v2	Injection Time d	Sum	Optimal Value
Parameter	Runner diameter 8	144	135	124	403	8 [mm]
	10	85	74	101	260	
	12	64	60	114	238	
	Gate width 8	104	75	103	282	10 [mm]
	10	102	107	133	342	
	12	88	87	103	278	
	Gate thickness 0,6	107	72	88	267	0,8 [mm]
	0,8	104	105	135	344	
	1	83	92	115	290	

The biggest value of the control factor of the diameter runner is at level 1, which is 8 mm, the biggest value of the control factor of the gate width is at level 2, which is 10 mm, and the biggest value of the control factor of the gate thickness is at level 2, which is 0.8 mm.

4 Result of Testing Analysis

4.1 Determination design of the diameter runner

The final test was carried out using Moldflow. Figure 7 shows the simulation results based on the control factor of injection response time as follows:

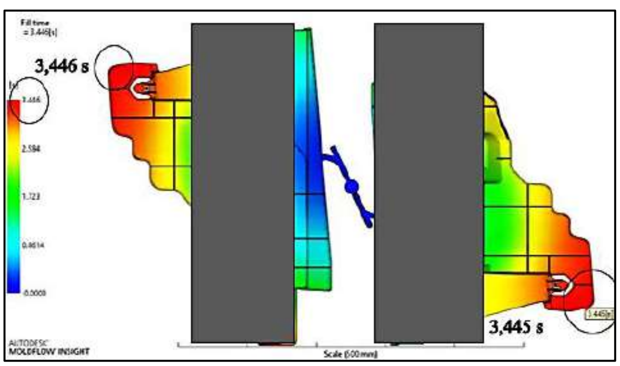

Figure 7 Simulation Test Results of the Final Injection Time Analysis on the Radiator Cover

The analysis was carried out using a sub feeding system on the 1st cavity with a runner diameter of 8 mm, a gate width of 10 mm, and a gate thickness of 0.8 mm. Figure 7 shows that the injection time determines the optimal value. Where the injection time value in 1st cavity is 3,446 s and the injection time in 2nd cavity is 3,445 s. So, the difference injection time between cavities is 0.001 s. The following is a Table 13 that considers before and after the analysis of injection time.

Table 13 Comparison of injection time conditions before and after analysis

Condition	Injection time at 1st cavity	Injection time at 2nd cavity	Difference between cavities
Before	3,457 s	3,444 s	0,013 s
After	3,446 s	3,445 s	0,001 s

5 Conclusions

The radiator cover mold has a problem of unbalanced injection time between cavities. This research proves that changing the feeding system design can correct these problems. Based on the previous discussion which refers to the main problem, it can be concluded that the design of a new feeding system is optimal for use in this mold with the following specifications:

1. The diameter of the runner is fixed at the size of 8 mm.
2. The gate width at the 1st cavity from 8 mm is enlarged to 10 mm.
3. The Gate thickness at the 1st cavity from 1 mm is reduced to 0.8 mm.

The results of the change in sub feeding system are as follows:

1. Injection time in the 1st cavity is 0.011 s, faster than the previous 3.457 s to 3.446 s.
2. Injection time in the 2nd cavity is 0.001 s, longer than the previous 3.444 s to 3.445 s.
3. Injection time difference between the two cavities is shorter than before, which is 0.012 s to 0.001 s.

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