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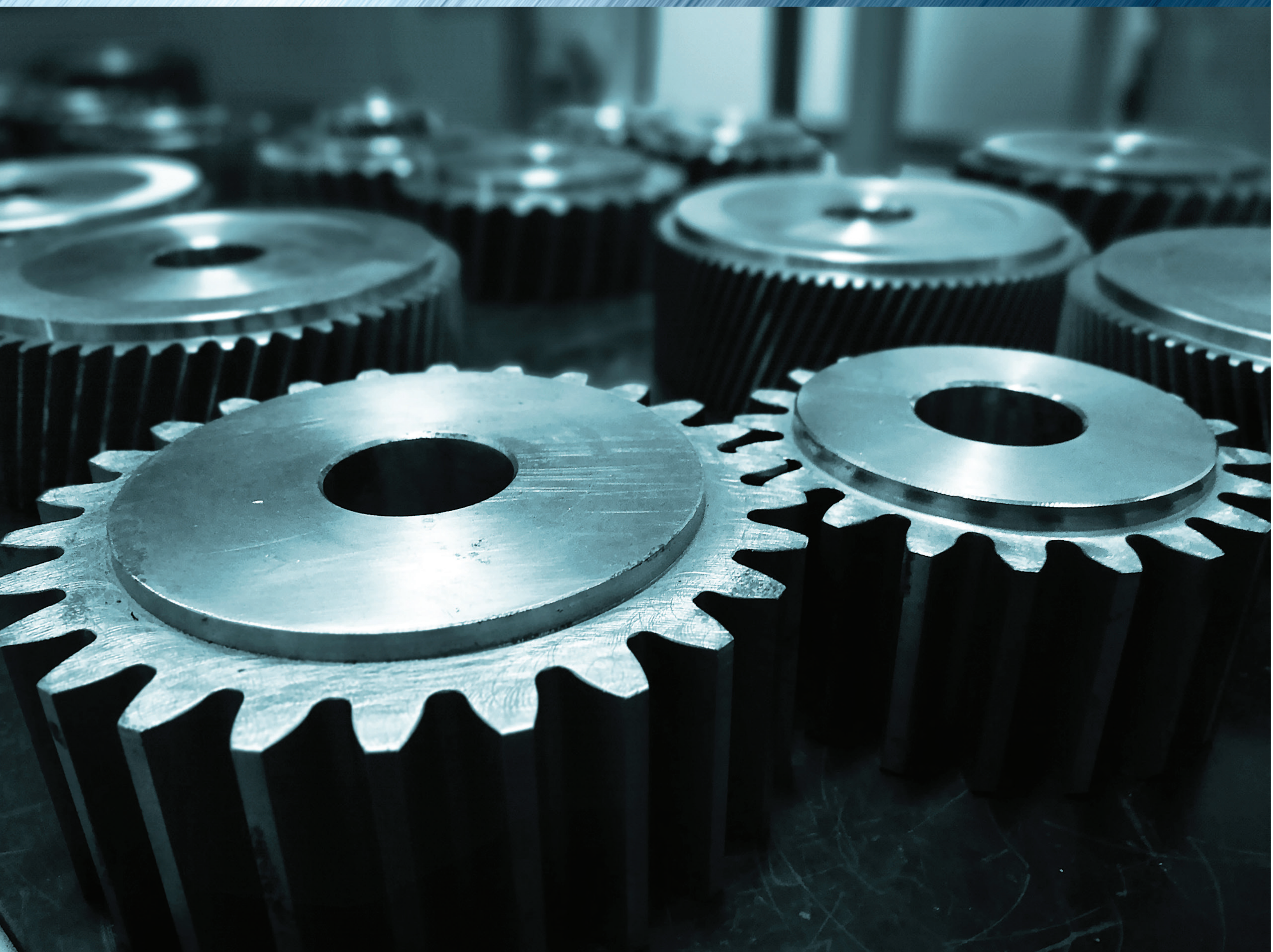

Department of Science and Technology
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Philippine Metals

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Preface

As we continue to strive for greater relevance to the metals, engineering (M&E), and allied industries, we constantly pursue research and development (R&D) initiatives through programs and projects we launch in cooperation with various industry partners. Our desire to come up with home-grown, science and technology-based solutions to address the industry's goal of becoming more productive and globally competitive serves as our motivation to engage in R&D. In the same manner, our successful collaboration with the industry further fuels this motivation and drives us to work even harder. The results of all these intensify the Center's desire to disseminate the information so that our valued stakeholders know what these researches and engagements are all about.

On behalf of the Department of Science and Technology-Metals Industry Research and Development Center (DOST-MIRDC), I present to you the Philippine Metals (PhilMet) Volume 6. Apart from the technical articles, the PhilMet also contains the Metals Review segment, where you will be given updates on the die and mold industry, as well as a report on the evaluation of internal and external factors affecting the die and mold, machining, and forging industries. Also contained in the PhilMet are write-ups that highlight an industry association and a personality prominent to the M&E and allied industries. In this volume, we are honored to feature the Philippine Parts Maker Association, Inc. (PPMA) and Mr. Angel P. Serra, a highly respected figure in the forging industry.

The Philippine Metals, like our R&D and collaboration initiatives, is an assurance that the DOST-MIRDC remains faithful to its commitment to support the M&E and allied industries, particularly where information exchange is concerned. I invite our stakeholders – the industry, the academe, other government agencies, and local government units, to name a few – to take advantage of the materials contained in this publication. May our pursuit of continued growth lead us to the path of productivity and global competitiveness

Robert O. Dizon
Executive Director

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Philippine Die and Mold Industry 2018: A Status Report

Alexander P. GONZALES*[1]

Abstract

At present, the manufacturing industry faces severe competition in the global market. It has to overcome challenges posed by issues such as globalization, digitalization, reliability, specialization, and collaboration to survive. The DOST-MIRDC aimed to look into the current status of the Philippine die and mold industry in terms of its general industry profile, technical profile, market profile, and research and development (R&D) requirements for 2018. This study utilized the mixed research method model, which incorporated a quantitative survey method and qualitative interview, focused group discussion (FGD), and document analysis using the Philippine Statistics Authority (PSA) data. The die and mold industry in the Philippines has a lot of potentials, but it also has problems and concerns. Demand for die, mold, and other related tools and products is steadily increasing. The Philippine die and mold industry needs to align its current capabilities with the present market conditions and leverage its key resources to take advantage of the opportunities.

Keywords: die and mold, tool and die, MIRDC, PDMA, metal industry, mixed method, statistics.

1. Introduction

The design and manufacture of dies and molds represent a significant link in the entire production chain because nearly all mass produced discrete parts are formed using production processes that employ dies and molds [1]. At present, the manufacturing industry faces severe competition in the global market. The manufacturing industry has to deal with issues such as globalization, digitalization, reliability, specialization, and collaboration to survive [2]. These conditions necessitate the Department of Science and Technology – Metals Industry Research and Development Center (DOST-MIRDC) to look into the present status of the die and mold industry in the Philippines.

Part of the mandate of the DOST–MIRDC, as stated in Republic Act No. 4724, Sec. 4b (3), is to collect information and statistics for preparation of comprehensive and up-to-date industry studies.

The last industry study conducted by the Center for the die and mold industry was in 2006. The Center sees it fit to do another research focusing on the die and mold industry. For this purpose, its technical and administrative staff engaged in the crafting of the survey questionnaire, fielding/collection of data, consolidation, analysis, and publication of the study. This time, the MIRDC aimed to look into the current status of the Philippine die and mold industry in terms of its industry profile, technical profile, market profile, and research and development requirements.

Fig. 1 shows the conceptual framework of the study. The inputs of the study are the industry profile, technical profile, market profile and research and development (R&D) involvements of the local die and mold industry. The process includes the preparation of the survey questionnaire and submission to the Philippine Statistics Authority (PSA) for approval, conduct of the survey proper along with the plant observation, consolidation of data, and conduct of the focus group discussion (FGD) for confirmation and validation of results. The output of the study is the status of the Philippine die and mold industry for 2018 which will be the basis of public policies as well as programs, projects, and activities (PPA) of the government.

1.1. Objective of the Study

This study aims to determine the status of the Philippine die and mold industry for 2018. Specifically, it aims to:

1. Provide an assessment of the Philippine die and mold industry in terms of its industry profile, technical profile, market profile, and R&D involvement;

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2. Identify issues and concerns of the Philippine die and mold industry; and
3. Analyze the internal and external factors affecting the Philippine die and mold industry.

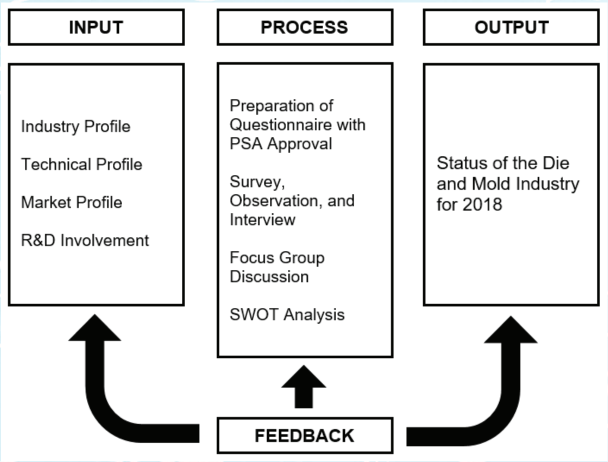


Fig. 1. Conceptual Framework

2. Methodology

This study utilized the mixed research method model, which incorporated a quantitative survey method and qualitative interview, focused group discussion (FGD), and document analysis using the PSA data. In combining quantitative and qualitative data gathering procedure, the mixed methods research can utilize the advantages of the two major research methodology, thereby providing a better understanding of the phenomena being investigated [3].

The status of the industry was gathered by the use of survey questionnaire designed by the Technology Information and Promotion Section (TIPS) of the Technology Diffusion Division (TDD) to extract significant information to attain the objectives of the study. The Questionnaire was validated and approved by the PSA with PSA Approval No. MIRDC–1814. PSA also granted the DOST-MIRDC clearance to survey the Philippine die and mold industry in a press release dated March 5, 2018 with reference number 2018-038.

Data gathering was conducted through field interviews, phone interviews, emailed questionnaire, and observations from April 1, 2018 to October 31, 2018. Data collected were further validated through an FGD conducted on November 28, 2018, attended by representatives from various die and mold companies. Data were further validated and analyzed by the Center's expert consultant, Engr. Antonio L. Mangubat.

Respondents were identified through the use of lists of shops/companies from the Department of Trade and Industry (DTI), the Philippine Die and Mold Association (PDMA), and the Philippine Economic Zone Authority (PEZA). Other sources considered were the files of the Business Permit and Licensing Office (BPLO) from the Local Government Units (LGUs) and internet searching.

The target of the study is to get the entire population of domestic companies belonging to the die and mold industry to obtain reliable data on its current status. The industry study team identified 138 potential respondent-companies but because of limited time, resources, and accessibility issues, the industry study team was able to survey 128 respondent-companies only.

3. Results

This study assessed the current condition of the die and mold industry in the Philippines for the year 2018.

The companies included in the study are situated in the National Capital Region (NCR), Region III, Region IV-A, Region VII, Region VIII, and Region XI. There are 62 die and mold companies in Region IV-A, all of whom represent 84% of the industry. The NCR houses 45 die and mold firms, making it the next region with the second highest number of industry players.

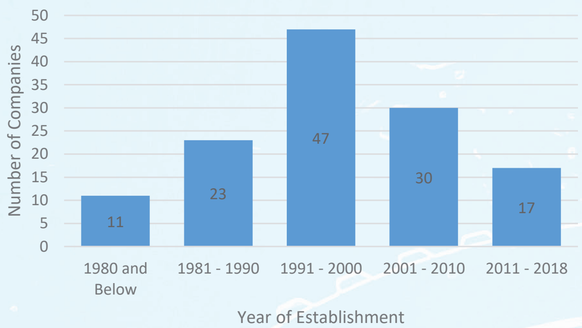


Fig. 2. Year Started Operations

As seen in Fig.2, the year 1991 to 2000 reflects the peak in the establishment of die and mold companies in the Philippines.

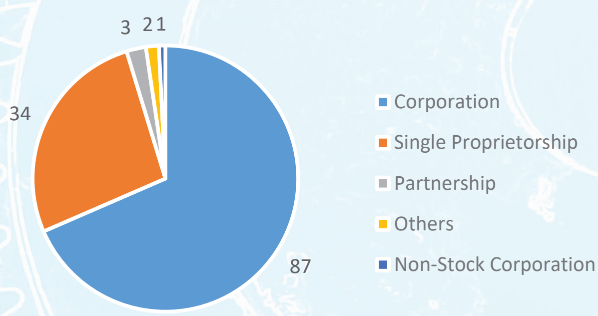


Fig. 3. Form of Business Organization

Fig. 3 shows that 87 out of 128 respondent-companies are corporations and 34 are single proprietorship.

In terms of classification according to capital, 43 respondent-companies are classified as medium, 40 are small, 21 are large, and 20 are micro. In terms of classification according to number of employees, 80 of the respondent-companies are classified as small, 19 are micro, 17 are large, and 12 are medium.

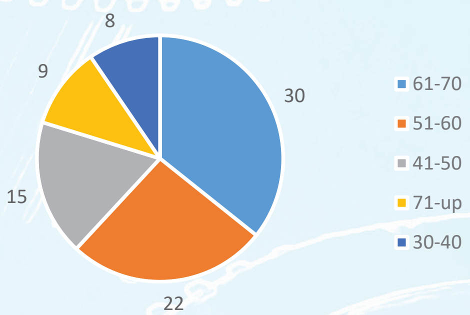


Fig. 4. Age of Company Owners

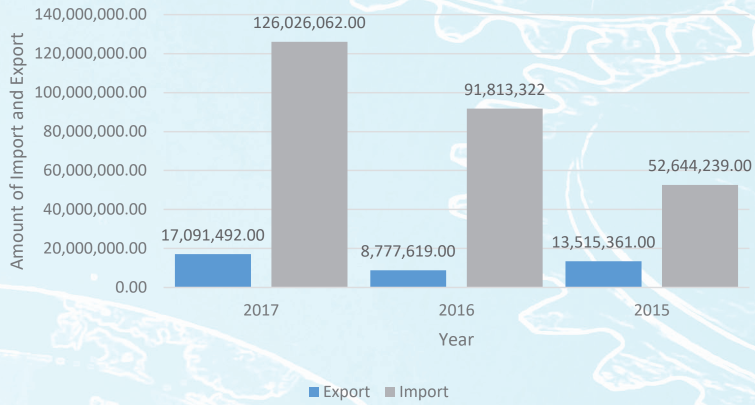
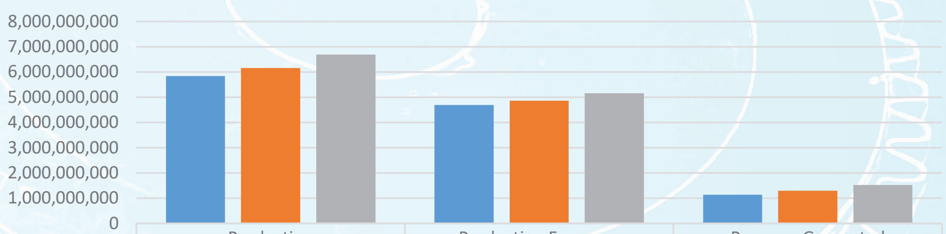


Fig. 6. Philippine Import and Export of Dies and Molds (in US Dollars)



	Production	Production Expenses	Revenue Generated
2015	5,839,000,798	4,694,884,290	1,144,116,507
2016	6,161,980,172	4,866,536,596	1,295,443,576
2017	6,685,985,820	5,159,917,406	1,526,068,414

Fig. 5. Production, Production Expenses, and Revenue Generated (in Pesos), 2015-2017

From the data presented in Fig. 4, the industry has ageing CEOs or company owners. Majority of the owners' age falls under the 61 to 70 and 51 to 60-year-old category, while the average age of company owners is 59 years old.

As presented in Fig. 5, businesses under the die and mold industry show an upward trend based on sales and revenues from 2015 to 2017. Based on the data gathered, the industry gained an average of 10% increase in revenue generated per year. The die and mold industry is continuously growing at a steady pace.

Fig. 6 illustrates that Philippine imports of dies and molds and other related products exceed the Philippine exports to a high degree from 2015 to 2017 based on the import and export data of the PSA. It shows that the manufacturing industries using die and mold products in the Philippines are import-dependent.

Most of the respondent-companies perceived that competition among the die and mold makers are just slight to no competition at all as presented in Fig. 7. Based on interviews conducted, as well as during the FGD, the sector is highly specialized and diversified. Very few companies compete within the same market segment. Those that specialize in semiconductors are not competing with those that specialize in automotive or mining. The die and mold industry has its own niche in the metals industry. Individual companies are aware of each other's expertise. This knowledge and familiarity among the companies allow them to work with one another rather than compete.

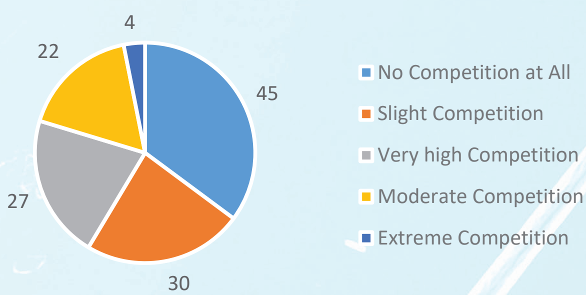


Fig. 7. Competition in the Target Market

Respondent-companies prefer tool steel, stainless steel, plates, sheets, bars, aluminum, and mild steel as raw materials (see Table 1). Generally, respondent-companies purchase their raw materials from local suppliers who are direct importers. According to the respondent-companies, they have to maintain an inventory of raw materials because of occasions where there are limited supplies in the local market. Raw materials purchase orders are made in advance to deliver the job orders without delay. Some companies who do not want to wait and compete with local suppliers import their input materials directly from international suppliers. Usually, companies import toolings such as carbide, tungsten, and titanium. The volume of raw materials consumed by respondent-companies depends on the sector they are serving. Semiconductor dies and molds usually are small and utilize a small amount of raw materials. Automotive and industrial machinery dies and molds are large, where the weight of single mold can reach over a ton.

Table 1. Source and Volume of Raw Materials

Raw Materials	Source of Raw Materials*		Volume of Raw Materials**		
	Local	Imported	No. of kg/tons from LOCAL sources	No. of kg/tons from FOREIGN sources	Total no. of kg/tons
Tool Steel	57	0	113.8	0	113.8
Stainless Steel	54	3	253.4	0	253.4
Plates/Sheets /Bars	53	4	1,187.10	0	1,187.10
Aluminum	51	2	64.6	1	65.6
Mild Steel	49	3	198.6	12,000.00	12,198.60
Cold Rolled Steel (CRS)	46	1	22.4	0	22.4
Shafts & Rods	41	0	1,110.40	0	1,110.40
Copper	37	1	65.7	0	65.7
Brass	29	2	10.2	1	11.2
High Speed Steel	28	0	3.7	0	3.7
Pre-Hardened Steel	26	1	500.4	0	500.4
Ductile Iron	11	0	0.6	0	0.6
Grinding material	8	0	0.2	0	0.2
Others	0	11	1.0	420.8	421.8

As depicted in Fig. 8, the majority of the respondent-companies do not engage in R&D. In the case of the Philippine Export Zone Authority (PEZA) locators, the R&D function is handled by their foreign counterpart. For most die and mold companies, they follow the specifications provided by their clients in the technical drawings. Those that engage in R&D are also involved in manufacturing or employ other processes, such as stamping, plastic injections and composite metal injection. Only a handful requires a patent or intellectual property registration or have produced new process, new product, invention, or discovery. Generally, their involvement in R&D is in the creation of prototype dies and molds. Respondent-companies usually outsource testing and analysis of materials and products to companies or institutions with testing and analysis facilities and equipment such as the DOST-MIRDC.

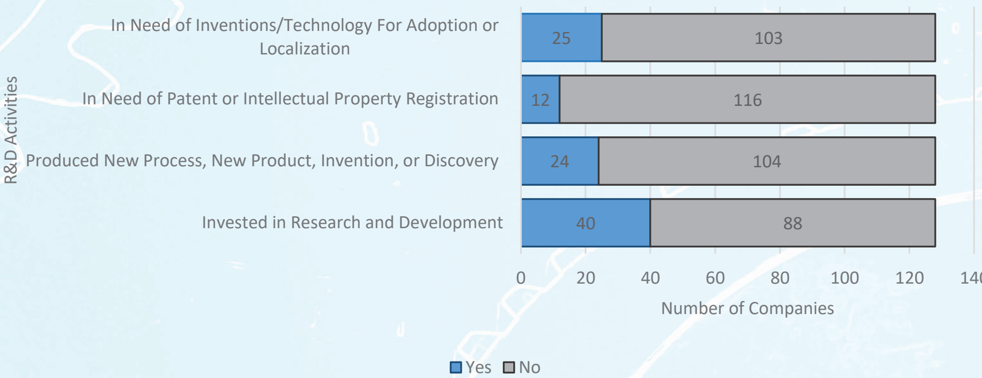


Figure 8. Involvement in Research and Development

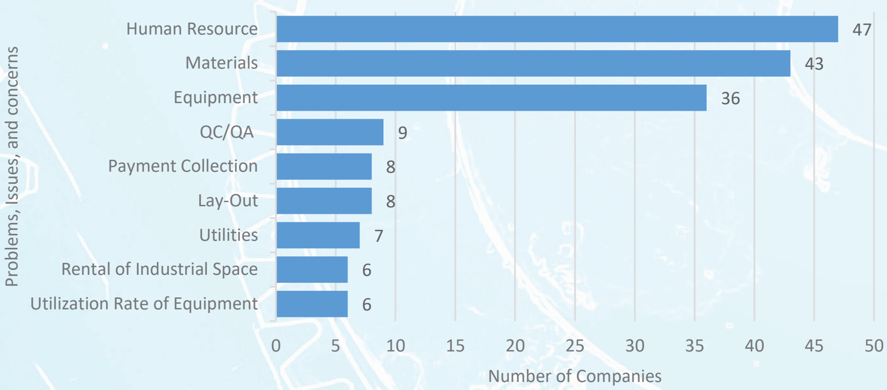


Figure 9. Production Problems, Issues and Concerns

For needed technologies, some respondent-companies requested assistance in the field of robotics and mechatronics. Others requested assistance in the area of fabrication and/or training for on-site turbine repair, advanced coating for cutting tools, diamond film coating process, and rubber mold fabrication. They also suggested fluid dynamic software training and assistance for upgrades and minimization of trial and error.

Fig. 9 shows the common problems, issues, and concerns encountered by the respondent-companies in their operations. Human resource, raw materials, and equipment are the significant problems, issues, and concerns of the die and mold industry.

Strengths and weaknesses of companies are internal factors that companies have control of, while opportunities and threats are external factors that companies have no control of, but both affect their operations.

The primary strengths of the die and mold industry, according to respondent-companies, are their reputation, quality of products and/or services, and their location. The significant weaknesses of the respondent-companies are internal research and development, a pool of skilled manpower, and marketing strategy. The opportunities for respondent-companies to take advantage of are the perceived satisfaction of their customers, the demand for their products and/or services, and the demand for complementing products and/or services. Possible threats are the tax policy, foreign competitors, and substitute products and/or services.

4. Discussion

The Philippine die and mold industry still holds a lot of potential for improvement in terms of its capabilities and commercial profitability.

Most of the die and mold companies are located within the NCR and Region IV-A or CALABARZON. These companies find the location strategic because they have access to raw materials and skilled labor force.

Most companies are corporations, reflecting the high capitalization required to establish a die and mold shop in terms of precision equipment and machinery for die and mold fabrication. Single proprietorship companies mostly cater to products not requiring a high degree of precision. It is observable that the majority of the respondent-companies fall under the small and medium enterprises (SMEs) category in terms of capitalization and employment.

Proliferation of die and mold companies in the 1990s can be attributed to the establishment of the PEZA on February 21, 1995 by virtue of Republic Act No. 7916 otherwise known as "The Special Economic Zone Act of 1995" as shared in the FGD conducted by the Center on November 28, 2018. The data reflected a downtrend beginning in 2001 in the establishment of new die and mold companies.

The import and export characteristic makes the industry, from an economic viewpoint, brittle because it is susceptible to multiple external forces such as exchange rate, tariff, customs fees, and the demand in the international market. The current imports and exports status of the local die and mold sector is in a dependency state. The observation of economic theorist like Raul Prebisch featured this phenomenon. In Prebisch [4] view, primary commodities, parts, and components from poorer countries are exported to rich countries, which will, in turn, be transformed into consumer products to be sold back again to poorer countries. The "value-added" in the manufacturing process is significantly higher than the mark-up value for primary commodities, parts, and components. This cycle will even make it hard for emerging economies to develop because their export will not be able to compensate for their higher import cost [5].

On the other hand, this information also shows opportunity for the die and mold industry to improve or expand because our country has high demands for dies, molds and other related tooling and products. The industry needs to foster a better economic model to boost Philippine industrialization as envisioned by the present administration [6]. The same observation is apparent in "The Philippine Tool and Die Industry: A 2006 Study" conducted by the DOST-MIRDC. In terms of ratio, figures from 2015 to 2017 significantly improved from the last study which includes data from 2003 to 2005. In 2005, the ratio of export over import is 1:14 [7]; in 2015, 1:4; in 2016, 1:10; and in 2017, 1:7. In 2015, the exchange rate is 45.5028 Philippine Peso (PHP) per 1 US Dollar (USD), while in 2017, it rose to 50.4037 PHP per 1 USD [8]. This decrease in the value of the peso is a big burden to an import-dependent industry.

The die and mold industry of the Philippines faces a lot of challenges in today's globalized economy. Human resource concern is the most common. There is a very high rate of attrition of skilled workers especially those who specialized in the design and fabrication of dies and molds. Based on the interviews conducted and the qualitative responses of respondent-companies, most workers will acquire one or two-year experience in the Philippines and then apply for overseas work. The Philippine die and mold industry is becoming a training institution for the international metalworking industry.

Concerns and issues on raw materials are also common among the respondent-companies. The lead time for the availability and delivery of raw materials is getting longer, forcing companies to maintain higher inventory to avoid production downtime. This issue further restricts the financial resource of the companies. In addition, the respondent-companies are complaining about the price and varying quality of raw materials in the Philippines. There is a standard price per part or component maintained by global manufacturers. It becomes difficult for the Philippine metalworking industry to compete globally especially in terms of price when compared to dies and molds from China, Taiwan, or Thailand.

Equipment is also a primary concern for the industry. Most lathe and milling machines owned by the respondent-companies are second-hand. As witnessed by the survey team during plant visits, some machines are even remnants of the American colonial period in the Philippines. Though these machines are time-tested in terms of durability, incidences of downtime because of mechanical failures become more and more frequent. According to the respondent-companies, new and upgraded machines are costly, and available cheaper ones are not durable and reliable.

Other minor concerns are the establishment of quality control systems, rental fees and space, the utilization rate of equipment, high cost of utilities particularly on power or electricity, and payment collection scheme with clients. The respondent-companies relayed that suppliers of raw materials observe a 30-day payment collection period from delivery of materials, while clients ask a 60 to 90 days payment period to properly process their accounting documents. The two-month difference also adds up to the cash flow problem of respondent-companies.

The local die and mold industry enjoys certain advantages or strengths. Since die and mold companies have specific specialization, their reputation among various manufacturing firms is already established, especially those companies that have existed for more than 10 years. Connected to an established reputation is the quality of products and/or services. During the interview, it was shared by the respondent-companies that they experienced very few reworks or rejections related to die and mold design and fabrication. Company location also is seen as a strength because clients prefer to outsource jobs to companies within their locality or in close proximity.

Weaknesses can potentially lead to problems in the future. During the interview, some of the respondent-companies still resort to trial and error in the prototyping stage resulting in considerable wastage in labor hours and materials. The Human Resource Department of some respondent-companies also find it difficult to hire a skilled workforce. This condition forces them to accept individuals with just the most basic skills. As such, the companies lose valuable production time and other resources to training of newly-hired staff. Most of the respondent-companies categorized as small and medium enterprises have no marketing office. Company owners usually handle the marketing function. Some micro companies rely entirely on walk-in clients and referrals.

There are available opportunities for the local die and mold industry to take advantage of. Almost all respondent-companies are unanimous in saying that their customers are more than satisfied with their work resulting in continuous patronage of their products and services. During the period of this study, the respondent-companies also perceived that demands for dies, molds, and other related products and services are increasing. One reason for the increase in demand is complementing products and services. Metalworking companies are continuously in need of die and mold services, especially those that engage in stamping and forging operations. The plastic and rubber products industries also contributed to this demand.

Threats in the local die and mold industry can be a source of a potential problem if not properly monitored. Most companies view the new tax policy or the Tax Reform for Acceleration and Inclusion (TRAIN) program as a nuisance. On the one hand, the TRAIN places the industry on a disadvantageous position in terms of its effect on the price of raw materials, the cost of their final output, and its impact on the demand for complementing products and services. Moreover, respondent-companies view the next stage of the implementation of the TRAIN law as an immediate threat which might affect the benefits extended to PEZA-located companies. Foreign competitors, particularly dies and molds coming from China, are seen as a significant threat. China companies enjoy a notable advantage over local companies: they have their government's support in terms of tax incentives and their raw materials are considerably cheaper. The Philippines is not alone in this struggle to survive in the metals industry. Even the United States' metals industry is struggling to compete in a China-dominated metals and steel industry. Chinese industry enjoys advantages in export rebates and quotas, subsidized financing, weak labor, safety, and environmental regulations, and the likes. There are also multiple countervailing and anti-dumping cases against Chinese steel products in the United States [9]. Manufacturers prefer to import large sized dies and molds from China because these are cheaper according to respondent-companies during the interview. During the FGD conducted by the Center, substitute products for local dies and molds are second-hand or used dies and molds coming from other countries notably China. Though second-hand dies and molds are a threat in local die and mold production, they are also seen as an opportunity because second-hand dies and molds need restorations and repairs.

5. Conclusion

The die and mold industry in the Philippines has a lot of potentials based on the data gathered through this study and statistics from the PSA, but it also has problems and concerns. Demand for die, mold, and other related tools and products is steadily increasing.

The Philippine die and mold industry needs to align its current capabilities and capitalize on its strengths that have allowed the industry to grow and prosper all these years. Strengths, such as established reputation, and quality of products and services, continue to serve as the local die and mold industry's source of competitive advantage, and must therefore be maintained as such. Efforts must be focused on further intensifying these strengths. Addressing the industry's weaknesses and threats, on the other hand, renders the industry's improvement efforts more well-rounded as it tackles on issues on internal research and development, availability of a pool of skilled manpower, and developing effective marketing strategies, to name a few.

With the industry's collective efforts to face challenges head-on, and with the services and R&D-based interventions of the DOST-MIRDC, the local die and mold industry is poised to fully take advantage of opportunities as we know them at present, as well as opportunities that are bound to emerge in the coming years.

6. Acknowledgment

The Die and Mold Industry Study Team, under the direct supervision of the Chief of the Technology Information and Promotion Section (TIPS), Ms. Lina B. Afable, acknowledges the local die and mold industry for the support and cooperation. The team is also grateful to the DOST-MIRDC Management for providing all the support to make this endeavor a possibility.

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Internal and External Factor Evaluation of the Philippines Metals Industry for 2018

Alexander P. GONZALES*1

Abstract

The study aims to evaluate the internal and external factors affecting the machining, die and mold, and forging industries. This study utilized the mixed research method model by including quantitative data from surveys and quantitative data gathered using focus group discussions, interviews, and observations extracted in the three industry studies conducted by the DOST-MIRDC in 2018. The strengths of the three industries studied are the perceived good company reputation, quality of their products and/or services, and reliable delivery due to production efficiency and company location. The weaknesses of the three industries studied are marketing and financial management. The three industries may take advantage of the opportunities such as improving customer satisfaction, increasing demand for products and/or services, growing demand for complementing products and services. The foreseen threats in the three industries are foreign and local competition, including substitutes for products and/or services, government regulation and tax policies, and external factors increasing the cost of production. Government intervention is needed to augment major external factors. Further study on the condition of firms classified according to capitalization is recommended.

Keywords: die and mold, tool and die, machining, forging, metal industry, mixed method, statistics, SWOT analysis.

1. Introduction

The current drivers of Philippine economy are the service, industry, agriculture, forestry, and fishing sector according to the Department of Trade Industry (DTI). The metals and engineering (M&E) industries play a central role in the activities of all these sectors [1]. Mass production and industrialization is made possible by machines operated by technically skilled individuals producing metal parts and components.

The Metals Industry Research and Development Center (MIRDC), an agency of the Department of Science and Technology (DOST), regularly conducts industry studies of the metalworking industries in pursuit of the mandate of the Center to assist the metals engineering and allied industries in information exchange. The focus of the 2018 industry study was on machining, die and mold, and forging industries [2].

This study aims to evaluate the internal and external factors affecting the Philippine metals industry, specifically the machining, die and mold, and forging industries.

2. Methodology

This study utilized the mixed research method model by including quantitative data from surveys and quantitative data gathered using focus group discussions, interviews, and observations extracted in the three industry studies conducted by the DOST-MIRDC in 2018. The DOST-MIRDC industry study teams surveyed the three sub-industries of the metals industry, namely machining, die and mold, and forging industries. Respondents of the 2018 industry study are composed of 1008 machining, 128 die and mold, and seven (7) forging companies. The profile and status of the industry were gathered by the use of survey questionnaires designed by the Technology Information and Promotion Section (TIPS) of the Technology Diffusion Division (TDD) to extract significant information to attain the objectives of the study. The questionnaires were validated and approved by the Philippine Statistics Authority (PSA) with PSA Approval No. MIRDC – 1801 for machining study, PSA Approval No. MIRDC – 1814 for die and mold study, and PSA Approval No. MIRDC – 1810 for forging study. PSA also granted the DOST-MIRDC clearance to survey the machining, die and mold, and forging industries through press releases with refer-

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ence numbers 2018-015, 2018-038, and 2018-037 respectively. Data gathering was conducted from 1 Apr 2018 to 31 Oct 2018. Data collected were further validated through an FGD held on 28 Nov 2018, attended by various metals industry representatives. Data were further validated and analyzed by industry experts.

3. Results

Multiple factors are affecting the internal and external environment of the metals industry in the Philippines.

Based on Fig. 1, there was a heightened interest among businesses to engage in the metals industry from 1991 to 2010. Discussed in the FGD, one of the factors that contributed to the increase of metals industry companies during that period is the establishment of the Philippine Economic Zone Authority (PEZA) on 21 Feb 1995, by virtue of Republic Act No. 7916 otherwise known as "The Special Economic Zone Act of 1995." This circumstance is generally observable in the die and mold and forging companies established within PEZA areas because they enjoy certain incentives and privileges.

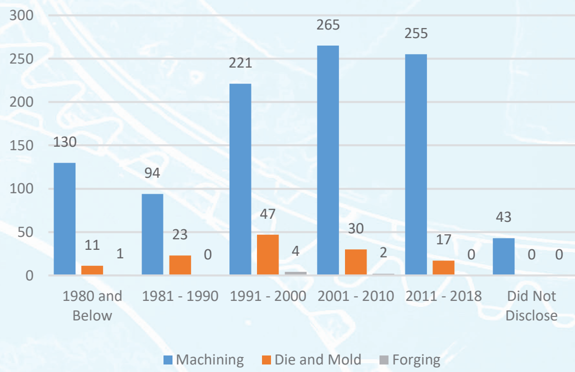

Fig. 1. Year of Establishment

The primary strengths of the die and mold industry, according to respondent-companies, are their reputation, quality of products and/or services, and their location. The significant weaknesses of the respondent-companies are internal research and development, a pool of skilled manpower, and marketing strategy. The opportunities for respondent-companies to take advantage of are the perceived satisfaction of their customers, the demand for their products and/or services, and the demand for complementing products and/or services. Possible threats are the tax policy, foreign competitors, and substitute products and/or services.

The machining industry, however, follows a different pattern. Based on interviews and observations on the machining industry, there is a significant rate of micro and small shops closing due to multiple factors. Some of the major factors are lack of customers due to limited capacity, attrition of skilled machine operators, and high operating cost due to space renting and high utility rate. The number of identified machine shops in 2018 is almost the same as that in the 2009 study of the MIRDC. Given this information, one may suppose that the machining companies that were in operation in 2009 remained in business all these years. But it is worth noting that some machine shops included in the 2009 study are no longer existing in 2018. Instead, there were newly established machine shops near the area. This observation only shows that as one micro or small machine shop closed, their machines and equipment are salvaged by other individuals willing to invest in the metals industry, an indication of low barriers to exit. This condition is a slippery slope situation on the part of the investors. They might have bought the machines and equipment cheaply, but they will also inherit the problems of the former shop owners if feasibility and strategies are not adequately studied.

Table 1 shows that machine shops are generally categorized as micro and small in terms of capitalization with one to three previously owned lathe and milling machines. These machine shops usually cater to the local transport sector and offer other jobbing works. Die and mold shops are generally small and medium with specialized machines and quality control equipment dedicated to cater to the quality requirements of the sector that they serve. Forging companies are usually large because of the high capitalization necessary to acquire forging machines and equipment.

Table 1. Classification According to Capital

Classification	Machining	%	Die & Mold	%	Forging	%
Micro (P3,000,000 or less)	710	70.44	20	16.13	0	0.00
Small (P3,000,001 – P15,000,000)	170	16.87	40	32.26	1	14.29
Medium (P15,000,001 – P 100,000,000)	92	9.13	43	34.68	1	14.29
Large (Greater then P 100, 000,000)	32	3.17	21	16.94	4	57.14
Did Not Disclose	4	0.40	0	0.00	1	14.29
Total	1008	100.00	127	100.00	7	100.00

Table 2 summarizes how the machining, die and mold, and forging businesses under the metals industry are organized. Majority of the machine shops are single proprietorship with the business owners also acting as a foreman or head machinist. Majority of the die and mold companies as well as all forging companies are corporations, which is reflective of the high capitalization requirements for these industries.

Table 2. Form of Business Organization

Form	Machining	%	Die & Mold	%	Forging	%
Single Proprietorship	793	78.67	34	26.77	0	0.00
Corporation	188	18.65	87	68.50	7	100.00
Partnership	17	1.69	3	2.36	0	0.00
Non-Stock Corporation	1	0.10	1	0.79	0	0.00
Cooperative	1	0.10	0	0.00	0	0.00
Others	8	0.79	2	1.57	0	0.00
Total	1008	100.00	127	100.00	7	100.00

Strengths and weaknesses of companies are internal factors that companies have control of, while opportunities and threats are external factors that companies have no control of, but both affect their operations [2].

Respondent companies are confident to have the following strengths: good company reputation as perceived by clients; quality products and services; reliable delivery due to efficiency of production and strategic company location. The study of Corkindale & Belder found that a strong corporate reputation influences clients' decision to patronize a company's services [3]. De Brentani supports this finding and states that a company's services are best marketed by clients who are impressed with the experience they get with a company, especially when the service provided is of high quality, innovative, and rises above the competition. Figure 2 presents the strengths or opportunities. Respondent companies from both the forging and machining industries marked good reputation and quality products and services as their top strengths and opportunities.

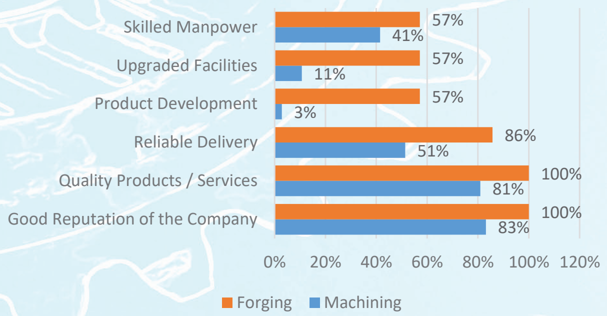

Fig. 2. Strengths or Opportunity of Forging and Machining Industries

Figure 3, on the other hand, lists various factors considered by the forging and machining businesses as weaknesses and threats. Limited capacity, sourcing of raw materials, and lack of customers are top three weakness among the machine shops, while stiff competition, high cost of production, and government regulations pose challenges for the forging industry.

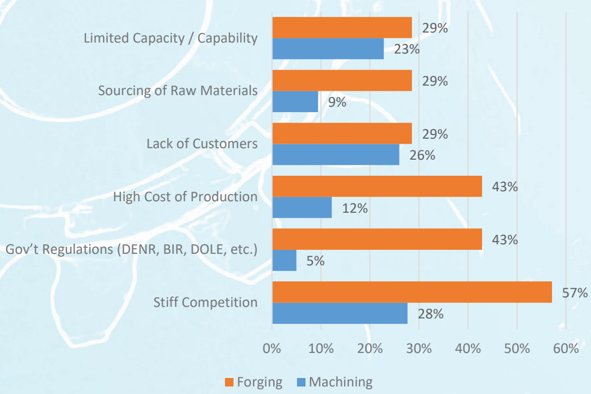

Fig. 3. Weaknesses or Threats of Forging and Machining industry

The studies reveal that marketing and financial management are two of the common weaknesses faced by the respondent companies. Marketing ensures that the business is focused on delivering superior value to customers in the competitive marketplace [5]. Majority of the respondent companies do not have a formal or organized marketing unit. Company or shop owners usually handle the marketing of products and services. Die and mold companies, for instance, rank marketing strategies among the lowest in the list of their strengths, as shown in Table 3.

Table 3. Strengths and Weaknesses of Die and Mold Industry

Strengths/Weaknesses	Rank
Shop/Company Reputation	1
Quality of Products and/or Services	2
Shop/Company Location	3
Production Efficiency	4
Internal Quality Control System	5
Facilities and Equipment	6.5
Market Reach	6.5
Output Capacity	8
Financial Resources	9
Marketing Strategy	10
Pool of Skilled Manpower	11
Internal Research and Development	12

Financial weakness is one of the challenges faced by micro and small metalworking companies due to a limited financial resource. Based on Table 3, respondent die and mold companies also listed financial resources among the lowest in their list of strengths. Medium and large metalworking companies also experienced this concern due to weak cash flow and fluctuating supply chain. Supply Chain Risk Management should be part of the company's planning strategy to address issues concerning supplies of raw material and other production needs [6]. It is also advisable for companies to incorporate concepts such as Cash Flow at Risk to address cash flow volatility [7].

The three industries may take advantage of the opportunities such as improving customer satisfaction, increasing demand for products and/or services, growing demand for complementing products and/or services (see Table 4). The findings of the study by Gustafsson, et al., support consistent effects of customer satisfaction on customer retention [8]. The business is defined by the customers, not its products or factories. The trend is relationship focus rather than transaction focus. Business enterprises should aim for long-term commitments with customers through quality and innovation [5].

Import and export data of the PSA on Fig. 4 show that there is an increasing demand for die and mold and die and mold-related products. In this case, dies and

Table 4. Opportunities and Threats of Die and Mold Industry and Mold Industry

Opportunities / Threats	Rank
Customer Satisfaction	1
Demand for Products and/ or Services	2.5
Complementing Products and/or Services	2.5
Market for Products and/or Services	4
Supplier Chain/ Raw Materials	5
Partnership/ Linkages	6
Government Assistance & Subsidies	7
External Research and Development	8
Local Competitors	9
Substitute Products and/or Services	10
Foreign Competitors	11
Tax Policy	12

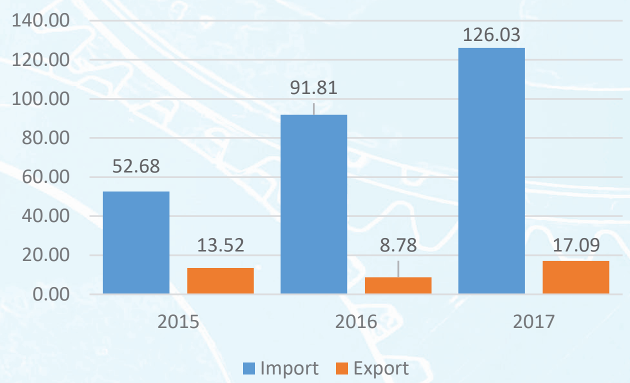

Fig. 4. PSA Import and Export Data on Dies and Molds Products (in Million US Dollars)

molds are complementing products to machining and forging services. Demand in dies and molds and other tooling products increases machining activities.

The foreseen threats in the three industries are foreign and local competition, including substitutes for products and/or services, government regulation and tax policies, and external factors increasing the cost of production. The respondent-companies are still confident that the industry can sustain its production and growth. The companies which expressed uncertainty and pessimism are those whose businesses are affected by foreign competition and cheaper China products, particularly those catering to the requirements of the mining industry. These companies are in the process of shifting to other industries. Those whose perception depends upon other circumstances are companies very much affected by changes in demand from the industries they are serving, such as those catering to the automotive industry. China companies enjoy a notable advantage over local companies: they have their government's support in terms of tax incentives, and their raw materials are considerably cheaper. The Philippines is not alone in this struggle to survive in the metals industry. Even the United States' metals industry is struggling to compete in a China-dominated metals and steel industry. Chinese industry enjoys advantages in export rebates and quotas, subsidized financing, weak labor, safety, and environmental regulations, and the likes. There are also multiple countervailing and anti-dumping cases against Chinese steel products in the United States [9].
The favorable by-product of fierce competition is the domestic enterprises' defense mechanism to augment competitive advantage through research and development activities [10]. Most companies view the Philippine government's new tax policy or the Tax Reform for Acceleration and Inclusion (TRAIN) program as a nuisance. On the one hand, the TRAIN places the industry on a disadvantageous position in terms of its effect on the price of raw materials, the cost of their final output, and its impact on the demand for complementing products and services. Moreover, respondent-companies view the next stage of the implementation of the TRAIN law as an immediate threat which might affect the benefits extended to PEZA-located companies which might result to the plight of manufacturers to other economic zones in Southeast Asia. The metals industry is machine driven. These machines are power extensive, especially machines in the forging industry. The Philippine electricity rate, one of the highest in Asia, is taking its toll on the industry. Senator Sherwin Sherwin Gatchalian clarified that while the Philippines has one of the most expensive power rates in the region, it is one of only two countries that does not subsidize power, which translates to consumers paying the actual cost [11].

5. Conclusion

The three industries included in the 2018 MIRDC industry study face myriads of challenges, yet they are still thriving in the different niches they created. There is a need for further study on the conditions of the metals industry classified according to capitalization to be able to propose a reliable program to improve the performance of the micro and small companies, as well as programs to transform the medium and large companies to become globally competitive. Control mechanism such as supply chain risk management and cash flow at risk based system should be part of the corporate practices of the metals industry companies. Government agencies such as the Department of Energy (DOE), Department of Trade and Industries (DTI), and Department of Science and Technology (DOST), should create a concrete plan in addressing major corporate external factors like high energy cost, influx of imported products in Philippine market, technical training, and research and development support.

6. Acknowledgment

The Machining, Die and Mold, and Forging Industry Study Teams, respectively headed by Ms. Eldina B. Pinca, Dr. Alexander P. Gonzales, and Ms. Zalda R. Gayahan, under the direct supervision of the Chief of the Technology Information and Promotion Section (TIPS), are deeply grateful for the cooperation of the industry players whose support helped make the industry study initiative a success. Further, the Industry Study Teams extend utmost thanks to the DOST-MIRDC Management for making this endeavor happen.

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Optimization of Annealing Parameters for Yellow Brass (C27000)

Joey G. PANGILINAN*[1], Hazel Marie T. MURCILLA*[2], Geoffrey L. ABULENCIA*[3]

Abstract

This study presents the establishment of optimized annealing parameters for a yellow brass (C27000). This brass is an alloy which has an approximate composition of 65% Copper (Cu) and 35% Zinc (Zn) with an average hardness of 58 HRB. Its formability however must be improved through annealing as forming process hardens the brass and may therefore pose difficulty in subsequent forming processes. The optimized parameters may be used as basis for the Department of Science and Technology-Metals Industry Research and Development Center (DOST-MIRDC) project of 'gong' fabrication. In the study, the recrystallization temperature and soaking time for annealing were considered. The result shows that the optimum parameters are set at 500oC with 30 minutes soaking time using water as quenching medium. Hardness tests were performed using Rockwell B scale. Results of the metallography of the pre-annealed and the optimized annealed sample support the observed decreased hardness of the latter.

Keywords: annealing, optimization, yellow brass.

1. Introduction

Brass belongs to the non-ferrous classification of metal comprising of Copper (Cu) as the base element and Zinc (Zn) as the major alloying element. It is applied in various domains of industry, such as in electrical, bullets, decorative applications, and musical instruments, among others, owing mainly to its excellent conductivity, corrosion resistance, strength, ductility, wear resistance, hardness, and formability.

There is a wide range of brass alloy that differs in properties and comes in various forms. There are about sixty (60) standard compositions for brass with copper content ranging from 58% to 95% [1]. Other alloying elements are added in small amounts – usually less than 5% in total – to modify the properties and fit a certain application.

The 'gong' fabrication is a project implemented by the DOST-MIRDC with yellow brass being the preferred material. Yellow brass UNS C27000 is a copper-zinc combination which is nominally 65% Copper and 35% Zinc with an average hardness of 58 HRB. The 'gong' is usually hammered to produce the final tuning, and is then reheated and allowed to cool slowly to give it a measure of hardness. Heat treatment is therefore crucial in providing the brass the hardness or softness required for every step of the process.

Hardness reduction of brass, while increasing its ductility, can be attained through annealing. During heat treatment, the grains recrystallize to an initial grain size that is dependent on the cold work along with prior in process hot anneals and purity [2]. It is supported by the study of Alhellia and Salim [3] in which they established the hydroformability property of a brass sheet by varying the microstructure of the material.

Grain recrystallization of brass only happens with the infusion of appropriate temperature, soaking time, and quenching medium. While there are available recommended annealing parameters for brass in general, available studies pertaining to yellow brass are only approximating and need further verification and refinement with experience. Also, there may be differences in the intricacy of their forming process compared to what the DOST-MIRDC will be performing. For these reasons, it would be best if the optimum parameters are determined and that the hardness result is exactly what is needed for the subsequent forming process.

This paper, therefore, presents the establishment of optimum annealing parameters for yellow brass. The effect of these optimum parameters on the formability of the brass sheets, however, is not part of the scope of this study.

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Fig. 1. (a) Specimens contained in a labeled box
(b) Actual loading of boxes inside the furnace

2. Methodology

2.1. Preparation of Test Samples and Pre-Hardness Test

Brass samples were heat treated for each annealing parameters – varying temperature and soaking time. Initial hardness of the sample was taken using the table top Rockwell Hardness Tester.

2.2. Annealing

Annealing heat treatment was carried out in an electric heat treatment furnace as shown in Figure 1, heating each specimen to different temperature and soaking time.

2.3. Post-Hardness Test

The heat treated specimens were hardness tested to determine the response of the material to heat treatment using the table top Rockwell Hardness Tester.

2.4. Metallography

A metallography was performed on the heat-treated specimens to identify and compare the microstructures present using different conditions. Samples were mounted, cut, ground, polished, and then etched with ferric chloride ($FeCl_3$). The grain size was determined for the pre-annealed sample and the optimized sample.

3. Results and Discussion

3.1. Chemical Analysis and Initial Hardness Test

The pre-annealed specimen was analyzed using the Center's Portable X-ray Fluorescence (XRF) Analyzer. The analysis showed the presence of the following elements:

Table 1. Chemical Composition of Yellow Brass (C27000)

Elements	Composition in %
Copper	64.4
Zinc	35.49
Niobium	0.016
Vanadium	0.066

3.2. Annealing Result

From Table 2, it can be observed that there was no significant reduction in hardness, except for the air cooling of the sample heated at 296oC. In fact, some even increased. These parameters apparently are insufficient, particularly the temperature to produce a significant reduction in hardness.

Table 2. Hardness test Results of the First Set of Parameters (Temp <450ºC)

Sample	Set Temp (ºC)	Soaking Time	Average Hardness Results (HRB)		
			Quenching Medium		
			Water 1	Water 2	Air
A	232	20 secs	58.2	62.7	63.1
B	232	3 hrs	58.4	56.2	60.3
C	260	2.5 hrs	61.2	62.9	63.2
D	296	2 hrs	60.8	57.0	45.4
E	316	1 hr	57.7	58.4	58.5
F	422	5 mins	55.8	55.9	57.2
G	427	20 secs	55.4	54.0	-

A second set of parameters was experimented using higher temperatures, namely: 450oC, 500oC, and 600oC. The temperature was set at constant 30 minutes and water-cooled to determine the effect of temperature on the hardness of the specimens. Table 3 shows the hardness results for the second set of parameters.

Table 3. Hardness Test Results of the Second Set of Parameters (Temp > 450ºC)

Sample	Set Temp (ºC)	Soaking Time	Average Hardness (HRB)
H	450	30 mins	32.5
I	500		12.0
J	600		11.0

These results show that yellow brass heated at 500oC and 600oC obtained the most significant drop in hardness of all the temperatures tested. From the comparison, however, of the obtained hardness of samples I and J, the 100-

Table 4. Hardness Test Results of the Third Set of Parameters (Temp = 500°C)

Sample	Set Temp (°C)	Soaking Time	Average Hardness (HRB)
K	500	10 mins	26.5
L		30 mins	14.5
M		1 hr	12.5

oC increment did not effect a significant drop. Therefore, heating beyond 500oC will not give any more significant change in hardness and may just be a waste of energy.

To validate the effect of soaking on the hardness of yellow brass samples, a third set of parameters was experimented. Resulting hardness is shown in Table 4.

The results depict that the 30-minute increment (from 30 minutes to 1 hour) in the soaking time did not cause a remarkable drop in the hardness of the samples. The optimum annealing parameters for yellow brass is set at 500oC with 30 minutes soaking time using water as quenching medium.

3.3. Metallography Result

Figure 2a depicts the microstructure of the pre-annealed and the annealed specimen using 100x magnification and etched with ferric chloride. Figure 2b is the microstructure of sample annealed at 500oC for 30 minutes soaking. The observed microstructure is equiaxed grains of α-copper solid solution with evidence of twinning.

Comparing the grain sizes, it is evident that the annealed sample has bigger grain size than that of the as-received. In fact, the annealed sample has 6.6 grain size number, while 7.33 for the as-received in accordance with the Planimetric Method ASTM E 112-13. As a rule, ASTM grain size number decreases with increasing grain size. The ASTM equation relating the number of grains per square inch at 100x and the ASTM grain size number is shown below:

$$n=2^{(G-1)} \qquad (1)$$

where n is the number of grains per in2 at 100x and G is the ASTM grain size number. In general, the increase in grain size explains the decrease in hardness of the annealed samples.

4. Conclusions

The sheet sample provided was analyzed to be yellow brass with an approximate composition of 65wt% Cu – 35wt% Zn. Based on the experiment performed, the optimized annealing parameter was established at 500oC soaked for 30 minutes and quenched in water. The initial hardness of 57.3 HRB went down to 12-14.5 HRB. The corresponding microstructure obtained for the annealed sample is equiaxed grains of α-copper solid solution with evidence of twinning or annealing twins. The measured grain size is 6.6 as compared to the pre-annealed sample of 7.33.

5. Acknowledgment

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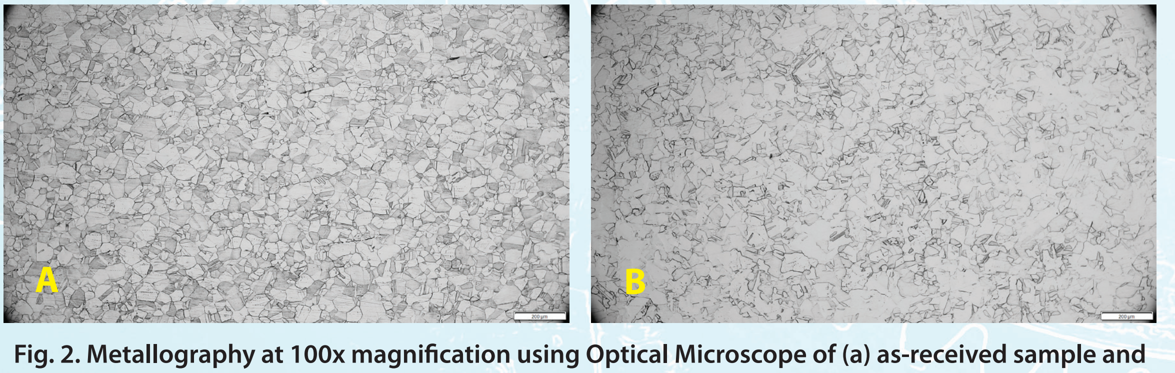

Fig. 2. Metallography at 100x magnification using Optical Microscope of (a) as-received sample and (b) as-annealed

Modification of Road Train Energy Storage System Using Lithium-Ion Batteries

Franz Joseph D. LIBAO*1, Robert O. DIZON*2, Rio S. PAGTALUNAN*3, Rommel N. COROÑA*4, Christian Glenn S. LIGON*5, Christian M. IBAÑEZ*6

Abstract

This project aimed to modify the energy storage system (ESS) of the Light Hybrid Electric Road Train (HERT) to improve its acceleration, safety, energy-sharing, and mobility. The HERT is a research and development (R&D) project of the Department of Science and Technology (DOST) being implemented by the DOST-Metals Industry Research and Development Center (DOST-MIRDC) which aims to provide an alternative mass transport system to help ease the worsening transportation problem here in the Philippines. The original ESS which is composed of 208 deep-cycle lead-acid batteries was replaced by an energy storage system consisting of 22 lithium titanium oxide (LTO) batteries. Based on the performance testing done, LTO batteries give a much better performance than the lead-acid batteries of the four-coach Light HERT. Due to the significant reduction in weight of the power coach, the Light HERT was able to traverse an inclined road even at full load thereby it is safe to say that it has better mobility and acceleration. Due to the lesser number of batteries, electrical connections of the battery bank are reduced, consequently reducing electrical hazards. Management and maintenance of the batteries are now easier compared before the modification of the ESS since every battery is accessible and can be monitored by the battery management system (BMS).

Keywords: Road Train, batteries, lithium-ion, energy storage system, hybrid electric, hybrid, Philippines.

1. Introduction

The HERT is an R&D project of the DOST that is being implemented by the DOST-MIRDC. It aims to provide an alternative solution to the worsening traffic conditions here in the Philippines [1]. Possibly the mass transport mode of the future, it is a hybrid electric vehicle that is centrally-powered by a diesel generator set and a bank of lead-acid batteries that serves as its energy storage system. The DOST–MIRDC developed two prototypes: the HERT, initially referred to as the Centrally-Powered Hybrid Road Train (CRT), and the smaller Light HERT, initially known as the Light Centrally-Powered Road Train (LCRT). Both were tested in Clarkfield, Pampanga to establish their functionality and performance. In the functional testing, major components were checked if they are able to work according to their intended purpose. In the performance testing, the HERT models were repeatedly run along specified routes to determine parameters like maximum speed, acceleration and deceleration times, and fuel consumption, among others. Critical electrical parameters were monitored and logged such as voltage, current, and kilowatt of the generator set and battery bank. Motor parameters like actual speed, rpm, output torque, and output current were also logged.

In the case of the Light HERT, the battery bank is composed of 208 sealed deep-cycle lead acid batteries arranged in a series-parallel configuration (four parallels of 52 batteries in series). Each battery has a nominal voltage of 12V and a rated capacity of 42Ah. Therefore, the nominal voltage of the battery bank is 12V x 52 = 624V, and total rated capacity is 42Ah x 4 = 168 Ah. The batteries are charged by the generator through an onboard charger and also by regenerative charging.

Having too many batteries posed a serious problem in doing the necessary maintenance and checkups. Due to the limited space of the power coach, more notably in the Light HERT, some batteries were inaccessible to the people doing maintenance, which makes monitoring the state of health of all batteries burdensome.

Another problem of lead-acid batteries is their short lifespan. The batteries of the HERT were bought in 2012 and are now at the end of their service life, which according to available data sheet is only three (3) to five (5) years maximum [2][3]. Many of the batteries have already died while others have also shown increased internal resistance which is an indication that they are also nearing their end. A new set of batteries must be purchased to replace the aging batteries.

One reason why the lead-acid battery was chosen as the energy storage for the HERT is cost. Lead acid batteries are less expensive than other battery types of the same capacity as lithium-ions [4]. While the lithium-ion battery has a much longer life, it requires a more complex

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BMS to ensure safe operation. It is also less forgiving in accepting high current spikes which is a characteristic of regenerative braking. To be able to accept the high current spikes, more batteries in parallel is needed to be used, thus, exacerbating further the cost issue [5]-[7].

There is, however, a new variant of the lithium-ion battery that uses LTO in its anode instead of the usual carbon. With this technology, the lithium-ion battery becomes much safer and can adapt better to temperature extremes and charge current spikes. It has a much higher energy density wherein a much fewer number of batteries are needed to provide the equivalent charge and discharge capacity of a bank of lead-acid batteries. Service life is also much longer, usually lasting up to 10 years, thus reducing the cost of ownership further [8].

Lithium-ion batteries, particularly the LTO type, are made of materials that are clean and safe for the environment, unlike the lead-acid battery which contains the toxic element lead [9]. Using Li-ion will make the HERT even more environment-friendly. They also do not emit harmful fumes and do not pose any hazard to people. The battery bank can now be placed in the Pilot Coach of the HERT making the Pilot Coach capable of running independently of the Power Coach.

One problem that was experienced during test runs of the two prototypes of the HERT is that it cannot accelerate from a standstill on an inclined or graded road. The weight of the bank of lead-acid batteries is a significant reason for this setback. Replacing the lead-acid batteries with the much lighter lithium-ion equivalent will help address this problem.

This project aimed to modify the ESS of the Light HERT to improve its acceleration, safety, energy recovery and energy-sharing capabilities, and mobility. To attain this objective, the specific objectives are as follows:

1. To decrease the weight of the power coach of the Light HERT by replacing the existing lead acid batteries with lithium-ion LTO batteries;
2. To install lithium-ion LTO batteries and incorporate a BMS for battery protection and safety;
3. To decrease electrical hazards by reducing electrical connections of the battery bank;
4. To install the lithium-ion battery bank in the Pilot Coach instead of the Power Coach for improved maintenance space, as well as to enable stand-alone operation for the Pilot Coach; and
5. To evaluate the performance of the Light HERT that uses lithium-ion LTO batteries.

Expected Outputs:

1. A Light HERT with reduced gross weight for better acceleration and mobility;
2. Safer battery circuitries;
3. Longer battery life;
4. Increased energy recovery of the batteries;
5. Improved power-sharing performance; and
6. Better management and maintenance of the batteries.

2. Methodology

The DOST-MIRDC spearheaded the project implementation while the DOST-PCIEERD provided the funds and served as the monitoring agency. The project had three stages of major activities as shown below.

Stage 1: Design, procurement, and deconstruction of old battery system
Stage 2: Fabrication and installation
Stage 3: Testing and project documentation

The number of lithium-ion batteries that are needed to replace the Light HERT's lead-acid battery depends on the manufacturer, specifications, and chemical design composition of the battery. For LTO type lithium-ion cells, the nominal voltage is 2.4V. These cells can be combined to form a module that is rated 40Ah and 27.6V nominal. In the case of the HERT and the Light HERT, at least 22 of these modules in series are required to attain 600VDC. According to literature, these modules can provide ten times the rated capacity for short durations [8]. Thus, these modules in series have the potential to give 400 A in short bursts. But to provide room for power augmentation in case one series might not be enough to supply the power required, another string of battery modules in series can be added in parallel.

The LTO chemistry has many advantages that makes it perfect for the HERT. The life cycle of the battery can last up to 20,000 cycles as compared to only 2000 cycles in standard lithium-based batteries. The LTO has a high recharge efficiency of up to 98%, highest energy-to-weight ratio, and enhanced safety since it avoids thermal runaway or overheating because it is entirely free of carbon [8].

The lead-acid batteries used for power storage in the power coach of the Light HERT were removed and replaced by Li-Ion batteries that were installed in the pilot coaches. The new location is at the rear end where the drive motor is located. Fig.1 shows the location of the Li-Ion batteries in the pilot coach and Fig. 2 shows the mounting configuration. (see figures at the back)


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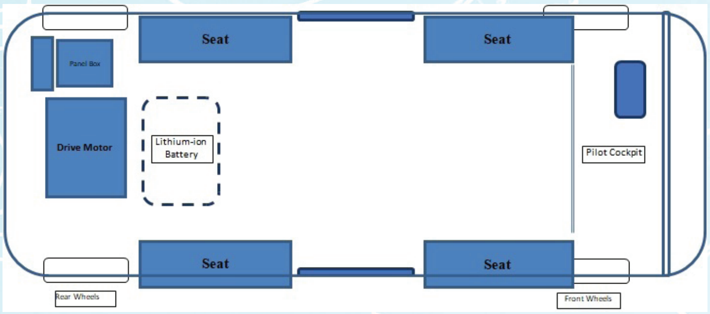

Fig.1. The battery bank in its new location at the rear end of the pilot coach.

Fig. 2. Battery mounting configuration during testing

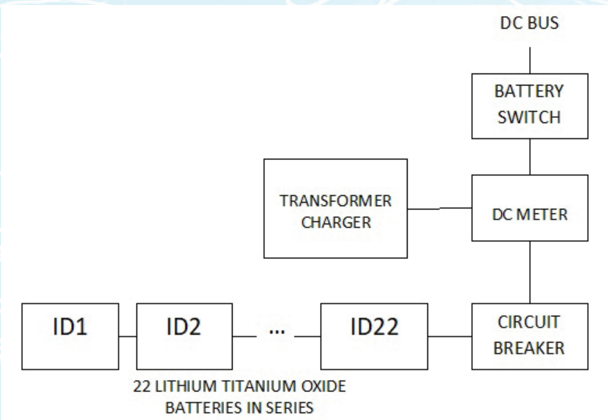

Fig. 3. Block diagram of the modified energy storage system of the HERT.

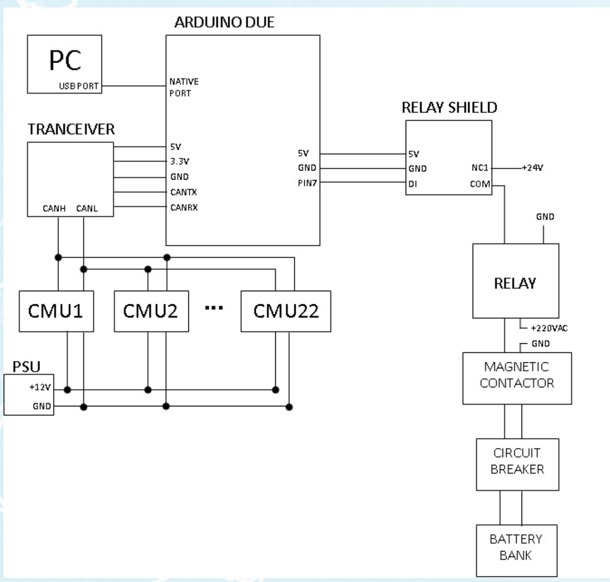

Fig. 4. Wiring diagram of the battery management system

For the modified ESS, the transformer charger, battery switch, and DC meter that was used in the old ESS was retained. The old circuit breaker was changed to a smaller capacity than before since only one string of batteries was be used. Refer to Fig. 3.

A very critical component that must be added to the new ESS is the BMS. The new batteries have a Cell Monitoring Unit (CMU) which is a device that monitors battery cells. It measures the voltages and temperature of the cells in a module. The data coming from every CMU must be collected and processed by BMS. The CMU and BMU communicate via CAN interface through a transceiver connector to a microprocessor board (Arduino Due). The Arduino Due then outputs and logs the processed data to a laptop. Fig. 4 shows the wiring diagram of the BMS.

With the new set of lithium-ion batteries, the approximate three (3) tons reduction in weight enabled the HERT to accelerate at a road with roughly a grade of 3 degrees. This theoretical computation was confirmed during the actual test.

The tests conducted for the Light HERT followed the standard test protocol for the HERT developed by the DOST–MIRDC which includes: electrical testing for power sharing, electrical testing for power requirement, mechanical acceleration, and safety test for braking distance.

Comparison of one string versus two strings of LTO batteries which was initially proposed was not made since the approved budget can only accommodate one string. Data such as speed versus time, power-voltage relationship, grade versus power, and other standard performance requirements were gathered.

The test site was in Clarkfield, Pampanga where the HERT and the Light HERT were originally tested. The same test route was used as much as possible so that the previous performance test results can be used as the baseline data. The new test site for the additional test for grade versus power was determined to be the Prince Balagtas route. It is the route that was used for the performance testing of the prototype two-coach HERT.

Table 1. Summary of parameters comparing lead-acid batteries and LTO batteries (specifications taken from the batteries' respective manuals).

Summary of Comparison

Parameter	Original ESS	Modified ESS
Battery type	Lead-acid	Lithium titanium oxide
Total Number of Batteries	208	22
Weight per battery (kg)	15	14
Total Weight (kg)	3120	308
Nominal Voltage (V)	12	27.6
Rated Capacity (Ah)	42	40
Energy Density (Wh/l)	91	135
Specific Energy (Wh/kg)	34	74
Internal Resistance (mohm)	8	7
Max Discharge Current (A)	420 (5s)	300 (10s)
Energy (kWh)	104.8	24.3
Full-cycle Life	1000 cycles	10,000 cycles
Approx. Cost Per Battery (PhP)	5,000	47,000
Total ESS cost (PhP)	1,040,000	2,100,000
Connection	52 in series, 4 parallel	22 in series
Dimensions LxWxH (mm)	197x165x170	360x190x125
Function	None	CAN communication, Cell voltage and module temperature monitoring, Cell voltage balancing
Protection	Circuit breakers, DC meter	Circuit breakers, DC meter, Battery Management System

Table 2. Performance testing results showing average acceleration, deceleration distance, and deceleration time of the LTO-based ESS compared to that of Pb acid-based ESS.

	AW0 (no load)		AW2 (full load)	
	Pb-Acid	LTO	Pb-Acid	LTO
Average Acceleration (m/s^2)	0.44	0.5	0.39	0.4
Deceleration Distance, electronic (m)	153	180	143	355
Deceleration Time, electronic (s)	19.7	33.28	18.7	27.35

Table 3. Percent of energy coming from gen set, battery, and energy regenerated comparison of LTO-based ESS compared to that of Pb-acid-based ESS

	Pb-Acid	LTO
% Genset	82.61	79.60
% Battery	17.39	20.40
% Regenerated	11.04	12.33

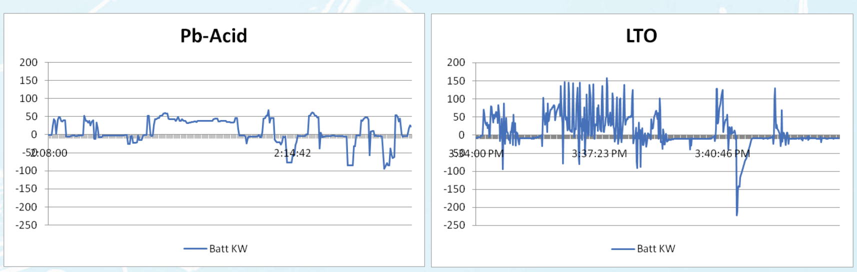

Fig. 5. Plot of battery power gathered from a respective test run of deceleration test of Pb-acid-based ESS (top) and LTO-based ESS (bottom).

3. Results and Discussion

Shown in Table 1 below is the summary of comparison between the original ESS which is composed of lead-acid batteries and the modified ESS with lithium titanium oxide batteries.

As seen from the data in Table 1, the ESS composed of LTO batteries has a considerable advantage in terms of the total number of batteries, weight, energy density, and specific energy over the ESS composed of Pb-acid. However, the modified ESS has a massive disadvantage regarding its high initial cost but considering its long cycle life, it may be a worthwhile replacement. The modified ESS also has additional functions for better battery protection, but it requires an additional BMS.

Based on the data gathered from the performance testing, the average acceleration after the modification slightly increased. In terms of braking parameters, only the data from deceleration tests using electronic brake can be compared since deceleration test using mechanical brake was not performed before. The deceleration distance became farther and deceleration time became longer than before. Refer to Table 2.

In terms of energy sharing, the batteries after ESS modification were shown to be sharing more energy than before, as presented in Table 3. From 83% of energy from the gen set and 17% of energy from the battery, it became 80% gen set and 20% battery energy landscape. Meanwhile, there is no significant change concerning percent regenerated.

The plots in Figure 5 show that LTO batteries share higher power compared to Pb-acid batteries. In terms of regenerative power, LTO batteries have higher peaks compared to the Pb-acid batteries.

4. Conclusion and Recommendations

Based on the performance testing done, 22 units of LTO batteries gave a much better performance than the 208 lead-acid batteries of the four-coach Light HERT.

Due to the significant decrease in weight of the power coach, the Light HERT was able to traverse an inclined road with a road grade that reached as high as 6% even at full load. These results show that the Light HERT has better mobility and acceleration.

Lesser number of batteries also reduced electrical connections of the battery bank, which in effect reduced electrical hazards. Management and maintenance of the batteries are now easier compared before the modification of the ESS since every battery is accessible and can be monitored by the BMS.

Gathered data show that there is a significant percentage of energy regenerated to charge the batteries and the LTO batteries can share the needed power to run the HERT.

An industry-grade BMS is recommended to be used for better protection of the batteries. For improved charging, it is recommended that the current charging system be modified by adding a charge controller.

5. Acknowledgment

The HERT project was supported by the funds given by the DOST-Philippine Council for Industry, Energy and Emerging Technology Research and Development (DOST-PCIEERD). The authors would like to thank all the HERT project members, designers, and staff who worked hard for the development of this project.

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Development Of A Portable Manual Abaca Fiber Stripping Machine

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Abstract

This study, entitled 'Development of an Improved Portable Manual Abaca Fiber Stripping Machine,' was initiated in response to the request of CARE Philippines—a non-government humanitarian organization that provides livelihood support to families affected by typhoon Haiyan. It was conducted to provide appropriate and convenient machine to the abaca strippers/ farmers in the province of Antique, and to allow local fabricators to benefit from the mass production of the machine. The general objective of the project was to develop an improved manual abaca fiber stripping machine that could easily be transported to mountainous abaca plantations. Based on the results of this study, an improved portable manual abaca fiber stripping machine was successfully designed, developed, and tested. Results showed that blade with 18 serrations per inch produced higher recovery rate of extracted fiber than with zero and 32 serrations. Furthermore, per evaluation of the stakeholders, the machine could also generate excellent fiber grade which is the best grade for classifying fibers. However, the blade easily gets rusty and blunted which forced the strippers to frequently sharpen the blade. With this, the blade material was changed to stainless steel 440C series to make it corrosion free and hardenable, increasing the blade's service life.

Keywords: Abaca fiber, fiber stripping machine, portable stripping machine.

I. Introduction

CARE, with support from the Global Affairs Canada (GAC) is presently implementing the Typhoon Haiyan Reconstruction Assistance (THRA) Project in the Philippines for the economic reconstruction of people affected by Typhoon Haiyan in three focus provinces of Antique, Iloilo and Leyte [1].

With the premise on livelihood resiliency, abaca was identified in Antique as one of the resilient livelihood sources with big market demands not only in the local market but also globally. The provincial government of Antique also identified abaca as among the top 10 priority commodities in the province because many upland farmers derive their income from production of abaca fiber. Abaca fiber production can also generate more employment to women and men in both upland and lowland communities [1].

The THRA project has been addressing the challenges in productivity through training on good agricultural practices, establishing demonstration farms, and training men and women on stripping, knotting, and twining. However, the need for an improved manual abaca fiber stripping machine was crucial to improve the productivity in fiber production. In this regard, CARE Philippines sought a technical collaboration with the Department of Science and Technology-Metals Industry Research and Development Center (DOST-MIRDC) for the development of an improved manual abaca stripping machine [1].

In addressing the issues raised by CARE Philippines, several designs of stripping machines have been considered as references. A mobile spindle stripping machine (Fig. 1) for example, can extract fibers at a rate of 80-100 kilograms per day [2]. The device can be easily transported near or right at the plantation using a carabao or any motorized vehicle for in situ fiber extraction. However,

Fig. 1. The KOLBI Mobile Spindle Stripping Machine

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Fig. 2. KOLBI Hand Stripping Device

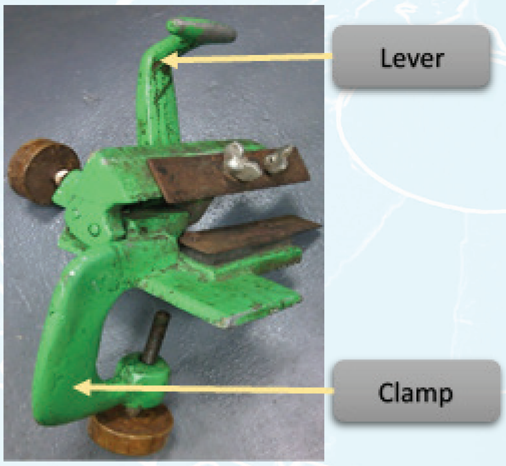


Fig. 3. The manual abaca fiber tripping machine to be improved

the said machine is heavy and not appropriate for terrains that are not accessible for any transport medium.

Another machine (Fig. 2) [3], also developed by KOLBI, is lightweight in nature which may be one potential solution for portability.

Similarly, a portable abaca fiber stripping machine (Fig. 3) developed by unknown fabricator is the favorite choice of a group of abaca fiber strippers in Antique. This machine has pivot shaft and stripping blade and plate positioned in parallel manner that facilitates the even extraction of abaca fibers. However, researchers saw operation issues that can be further improved in this design. Researchers likewise observed that the blade used was prone to rusting and eventually blunting.

This project was implemented with the general objective of developing an improved manual abaca fiber stripping machine that can be easily transported to mountainous abaca plantations. Specifically, the project aimed to 1) design an improved portable manual abaca fiber stripping machine; 2) fabricate a prototype unit of an improved portable manual abaca fiber stripping machine; and 3) test and evaluate the prototype unit.

2. Materials and Methods

Discussed in this section are relevant materials and steps that the researchers undertook for the completion of this project. Said materials include but not limited to mild steel plates, spring steel plate, stailess steel plate, M8x20 hex-screws, M8 nut, medium load die spring, cnc-lathe machine, CNC-milling machine, and welding machine.

Review of Relevant Literature. This step includes the collection of required data and information which guided the researcher through the proper track during the course of this study. The necessity of conducting the study was also one criterion which was considered in collecting the related literature. Results derived from this step helped identify the appropriate machine which served as the bench mark for developing an improved model.

Design Conceptualization, Review and Modification. The conceptual model of the abaca fiber stripping machine was developed using NX 3D modelling software. Said design was presented to a panel of technical personnel for design review. Results derived from the design review was used to improve the conceptual design made. A 2D drawing was developed and subjected for checking of corresponding technical personnel. This was made in preparation for the fabrication of the final machine.

Final Design Development. The final design of the abaca fiber stripping machine was made after the conduct of several activities such as design conceptualization, design review and design modification. Technical drawing was the final output of this step, in preparation for the fabrication of the machine.

Machine Fabrication. The fabrication of the machine was undertaken at the DOST-MIRDC in conformity with the prepared detailed drawing. Major components were made of mild and stainless steel plates, and were fabricated using a wire-cut EDM, CNC-milling and a welding machine.

Functional Testing and Debugging. Functional testing and debugging were done to ensure that the machine delivered to the recipient can extract abaca fibers of acceptable quality. Functional testing was initially done at the DOST-MIRDC. Results were validated in Antique, and the debugging was done at the DOST-MIRDC.

3. Results and Discussion

Design Conceptualization. The conceptual design of the developed portable abaca fiber stripping machine was the product of several activities conducted. Among which are the conduct of preliminary visit to the stakeholders in Antique: the Antique Development Foundation; the CARE Philippines; and the abaca farmers/ strippers.

Related information was gathered by the project team pertaining to the problems encountered in using the existing machine. The team learned that the drawbacks the strippers were complaining about generally focused on the performance of the machine in terms of ease of operation and the mechanism to adjust the blade position. Another major aspect of the machine that the team discovered was the design of the blade which was collected from the

PhilFIDA regional office in Iloilo. Based on the gathered information, the thickness of the blade should be around 6mm, and the depth of serration should be approximately 1-1.5 mm. Number of serrations is dependent on the required fiber quality. The material used for the blade was spring steel.

The design of the abaca fiber stripping machine was conceptualized based on the gathered data and in accordance with the requirements of the abaca farmers/ strippers.

Design Improvement. To operate the machine with its current design (Fig.3), the lever should be manually pulled to put it in the open position and pushed back, to put it in close position. This is done repeatedly prior to the stripping operation. This process is time-consuming which renders the strippers less productive.

On the other hand, the clamp is placed in the position where when the stripping force is applied, there is a tendency that the machine will pivot accordingly. Hence, this design made the machine unstable which also forced the strippers to frequently tighten and adjust its position, adding to the down time of the stripping operation.

In the developed design, the machine is foot-operated which eliminates the tedious process of pushing and pulling the lever before abaca fibers can be stripped. The machine is spring-loaded which puts the machine always in the closed position. When the stripper steps his foot on the pedal mechanism, the string which is tied to it pulls the lever on its other end putting the machine in open position. In the same manner, releasing the foot will put the lever back to its normal position. This allows easier loading of the abaca tuxy on the machine for stripping.

Furthermore, the developed design gave the clamp a resisting force while stripping, hence keeping the machine in sturdy position. Frequent adjustment, therefore, is no longer necessary in the developed design.

The 3D Model of the Portable Manual Abaca Fiber Stripping Machine. Fig. 4 shows the 3D model of the portable manual abaca fiber stripping machine. The model and the corresponding detailed drawing were developed using NX 3D modelling software.

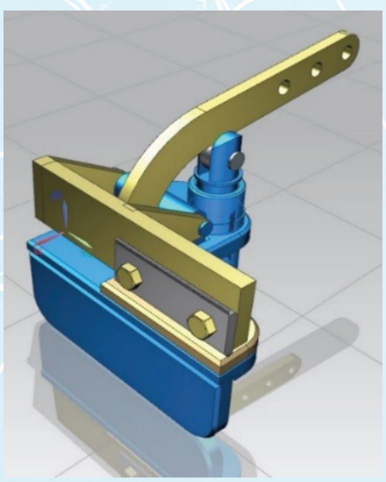


Fig. 3. The manual abaca fiber tripping machine to be improved

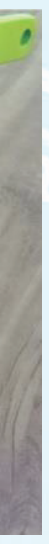
Fig. 5. Fabrication of the abaca fiber stripping machine.

Fig. 6. Functional testing and debugging of the abaca fiber stripping machine.

Fabrication of the Portable Manual Abaca Fiber Stripping Machine. Upon completion of the technical drawing and securing of necessary materials, the stripping machine was fabricated using various machine operations such as cutting, milling, turning, and welding.

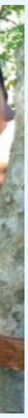
Functional Testing and Debugging. In order to evaluate the functionality of the developed machine, series of tests were conducted. Fresh abaca tuxy was requested from the CARE Philippines to facilitate the testing process. This was done twice correspondingly with the adjustments and improvement every after each test conducted.

After the testing made by MIRDC's researchers/ personnel, series of tests were made in the presence of CARE's representative/ recipients for evaluation of the quality of extracted fiber and the quality of developed machine. Said tests were conducted in various stripping sites in the province of Antique. As the result of various tests show, blade with 18 serrations per inch produced higher recovery rate of extracted fiber than with zero and 32 serrations. Furthermore, per evaluation of the stakeholders, the machine could also generate excellent fiber grade which is the best grade for classifying fibers. However, the blade easily gets rusty which consequently makes it blunted. This in turn forced the strippers to frequently sharpen the blade. With this, the blade material was changed to stainless steel 440C series to make it corrosion free and hardenable, increasing the blade's service life.



4. Conclusion

Based on the results of this study, it is concluded that an improved portable manual abaca fiber stripping machine was successfully designed, developed, and tested. The machine has a potential to generate excellent fiber grade which is the best grade for classifying fibers. Blade with 18 serrations per inch produced higher recovery rate of extracted fiber. Furthermore, stainless steel 440C series was determined to be the appropriate material for improved blade service life.



5. Acknowledgment

The completion of the project was made possible through the efforts of the engineers and technicians of the Prototyping Division of the DOST-MIRDC who devoted their time and expertise to bring this project to success, particularly the contribution made by Engr. Romanico F. Salido, Engr. Jose B. Ferrer, Engr. Isidro D. Millo, and the technicians who are involved in the fabrication of the machine.

Likewise, gratitude is extended to the CARE Philippines for providing the necessary resources and other valuable information for the conceptualization and realization of this project.

The project team would like also to acknowledge the invaluable support of the DOST-MIRDC R&D Management: Executive Director Robert O. Dizon; Deputy Executive Director for R&D, Engr. Jonathan Q. Puerto; and Prototyping Division Chief, Engr. Fred P. Liza.

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			H	300	400	600	600
			L	450	600	900	1400
		Loading Capacity (Kg)		100	200	500	1000
	Temperature	Max Temp.		1300 ℃			
		Operation Temp.		500～1250℃			
		Temp. Uniformity		1150℃ within ±5℃			
	Vacuum	Ultimated pressure		≤1 Pa (3×10^{-3}Pa with Diffusion pump)			
	Cooling	Cooling time 1150℃⇒150℃		Within 30/10/8min			
Utility	Floor space requirement (W×L×Hm)			2.8×3.0×2.5	3.4×4.0×3.18	3.55×5.0×3.18	3.55×5.0×3.18
	Power requirement (kVA)			85	145	250	250
	Cooling water requirement (m^3/hr)			10	15	20	20
	Inert Gas requirement (m^3/times)			1.5/9/15	3/18/30	7/42/70	8/48/80
	Compressed air requirment (NL/min)			260	600	600	600

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ULVAC

Study of Broken Chain Sling Using Optical and Scanning Electron Microscopes

Carla Joyce C. NOCHESEDA*1, Ariel R. SERNAL*2, Randy E. SONGAHIL*3

Abstract

An investigative research of the cause of failure of chain links that occurred during towing operation of heavy vehicle chassis is reported in this study. All failures took place near the weld area of the links after what the user called a short service life of five (5) years. Optical metallography and scanning electron microscopy (SEM) analysis revealed that the fatigue was initiated and caused by undetected defect at the outer circumference of the weld. Fatigue propagation is evident as there are striations seen. Their distribution was not rotationally symmetric, indicating a possibility of combined cyclic loading on the links. The large area of final rupture indicated a ductile rupture in the weld chain link part and brittle fracture in the rest of the region of the same due to overloading. The results suggest that the majority of cause of chain failure is due to high cyclic loading in combination with torsion and bending.

Keywords: Failure analysis, fatigue, steel chains, welding, metallography, scanning electron microscope.

1. Introduction

There has been little to no number of adequate investigation about the in-service performance of chain links in the Philippines, though chains have been in use for a long time in lifting and mooring operations.

Generally, the chain permanency is mainly related to the following factors: the process used in chain manufacturing; the developed stress state in the chain links during service; loading cycles; and weld integrity. The processes applied during the manufacturing of chains consist of cold forming, flash welding, post-weld heat treatment, and proof load testing. In cold forming, a coiled metal rod is cold drawn to the desired diameter, then cut and bent to the link shape, where the links are simultaneously weaved together to form a continuous chain. The links are welded using an automated flash welding machine by which the ends of the chain links are heated to fusion and then pressed together and cooled down to room temperature. The heat applied at the molten metal ends of the link causes surface displacement by the upsetting action and material extrusion out of the weld. Oxidation and foreign contamination may result as well causing weld flaws. Circumferential crevices at the bond line, cracks caused by brittleness of the weld in the heat affected zone (HAZ), and other flaws such as cast metal, voids, and inclusions may also appear.

To address these flaws, post-weld heat treatment is usually done to relieve stresses developed in the chain during the welding process and to obtain uniform mechanical properties similar to the base metal of the chain links. In the case of high-strength hardenable grades of steels, the treatment usually consists of austenitising, quenching, and tempering.

As a final step of the chain manufacturing process, proof weld testing is required to assure the qualification of the weld. The proof test consists of applying a certain tensile load to a portion of the chain to detect any material defects and/or excessive change in the chain dimensions. According to ASTM A391 standard specification for alloy steel chain for grade 80 and ASTM A973 standard specification for alloy steel chain for grade 100 the required proof load is approximately 50% of the break load of the chain [1]. At this load level, plastic deformation of the chain occurs, resulting in compressive residual stresses upon load removal. Such stresses reduce the tensile mean stress during service loading cycles and thus enhance the fatigue life of the chain.

There have been few theoretical investigations about the stress distribution of chain links under elastic static loading. Early studies focused on the effect of proof load testing on enhancing fatigue life of the chains. Tipton and Shoup [2] examined the effect of proof load on the fatigue life of Grade-80 steel chains. It was concluded that higher proof load increased fatigue strength and correspondingly, fatigue life. This was attributed to the presence of compressive residual stress resulting from the proof loading.
The present study reports an investigation of failure of

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steel chain links of unknown grade that took place approximately near the weld during towing operations of heavy vehicle chassis in an environment, under which temperature is about 33˚C and humidity level reaches more than 75%. The failed chains were said to have failed under a total of five (5) years in service towing heavy vehicle chassis of about eight (8) tons. Four (4) chains fixed to a non-swivel hook were used in each towing operation, with unknown frequency of use per week. It was also indicated that the chains were stored in normal conditions without temperature and/or humidity control. The utilized towing method produced complex loading in the chain links, and consequently fatigue failure may have been accelerated or, considering the period of use, may have already been reached [3].

Scanning electron microscopy (SEM) is an invaluable tool in conducting failure analyses of metallic and non-metallic components, and many investigations performed involves its use in some capacity. The SEM is a powerful tool when identifying mode and direction of propagation of cracks or fractures. It is used in conjunction with detailed macro-photography and stereomicroscopy to give a complete representation of the features or component being examined. SEM is also employed heavily in the evaluation of various products requiring high magnification examination. The necessity and versatility of these instruments is evidenced by their presence many laboratories. Metallographic examination of the base metal and the weld was carried out for failed chains by using optical microscopes and scanning electron microscope (SEM).

Fig. 1. Chain link that failed during operating condition.

Fig. 2. (a) shows weld fins kept on the inner side of the link (b) while the outer side of link is machined.

2. Methodology

Fig. 1 shows a chain link of unknown grade that failed during operations. There is no information given on its storing condition. The link was initially tested for magnetic particle test to detect surface and shallow subsurface discontinuities in ferromagnetic materials. The process puts a magnetic field into the chain link. The link is 13 mm in diameter and made to conform to either ASTM standard A391 for Grade-80 alloy steel or ASTM 973 for Grade 100 alloy steel chain. There is no way to distinguish one grade from the other since both have same chemical content as such, both standards are mentioned. No other information was provided about the manufacture specifications of the chains. For the purpose of this study, the chain links are assumed to be rods cold drawn followed by a typical upsetting and flash welding. The weld of the unused chain link was visually examined, as shown in Fig. 1. It is clear that the weld fins were kept on the inner side of the link (Fig. 2a), while it was machined at the outer side of the link (Fig. 2b).

Metallurgical examinations of the chain links were also carried out using an optical microscope, Olympus GX53, to study the microstructure of both the base metal and the weld. Samples were prepared by cutting, grinding, polishing and chemical etching using a 2% concentration Nital solution. Fractography of failed chain links were also made using Hitachi 3500 SEM.

3. Results And Discussion

Using an optical microscope, Figure 3 shows the microstructure of the as-received chain link sample of the base metal. It shows quenched tempered martensite with some dark features viewed at low magnification (a). This could be an oxide as shown at higher magnification in (b). There is also presence of longitudinal feature observed as shown in (c). This sample is a part of the chain link that failed but not fractured area.

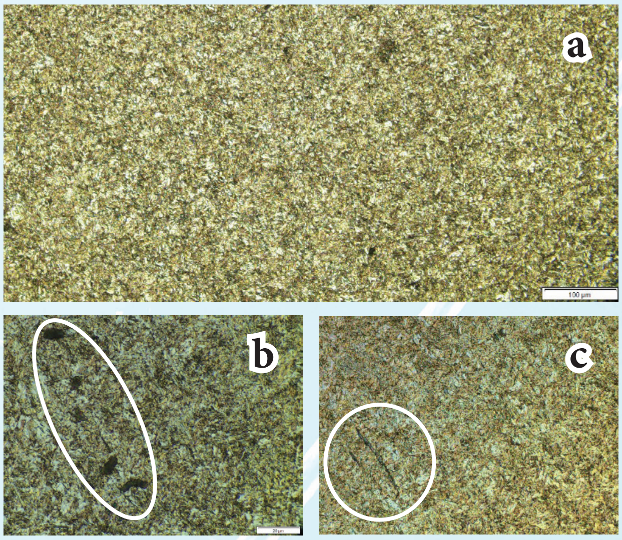


Fig. 3. Optical microscope photographs showing: (a) microstructure of as-received chain showing base metal and features observed at higher magnification (b) and (c).

The weld part of the link shown in Fig. 4 is also observed. The magnified image shows grain size is similar with that of the base metal.

Having quenched tempered martensite both at the base metal and the weld part with exemption at the interface is highly responsible for the strength requirement for both grade 80 or 100 steel alloys. Generally, high content of manganese provides strengthening effect through grain refinement. However, if Ni, Cr, or Mo contents are too low then this can lower the hardness and strength of the alloy.

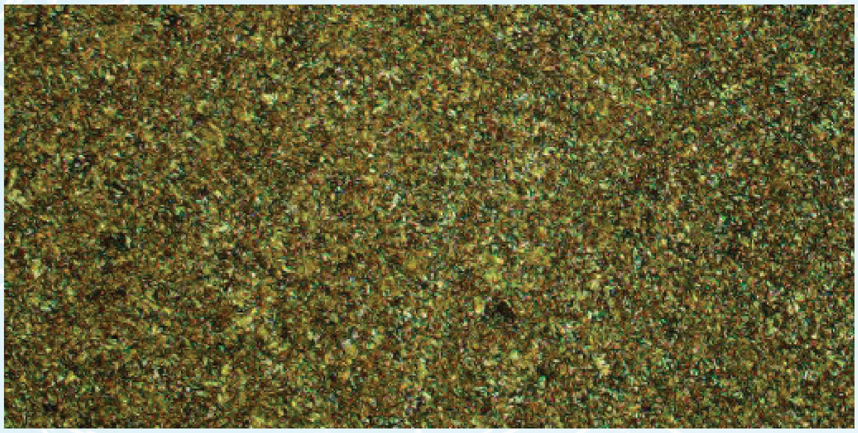


Fig. 4. Microphotograph of weld part having quenched tempered martensite with similar grain size as the base metal at 500 microns.

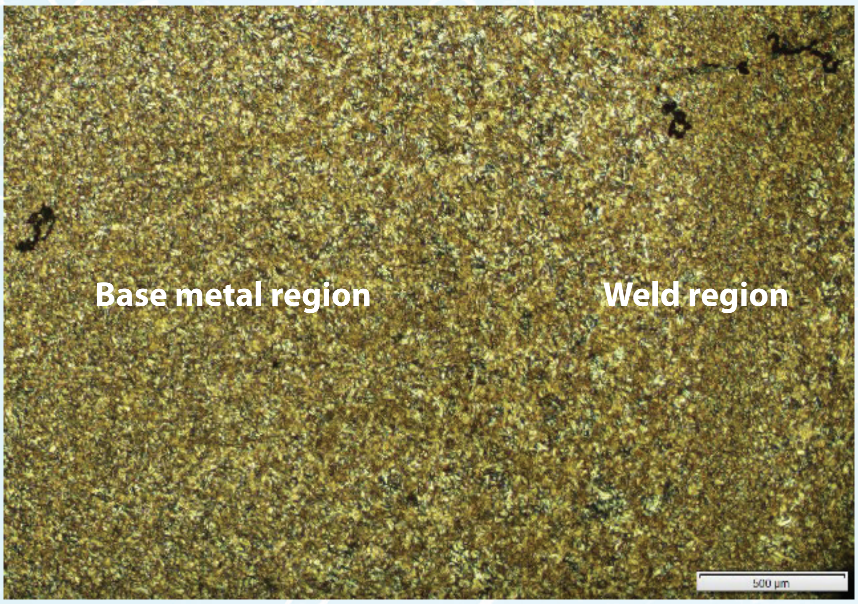


Fig. 5. Microstructure of the chain link showing the base metal and weld region at 500 microns.

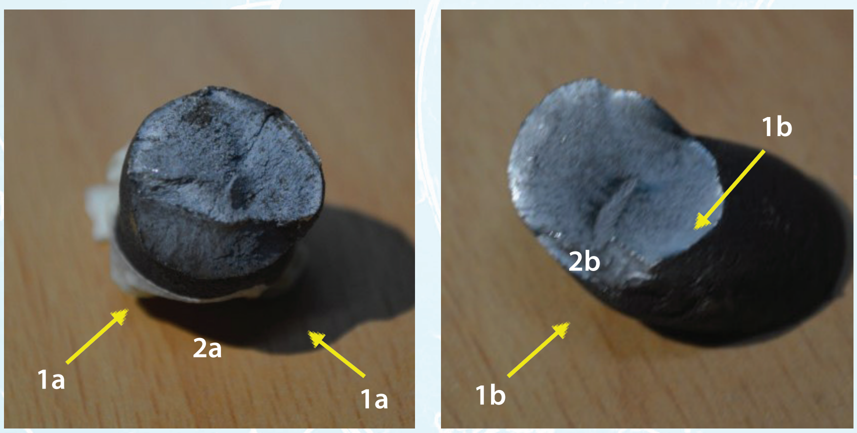
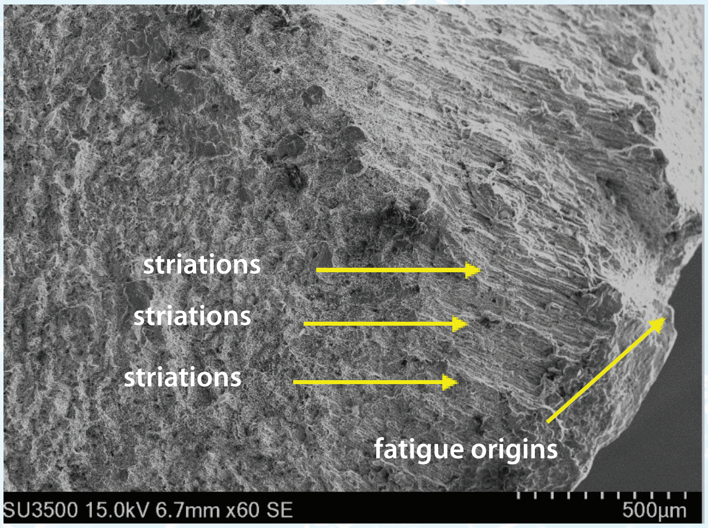


Fig. 6. Fractured parts of chain link showing different fractured profiles.

If flash welding is used in this sample, it is properly executed as there are no large external cracks seen. It should be noted that ASTM standard 391 makes only a general requirement *that the chain at the time of shipment shall be free of discontinuities that would prevent the chain from enduring the working load limit force.* However, British standard 1834 on "Short link chain for lifting purposes" indicates that for a smooth welded chain as the case for the sample in use, the fins caused by flash welding shall be removed [5]. The weld fins therefore are major source of discontinuities and are susceptible to fatigue crack initiation when under cyclic loading.

The fractured surfaces of the failed chain link shown in Figure 1 reveal the fracture appears to occur near the weld on one side and at the opposite side on the base metal. This is an indication that the defect might have originated at the weld fins in the inner side of the link during fatigue load and grew in the direction perpendicular to the axial load. The weld part might have fractured first allowing only the base metal part to support the load and then also fractured eventually. Figure 6 shows the fracture surface of the failed chain link near the (a) weld area and at the opposite side of the chain link in the (b) base metal. The other fractured half of the sample was not recovered.

Figure 6a and 6b shows the fractured parts of the chain link. These parts are not connected to each other. 6a and 6b's connected halves were not recovered. It can be observed that the two fractured parts have different fracture profile. The start of the fracture is assumed to have occurred at the weld in 6a since it shows most regions pertaining to stages of fatigue failure. Region (1a) is where fatigue origins were identified at the inner surface of the link. Fatigue propagation is identified at Region (2a) described by progressive marks and striations. This region is typically located along the weld circumference with length of 4 to 5 mm. Final fracture is denoted by region (3a). Fatigue origins were also identified as shown in region (1b) in part 6b. Final



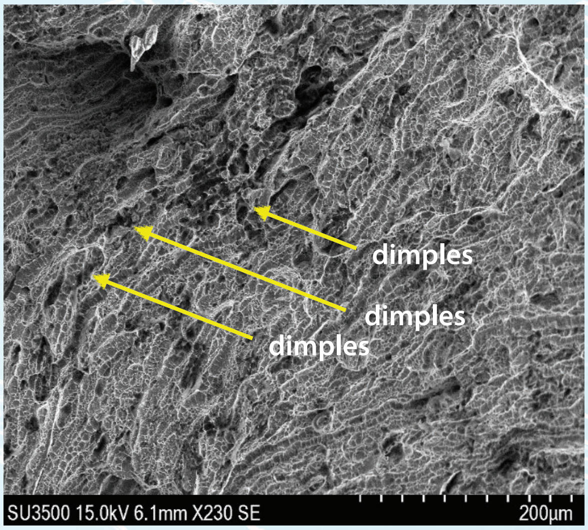


Fig. 7. Fractography of fractured sample near weld, 6a showing fatigue origins near surface and striations but final failure shows ductile failure through existence of failure.

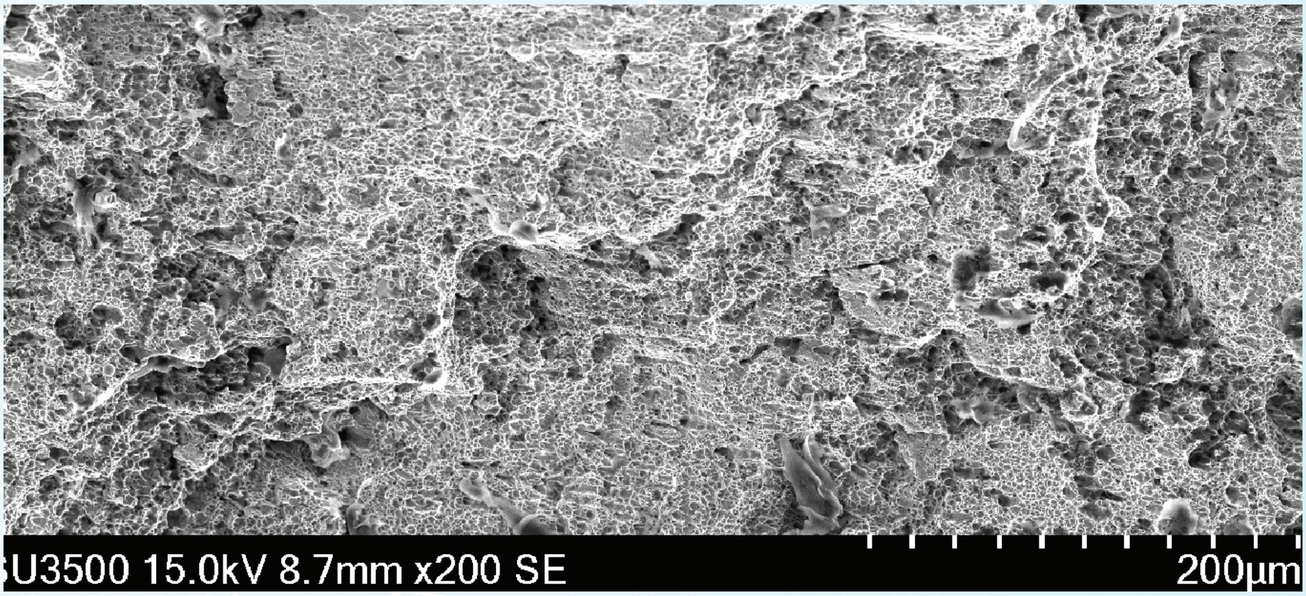


Fig. 8. Fractography of fractured sample 6b without weld showing evident dimples consistent with ductile failure.

fracture is denoted by 2b. Figure 7 shows the additional metallographic exam using SEM showing the details of regions (6a), and (6b).

Figure 7 and Figure 8 show the fractography analysis using SEM for 6a and 6b fractured parts respectively. As observed in Figure 6a, presence of surface cracks at the circumference of fractured sample near weld in which fatigue cracks were initiated, region (1a). The striations are not rotationally symmetric meaning the distances separating the marks are not the same along rotation direction. This means that alternating tensile loads with bending and torsion are directly responsible for failure in 6a regions 1a and 2a. Region 3a, anomalously indicated a ductile fraction as indicated by presence of dimples which is consistent with ductile failure.

Figure 8 shows evident dimples on the entire area that firmly confirm sudden ductile failure. Ductile fracture is characterized by a dimple structure: The cavities seen from inclusions or coarser precipitates are enlarged and during further yielding the material between them is necked and sheared. The depth of these dimples can be considered as a measure of the ductility.

The SEM view of transgranular cleavage fracture shown in Figure 8 presented impact overload of a material with low ductility. However, there is no overload and the material does not have low ductility. The load carried by the chain link is way within the capacity of the material. But since there is failure on the other side of the chain where the weld was, the remaining chain part was not able to carry the load on its own and failed.

4. Conclusion

Failure of chain links were examined in this study using Optical and Scanning Electron Microscope. When the as-received base metal and weld parts were examined it was found that both microstructures were homogenous and both have quench tempered martensite microstructure. The grain sizes for both are also similar making this steel alloy suitable for towing and mooring applications. Although some features were observed, they are minimally present in the base metal and weld metal. This means that the material has overall good quality. Since the failure occurs mostly near the weld, there could have been presence of undetected defect in weld fins introduced during or after welding which could have significantly promoted fatigue at the weld. This undetected defect may only be on this particular chain link as there is no evidence to suggest presence of this undetected defect in other chains. Although there is no overloading as the load used during operations is within the limit of the material, the undetected defect at the weld which was promoted by application of cyclic loading has significantly lessened the overall area to withstand the load. Thus, ductile failure still occurred and is seen along a larger part of the chain where the weld is. Additional causes of failure are excessive loading and storing conditions that may promote corrosion marks at the surface. It is advised to use chain links with new type at the chain ends to minimize twisting during towing. Routine inspection of the chain should be done to examine unacceptable deformation and corrosion marks. Control in humidity and temperature, if possible, may enhance fatigue resistance

5. Acknowledgment

The project was implemented with the collaboration of the T.R. Santi, and consistent support from the DOST-MIRDC, especially the Executive Director, Engr. Robert O. Dizon, and the Deputy Executive Director for R&D, Engr. Jonathan Q. Puerto. Likewise, the project team acknowledges the support provided by the DOST-Philippine Council for Industry, Energy and Emerging Technology Research and Development (DOST-PCIEERD) and the ULVAC Philippines.

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Modification of Primary Slurry Materials for the Development and Improvement of Investment Casting Coating Process

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Abstract

In investment casting coating process, the newly assembled wax patterns are initially dipped into a primary slurry. The primary slurry is a composition of Zircon Flour which is usually preferred due to its grain fineness at 300 to 320 mesh and its refractoriness at high temperature, and Colloidal Silica as the binder, which is commonly used by some local foundries with Investment Casting Process. It was observed that with this mixture, removal of ceramics takes significant amount of time. The research entails modification of primary slurry mixture used in investment casting coating process by introducing Fused Silica Flour. The results showed substantial reduction in material cost and production time without compromising the quality of the casting.

Keywords: slurry mixture, colloidal silica, zircon flour, fused silica, investment casting, wax patterns

1. Introduction

Metals that are too hard for machining are usually being cast to maintain close tolerance. Hence, casting is preferred for components with intricate design which will then require no or only a small amount of straight conventional machining.

Investment casting, in particular, involves application of ceramic slurry around a disposable wax pattern that is allowed to harden to form a disposable pattern mold into which the molten metal is being poured. The cast product is taken out by breaking the ceramic mold, which is, unfortunately, disposable and cannot be reused. Apart from the fact that materials are either imported or not always available in the local market, the ceramic mold being disposable and non-reusable makes investment castings expensive.

Local foundries engaged in investment casting commonly use a primary slurry mixture of Colloidal Silica and Zircon Flour. While the latter compound is preferred due to its principal advantages such as high refractoriness, resistance to wetting with molten metals, round shape, and availability, it is considered as the most expensive among the coating sands in the market.

The Department of Science and Technology-Metals Industry Research and Development center (DOST-MIRDC) uses a standard composition of 3.30 kg Zircon Flour per 1 liter of Colloidal Silica. However, it was noted that with the use of this compound, the fettling process is prolonged due to difficulty in removing ceramics from the metal clusters. While it does not directly affect the quality of the casting surface, the extended duration of the process may translate to additional cost.

In 2018, the Center's Materials and Process Research Division (MPRD) conducted a study on primary slurry materials to provide cost effective alternatives through modification of compound ratio and introduction of Fused Silica Flour into the mixture. Fused Silica is an extremely pure substance made from non-crystalline glass. Due to its remarkably low thermal expansion and exceptionally good thermal shock resistance, it is now being used as replacement to Zircon Flour for making investment casting ceramic shell and other refractory applications.

The research aims to provide and promote alternative materials that are cheaper and may be sourced locally.

Objectives of the Study

1. To be able to have a right modification of coating materials of the primary slurry for investment casting coating process improvement.
2. To support and assist local foundries with investment casting process in the development and improvement of their coating process.

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2. Review of Related Literature

Generally, primary slurries that contain finer refractory powder are used at a higher viscosity and are stuccoed with finer particles than backup coats. These characteristics provide a smooth-surfaced mold capable of resisting metal penetration.

Back-up coats are formulated to coat readily over the prime coats (which may be somewhat porous and absorbent), to provide high strength, and to build up the required thickness with minimum number of coats. One or two additional prime coats are the backup coats. The number of coats required is related to the size of the clusters and the metal weight to be poured and may range from a few as five (5) for small clusters to as many as 15 or more for large ones. For most application, the number ranges from six (6) to nine (9).

Silica is generally used in the form of silica glass (fused silica), which is made by melting natural quartz and then solidifying it to form a glass. It is crushed and screened to produce stucco particles, it is ground to a powder for use in slurries. Its extremely low coefficient of thermal shock resistance to molds, and its ready solubility in molten caustic solutions provides a means of removing shell material chemically from areas of castings that are difficult to clean by other methods.

Zircon occurs naturally as a sand, and it is used in this form as a stucco. It is generally limited to use with prime coats because it does not occur in sizes coarse enough for stuccoing backup coats. It is also ground to powder (and sometimes calcined) for used in slurries, often in conjunction with fused silica and/or aluminum silicates. Its principal advantages are high refractoriness, resistance in wetting by molten metals, round particle shape, and availability.

The actual percentage composition of ceramic shell slurries depends on the particular refractory powder, type, and concentration of binder, liquid vehicle, and desired slurry viscosity. Slurry compositions are usually proprietary [1].

Fig. 1. Dipping or Coating

Fig. 2. Stuccoing

Fig. 3. Drying

Fig. 4. Chipping

Fig. 5. Sand Blasting

3. Method

Formulation of Slurry Mixture

The proposed slurry composition is the 3.30 kg (mixture of 70% Zircon Flour and 30% Fused Silica Flour) per 1 liter of Colloidal Silica.

Preparation of Ceramic Molds

The project team produced a total of four (4) ceramic molds:

a. 2 pcs. of molds using the old composition of 1L colloidal silica for every 3.30 kgs zircon four

b. 2 pcs. of molds using the proposed composition of 1L colloidal silica for every 2.30 kgs zircon flour (320 mesh) and 1 kg fused silica flour (200 mesh).

All ceramic molds were produced using the same standard steps: dipping, stuccoing and drying.

Processing of Ceramic Molds

All ceramic molds were dewaxed, shelled fired, poured with molten metal, and cooled down.

Testing

The ceramic molds were subjected to test to compare the fettling time which includes chipping and sandblasting, casting surface quality and cost of materials.

Table 1. Fettling time for both ceramic molds.

	100% Zircon Flour	70% Zircon Flour / 30% Fused Silica
A. Knocking	10:43	9:08
B. Sand Blasting	23:30	17:42
C. Cut-Off	4:00	4:00
D. Belt Sanding	3:00	3:00
Total	41:13 = 41.22 seconds	33:50 = 33.83 seconds

Table 2. Cost of materials used for both ceramic molds.

	100 % Zircon Flour	70 % Zircon Flour /30 % Fused Silica Flour
50 kgs Zircon Flour	Php8,650	
35 kgs Zircon Flour		Php6,055
15 kgs Fused Silica Flour		Php1,470
Total	**Php8,650**	**Php7,525**

Fig. 6. Castings surface using 2 different ceramic molds (left: 100% zircon flour; right: 70% zircon flour/30% fused silica).

4. Results and Discussion

A. Fettling Time

Table 1 shows that the fettling time is shortened by 17.93 %. Consequently, manpower required and use of sand-blasting machine are also reduced.

B. Casting Surface Quality

Figure 6 below shows that new slurry mixture does not affect the quality of casting surface.

C. Cost of Coating Materials

Table 2 shows the cost of materials used for both ceramic molds. Material cost is reduced by 13.01%.

5. Summary

The modification of the primary slurry by changing from 100% (by weight) zircon flour to 70% Zircon Flour and 30 % Fused Silica Flour shows a favorable result in terms of reduced fettling time and cost of materials.

The project will be promoted to local foundries with investment casting.

6. Acknowledgment

The DOST-MIRDC acknowledges the efforts of the hard work and dedication in the conduct of this research project.

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Characterization of the Locally-developed Clay Molding Equipment: Electric Potter's Wheel, and Jiggering and Jollying Machine

Ronie S. ALAMON*1, Joein L. LUCES*2, Raymond S. DE OCAMPO*3

Abstract

The University of the Philippines-College of Fine Arts (UP-CFA), the Department of Trade and Industry–National Capital Region Office (DTI-NCRO), and the Department of Science and Technology-Metals Industry Research and Development Center (DOST-MIRDC) conducted a joint research to develop, localize, and even improve the electric potter's wheels and jiggering and jollying machines. The joint research will directly benefit the FABLAB at the UP-Diliman as well as the ceramics industry and the metals and engineering industry.

The conceptualization of the electric potter's wheels and jiggering and jollying machines was through benchmarking of imported and commercialized models. The electric potter's wheel has 14 inch-diameter anodized aluminum wheel head plate that rotates clockwise and counter-clockwise with a speed range of 0 – 250 rpm. It has foot pedal speed control and a variable frequency drive (VFD) that controls ½ Hp the brushless motor. The jiggering and jollying machine is equipped with a tool holder ready for the attachment of jiggering and jollying tools. It has a plaster mold holder that rotates clockwise and counter-clockwise with the aid of a standard ball bearing and chrome plated-ball bearing holder. It has a foot pedal brake and VFD that control the ½ Hp brushless motor. The frame and main body parts of both electric potter's wheel and jiggering and jollying machine are powder coated for rust protection and aesthetic purposes.

Results of functional testing and performance testing showed that the electric potter's wheels and jiggering and jollying machines could be locally developed, conforms to user's requirements and reasonable for technology transfer.

1. Introduction

Pottery-making is a quite small industry in the Philippines even though it is a source of useful arts and crafts. Several studies attested that it is one of the oldest industry in the country. In fact, pottery-making was already practiced by ancient Filipinos even before China introduced techniques to create porcelain and pots. Though pottery is art in nature and most of the ceramic craft are for decorative purposes, its products are undoubtedly functional as well. Ceramic plates and bowls, for instance, are essential in everyday activities. In addition, other arts and crafts are used for practical purposes such as containers or storage of foods, both liquid and dry goods; tools for daily cooking (such as palayok); and even pots intended as grave furniture. Nowadays, pottery products come in various forms and are used in a wide spectrum of applications. They can be seen commonly in the form of ornamental ceramic wares, goblets vases, pouring vessels, globular bottles, etc. [1], [3]

Fundamentally, pottery is governed by the artist's skill alone and it takes years to of practice to produce uniform ceramic crafts. History reveals that intervention of technology in pottery results in piles of creations with ease and uniformity. The very first time that a rotational device for forming ceramic objects was used marked a fundamental innovation in pottery technology. Later, motors and pulleys that aided in rotating the device for crafting ceramic materials was introduced. Nowadays, pottery technology ranges to the of use the electric potter's wheel to produce and shape round ceramic bodies and the use of a jiggering and jollying machine to generate and form oval ceramic bodies into hollowware by the differential rotation of a profile tool. [5], [6], [12]

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In 2016, the FABLAB (fabrication laboratory) was inaugurated at the University of the Philippines-College of Fine Arts (UP-CFA) located in Diliman, Quezon City under the Shared Service Facilities (SSF) Project of the Department of Trade and Industry (DTI). The FABLAB focuses on design and processing and fabrication of various materials such as wood, plastic, metal, ceramics, and jewelry with the aid of digital design and rapid prototyping. The DTI–National Capital Region Office (NCRO) spearheaded the implementation of the said FABLAB. As a government agency duly organized and existing under the laws of the Republic of the Philippines, the DTI-NCRO also acts as the implementing arm in Metro Manila of the Department's policies, programs, rules, and regulations as well as those laws which the Department is mandated to enforce.

UP-CFA and DTI-NCRO identified twelve (12) units of electric potter's wheel and five (5) units of jiggering and jollying machine for the FABLAB. However, for several instances, no local bidder could comply with the government bidding procedures in the sense that there is no local fabricator or manufacturer of electric potter's wheel and jiggering & and jollying machine. Besides, the suppliers of imported electric potter's wheel and jiggering & and jollying machine are also limited. The DTI–NCRO decided that the matter can best be addressed through research and development. This is where the expertise of the Department of Science and Technology-Metals Industry Research and Development Center (DOST-MIRDC) of providing design and equipment prototyping services was tapped. The DTI–NCRO recognizes the benefits, in terms of savings and efficiency of local development vis-à-vis importation of the electric potter's wheel and jiggering and jollying machines. Further, the DTI– NCRO and the UP-CFA acknowledges that a joint research with the DOST-MIRDC will be advantageous to the DTI and the FABLAB as well.

This joint research by the DTI-NCRO, DOST-MIRDC, and UP-CFA is considered as a Science and Technology (S&T) response to localize and improve the electric potter's wheels and jiggering and jollying machines. It is expected that this research will directly benefit the FABLAB at the UP-Diliman as well as the ceramics industry and the metals and engineering industry.

2. Materials and Methods

Benchmarking Activity

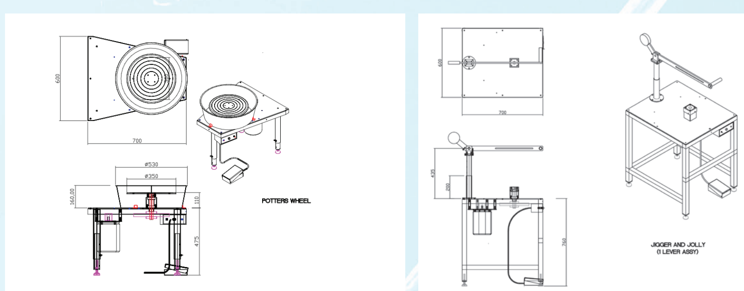
The old kick-wheel at the UP-CFA, an imported Shimpoo brand potter's wheel, and the jiggering and jollying machine at the Eliano Baluyot Pottery in Pampanga were some of the equipment that were evaluated and documented. Actual operations were performed to allow the research team observe the equipment's functionality. Also, the project team interviewed the users of the said machines to understand the involved mechanisms of operation and to identify the design features to be incorporated to the electric potter's wheel prototype and jiggering and jollying machine prototypes. Figure 1 (a,b,c) are some of the equipment that were benchmarked.

a. kick-wheel b. Shimpoo Model c. jiggering and jollying machine of Eliano Baluyot Pottery

Fig. 1. Benchmarked equipment

Designing Activity

The design of the electric potter's wheel and jiggering and jollying machine prototypes was conceptualized after an intensive literature review, prior art search, and thorough consideration of the results of the benchmarking activity. The engineers involved created the 3D model and the detailed drawings of the electric potter's wheel and jiggering and jollying machine prototypes, shown in Figure 2 (a,b). For this task, the project team used different Computer-Aided Design (CAD) software namely Solidworks, and AutoCAD.



a. electric potter's wheel b. Jiggering and jollying machine

Fig. 2. Final Design of the Prototypes

Fabrication and Assembly

The design materializes through machining, fabrication, or assembly. The fabrication and assembly of electric potter's wheel and jiggering and jollying machine prototypes were done in partnership with the MICROCONTROL Design Technology (MDT Automation), a local company specializing in machine automation, design, and fabrication. From the final prototype design, most of the parts were machined using conventional machines such as lathe, milling, and grinding. Some of these parts are aluminum wheel, base plate, and stands. Standard parts were purchased directly as necessary based on requirements such as motors, VFD's, basins, and foot and brake pedals. Electrical simulations were conducted in parallel to machining of various parts. Critical parts such as aluminum wheel plates were anodized while bearing housings were chrome-plated to withstand corrosion and worn-out. Other parts, especially those made of mild steel, were powder coated not just for aesthetic purposes but for protection from rusting and slight damages as well. Figure 3 (a,b) shows the final model of electric potter's wheel and jiggering and jollying machine prototypes.

a. electric potter's wheel prototype   b. Jigger and jolly machine prototype

Fig. 3. Final Model of the Prototypes

Functional Testing

The developed electric potter's wheel and jiggering and jollying machine prototypes were subjected to preliminary testing to determine functionality, to identify the possible problems that may be encountered during operation, and the appropriate adjustments necessary. The researchers observed certain conditions like motor movement (direction and speed), control switches, wobbling of wheels during the functional testing. As a result of testing activities, improvements such as provision of switch for clockwise and counterclockwise motion, reduction of basin's height, and extension of cord were carried out. The site for functional testing is at the UP-CFA as shown in Fig. 4 (a,b).

a. Functional Testing of Electric Potter's Wheel on 20 Dec 2017 at UP-CFA

b. Functional Testing of Jigger and Jolly Machine on 20 Dec 2017 at UP-CFA

Fig. 4. Functional Testing of the Prototypes

Replication and Testing

The replication of the design of the original unit produced 11 units of electric potter's wheels and four (4) units of jiggering and jollying machines were replicated from the original unit. Improvements carried out on the original prototypes units were integrated into the replicated units. A series of testing of the replicated prototypes were conducted on March 2018 at UP-CFA, as shown in Fig 5 below.

a. Series of Testing of the replicated Electric Potter's Wheel prototypes

b. Series of testing of the replicated Jiggering and Jollying Machine prototypes

Fig. 5. Testing of the Replicated Prototypes

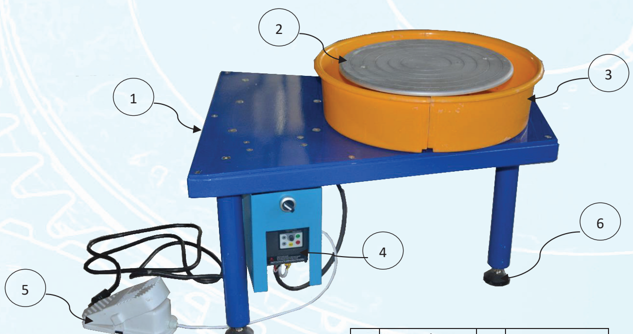
3. Results and Discussion

The developed electric potter's wheel and jiggering and jollying machine prototypes were characterized by the composition of their parts with essential functions.

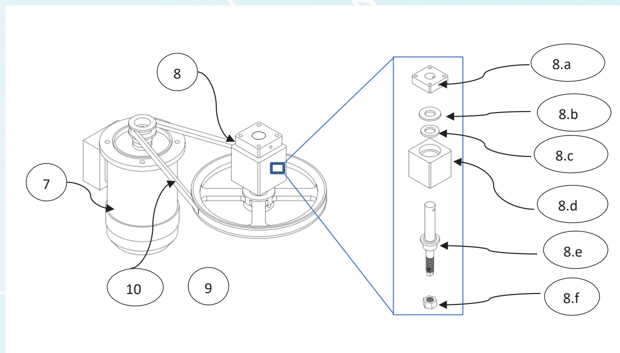
A. Electric Potter's Wheel

An electric potter's wheel is composed generally of 10 major parts, as shown in Fig 6. A basin is placed at the top of the working platform but just below the aluminum wheelhead. The said basin is a plastic material which can be divided into halves. Each half is provided with male and female slots which can be joined to form a standard basin. The purpose of the said basin is to collect excess water and clay during the "throwing" process. Another part is the aluminum wheelhead which is mounted to a rotary chuck that is also attached to the working platform. Aluminum is the material chosen for the wheelhead because it is lightweight and can resist corrosion caused by water and clay. The said rotary chuck is comprised of a rotating base plate, a standard ball bearing and chrome plated bearing-house where the aluminum wheelhead is attached on one end. At the other end of the rotary chuck is a belt-driven which comprised of longitudinal shaft and pulley. A V-belt connects the pulley to a synchronous motor controlled by a VFD. The speed of the synchronous motor increases or decreases depending on the pressure to the foot pedal. Moreover, the whole working platform is provided with adjustable footings with self-aligned bearing for height adjustment and adaptability to the floor surface.

Table 1 below summarizes the physical characteristics of the developed electric potter's wheel.



1	Working platform	4	VFD
2	Aluminum wheelhead	5	Foot pedal
3	Splash pan	6	Adjustable footings



8	Rotary chuck	8.a	Rotating base plate	8.d	Bearing housing
9	pulley	8.b	spacer	8.e	Longitudinal shaft
10	V-belt	8.c	Ball bearing	8.f	Locking nut

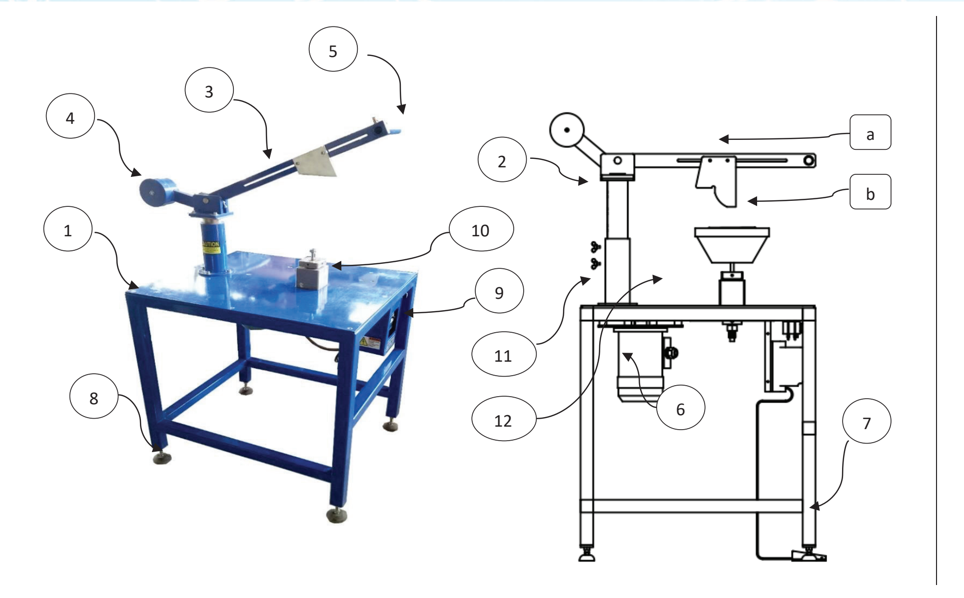
Table 1. Specifications of the hand tractor-attached harvester prototype

Physical Characteristics of the Electric Potter's Wheel	
Parts	**Specification**
Motor	½ HP, AC220V, 60Hz, 1-phase
Drive System	Inverter Drive System for speed control with DC Brushless Motor
Wheelhead rotation speed	0 ~ 250rpm
Speed adjustment	Foot Pedal or through the VFD
Wheelhead Direction	Clockwise/Counter-Clockwise
Wheelhead Material	Anodized aluminum plate
Wheelhead diameter	14" diameter
Dimension	70 cm x 60 cm x 54cm (L x W x H)
Weight	48 Kgs

B. Jiggering and Jollying Machine

The jiggering and jollying machine, presented in Figure 7, has the same configuration of rotating mechanism as that of the electric potter's wheel as shown in Fig 6 above. This machine is generally comprised of 12 components. The working platform holds the adjustable tool-stand, which also holds the tool-holder. The said tool-holder holds either a jiggering or a jollying tool at the slotted portion with locking screws. The mentioned tool holder is also provided with handle and counterweights for balance and stability. Another part is the rotary chuck that is also attached to the working platform. It comprises of rotating base plate where the plaster-mold is mounted, a standard ball bearing placed inside the chrome plated bearing-house, the longitudinal shaft which is connected to pulley. The synchronous motor drives the said pulley through a V-belt. Next part is the VFD that controls the speed of the synchronous motor. The rate of the synchronous motor is adjusted at the potentiometer of the VFD and can be halted through a pedal brake. Lastly, the complete working platform is provided with adjustable footings with self-aligned bearing for height adjustment and adaptability to the floor surface.

Table 2 below summarizes the physical characteristics of the developed jiggering and jollying machine.



1	Working platform	5	Rotating base plate	9	VFD	a	Jiggering / jollying tool
2	Tool-stand	6	synchronous motor	10	Rotary chuck	b	Plaster mold
3	Tool-holder	7	Brake-pedal	11	pulley		
4	counterweight	8	Adjustable footings	12	V-belt		

Fig. 7. Jiggering and Jollying Machines and its parts.

Table 2. Physical characteristics of the developed jiggering and jollying machine.

Physical Characteristics of Jiggering and Jollying Machine	
Parts	**Specification**
Motor	½ HP, AC220V, 60Hz, 1-phase
Drive System	Inverter Drive System for speed control with DC Brushless Motor
Plaster Mold Speed	0 ~ 250rpm
Speed adjustment	VFD potentiometer
Plaster Mold Rotation	Clockwise/Counter-Clockwise
Dimension (H x W x L)	150 cm x 60 cm x 85 cm
Weight	85 Kgs

Summary and Conclusion

Based on studies conducted on the actual units of electric potter's wheels and jiggering & and jollying machines, these ceramic equipment can be developed locally using available materials in the country. The functional testing results implied that these ceramic equipment functions to their purposes.

Testing and repair of the electric potter's wheels and jiggering and jollying machines showed the simplicity and maintainability of the prototypes. With proper maintenance, those prototypes may last for several years.

R&D activities conducted by the project team resulted to locally-developed prototypes of the electric potter's wheel and the jiggering and jollying machines with some characteristics that distinctly define them from their imported counterparts. These characteristics include: (1) the use of VFD to drive and control the brushless motor for both electric potter's wheels and jiggering and jollying machines; (2) forward and reverse motion of wheel head for electric potter's wheel and plaster-mold holder of the jiggering and jollying machines; (3) machined and anodized wheel head for electric potter's wheel; (4) adjustable jiggering and jollying tool holder; and (5) integration of self-aligning and adjustable footings.

In addition, the particular design of the electric potter's wheels and jigger and machines marks the industrial applicability of the said clay molding equipment

Recommendation

Based on the series of testing, the R&D activities in developing the electric potter's wheels and jigger and jolly machines produced favorable results though some improvement may still be incorporated. As such, it is recommended that electric potter's wheels and jigger & and jolly machines undergo an endurance test at the UP-CFA FABLAB to determine their durability when subjected to prolong days of usage.

It is also recommended based on the positive results that the electric potter's wheels and jigger and jolly machines undertake post-R&D activities such as patent filing, promotion, exhibits, and other technology transfer activities.

Acknowledgement

This project would like to acknowledge the cooperation of various institutions and their dedicated experts. Utmost respect and gratitude are hereby extended to the DOST Management, MIRDC Management and project support units; the joint research partner and funding institution - Department of Trade and Industry – National Capital Region; the cooperating agency and project beneficiary – the University of the Philippines – College of Fine Arts ; private R&D partner – the MICROCONTROL Design Technology, Inc (MDT Automation).

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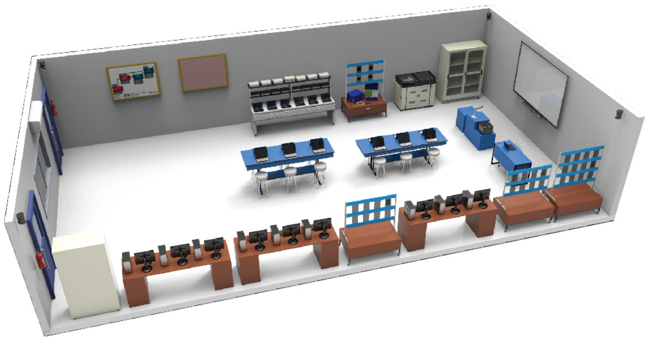

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Men in the M&E Industries

MR. ANGEL P. SERRA:

A Story of a Simple Man with Simple Dreams Who Made it BIG in the Forging Industry

Zalda R. GAYAHAN[*1]

'Very simple ang life. You have to think of capacity. Ang tao, the same din…You have to think of capacity. When you say capacity, kuryente. It's about the size of the wire. Hindi pwedeng sobra ang load mo or else masunog ang wire. Yung kotse, meron 1300 cc, 2000 cc engine - it's again capacity. Hanggang dun ka lang. Ganun din yung bulsa mo. Hanggang dun ka lang din. Everything has a capacity. It has a limit. Now you can apply that in your everyday job.'

I first heard of Mr. Angel P. Serra at the time when the Center was getting ready to implement a project that involved conduct of surveys covering three industries simultaneously. Each industry study team sought the help of a consultant – one who must be very knowledgeable and prominent in the field. I had the impression that the Center had only one name in mind for the forging industry study: Mr. Angel P. Serra III. As it turns out, he is really the one and only perfect person for the part.

How so? Well, read away…

Mr. Serra's professional record is marked by very important milestones that groomed him to be the prominent person that he is in the industry. His very inspiring 'simple' story began when he was just a young gentleman in college.

Angel, Margel to family and close friends, was bent on taking up mechanical engineering in college. But two (2) years into the Mechanical Engineering program at the Mapua Institute of Technology, he realized that there are

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so many mechanical engineers. He said he had to look for another field where there will only be a few of them so that it will be easy to find a job after graduation. He was thinking of fields like mining, geology, or metallurgy. Also among his considerations was the presence of the Philippine Iron Mines back in their province. He knew that his father's friends were bosses at the Phil. Iron Mines, which assured him that he had the necessary connections. And so, he shifted to Metallurgical Engineering when he was in third year college.

Born and raised in Daet, Camarines Norte, the young Angel always dreamed of working in the mines in their province. He was not wishing for a life in Manila, which at that time was already busy and crowded. To him, life in the mines is not stressful as in the city.

Then came the time when he was required to complete two months of OJT for their Mine and Mill Practice, along with two colleagues who were taking up mining engineering. They went to the Phil. Iron Mines back in Angel's province. Others opted to go to Cebu, because the company offered a large stipend for OJTs. Angel and his colleagues were only offered free board and lodging. There they gained actual experience on ore beneficiation and time and motion study. 'Kailangan malaman mo ang galaw ng mines, kasi 24 hours ang takbuhan ng Phil. Iron Mines at that time.'

The two-month stay in the mines led him to realize that life in the province is gloomy. He saw the same people day in and day out. He was young and single, and he wanted to spend nights out with friends. The job became a routine. He then started to compare this routine with his life in Manila. Then he saw things a bit clearer: he no longer wanted to work in the mines. But he still wanted a job related to the metals industry.

After the OJT, he went back to Manila, finished his degree, and graduated in April 1975. At that time, his uncle who was then the President of the AG&P asked him to join Honiron Division as this was newly acquired by the company. He had some hesitations about working there, and one of them was lack of confidence. Angel says, 'I remember at that time, natatakot din ako. Wala pa akong confidence na pumasok sa malaking kumpanya agad. '

Although he gave up this opportunity, he found another through his own connections. He applied for the position of a lab assistant at the Malleable Metals Industries, Inc. (MMII). MMII is a foundry, a company definitely smaller than AG&P. He was hired immediately and was asked to start working the following week. As a lab assistant, he does the charge calculations, metallographic analysis, and also 'taga kuha ng samples ng melt, kukunin mo yung carbon and sulfur, bago nila ibuhos.' Because he was a metallurgical engineer, he had a lot of chemistry subjects so he was very confident about doing the job. But the position was just a start for Angel. Within a month, his assignment was changed. He was promoted to supervisor level. This time, it was kind of an all-around task: aside from supervising, he was also in charge of quality control. It was during this time that Angel and his team at the MMII pioneered the production of the SG iron. This was a long-term engagement for the company, and Angel is proud to have this in his professional portfolio.

He stayed on at the MMII and continued his work as an 'all-around' supervisor. In the early seventies the Marcos administration launched the Progressive Car Manufacturing Program (PCMP). One of the program's objectives is to produce a local car. To produce a car there should be a body maker that implements the stamping process, an engine, and a transmission maker. This gave birth to the establishment of a forging company in the Philippines to support the PCMP. And so, it was in 1976 that the commercial production of forgings started at the facilities of the ANI Philippine Forge Inc. in Santa Rosa, Laguna.

With his knowledge in metallography, chemical and failure analysis, and heat treatment he acquired from MMII, he was hired by the ANI Philippine Forge Inc., even at the young age of 23 years old, to become their Metallurgical.

In less than six (6) months, Quality Control was also assigned to him. It was a huge task because as QC, Angel is in charge of the delivery of the forgings to the local two transmission companies at that time. He remembers the local customers such General Motors Philippines Transmission Plant in Almanza, Paranaque, the Asian Transmission Company in Canlubang, Laguna, which are both participants in the PCMP program and also export customers in the U.S.A. such as Hyster, Cascade and Rockwell International and Australian companies like Victa Crankshafts and GM Holden. Exports accounts to 60% of the forging production of the company.

Apart from the many responsibilities assigned to Angel, he was also involved in development. He shares, 'We were developing a digger tooth for Semirara Coal. The part that they are using laging nababali o nababasag. Yun pala ang original part should be a forging. So, we developed the part as a forging, humaba naman ang tool life nya considerably pero nababasag pa rin. What I did is to change the heat treatment process from straight hardening to localized hardening. I put up a lead bath. Kalahati lang ang hinaharden nya. Then tinetemper namin yung kalahati nya. Para wag mabali. It's an idea that I proposed. Inaccept naman.'

Angel was happy with the outcome, yet very humble about this achievement. 'Known naman yung heat treatment na yun e. It's just how you improvise a process to suit the application. Tapik lang sa balikat ang nakukuha ko dyan,' he smiles. 'Dumating nga yung dati kong Doctor na propesor. Nakita nya. Sabi, "Wow! You are really my good student!"'

The ANI Philippine Forge Inc. was at the height of its operations from 1976 to 1990. The mother company, which is the Australian National Industries, is a big company in Australia. They are into banking, property, leasing, rentals, and manufacturing. ANI got into trouble and a much bigger company had to buy it and was forced to spin off the companies, and so the forging operations had to go. In 1991, the BPI acquired the ANI, and changed the name to Philippine Forge, Inc. The company still continued operations after the acquisition. A lot of the employees were paid off based on their length of service. If they still opted to continue working with the company, they were to start in Day 1. It was as if it was a new company.

APS attends Power Forums as EVP of the Aichi Forging Company.

'They wanted me to continue so the length of my service was not discontinued. Kasi halos ako na yung on top when they were acquired by the BPI. Ako, the President, and a few managers ang hindi binayaran.'

Under BPI as Plant Manager, he also sits in the Management Committee. For about five years BPI run the business, and in 1995 Aichi Steel Corporation of Japan acquired the company and so it then became known as Aichi Forging Company of Asia Inc. (AFP). He was sent to Japan on the same year. At first, he did not know what the trip to Japan was about. It all became clear when Aichi bought the company. He was Plant Manager at that time, and the Japanese retained his position. 'When you say plant manager, operations, pati QC, lahat, pati planning, ako pa din,' shares Angel.

Angel recounts that during the time of ANI, there were the GM and Asian Transmission. 'Nawala sa picture ang GM. Ang pumalit dun, Toyota. Ang Aichi kasi entered sa Philippines because of Toyota Autoparts.' According to Angel, TAP produces G-type manual transmission that goes in to the Hi Ace, Tamaraw and Innova and is shipped to Thailand and South Africa. Later on, it was replaced by the R-type model.

At the Aichi, Angel continued to serve to the best of his abilities. He gained expertise, he shared by teaching his subordinates and colleagues, and not surprisingly, he journeyed toward the top of the corporate ladder. From being Plant Manager, Angel was promoted to Assistant Vice President. Later, he was named Vice President. Eventually, he became Executive Vice President.

Then I had to ask: Were there times na hindi ka na nachallenge kasi madali na ito for you?

Hindi naman. Nung nasa forging ako, I was the highest Filipino officer. Marami na akong nakasama na umalis. I think I belong to that company e. Kahit nagbabagyo, nandun pa din ako. Kargo ko lahat e. manufacturing and facilities, sa akin. Lahat lahat yun. We are running 24 hours. Pag tumigil ang planta, ako ang tatawagin. Ako lahat, walang ibang pupuntahan yun. Pag may bagong project, ako pa din.

I shot the next question: What to you is Angel Serra's contribution to the forging industry?

'I'm the go-between e,' Angel replies thoughtfully. 'I think the greatest participation ko is paano ko ipapaintindi sa kasamahan at tao sa linya ang gustong mangyari ng Hapon.

Angel analyzes that it was more than just the language barrier. It's about understanding. He shared that their President will call him and present a drawing. Angel will go back to the line and do what the President wanted. 'Pag ibang tao ang iharap mo sa kanya, magtatagal kayo dahil hindi maintindhinan ang gusto ng Hapon. It's easier for me to understand what they like. Maybe because of my background, engineering ako. Meron akong chemical, civil, mechanical, electrical know-how. When they talk to you, you should know yung basic technical terms…. Other people, kahit engineering, hindi nila maintindihan yun. [I think it's] because of the application. Kaya it's easier na ako ang kinakausap.'

In addition, he says, 'I think I have the ability to absorb easily. Madaling i-apply. Napag aralan mo, then [you have to know] ano yung application nyan?'

Moving on to the next question. Did you find your job tiring?

Angel described already the nature of the job. 'Lagi kang wala sa bahay.' By this he means that he is not tied to do an 8 am-5 pm office job. He must be on the move at all times. 'The job is really demanding,' he says. 'It's a responsibility e. If it [the operation] stopped, kailangan mo patakbuhin. Kasi ang tanong sayo e, "what time are we going to run the factory again?" Pag nagkaroon ng power failure due to acts of God or technical problems within or outside of the company, ako pa din ang nasagot kasi kilala ko naman ang connections sa Meralco. Pag iba ang problema, you have to size it up. Magtatanong ka. Nung nagbagyo, gano kalaki ang damage. Sila din may plus or minus. Balik ka. [Then you tell the management that operations can be restored in] One week. Ang sunod na tanong, "gano kalaki ang ipapa-stock natin? What will we do for the meantime para hindi magsuffer [ang operations]?"' Angel emphasizes the importance of contingency. The importance of not giving up.

But the answer to the question is no. He did not get tired of it at all. 'Mataas ang adrenalin ko e. Nung hindi pa ako nag gogolf, I am an avid tennis player. [But] I changed my hobby from tennis to golf. I found out na hypertensive ako.' He became conscious about this because he shared that he had a friend, also hypertensive, who died in the tennis court. His shift to golf proved advantageous. When their company was acquired by the Japanese in 1995, he learned that the Japanese were too obsessed with the sport. And so, golf became his means to exercise and to connect with clients.

But did you face bigger problems the higher you went up the corporate ladder?

'I would say it really depends on you e. If you are not prepared, it will eat you up. Since you know the ins and outs, number one sabi ko, wag ka magpapanic. I think hindi ako masyadong affected. Kasi alam ko na kung ano ang gagawin ko e. [And also] You need to be honest. Hindi mo na kailangan lagyan ng palabok yung situation.'

Habang tumataas ang position mo, nababawasan ka ba ng personal space?

'Alam mo, totoo yun. I realized that also. If I had time to go back, maybe I would like to… if I'm giving four hours to tennis, gagawin kong two hours na lang. Yung two hours ibibigay ko sa pamilya ko. I will divide the time.

What legacy did you leave behind for all the people whom you worked with? What did they learn from you?

I give them a chance to work with me. Hindi ako madamot. I share. Alam ko kasi ito ang susunod sa akin…. Sabi ko, turuan kita. Ito ang gagawin mo. Hindi mahirap. Kasi pag alam na nila ang gagawin nila, e di libre ako,' Angel says with a chuckle. 'Pag hindi magtuturo, hindi ka aasenso. Hindi ka dapat madamot.'

I found myself nodding in agreement with him. True. There is no room for greed in this world. Ideally.

Angel goes on to say, 'Very simple ang life. You have to think of capacity. Ang tao, the same din…You have to think of a capacity. When you say capacity, kuryente. It's about the size of the wire. Hindi pwedeng sobra ang load mu or else masunog ang wire. Yung kotse, meron 1300 cc, 2000 cc engine - it's again capacity. Hanggang dun ka lang. Ganun din yung bulsa mo. Hanggang dun ka lang din. Everything has a capacity. It has a limit. Now you can apply that in your everyday job.'

Then I asked about what he thinks of the idea of stretching limits. His reply:

'Stretching limit? Again, may parameter yan. May sinasabi kang safe working load. Lagi. Of course, pwede mo naman gawin yan but not all the time. You work with that and you will never go wrong. [For instance] Makina. Nakalagay dyan, 1300 tons. So you cannot design more than 1300 capacity…[otherwise] magsusuffer ang volume mo. Hindi ka makakagawa ng madami. So may tradeoff lagi. You think about that.' And I was nodding in agreement again.

The next question: Ganyan ka ba din magdevelop ng tao mo?

Angel and wife, Bebs, spend quality time in Paris.

I still believe that a person has his own purpose actually. Yung timeframe, hindi mo pwede ipilit dun e. Meron talagang slow learner. You have to look for a place na babagay sya and then educate, then re-evaluate.'

Angel retired from the industry when he turned 60 in 2014. But he was tapped by the Aichi as Consultant from 2014-2017. 'In the first year, ginawa nila akong admin. Wala na ako sa operations. Before that, nung wala ako sa admin, pati union hawak ko pa din. Ako nakikipag-negotiate.' He was again laughing when he said, 'Kaya makikita mo dati sa Sta. Rosa: Angel Serra, Berdugo ng Aichi.' He sure had a funny way of telling serious stories like this one. But on a more serious note, he adds, 'They gave me security. There were threats to my life.'

'My priority after retirement? Maglaro na lang yata. [I was] Looking forward to retirement. Hindi ako makapagtravel nun e. Sayang ang time. Wala akong travel. One time nakahingi ako ng three weeks, nakapunta ako ng Europe kasama misis ko.

Oops, love life. I almost forgot to ask about that. Angel openly shares, 'Nung lumipat ako ng ANI in 1977, single pa ako. [One time there was an] Australian visiting manager. Kung sya daw ang nag interview sa akin at nalaman nyang ako ay single, hindi nya ako kukunin. Kasi ako daw ay isang immature person. Irresponsible, immature pag hindi married. Sabi ko, "don't worry, I'm getting married in a few months."' I was not sure if he was kidding, but his chuckling was contagious.

Now that he is at a point in his life where he can look back and review how the forging industry's story unfolded in the country, I asked him if there was ever growth in the forging industry?

My thinking of growth is improvement in the turnover from the time that a customer gives you a drawing – how fast you can make an approved forging. That is the growth or improvement. Volume depends on the budget. Growth is kung gaano mo kabilis magagawa.

And so, his answer brought us to the next question: May natututunan pa bang bago sa forging?

'It's always the turnaround. How do you shorten it? The normal way before, get the drawing, drawing mo ulit sya, drawing ng dies, imamachine, ihiheat treat, lalagyan mo sa forging machine, itatrial mo. Pag may nagpaquote sa amin, three months ang quotation bago magkaron ng sample. Nowadays, meron kang material, meron kang correct material, in two weeks makakagawa ka ng sample. It will require a technology. Mahal yun e. Naggagawa ka na ng design, at the same time sya na ang gagawa ng program para imachine mo yung die.'

Although already retired, Angel is still very much in touch with the industry that he helped grow. With his expertise in the field, I asked for his thoughts on how we can still make the forging industry level up.

APS shares his insights for the forging industry during the FGD held in December, 2018 at the DOST-MIRDC.

'Dapat magkaron ng isang product na associated talaga dito sa atin. Dapat magkaron tayo ng maipagmamalaki mo na dito ginawa.' He elaborates further, 'Kaya ako, promining ako. Pag binuksan mo yung mines, madaming trabaho. Madami kang pwedeng gawin doon. Pwedeng iforge. Pwedeng icast. I hope the mines will open, if environmental concerns is the issue [During the olden times, you cannot see what's happening.] Ngayon cellphone lang pwede ka nang mag sumbong. Maraming ways na mamomonitor, macocontrol…. Pag meron ka dito sa Pilipinas na pag kukunan, dun ka makakapag isip kung anong idedevelop mo. Number one [example], pang kamot ng lupa.'

Out of curiosity, I asked him how he got to know the DOST-MIRDC. It turns out, he got to know of the Center when he shifted to Met. Eng and needed to do research in its library in Ortigas. Mr. Eduardo Lacbay was his classmate and they would often bump into each other when he needed to have some tests done during the time when Angel was at the MMII. Engr. Mike Laigo was also in his circle of friends. I asked him what interventions does the Center need to offer to the forging industry. To this, he said that the support of the MIRDC will be coming from training. Not really in forging, but related to forging like quality metrology 'kasi may sarili naman ang mga kumpanya ng training.'

I'm really happy to learn that the new President [of Aichi] nagpapadala ng tao sa Japan. Yan ang sinabi ko noon. Mag invest sa tao in the form of overseas training. Part ng requirement, ang mga tao matuto. Sabi ko bigyan mo ng break na makakita ng ibang lugar, mag-iiba ang pag-iisip at pang uunawa. Sabihin mong nakapagtrain ka ng 100 na tao. Ang matitira sayo sampu. May sampu ka pa din. Kesa wala.

With such colorful and success-filled experiences, what is your greatest lesson in life?

'It's about our family,' was Angel's ready reply. 'Kami sa probinsya, we are something also [because they were landed and prominent]. [But] We cannot sustain. Bababa ka din. Pag nakaasa ka lang sa tanim mo, mababa ang value. Seasonal ang produkto. Siyam kaming magkakapatid. Nung nakita kong bumaba kami, yung time na yung expenses mo mas malaki na kesa sa kinikita mo. Nung namatay ang father ko, I assumed the responsibility na. I finished my degree on time. Sabi ko sa mga kapatid ko, dapat kayo ganun din. Sayang e. May mga relatives kami sa Manila, happy go lucky lang. They did not mind if they finish college on time.

I asked if he misses the hectic schedule he had while he was still in the industry. His CV gives an answer to this. He is currently the President of Starzek Trading, a company based in Calamba, Laguna. It is a sole proprietorship business engaged in the business of food ingredients, supplements, and pharmaceutical products. Angel is also presently a member of the Steering Committee of the Philippine Die and Mold Association, Inc. (PDMA). He may not be as busy as he was back then, but he still has his hands full with productive initiatives.

An accomplished golfer! Angel makes two holes in one. The first time was in January of 2002 at the Old Course in Canlubang, during the Yulo Memorial Tournament. The latest was at the Palmer Course Hole no. 7 at The Orchards during their Prestigious Tournament in November 2017.

So, if life now is not as busy as before, how does Angel spend his every day? His quick answer was, 'Nanonood ng Netflix.' Wow, great! I met another Netflix fan. 'Nainom ako,' he adds. 'Social drinking. Kasi nagluluto ako. Maaga ako nagigising. When I wake up, naglalakad ako. When I'm not golfing, naglalakad ako.' At his age, no bulging tummy. Great physique. Golf and the regular walks are doing him good.

A few more quick Q&A follows.

What kind of food do you love to cook?
Angel: Tomato-based dishes.

Where would you be, if you were not in the industry?
Angel: Nasa palengke. Nagtitingin tingin kung anong meron.

Did you get rich?
Angel: Just enough for us to survive until 80 years old if God permits more pa. Nakapag patayo naman ako ng resort sa Pansol in preparation for my retirement.

Favorite place for recreation? Golf course.
Favorite destination? Japan.

Then, the question for the wraps: Are you a successful man?

'I think so. From the beginning na nag aaral ka, there will come a time na titigil ka na sa pagtatrabaho. Yung pag tumigil ng trabaho, ibig sabihin, made ka na. Pag hindi ka pa made, hindi ka pa titigil sa trabaho. When you say you're made, pwede kang hindi magtrabaho, nakakain ka. Simple lang.'

'Another thing is the family life. Pag ikaw nandun, wala ka namang sakit ng ulo kasi napag-aral mo ang mga anak mo. He has three kids, but not one became interested to be in the industry. 'Ayaw ko din,' confesses Angel. 'Mahirap.' And I guess he was serious again when he said, 'If I would have another life, hindi ako pupunta dyan. I will try a different path.'

Last question. Walang regrets?

He was consistent in saying, 'Hindi na ako uulit [sa industry] ….. Mag-cooking na lang ako, saka maghahanap ako ng misis na malambing if given another life.' We both ended up laughing. Because this is definitely on the record.

Thank you, Sir Angel, for being such an amazing interviewee. I enjoyed chatting with you. I am sure the industry is thanking you, too. For the many contributions, for the many years of selflessness. Teach us how to play golf one of these days.

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Feature Article

Philippine Parts Maker Association Inc. (PPMA):

Making a way to provide abundant solutions to automotive setbacks.

ABOUT

Philippine Parts Maker Association Inc. (PPMA), originally known as Motor Vehicle Parts Manufacturers Association of the Philippine (MVPMAP) established June 1994, was re-established in July 2015 to represent the industry and to provide technical and management support to its members. The association serves as an effective link between the policy-making echelons in the government and the auto parts manufacturing industry. PPMA is also a member of Federation of Automotive Industries of the Philippines Inc. (FAIP). One of the premier suppliers to the industry and provides technical and management support to its members. Incorporating its name to the top suppliers for local vehicle manufacturers, making a way to provide abundant solutions to automotive setbacks.

With a registered membership base of over 113 parts manufacturers, out of over 302 industries, PPMA has under its wings, parts makers of cars who supplies to multinational companies of repute, including Toyota, Mitsubishi, Isuzu, Honda, etc.

Our Mission

Enhance the recovery and sustain the growth of the motor vehicle parts and components industry, as well as meet the challenges of the new millennium. Modernization of local vehicles to improve road safety, comfort and introduction of new innovations.

Our Vision

Emphasizing the local industry's brand on qualifying to the international standards with highly skilled workforce continuously training to maintain its stand on forming top of the line products. Supporting the partners in developing the locally produced parts and assembly.

Our Goals

Flourishing the local parts maker industry to being the top suppliers of local and international vehicle and motor assembly. Constantly providing materials relating to the new technologies and adapting resourceful idealism on top of competitive brands, making our very own mark and identity to the public market.

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Local auto parts makers say "We better get going now"

Eco PUV Showcase highlighting some sixteen prototypes of the modern PUV from various platform suppliers and body builders. The Eco PUV Program of the Department of Trade and Industry aims to answer the supply side of PUVPM. To finance the various incentives to support this program, the budget of P9.0 Billion for the coveted third slot of the CARS Program will now be allocated to the Eco PUV Program. Program participants must however commit to locally manufacture and assemble 200,000 units of the both the PUV platform and the body over the next five to six years.

PPMA President Engr Ferdinand Raquelsantos says that there seems to be an alignment of the stars now that DOTr is creating the demand while the DTI is taking care of the supply side. "Other government agencies like the DENR, the Bureau of Philippine Standards, DOST and event the DOE are in full support mode. Now, the latest one to throw in his support and put his weight behind the PUVMP is no less than President Rodrigo Duterte himself"

Exhibits made the local auto parts makers scrambling to get ready for the PUV Modernization Program (PUVPM) of the Department of Transportation. Its sole purpose is to show the auto industry the local supplier base developed to serve the needs of the Comprehensive Automotive Resurgence Strategy (CARS) Program of the government.

Engr. Ferdinand Raquelsantos explains that PPMA is very confident that the BOI PMO together with DOST MIRDC behind both the CARS and Eco PUV Programs will come up with the best programs and incentive packages that will support manufacturing resurgence in the country. "This will promote the advocacy that given the opportunity and the proper government support, the Filipino can make a truly Pilipino utility vehicle that the Filipino commuters deserve, the modern PUV. The theme was "Gawang Pilipino, Para sa Pilipino".

Engr. Ferdinand Raquelsantos concludes that PPMA is very excited to support both the PUVMP and the Eco PUV Programs and promote local manufacturing and assembly. "We together with all the auto industry groups will continue to work closely with the local government offices to make sure these programs succeed. These will take us to the next level that we have long aspired for so we better get going now and prepare early"

PPMA members were also in full force from the big boys such as Yazaki-Torres, Valerie/VSO Group, Manly Plastics, Motolite, AGC and Roberts to the smaller ones such as MD Juan Enterprises, Kea and ROH Wheels.

PhilAPEX showcases locally-made vehicles and parts

The event serves as a venue for auto parts manufacturers and related industries to highlight their manufacturing capabilities and potential to the local industry.
The event was organized by us Philippine Parts Makers Association (PPMA) with the theme, "Gawang Pilipino, para sa Pilipino!" The event wouldn't be possible if not with the support of the Department of Trade and Industry - Board of Investments (DTI-BOI), Department of Transportation (DOTr), Department of Science and Technology (DOST) and Automotive Body Manufacturers of the Philippines (ABMAP).

At the end of the day, we are still looking forward to the continues patronage of our local vehicle producers as well as to increase the volume of production and supply of the local parts assembly to bring out the extensive capabilities of our local manufacturers making solutions for the future innovations we could supply improvements on their design, materials, safety, components, technology and various needs for the automotive sector. Generally, we wish to offer you the best rides of your life, passenger or not these changes will definitely affect our lives. Mabuhay ang Gawang Pilipino!

Present at the opening ceremonies and offering keynote speeches were PPMA president, Engr. Ferdinand Raquelsantos, Hon. Arthur Tugade, DOTr Secretary, and Hon. Ramon Lopez, DTI Secretary. Also present was LTFRB Chairman, Martin Delgra III.

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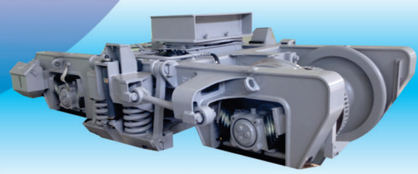
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