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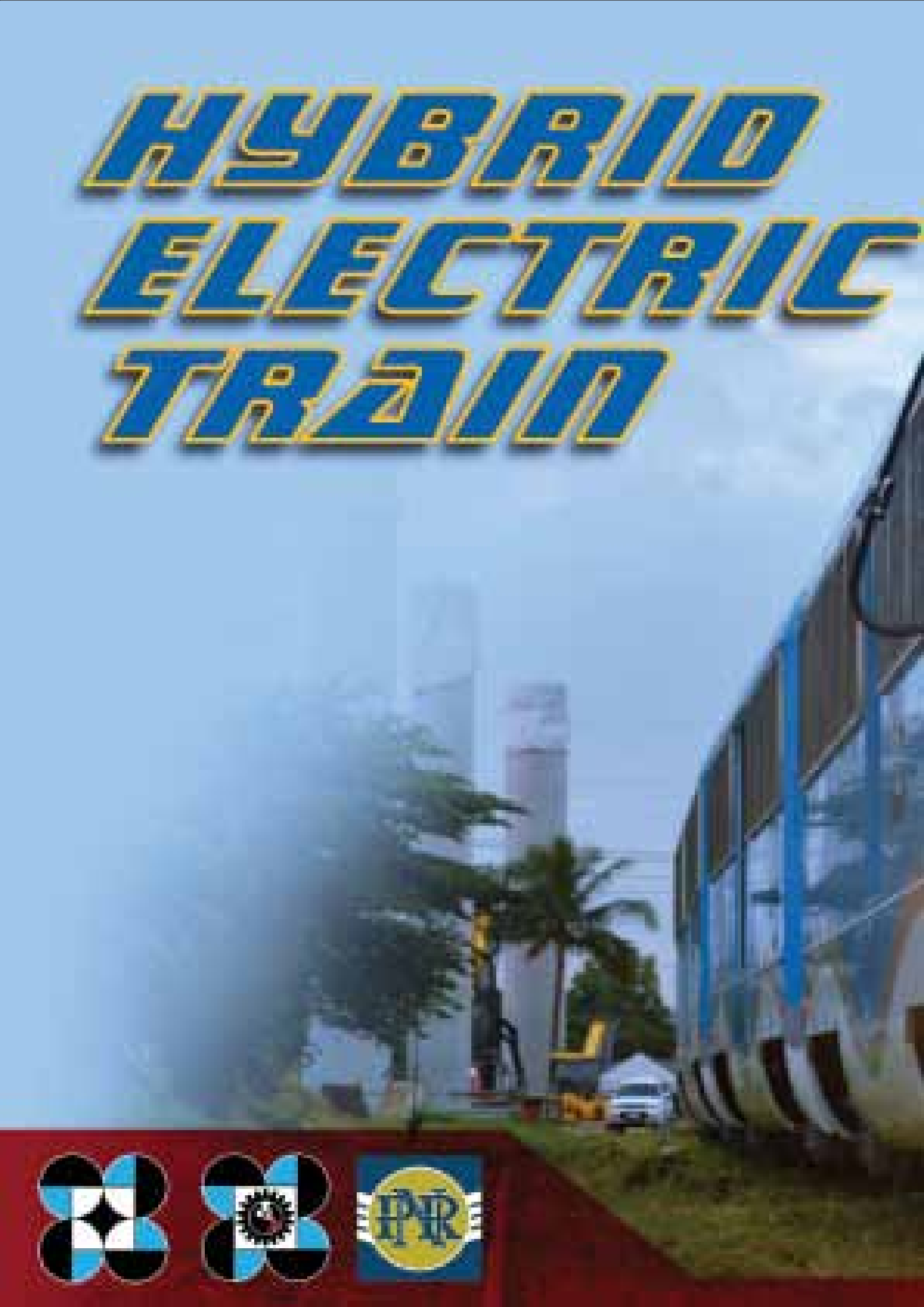
METALS INDUSTRY RESEARCH AND DEVELOPMENT CENTER

HYBRID ELECTRIC TRAIN

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The Philippine Metals (PhilMetals) serves as the Metals Industry Research and Development Center's (MIRDC) tool to disseminate information relevant to the technical and economic development of the metals, engineering and allied industries. Since the Center's establishment in 1966, the MIRDC takes full advantage of the power of information sharing. The PhilMetals has remained one of the most effective platforms by which the Center is able to impart to the industry the results of its undertakings.

Through the years, the MIRDC was able to catalyze a beneficial alliance among various associations involved in the M&E industries. The Center aims to consistently provide the network of organizations with access to information regarding the MIRDC's research and development initiatives. Our R&D activities define who we are, and our ability to communicate our R&D outputs plays a significant role in our being able to offer longer-term solutions to challenges surrounding the industry.

Among the valuable outputs of our R&D initiatives are the technical papers that count as one of our most important strategies for information exchange. Authored by the Center's very own engineers and R&D staff, the compilation of the technical articles advocates the MIRDC's projects and activities focused toward enhancing the M&E industries' global competitiveness and productivity.

With pride, we present to you Volume 3 of the Philippine Metals, a publication that serves as a testament of the MIRDC's steadfast commitment to champion science, technology and innovation across all organizations in the metals, engineering and allied industries.

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The Philippine Electroplating Industry: Averting Barriers to Raise the Curtain

Ma. Rodessa A. MERCADO,*1 Eldina B. PINCA*2

Abstract

With the demand for electroplated products forecasted to grow, as carried by the rising status of the different sectors catered to by the electroplating industry, the changing condition also warrants positive intervention against the backdrop of its existing challenges. By analyzing the result of the Philippine Electroplating Industry conducted in 2015 , a little evidence of inflection point defines the competitive behavior of proprietors delving into creation of level playing field to accommodate the impact of this fundamental, yet very dynamic, industry. The changes in the current situation may provide a volatile outlook for the electroplating industry's opportunities as some issues that were previously identified such as readiness for manpower has been gradually addressed but other challenges such as fierce competition, lack of marketing strategy, high cost of production and sourcing of raw materials may still hamper its opportunities to grow. This paper provides an overview of the Electroplating Industry's 2015 survey results, identifying the status of the electroplating sector in term of its market and technical profile which are further analyzed in connection with the existing challenges for the industry. As described by the data, the electroplating industry is still in the growth phase and is heavily depending on the increasing demand for electroplated products which comes together with the improving status of the manufacturing sector. To go along with the rapid production trend, an extent to invest with technological advancement becomes necessary for the industry to overcome its key issues.

Introduction

The country's electroplating industry has consistently shifting demand patterns in the past but is slowly exhibiting an optimistic growth in the recent years. Generally, this subsector covers a broad category of products that are used by different industries and businesses such as automotive, electronics, aerospace, jewelry, appliances, home and office items, etc. As it covers an upstream production, the industry's level of competition also increases but still appears to be limited by the fundamental technologies that have been developed in the Philippines. The electroplating process adds attractive attributes to different products that make it highly significant in the manufacturing process. The electrolytic process utilized in the electroplating industry is uniquely adding value to a certain product by enhancing both its appearance and surface hardness and by protecting base metal from atmospheric corrosion.

The electroplating industry comprises only 4% of the metalworking sector in the Philippines (MIRDC, 2013) but may still bring invaluable contribution as a catalyst of the economy's development. The number of establishments that has plating operations in the country can be observed to follow an ascending direction which is an impact of the performance of the different sectors that it serves.

The electroplating business is typically classified on the basis of plating applications and end-use industries. Of the sectors served by the electroplating industry, both the automotive and electronics sectors make notable connection with the developing trend of the manufacturing activities that requires electroplated products. For one, the domestic base expansion for the automotive industry required a step-up from completely knock-down assembly to full car manufacturing (House of Representatives, 2013). Electroplating is an essential process in car manufacturing specifically in improving the aesthetic quality of some parts such as bumpers, grills and tire rims. Electroplated products also become a vital part of the fast-emerging fields in the electronics and aerospace industry. The robust expansion of demands for electroplated products has evidently fueled the electroplating operations and services in the last two decades.

In this review, the industry's capability to make impact with the increasing demands of the manufacturing sector is discussed. However, this will not tackle all aspects of the industry such as the implementation of environmental regulations since it was not covered in the study conducted by the Metals Industry Research and Development Center.

1.1 Industry Profile

In the Philippines, about 117 electroplating shops are identified to be

1. All Tables and Figures in this review were lifted from The 2015 Philippine Electroplating Study

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in operation, 68 of which were participants in the survey conducted by the MIRDC and are geographically located in Regions III, IV, VI, VII, XI, CAR and NCR. Among these industrial pockets of the electroplating industry, there is a heavy concentration of jewelry businesses with electroplating operations in Region III, particularly in Meycauayan, Bulacan. The electroplating businesses in Region VII (Cebu), on the other hand, appear to be more inclined in exporting electroplated products. Moreover, Region VII is also well-known for the electroplating business as it covers various products and services compared to other regions. Cebu's local government unit has also acknowledged the potential of growing electroplating industry by providing assistance to manage hazardous waste from electroplating companies. In today's industry, both Region IV and the National Capital Region exhibit competitiveness in terms of covering various electroplating processes to serve more sectors.

The sharp increase in the number of businesses with electroplating operations from 1991-2010 on the other hand, was championed by the increasing demand in the automotive, electronics and jewelry industries. As discussed by Aldaba (2014), the Philippine's strategy to focus on the development of the manufacturing sector since the 1980s is indeed important. The development in the manufacturing industry during the first decade was slow but both the automotive and jewelry industries made significant take off in terms of production in the 1990s while the Philippine electronics industry had a remarkably increasing investment from 1992 to 2001 (Agawarlla, n.d.).

A large segmentation of the electroplating industry in the Philippines, classified as independent businesses are mainly managed through single proprietorship. The nature of business is most likely inclined to jobbing activity as depicted by 46% of responses from MIRDC survey participants while 38% are into manufacturing activity. The nature of electroplating activities include an intricate process. The prevalence of jobbing operation in the electroplating industry is concurrent to the application of varying techniques in electroplating to accomodate modified requirements of the customers.

The electroplating firms in the Philippines are classified in the survey based on two key metrics: asset/capital worth and number of employees. The dominance of microenterprises, mostly home-based jewelry manufacturing in Region III, was noted in the survey. The trend of popularity of these microenterpises, however lacks relevant findings to identify its lucrative impact in the electroplating industry.

The data on the electroplating workforce, on the other hand, describes an improving condition in terms of increasing number of skilled workers. In the 2004 Electroplating

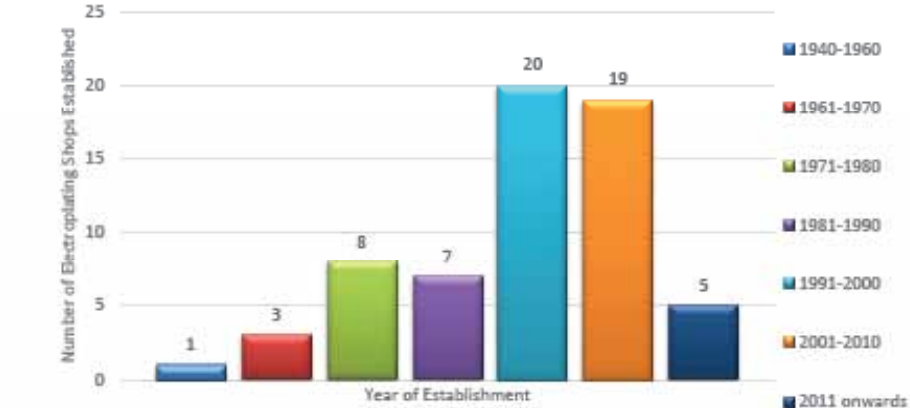

Figure 1. Year of Establishment of Electroplating Shops

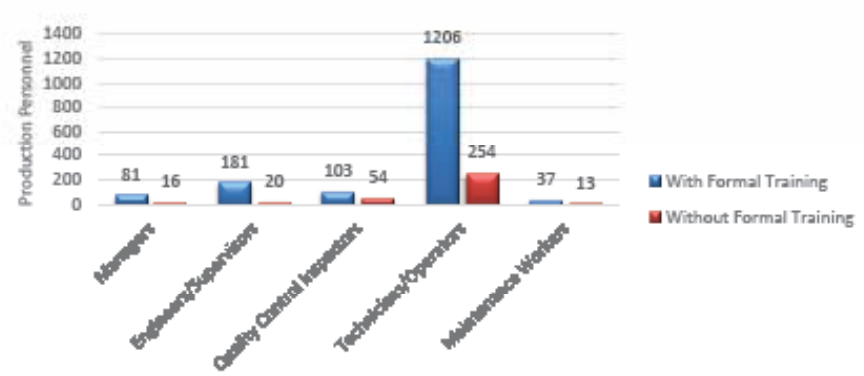

Figure 2. Production Personnel in the Electroplating Industry

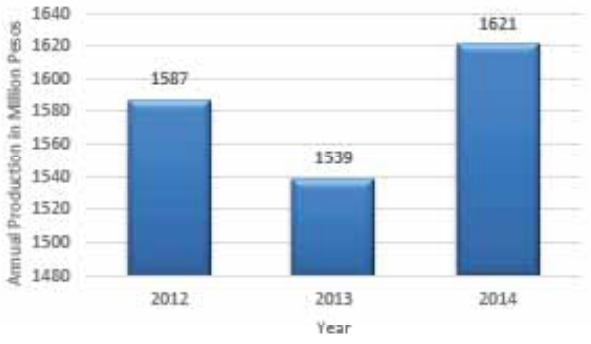

Figure 3. Annual Production of Electroplating Shops

2. The portal for the manufacturing of automotive parts and components opened doors to accomodate new players in the 1990s (Aldaba, 2007)

Industry Survey of the MIRDC, there was a reported shortage of skilled workers. This, however, was addressed with the noteworthy increase in the number of Technicians and Operators that have formal training, which may alleviate the threat of lack of proficiency among the electroplating workforce.

As seen in Figure 2, the production personnel in the electroplating industry is primarily composed of Technicians and Operators, followed by Engineers/Supervisors and Quality Control Inspectors respectively. Also noteworthy is the consistency of having formal training among all production personnel. The data however, may not provide an accurate picture of the competence of the production personnel in an electroplating shop. The most important thing to ensure in manpower development in the industry is to make the training specific to the needs of sectors it serves.

The data shown in Figure 2 reflects a sharp rebound in 2014 from diminishing production in the previous year. On the back of its exposure to strong challenges that results to an upward and downward shifts in annual production in the last two decades, the customer-specific requirement for electroplated products especially in mass production has led to a positive outlook paramount to the industry's future. The fact that the figures in the 2014 annual sales have recouped from the slump means that the industry can easily grasp effective measures to swing back to its competitive position after being dragged down by unforeseen circumstances.

As described by the local electroplaters, they are mostly serving a combination of company and individual customers. This appears to be a strategy for a more efficient business sustainability considering that the electroplating business is going through a phase of transition from traditional to a more advanced level of technological requirement. Furthermore, the competition in the industry is also perceived by the survey respondents to be very competitive, hence making a more reliable solution to cope with it.

1.3 Technical Profile

The Philippine electroplating industry largely utilizes the functional plating application while precious metal (gold and silver), hard chrome and copper-nickel-chrome plating are the most common types of plating operations. Functional plating application is commonly used for abrasion resistance, conductivity, contact resistance, non-stick resistance, oil retentiveness, rubber adhesion, softness and lubricity, solderability and rebuilding worn parts.

Due to the expansion of demand for electroplated products, the congruity of plating operations to the present condition has also become apparent. Compared to the result of the 2004 Electroplating Study charting the frequency of the brass plating operation, the update in 2015 survey reveals a totally different trend. In particular, the most common type of plating operation as reported in the latest survey shows a drastic inclination to precious metal electroplating. This type of plating operation is usually applied to jewelry, electrical and electronic parts and household goods due to its unique characteristics such as good electrical conductivity, resistance to corrosion and enhanced value, to name a few. Other plating operations that top the roll are hard chrome and copper-nickel-chrome plating, both widely used in the automotive sector.

Rectifiers and plating tanks, both considered as the most important equipment in the electroplating process, were mostly purchased brand new from 1991-2000. These equipment are mainly imported and are presently in good working condition. On the part of quality control in electroplating firms, visual inspection is commonly applied.

2. Industry Analysis

The electroplating industry is projected to have a boost in the coming years. In terms of addressing the needs of the industries that have vested interest in expanding production to maintain their competitive position in the market, a close link to fostering growth of the industry are as follows:

In the Philippine Development Plan 2011-2016, the Philippines' goods export concentration has improved in 2012 and is heavily dominated by electronics. In the electronics industry roadmap (SEIPI, n.d.), optimum business condition is targeted through government support and academe partnership, which may also positively impact the electroplating industry since it offers an integral process applied in the manufacture of electronic components by altering and improving the physical characteristics of the end product.

Moreover, the targets for the automotive sector as discussed by Mills (2013) includes 1) increasing production output to 506,000 units; 2) increasing domestic sales of locally-produced vehicles to 350,000 units; 3) increasing localization levels with new parts manufacturing capabilities; 4) exporting 156,000 vehicles; and 6) increasing parts export to USD 7 billion, while the jewelry sector is looking forward to conversion of small-scale businesses into world class players through strengthening of domestic market (Florencio, 2014). Both future directions are also creating an opportunity for the electroplating industry to continuously attain spur of growth in the succeeding years.

The assistance that the aerospace industry needs from the government is pertaining to the supply chain integration (AIAP, n.d.). What is being required on the part of the electroplating industry is the assurance that there will be chemical supplies, which include plating chemicals that conform to aerospace standards. Strict environment measures oversee the electroplating industry. As a result, sourcing of raw materials especially chemicals may be one of the challenges faced by the industry. From the survey conducted by the MIRDC, the respondents reported that most

3. The Philippines' goods export concentration based on the Herfindahl-Hirschman Index has improved from 0.25 in 2011 to 0.22 in 2012. (NEDA, 2014)

raw materials and chemicals can be sourced locally. Though this appears to be a favorable condition as this most likely reckons a smooth transition in production, it is still evocative that in order to aid an agreeable development projected towards a continuous supply of electroplated products, suppliers who are mostly importing chemicals in particular, should be keen with supply logistics to keep the particular standard of 'in-time' production and effectively respond to the challenges. Local electroplaters, especially those who are focusing on both jobbing and manufacturing activities are very particular in meeting production commitments to maintain customers' satisfaction on their services.

On the other hand, as expressed by the survey respondents polled from different electroplating shops and companies, there are challenges that they consider as top risks.

1. Stiff Competition. Price competition in the electroplating industry becomes fierce due to lack of standard price for electroplated products. The clincher, however, for proprietors going in this business is that they can still strongly compete by offering different options to customers through expansion of the plating operations that they carry out in their businesses. The more knowledge acquired by the technical experts in the electroplating establishments, the higher the technical capacity that can be offered to customers.

2. Lack of Customers. Due to inadequate marketing strategy for the electroplating industry, there has been lack of communication between the local electroplaters and their potential customers. Since most of the new processes are coming abroad, customers, especially those who are requiring detailed parameters for the electroplated products that they need, are mostly importing these products from foreign shores, not knowing that the same products may already be available locally from electroplating firms that have upgraded facilities to accomodate manufacture of new products. This deficiency, however, if addressed properly is seen to be a major opportunity for the electroplating industry.

3. High cost of production. Electroplating is not an inexpensive business to get into. Aside from materials, labor and equipment, the production cost of electroplating operations are also attributed to the utilities cost particularly electricity and maintaining waste facility. Most electroplaters are keen with the high production cost in the electroplating business but are still discerning on the offset of the advantages of mass production.

3. Discussion

According to Castells (2000), rapid technological change leading to knowledge generation gives face to contemporary economic development and may further increase competition between companies. The growth of the economy may be carried by constant development of new products, processes and varying nature of technology. For the local electroplating scene, an evident demand for electroplated products for the emerging aerospace industry needs viable attention. Electroplating has been traditionally used primarily for corrosion resistance, decorative finish and wear resistance but as the technology advances, the requirement for the electroplating industry also needs to make headway especially with its engineering qualities in order to make a parallel upgrade with competitive sectors that it serves. However, to get the point across, it is also important to see the social condition of the country to identify how it can foster technological innovation that further feeds into the path of economic development and further innovation (Castells, 2010).

The logic behind the positive improvement of the electroplating industry in contrast to the challenges that are still existing is this: the Philippine Electroplating industry may have established a fundamental structure of readiness for an advanced quality for its manpower by focusing on having skilled workers but exhibits slow innovative responsiveness to opportunities offered by the different sectors it serves. As a result, there seems to be a strong force that acts as damper on the industry to boost its ability to advance in the local scene of the M&E Industries.

As described by the four-year comparison of the import and export data from 2011-2014, both figures are exalting but still depict that the consumption of electroplated products from other countries is still much higher than its production in the country.

Globalizing production, in this sense will allow opportunities to sieze the most advantageous conditions to make competitive advancement. Electroplating, as a critical step in manufacture of different automotive and electronic components, presently requires processes focusing on adaptablity to existing business condition as well as flexibility and efficiency.

In a nutshell, it can be argued that in order to win the local market,

Table 1. Import of Electroplated Products (4-Year Comparison)

	2011	2012	2013	2014
Quantity (GK)	423,559,260	283,158,715	456,490,199	801,825,776.92
CIF Value ($)	805,791,067	278,112,999	425,151,616	838,524,507

Table 2. Export of Electroplated Products (4-Year Comparison)

	2011	2012	2013	2014
Quantity (GK)	11,318,120	9,998,485	28,728,507	72,738,809.78
FOB Value ($)	12,653,676	6,346,368	258,726,474	553,949,616

a unique strategy is a necessity for the electroplating industry. The surging popularity of electroplated products in the manufacturing industry stems from the demand for a range of automotive and aerospace parts, electronics and semiconductor assembly, jewelry manufacturing and the like.

Aside from technical consultancy and training, the MIRDC has also made R&D initiatives to elevate the status of the Electroplating Industry. The non-cyanide copper and gold electroplating is one of the projects of the MIRDC. This drive offers several benefits such as eliminating the dangers inherent in using cyanide and cyanide compounds; minimizing employee health risks; reducing pollution to environment; and reducing costs by simplifying waste treatment process.

4. Conclusion and Recommendations

The M&E industries in the Philippines has a well-established network of support groups that work on providing the needed enhanced services and operations while the MIRDC provides the relevant technical consultancy to address existing challenges of its industry partners and to assist them beforehand. The shortfall in expectation for the electroplating industry can be addressed by considering a collaboration between the government (MIRDC) and its industry partners through conduct of focus group discussions to identify the gap between the electroplating industry and the sectors it serves. By doing such, it can be discussed in detail how the following recommendations can be translated into actions:

- The revitalization of the Philippine Electroplating Association will help its members to gain technical know-how in the production process which further leads to efficiency. This association will also widen the industry partnership that will allow each member to identify the specific needs of the industry in a widespread reach. To stay competitive, facilitating collaboration and communicating for knowledge exchange is necessary. One of the possible benefits from doing this is being able to gain an upper hand in determining the services and new processes, as well as the type of products that can be produced competitively depending on the needs of the continuously expanding industries with various demands for electroplated products. Additionally, participation in cooperative research programs with the government will effectively allow industry partners to gain access to new technologies on the electroplating processes since the industry needs a versatile technology.
- Areas of cooperation includes recognition of professional qualification that should be incorporated in human resources development. The local pool of electroplaters have been prepared relevant to the promising future of the manufacturing sector but should be kept abreast of the coming skills requirements which will be more comprehensive. Investing further on training of electroplaters and technical staff will definitely generate a large return to the industry especially in identifying the most relevant tool for expansion of business to properly address what the industry is lacking.
- Producing a roadmap for the Electroplating Industry will be an effective measure to spell out an outline for the strategic approach to maintain a competitive position in the M&E industries..

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Development of Vacuum Gas Quench Heat Treatment Furnace

Jonathan Q. PUERTO,[*1] Maria Gracia M. PERALTA,[*2] Joey G. PANGILINAN,[*3] Mervin B. GOROSPE[*4]

Abstract

In the hopes of providing the metals and allied engineering industry of high impact technology with efficient, accessible, and cost-effective services, the Metals Industry Research and Development Center (MIRDC), with the help of PMEDSO, PDMA, and MIAP, pursued to establish a vacuum gas quench heat treatment furnace service facility that is capable of heat treating ferrous alloys with a maximum temperature capability of 1300^{0}C and a maximum operating load of 200 kilograms.

Results show that the required parameters to make the facility competitive with existing heat treatment facilities are met. The maximum vacuum level is achieved at 6.2 x 10-1Pascal (Pa) and the temperature uniformity is at ± 5^{0}C measured at 9 points within the effective size held for one hour. The vacuuming time from room atmosphere to 5 Pascals and the heating up from ambient temperature to 1,200^{0}C is 11 and 33 minutes, respectively. And in relation to quenching, the cooling speed from 1,200^{0}C to 150^{0}C is 14 minutes. To date, about one (1) ton of steel has been heat treated in the facility and has passed the hardness quality inspection requirements (March 2016).

Introduction

Heat treatment is a combination of timed heating and cooling applied to a particular metal or alloy in its solid state in such a way that it will produce certain microstructure and desired mechanical properties such as hardness, toughness, yield strength, ultimate tensile strength, Young's modulus, percentage elongation, and percentage reduction. Annealing, normalizing, hardening, and tempering are significant heat treatments often used to modify the microstructure and mechanical properties of engineering materials particularly steels [1].

Heat treatment plays vital role on the properties of metals. The process dictates the mechanical property of the final product suitable for its application. While this may already be effective in treating metals and alloys, innovation of the system through the development of a vacuum heat treating facility will increase the process performance and reliability. A controlled environment is effective in preventing scaling, decarburization, and oxidation thus; products with superior finish and chemistry are produced unlike those treated conventionally. Consequently, Vacuum Heat Treatment also offers the following significant processes:

- Removing of surface contaminants such as oxide films and residual traces of lubricants resulting fromfabricating operations;
- Addition of substances to the surface layers of the treated metal/alloy (through carburization, for example)
- Removing of dissolved contaminating substances from metals through the degassing effect of a vacuum (removal of H2 from titanium, for example);
- Removing O2 diffused on metal surfaces by means of vacuum erosion techniques; and
- Joining metals by brazing or diffusion bonding [2].

Stamping dies, punching dies and automotive parts are among the top products for heat treatment. These parts are easily manufactured in the Philippines through machining and forging and consequently a reliable hub for vacuum heat treatment will then support the technical qualities of the product. Most vacuum heat treatment facilities in the country today are in-house, meaning; they cater to their own products. There may be few that offer commercial vacuum gas quench heat treatment facilities however, service costs are high. Some companies in the local metalworking industry are forced to avail of the vacuum heat treatment services abroad, thus, spending more on shipment and experiencing delay on delivery. To address this avertable inefficiency, MIRDC will offer the same service yet entailing a much lower cost (based on price standards of neighboring Asian countries). Once the facility is established, the technology may encourage local companies to adopt and/or invest on the facility to aid them in increasing their productivity and meeting on-time delivery of products. In this kind of situation on vacuum heat treatment services in the country, made DOST realize the need to establish and develop a local vacuum heat treatment facility to level the playing field from other country in terms of cost and delivery schedule.

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The Development of Vacuum Heat Treatment Furnace Project in MIRDC aims to:

1. cater the industry with technology edge heat treatment services for various ferrous metals by locally fabricating a vacuum heat treatment facility operational for its purpose; and
2. continuously innovate other process and materials that could be possibly processed on this facility.

The use of vacuum furnace has several advantages. In one literature, a comparison was made between Vacuum Furnace and Atmosphere Furnace Processing. Unlike in the conventional atmosphere heat treatment, vacuum heat treatment does not require control of carbon potential of prepared atmospheres and related furnace conditioning requirements. The water-vapor content or dew point of a protective gas atmosphere in atmosphere heat treating is often the most critically controlled variable in addition to the temperature and time of processing. A vacuum furnace contains minimal amount of residual gases. After a vacuum furnace has been evacuated, gaseous reactions are virtually eliminated [2].

Although the vacuum heat treatment is originally developed for processing of electron tube and space-age materials, it has been found that it has significant advantages for metallurgical processing such as [3]:

1. Prevention of reactions at the surface of the work, such as oxidation or decarburization, thus retaining a clean surface intact
2. Removal of surface contaminants such as oxide films and residual traces of lubricants resulting from fabricating operations. The latter often are severe contaminants to the furnace;
3. Addition of substance to the surface layers of the work, such as by carburization;
4. Removal of dissolved contaminating substances from the metals, using the degassing effect of a vacuum, such as a hydrogen or oxygen from titanium; and
5. Joining metals by brazing or diffusion bonding.

Scientific Basis/Theoretical Framework

In a hardening process for steels, quenching is the most critical step since it will determine whether enough martensite is formed to meet or go beyond the required hardness. Martensite is a microstructure characterized by its hardness and brittleness at the same time. Quenching is the rapid or sudden cooling employed to create a super saturated solution.

In general, quenching is the transfer of a hot load to a quench medium such as water at high speeds in order to minimize the decrease of temperature of the load prior to immersion. During this transfer, it is inevitable that items to be quenched are exposed to air, specifically oxygen. This creates oxidation on the surfaces of the steel resulting to scaling which is highly undesirable and possibly be detrimental to the product. With vacuum heat treatment, this effect can be minimized, if not eliminated, by heating the items in a controlled environment. Heat treatment in vacuum is carried out with high consistency and low contamination due to the absence of air, thus heat transfer through convection is prevented. Better uniformity of temperature and ensured metallurgical repeatability are met when computer controls are incorporated in the design.

Furthermore, there are two major applications of quenching [3], these are:

1. Development of acceptable gas-quenched microstructure and mechanical properties and tempering, and
2. Retaining of a uniform solid solution for subsequent forming process and then precipitation hardening process or aging.

Both applications above can be explained by metallurgical aspects. For most ferrous alloys the hardness is explained by the transformation of the austenite. Since the desirable effect is to harden the metal, martensite is the favorable microstructure.

Methodology

For better appreciation and understanding of the technology, several companies in the country having Vacuum Gas Quench Heat Treatment facility were visited by the project team. These furnaces were purchased abroad, while the assembly and commissioning follows after the delivery. Some of these organizations cater only to their own products and do not accept external jobs*. The following are the companies who have given their support for this project:

- Aichi Forging Company of Asia, Inc. in Sta. Rosa, Laguna*
- Air and Water Philippines, Inc. in Biñan, Laguna
- Penta Technological Products, Inc. in Pasig City
- MOOG Inc. in Baguio City*
- Bangko Sentral ng Pilipinas in Quezon City*
- Lufthansa Technik Philippines in Pasay City
- Philippine Precision Technology, Inc., in Calamba City, Laguna

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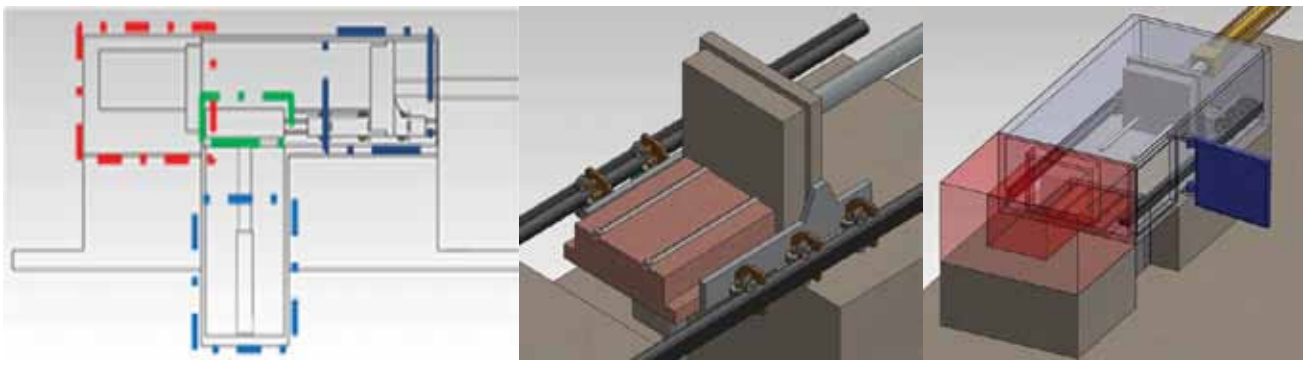


Figure 1 Concept Design by PMEDSO on Vacuum Oil Quench Heat Treatment Furnace showing the transfer mechanism of load from heating to quenching and unloading.

The visits were done to gather data and other relevant technical information such as materials used, dimensions and specifications of components, and operating parameters. The result of the plant visit has served MIRDC to its direction and has aided the Project Management and Engineering Design Services Office (PMEDSO) in coming up with the concept design of the furnace.

A. Concept Designing

Several concept designs with corresponding advantages and disadvantages were prepared and presented for approval. These were the result of the plant visits and other research activities made by MIRDC and PMEDSO. Shown below was the approved horizontal loading concept design for vacuum oil quench furnace:

B. Development Phase & Fabrication

Technical complications arise during this phase. The Office of the Secretary through the Usec of R & D recommended collaboration with Metal Working Industries Association of the Philippines (MIAP) this has been in connection with result of consultative meetings with various stakeholders in metalworking industries, technical experts and academe. MIRDC, PMEDSO & MIAP finally work on the Vacuum Gas Quench Heat Treatment Furnace from the oil-quench vacuum furnace.

Based on the finalized technical specification the team has identified the following five (5) main systems of the vacuum gas quench heat treatment facility:

1. Vessel and Heat Chamber System;
2. Vacuum System;
3. Control System;
4. Gas Quench System; and,
5. Water Cooling System.

Of the five systems, the Vessel and Heat Chamber System, Vacuum Pump System, and Control System were contracted to ULVAC. The gas quench and water cooling systems were pre-identified to be having local suppliers capable of meeting the required specifications and design.

C. Installation, Integration, Commissioning and Testing

The final integration of the five (5) systems including commissioning and testing were done in MIRDC. The design and construction of concrete tanks to serve as reservoir for the water cooling system was done by MIRDC personnel from the Materials and Process Research Division (MPRD).

Tables 1 & 2 show the inspection and testing as well as the corresponding result of the newly installed vacuum chamber machine. Whereas, for the utilities; nitrogen quench and water cooling systems has been inspected through leak testing and pressure drop test.

Discussion of Results and Findings

A. Vacuum Heat Treatment Vessel & Assembly

1. Fabrication Stage

The fabrication of the heating chamber was done at ULVAC, Shen Yang, China. The mechanical fabrication and control panel instrumentation assembly commenced also at the same site. Below are the images of the fabrication stages which were monitored by MIRDC.

a. The vacuum heat chamber

Figure 2. The picture shows (clockwise) the fabrication of the heating chamber. It started with the rolling of the sheet metal and structural reinforcement. The chamber is then insulated. At the lower right, the tubes for evacuation are welded and the whole heating chamber is placed in the outer shell vessel. At the lower left, shows the graphite heaters are configured.

b. Heat exchanger and the outer shell

Figure 3. Picture (clockwise) shows the fabricated heat exchanger. Picture shows the finished vacuum vessel – outer shell. Picture shows the heat exchanger is installed at the rear of the vacuum vessel.

c. Motor fan vessel and installation

Figure 4. Images depicting the development/fabrication of motor fan vessel and installed at the back of the vacuum vessel.

2. Installation, Integration, Commissioning and Testing

a. Control panel and Instrumentation

After the fabrication at Ulvac, all the three systems are integrated, the chamber, the vacuum system, and the control panel. The control panel and its components are assembled at Ulvac site. The minimum terms required by the project team was met. MIRDC project team and the MIAP members have visited the site for the equipment audit. The audit includes the visual and physical equipment audit, the hot and the cold tests. There were observation and findings during the physical inspection while equipment is running at the fabrication site. Ulvac, China has committed to correct some observation and was corrected based on the report and during the arrival of the equipment. At this stage, the team has a real experience on the metal fabrication of the different parts of the machine.

Figure 5. The images presented show the development and installation of Instrumentation on the control panel cabinet

Figure 6. Images above show the integration of the systems as part of the commissioning and training activities

b. Cold and Hot Testing Results

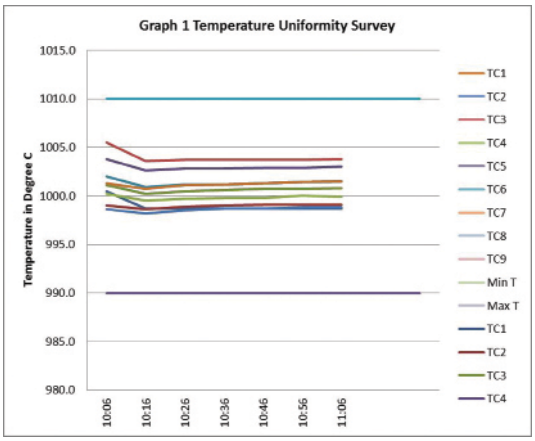
The cold and Hot Inspection/Testing results both during the commissioning at MIRDC and prior the delivery of the machine at the supplier end provide a reliable furnace. The technical specifications were met during the testing and commissioning. Vacuuming time and the vacuum state were achieved. Equally important is the heating up and its temperature consistency as reflected in the Temperature Uniformity Survey result (Graph 1). With these important parameters such as temperature as well as pressure inside the vacuum vessel would mean a positive response of metal being heat treated.

b.1 Cold Test Result

Table 1 .Equipment Audit at MIRDC Site Result (Cold Test)

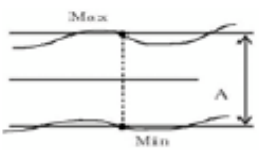
Item	Inspection Item	Criteria	Result
1*	Safety Valve	0.15MPa*G	Tested at Fabrication Site
2	Ultimate Pressure	Ultimate Pressure ≦1Pa	6.2×10^{-4} Pa
3	Vacuuming Time	from ATM to 5Pa ≦ 20min	Achieved 5 Pascals within 11 minutes
4	Pressure Rise	within 0.4Pa/h	0.11 Pa /h
5	Safety interlock	No abnormality on interlocks	As observed/ witnessed – no abnormality on interlocks
6	EMO	EMO Works properly	As observed/ witnessed – no abnormality on interlocks
7	Cooling Fan	No abnormality on mechanical and electrical	As observed/ witnessed – no abnormality while fan is being operated, no electrical tripping or any mechanical damage

*No further test at MIRDC site



b.2 Hot Test Result

Table 2 Equipment Audit at MIRDC Site Result (Hot Test)

Item	Inspection Item	Criteria	Result
1*	Maximum Temperature	1340°C (hold for 30min) No work, No tray, after de-gassing	Tested at Fabrication Site
2	Heating Up	≦60mins at empty chamber room temperature to 1200°C	Achieved from ambient temperature 1,200°C at 33 minutes
3*	Heat-Keeping time (empty chamber)	Keep 1200°C for 1 hour and no damage nor distortion inside the chamber	Tested at Fabrication Site
4	Temperature Uniformity	within +/- 5°C at 1000°C at 9 points measurement. No work Uniformity : A, ±Δt, t=A/2 	T/C no / Temp °C (Ave per TC): 1: 999.0; 2: 999.0; 3: 1000.7; 4: 1005.0; 5: 1001.4; 6: 1001.2; 7: 998.6; 8: 1004.0; 9: 999.8 Δt = (1004.0-998.6)/2 = ± 2.7°C (See Graph 1)
5	Cooling Speed	from 1200°C to 150°C ≦ 20min No Work, No Tray	From 1200°C to 150°C, 14 minutes (1.25 °C / sec)

*No further test at MIRDC site

B. Utilities Commissioning and Testing

1. Quench or Inert Gas System

Leaking is tested by simple method. Joints and welded areas are sprayed with detergent solution and bubbles denote leaks. No major leaking is observed.

To further check the integrity of the pipeline, pressure is observed over time or the pressure drop test is done. Wherein, argon gas was supplied to the pipeline and at both ends of the pipeline the pressure was held to 200 bars and the supply of argon gas is then closed. The set-up is held overnight or for 12 hours, no change in the pressure gauge is observed.

Figure 7. Cylinder and pigtail connection. The arrows below show the connection of pigtail from the nitrogen cylinder (source) to the main pipeline orifice. Leak is most likely to occur at these points if improperly set or connected.

2. Water Cooling System

No major leak was found in the joints and welded areas of the water pipes. However, before the testing and commissioning a minor concern was raised that is the height of the "hot" water collection tank is lower than the built reservoir tanks; technically there will be no flow of water (gravity) towards the "hot" reservoir tank.

Figure 8. The Water Collection Tank

To address the problem stated the team manages to reconfigure which pump rating should be on the right tank. The water circulation has been effective or balanced after several runs because neither overflowing/spillage nor lack of water from the different tanks were experienced.

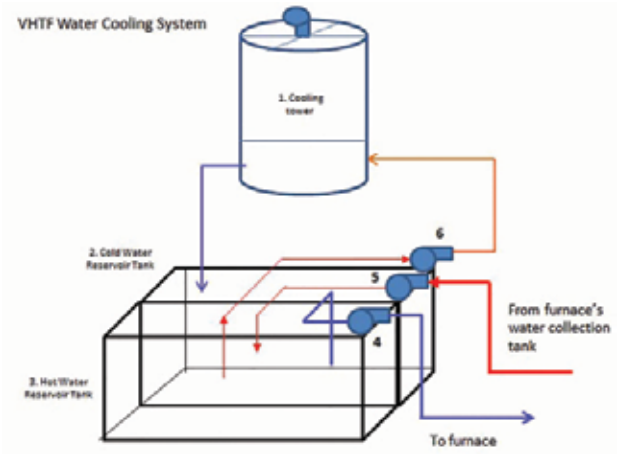


Figure 9. Image above shows the final design installed for water cooling system for the vacuum furnace. Below left is the specification for the design. While the image below right is the actual installed pipe & motor pumps.

Summary and Conclusion

Outcomes from every step to complete the project can already be considered a milestone. The MIRDC project team together with PMEDSO, MIAP, and PDMA has undergone collaborative efforts to meet the challenge of the MAKIBAYAN program.

From this day forward, the local metalworking industry will no longer rely on vacuum heat treatment abroad as this high impact technology process for ferrous metal alloys can already be accessed locally. With due diligence in exploring possibilities of fabricating the vacuum chamber body locally, MIAP was able to witness fabrication and design of the technology through the equipment audit held at ULVAC site Shenyang, China.

At this point, the temperature uniformity survey, the heating up rate, the vacuum environment processing, and evacuating time are among the data that prove that the equipment that this equipment is ready for its service purposes. Generally, temperature setting parameters are already established in the conventional heat treatment furnace and these can be easily programmed in the controller for the vacuum heat treatment furnace. The system will then run automatically until the quenching or hardening process. The cooling down data indicates the rate of cooling which is acceptable for the formation of martensitic microstructure that induces the physical and mechanical properties of metal. Moreover, it is imperative to offer the services now (at the time of writing) for vacuum heat treatment to the public without numerous testing of different alloys that are very responsive to heat treatment. Aside from hardness test, a series of metallographic inspection is to be done with each heat-treated type of metal to fully secure that the necessary parameters are properly met. Consecutive successful results should trigger to cater the industry needs for vacuum heat treatment. These pro-

cess testing were not accomplished due limited time incurred with the undertakings during the designing period. And to meet the objective of this project, that is to cater the industry with technology edge vacuum heat treatment services, this will be formally launch alongside with the surface engineering technologies such as anodizing and electroplating.

In addition, once the ferrous vacuum heat treatment parameters are established, this will be the avenue for the research and development for the processing of parts for advanced transportation and aerospace. With the above processes foundation this will start the innovation using other process and materials; processes such as sintering and brazing and introduction of materials such as other gas atmospheres for different non-ferrous materials. The achievement of second objective to continuously innovate other process and materials may take time.

In addition, the establishment of this new equipment for heat treatment is an attribution for strengthening the competency of MIRDC in vacuum technology.

Update: *As of March 2016, there were more than ten customers availing the services of the vacuum heat treatment furnace and almost one ton of ferrous alloy has been heat treated. D2 and H3 ferrous alloys are mostly process in the MIRDC Vacuum Gas Quench Heat Treatment Furnace.*

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9. Letter from the Office of PMEDSO signed by ASec. Robert O. Dizon
10. Copy of Letter from PCIEERD to Usec. Amelia P. Guevara signed by Dir. Cristina L. Guevara
11. Letter informing PCIEERD as instructed by the Office of the Secretary to collaborate with MIAP signed by Dir. Arthur Lucas D. Cruz.

Figure 10. The Vacuum Gas Quench Heat Treatment Furnace.

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Design and Fabrication of Jigs Fixtures, Tools & Die Components, Precision Machining of Test Equipment / Machine Components Parts.

Support to the Surface Engineering Requirements of High Technology Manufacturing Industries

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Abstract

With the high demand for a technology that will make the local Surface Finishing industry competitive, the Metals Industry Research and Development Center (MIRDC) established an anodizing facility. Anodizing is a process of producing the film of aluminum oxide which forms aluminum when current at sufficient voltage is passed through aqueous acid electrolyte. In this process, aluminum product (substrate) is the anode and a suitable material is the cathode. Anodizing related equipment and materials were installed at MIRDC's surface engineering building. These include: approx. 400-L capacity tanks, direct current (DC) rectifier, pulse rectifier, chiller, cooling tower, de-ionizing water facility, fumes scrubber and waste treatment facility. Anodizing of different aluminum products with diluted sulfuric acid solution were conducted using direct current and pulse power supply. With the formulated anodizing solution and established operating parameters, anodized products with acceptable coating thickness were obtained. With this new facility and established parameters, decorative and hard-coated aluminum anodized products can be produced. MIRDC's anodizing facility will help address the needs of different sectors such as automotive, industrial, aerospace, shipping, and among others. It is also envisioned that the availability of this facility will develop the capability of local companies involved in the surface finishing business and enable them to be at par with international standards in quality and productivity that will significantly redound to a better domestic economy.

Introduction

Surface finishing is a broad range of industrial processes that alter the surface of manufactured products to achieve a certain property. Finishing processes may be employed to: (1) improve appearance, (2) adhesion, (3) solderability, (4) corrosion resistance, (5) hardness, (6) modify electrical conductivity, (7) remove burrs and other surface flaws, and (8) control surface friction. Surface treatments are widely used in most industries to provide improved surface properties of a component. Some of the industries that are being served by the surface finishing industry are automotive/transport, aerospace/aviation, semiconductors/electronics, appliance, jewelry making, etc.

Hard coat anodizing is a type of surface treatment that involves placing an aluminum part into an electrolytic bath and applying electrical current through the bath. This process forms an oxide coating on the aluminum part. The oxide coating is built up by a process of anodic oxidation in an acid electrolyte, thus preventing any thermal or physical distortion of precision-engineered components. This oxide coating can be harder than case hardened steel thus, providing an excellent abrasion resistance; it is protective to the aluminum part and can be very durable.

Anodized aluminum is used in thousands of applications and remains a relatively low-cost finish that, for some markets, has no suitable replacement. Although significant growth isn't anticipated for the upcoming years, the anodizing industry as a whole is healthy and should exhibit sustainable growth in the future. An important benefit of anodized aluminum is that its life cycle is relatively benign to the environment compared to other metal finishing processes.

Since 2011, the Department of Science and Technology (DOST) focuses on developing scientific and technological solutions to enhance delivery of government and social services to address pressing national problems. In DOST's five-point agenda for 2011-2016, the agency intends to develop the global competitiveness of our local industries through the use of science and technology. This is in support to DOST's plan to employ "smarter ways of doing things". In this light, DOST through the Metals Industry Research and Development Center (MIRDC) desire a locally-available support facility for our local Surface Finishing Industry.

The project generally sought to establish a Surface Finishing Facility in MIRDC that will focus on new technologies, new innovations, and new products and processes that will enable them to be at par with international standards in terms of quality and productivity and consequently contribute to a better economy. Specifically, it aimed to (1) establish a hard anodizing facility in MIRDC, and (2) evaluate the applicability of the pulse rectifier in the anodizing process.

However, due to high cost of titanium, aluminum rod and aluminum wire are used in the operation. Unlike

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titanium, it is necessary to remove thoroughly the anodic film from aluminum jigs after each process.

The evaluation of the applicability of the pulse rectifier was only conducted in the anodizing process. The pulse rectifier was installed in the anodizing area and it is not advisable to transfer the connection to the plating room. The application of pulse rectifier in plating processes was being done in another project by MIRDC entitled "Application of Pulse Techniques in the Surface Finishing of Metal Products".

Only 3 types of aluminum were tested and experimented in this study i.e. Al 1100, Al 6061 and Al 7075 . These aluminum types are those that were provided by the customers and are available in the local market.

Through the establishment of this new emerging technology on Surface Finishing in MIRDC, the growth of the Surface Finishing Industry in the Philippines will be supported.

Review of Literature

Anodizing is a process of producing the film of aluminum oxide that forms aluminum when current, at sufficient voltage, is passed through a suitable acid electrolyte –in which aluminum is the anode and a suitable material is the cathode.

The anodizing process involves the electrochemical conversion of the treated surface to aluminum oxide, the aluminum serving as the anode in an aqueous electrolyte and the oxygen being provided by electrolyte dissociation of water. As the reaction of process continues, the oxide grows in the metal.

There are many important parameters that affect the anodizing process. Some of them are the following:

a. Temperature of the solution. Decorative anodizing process is conducted at room temperature. For hard anodizing process, a chiller is needed to cool the solution at about 10 oC or lower to achieve better results.
b. Concentration of the electrolyte. Diluted solution of sulfuric acid is used. Increased concentration of sulfuric acid causes voltage drop which requires more solution to maintain the desired current density.
c. Current Density. The current density determines the rate of film growth.
d. Anodizing Time. The thickness of coating in anodizing depends on the anodizing time. For hard anodizing process, the longer the anodizing time, the thicker the coating.
e. Degree of air agitation. Air agitation is essential in anodizing process.\
f. Aluminum grade. Different aluminum alloys have different anodizing rate.
g. Voltage. The voltage required to produce a given current density is inversely proportional to the electrolyte concentration and the electrolyte temperature.
h. Film thickness. Film thickness increases in proportion to the amount of electricity flowing on the aluminum surface and the anodizing time.

Methodology

Study missions

Study missions were conducted here in the Philippines and other Asian countries, particularly in Taiwan and Singapore. New technologies and techniques on Surface Finishing were learned and acquired during these study missions.

In the Philippines, the project team visited the Kapco Manufacturing, Inc. located in Cavite. Kapco has different metal surface treatment and anodizing lines such as electro-deposition coating, electroless- nickel plating, chemical etching, and anodizing. During the visit, only the decorative anodizing line was operational. The hard anodizing line is temporarily closed since the chiller for anodizing process was defective at that time. The team also visited and observed the anodizing processes offered by the RVM company in Laguna.

Two study missions were conducted to benefit the project. One was in Singapore on March 18-22, 2012 as funded by the Cordillera Administrative Region's Regional Development Council from its Special Autonomy Fund and another in Taiwan on May 5 – 9, 2013 through the MIRDC disaggregated project entitled "Support to the Surface Engineering Requirements of High Technology Manufacturing Industries in which companies with surface treatment and anodizing operations were visited and observed surface engineering technologies, facilities, and actual operations by companies in the said countries in both decorative and hard anodizing. Please refer to Annex A for the Official Travel Report of the Taiwan study mission.

Anodizing Facility

Anodizing facility was established in MIRDC's surface engineering building. Anodizing related equipment and facilities were installed. These include the following:

a. SCR Rectifier, 1000 Amp, 0- 60 V
b. Pulse rectifier, 500 Amp
c. Chiller, 5 Hp, 3P
d. Cooling Tower, ¼ Hp, 1P
e. Chemical Tanks (approx. 400-L capacity) tanks with fumehood and ducting
f. Rinsing Tanks

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Figure 1. The anodizing line (tanks, rectifiers, and chiller)

Figure 2. De-ionizing water facility

Figure 3. Fumes scrubber, cooling tower, and waste treatment facility

g. De-ionizing water facility
h. Fumes scrubber, 7.5 Hp, 3P
i. Waste treatment facility

The complete aluminum anodization process generally consists of three major processes: (A) Pre-treatment processes – both mechanical and chemical; (B) Anodizing process; and (C) Post-treatment processes – coloring (optional) and sealing.

Anodizing process includes the following:

1. Mechanical Pre-treatment

The mechanical pre-treatment is used to remove scratches, burrs, wrinkles, etc. on the product surfaces. Different methods of surface preparation are the following:

a. Buffing - Grinding and buffing are used for the purpose of creating a mirror gloss. A bulk disk rotating at a high speed using cotton cloth can be used.
b. Blasting - Blows tiny particles into products for the purpose of creating a matte finish, or for obtaining uniform surface roughness.
c. Barreling - Polishes product by gently vibrating them in a barrel filled with abrasive material and water. This is used mainly for deburring.

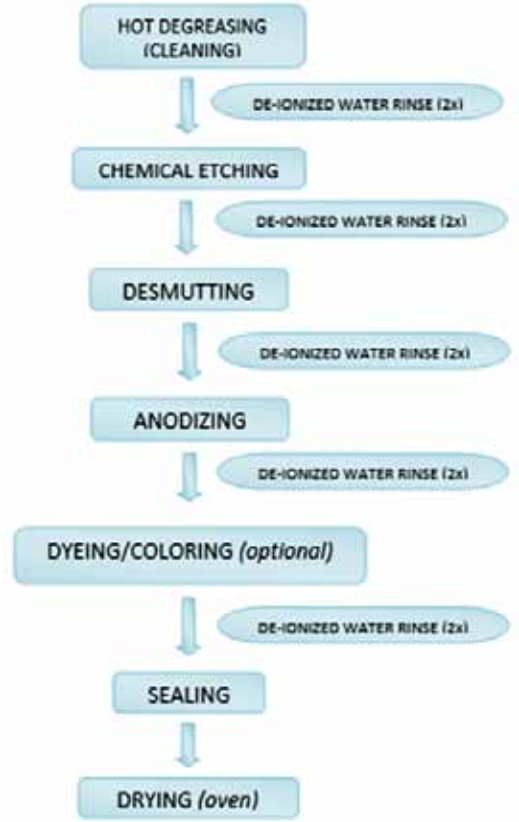

Figure 4 shows the Anodizing process flow chart

2. Racking or Jigging

Electricity is used for anodizing process. A jig (usually made of aluminum) is necessary to conduct the electricity and to support the work piece.

3. Hot Degreasing (Cleaning)

This is a process to chemically remove the natural oxidation film, fats, oils, or abrasive materials stuck on the object which is important in the uniform coverage of the overall surface of the work piece. A surface active agent or organic solvent can be used.

4. Chemical Etching

Alkaline solution or acid solutions can be used for surface preparation depending on the product's characteristics, configuration, purpose of use, etc. However, alkaline cleaning is said to be the more efficient method.

5. Desmutting

This process includes the removal of the gray materials formed after alkaline cleaning.

6. Anodizing

The anodizing process is carried out in a diluted sulfuric acid electrolyte. Different operating parameters were experimented to come up with good anodized products.

7. Coloring/Dyeing (optional)

The concentration of the dye depends upon the shade of color required. For a pale color, the dye should be more diluted. Deeper shades require more dye concentration. The water used for making up the solution should be deionized water since a small amount of iron or phosphate in the water can reduce the intensity of certain dyes and may cause bleeding during sealing operations.

8. Sealing

Sealing is very important in anodizing aluminum especially after dyeing. It closes the pore structures of the oxide coating to make the work piece smooth.

9. Drying (Oven)

Visible inspections and coating thickness tests were conducted on the anodized products.

Discussion of Results and Findings

Racking or jigging is an important primary step in anodizing. Akin to electroplating, electricity is also used in anodizing. A jig, usually made of aluminum or titanium, is necessary to conduct electricity and to support the work piece. This is removed after processing. Due to high cost of titanium, aluminum rods or wires were used as jigs for this particular project.

During the early stages of the experiment, unsatisfactory anodizing results i.e. chalky/powdery appearance, thin film formation or no anodizing film were obtained on the sample products even after immersing the treated product in the anodizing tank for a considerable amount of time. Improper jigging of the work piece may result into uneven supply of current into the jigs and work piece. This may bring possible damage in the aluminum frame/jig or even on the product to be anodized as seen in Figure 5.

Modifications on the racking/jigging of the sample products were done to address problems encountered in during anodizing of aluminum. The size of the jigs (aluminum frame), the orientation of the work piece on the jigs, and the proper insulation during processing were taken into consideration in jigging or racking when anodizing. It is also very important that the jigs or racks have

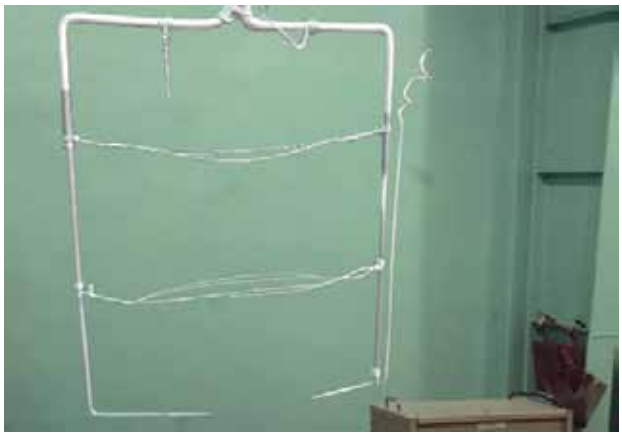

Figure 5. Sample of damaged aluminum jig frame

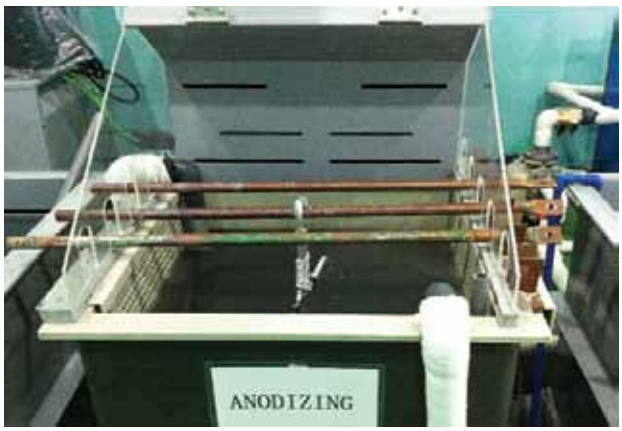

Figure 6. Sample of good racked aluminum product

Figure 7. Anodizing process set-up

enough distance from the cathodes when placed in the anodizing tank. The distance of the anode (work piece) to the cathode should be far enough to allow a good flow of electricity in the anodizing system (please refer to Figure 6).

In anodizing process, several adjustments on the parameters like the anodizing time, solution temperature, and current density were repeatedly done until desirable product was obtained. Figure 7 shows the anodizing set-up.

Parameters used are as follows:

The supplied current, processing time, and the temperature of the anodizing solution were adjusted to estab-

1. Hot Degreasing (Cleaning)

Cleaning Compound	:	10- 25 g/L
Temperature	:	60 oC – 65 oC
Time	:	5 – 15 minutes

2. Chemical Etching

Sodium Hydroxide	:	40 -50 g/L
Additive	:	2 % – 3% by volume
Temperature	:	55 oC – 65 oC
Time	:	10 – 25 minutes

3. Desmutting

Sulfuric acid	:	27 – 110 ml/L
Additive	:	1% - 3% by volume
Time	:	3 – 10 minutes
or		
Nitric acid	:	10% - 20% by volume
Time	:	1 – 2 minutes

4. Anodizing

Sulfuric acid	:	80 – 90 ml/L
Temperature	:	-8 oC to 8 oC
Time	:	60 – 120 minutes
Current Density	:	30 – 50 Amp/ft2

5. Coloring/Dyeing (optional)

Dyeing compound	:	10 g/L
Temperature	:	55 oC – 60 oC
Time	:	15 mins

6. Sealing

Sealing Salt	:	5g/L
Temperature	:	boiling
Time	:	45 minutes

Dip in boiling water afterwards, rinse and dry.

7. Drying (Oven)

Temperature	:	75 oC – 85 oC
Time	:	10 – 15 mins

lish parameters to attain the required anodizing thickness. Using the Positector 6000 Coating Thickness Gauge, thickness of anodized products were measured. Figure 8 shows the thickness of coating tests conducted. The thickness of coating for decorative anodized products was below 50 microns in almost 30-45 minutes of dipping time. When dipped for 60 to 120 minutes in a cold diluted acid, a thickness of coating of above 50 microns was achieved.

Summary and Conclusion

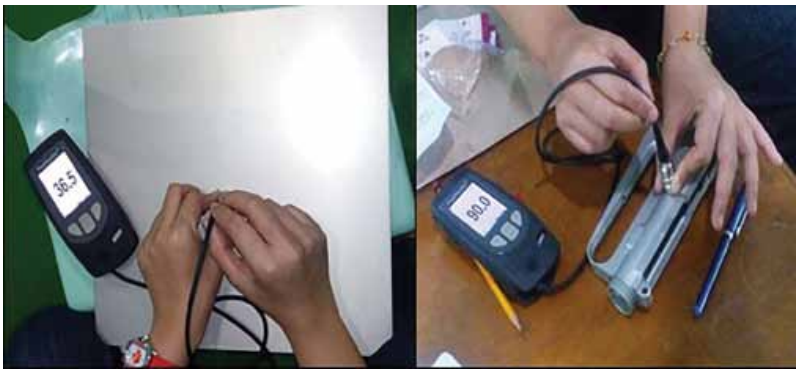

Figure 8. Thickness of coating tests conducted

In response to the demands for a technological shift to make the local industries, specifically the metals and engineering (M&E) industries, competitive, DOST, through Metals Industry Research and Development Center (MIRDC) established an anodizing facility that will cater to in-house and external surface engineering needs of MIRDC and other M&E companies.

Anodizing related equipment and facilities were installed at MIRDC's surface engineering building. These equipment and facilities include: approx. 400-L capacity tanks, DC rectifier, pulse rectifier, chiller, cooling tower, de-ionizing water facility, fumes scrubber, and waste treatment facility. The MIRDC anodizing line consists of the following processes: cleaning, etching, desmutting, anodizing, dyeing, sealing, and drying process by means of electrical oven.

With this new facility, together with its established parameters, decorative and hard-coat anodized products can be formed. Coating thickness for decorative anodized products are below 50 microns for almost 30 to 45 minutes of dipping time at room temperature of diluted acid solution while above 50 microns of coating thickness at 60 to 120 minutes dipping time with approximately 0oC temperature of diluted acid solution for hard-coat anodized products.

MIRDC's anodizing facility will help address the needs of different sectors such as automotive, industrial, aerospace, shipping, among others. It is also envisioned that through this facility the capability of local companies involved in the surface finishing business will be developed to make them at par with international standards in quality and productivity. This is seen to significantly redound to a better domestic economy for the country.

Recommendation

The specifications of the anodized products such as appearance, gloss, thickness etc. are affected by the parameters used in the study. It is important to identify what kind of aluminum material will be used since these specifications i.e. color tone and performance are affected by the alloy components of the metal. It is advisable that same aluminum alloys with relatively same sample configuration/size be anodized at the same time for easier configuration of current and voltage to be used during treatment.

Few companies under the Aerospace Association here in the country says that there is a need for other types of anodizing such as Type I – Chromic acid anodizing. It is recommended that additional tanks, accessories, and scrubber in the MIRDC's anodizing facility be installed to cater to the chromic anodizing needs of the M&E sector. The use of environment-friendly materials as cathode for anodizing is highly recommended.

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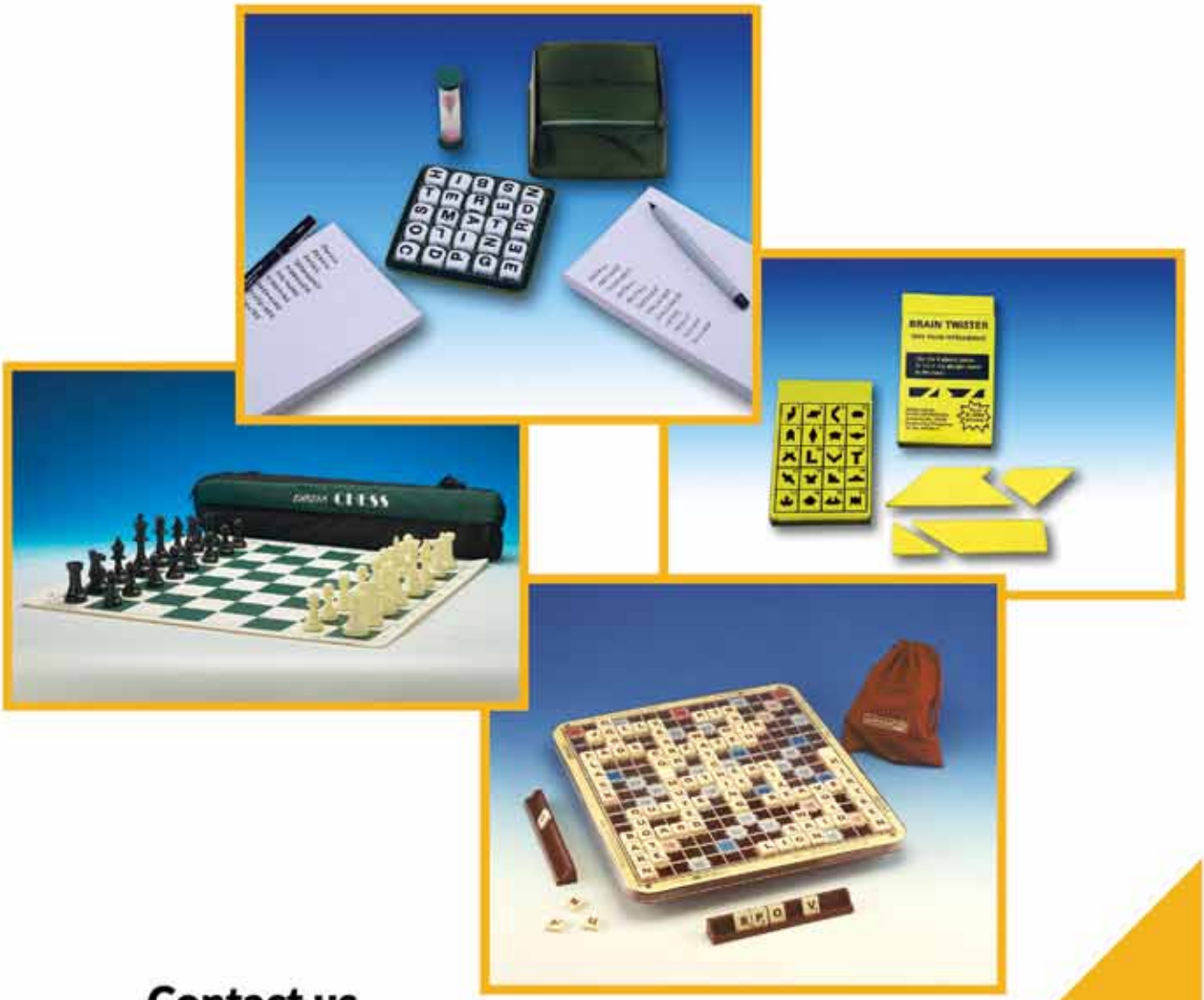

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Development of Paper Twining Machine

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Abstract

Twined product or rope was used in early times even during the prehistoric era where there is evidence that ropes were made from grasses and vines twisted together by hand. Ropes were used for moving heavy objects like stones and logs. The ancient Egyptians were probably the first civilization to develop special tools to make rope and as modernization continued, more rope machines were developed and produced. Common materials for rope include natural fibres such as manila hemp, hemp, linen, cotton, coir, jute, straw and sisal, as well as synthetic fibres such as polypropylene, nylon, polyesters, polyethylene, aramids, and acrylics. Rope is of paramount importance in diverse fields such as construction, seafaring, exploration, sports, and communications. Nowadays, it is also used in making handicrafts and as decorative materials. Twined paper is used in handicrafts or as decorative material but is more popular as paper bag handle. Rope can be made using the traditional method or with the use of machines. Traditional or manual method is done by rubbing the said material in between both palms, or between the palm and leg. Large rope making machines are commercially available, but only large companies meeting huge demands are able to use them due to high equipment cost and high energy consumption. For small and medium enterprises some machines are available but the capability of large machine is either split into series of processes and machine or is limited to only one rope diameter. This study opted to develop a prototype of the Paper Twining Machine. A prototype that is portable, low cost, yet consumes low energy and still produce high quality rope or twine. Eventually the working prototype will be tested and evaluated to twine different materials such as dried and slithered hyacinth, coir, fibres, hemp and any imaginable material that is twinable. This was subsequently tested using a working model to ensure that the device performs satisfactorily during service. The prototype unit should successfully pass the functional testing and evaluation conducted at the MIRDC.

1. Introduction

The use of ropes for hunting, pulling, fastening, attaching, carrying, lifting, and climbing dates back to prehistoric times. It is likely that the earliest "ropes" were naturally occurring lengths of plant fibre, such as vines, followed soon by the first attempts at twisting and braiding these strands together to form the first proper ropes in the modern sense of the word. The ancient Egyptians were probably the first civilization to develop special tools to make rope. Egyptian rope dates back to 4000 to 3500 B.C. and was generally made of water reed fibres. Starting from approximately 2800 B.C., rope made of hemp fibres was in use in China. Rope and the craft of rope making spread throughout Asia, India, and Europe over the next several thousand years.

Some rope continues to be made from natural fibres such as coir and sisal, despite the dominance of synthetic fibres such as nylon and polypropylene which have become popular since the 1950s. This is because demand for eco-friendly product become more and more popular thus products such as handicrafts and dec-

Fig.1. One strand paper rope

Products made from twined paper rope.

Fig.2. Paper bag handicrafts using paper rope as base material

Fig.3. Paper bag using paper rope as handle

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orative materials made from natural fibres are widely accepted.

1.1 Significance

The project was made due to demand in twining mechanism for twinable materials such as hemp, jute, fibres and paper. But more particularly, due to the demand for a twining machine for paper, that is mostly used in handicrafts and paper bag handle.

This is to produce quality twined two strand rope, which will be used in many livelihood program such as basket weaving, paper bag making and many more.

The project will provide employment to individuals in the barangay who are skilled in making handicraft products from such materials.

1.2 Objectives

To design and develop a locally manufactured twining machine capable of twining a two strand paper twine.
To design and develop a portable twining machine which combine the function of the slivering machine and twining machine used in coco coir.

1.3 Time

The development of the prototype initially took six (6) months, followed by another six (6) months to fully refine and synchronize the twining operation of the machine.

1.4 Place of Study

The development of the prototype was done at the Metals Industry Research and Development Center (DOST-MIRDC) where design and fabrication facilities are present including the testing facility.

The facilities are composed mainly of the machine shop, welding shop, assembly area and painting area for finishing of parts and components.

Fig.4. Manual twining in between both palm

Fig.5. Manual twining in between palm and leg

2. Review of Literature

2.1 Manual Twining

The following images are just some of the similar and probable models that could be considered in designing the prototype of the twining machine.

Manual twining is done by rubbing/twisting a small amount of materials in between both palms as shown in Fig. 4 or between the palm and leg as shown on Fig. 5. This creates a single strand rope which is then combined to make a two or more strand rope using the same method. This traditional method has many disadvantages like inferior quality, short length produced and low strength worthiness due to uneven twist and diameter of said material. Manual twining is a labor-intensive method thus the rate of production is slow.

2.2 Conventional Twining Machine

The conventional type twining machine shown in Fig. 6 is consisted of several sub-assembly such as conveyor, carding, twining, spool, transfer mechanism and prime mover. The current condition of mechanized twining process is not only fast than the manual, it also results in more uni-

Fig. 6. A conventional twining machine

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form and with better quality twined rope. It has a higher tensile strength due to added carrying thread in each single strand yarn.

This machine produces two-ply rope of 4-6 mm diameter by intertwining the loose and twisted coco coir fiber coming from the belt conveyor and it goes to carding process to remove impurities, dust and short fibers. Then it passes thru the two crumpets to twist each strand and after twisting it will intertwine the two single strand to produce two-ply fiber rope. The rope will then be wound and spanned by a revolving spooler in the spindle assembly. The machine capacity can produce twined rope of about 18-20 kg/day. However, this type of twining machine demands highly skilled operator, upon whom the quality and productivity of the end-product is largely depend. Frequent problem encountered is the breakage of fiber rope due to uneven distribution of fallen fibers along certain portion of carrying cotton thread which cause disruption on the production.

2.3 Three Strand Gear Type Hook Rope Machine

In this method the yarns or fibres were attached to hooks. The hook was rotated, twisting the strands into a rope. The rope stayed together because the twist went in opposite directions. Fig. 10 a rope tool was placed between the strands as they were twisting to keep the twist tight and even.

Fig. 7. Portable three strand gear type hook rope machine

Fig. 8. Single strand paper rope making machine

2.4 Twining Machine with Spooler

Conventional twining machine uses a conveyor to transfer fibers into the crumpet prior to twining. This results to frequent breakage of twined ropes because of inconsistency of fiber lengths.

Instead of using a conveyor, slivered fiber rope from MIRDC developed slivering machine is used in twining. The twining machine will produce 2 ply rope of 6-10 mm diameter by intertwining slivered ropes from the slivering machine. The slivered rope and yarn will then be twined in the spindle assembly. This twining machine is better and simpler in operation since it eliminates the common problems in conventional twining machine i.e. disruption in twining operation due to breakage of fiber rope, high skill requirement, etc.

Figure 9. Twining machine with spooler

2.5 Paper Rope Making Machine

This machine uses kraft paper as it raw material producing a single strand paper rope. Paper rope is commonly used as paper bag handles, and or as a decorative material, or in making handicrafts.

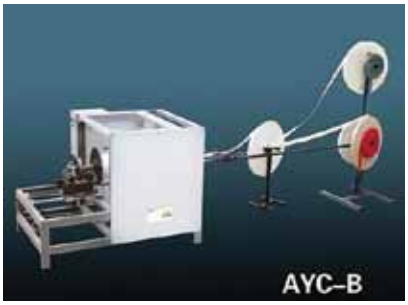


Figure 10. A rope tool / separator

2.6 Global Handicrafts Trends

Handicraft products are not identified separately in H.S. Codes and therefore no reliable trade data is available on an international level. According to an extensive study done by US AID in 2006 on the "Global Market Assessment for Handicrafts" it specified that handicrafts are part of a much larger home accessory market, which includes handcrafted, semihandcrafted, and machine-made goods. The study also examined the global demand of handicraft as part of the home accessory market in the U.S. as an indicator of the size of demand.

The global market for home accessories was estimated to be at least $100 billion in 2006 according to the study. The U.S. is the largest importer of the home accessories and was valued at $67 billion, the second largest market is the E.U. collectively followed by Japan and Hong Kong.

The study segments the home accessory market in the U.S. in 2004 according to market share as follows: Accessories and Gifts 22%, Accent furniture 21%, Portable lamps 11%, Area rugs 9%, Wall décor 9%, Lighting fixtures 7%, Tabletop and tabletop accessories 7%, Collectibles 6%, Soft goods 5% and Permanent botanicals 4%.

The study highlighted the potential buyers of handicrafts in the U.S. as follows: (1) Specialty and lifestyle stores; (2) Catalog and internet retailers; and (3) Independent retailers.

The study lists most common raw materials used by handicraft producers as classified by ITC as follows: Basket, wicker and vegetable fibers, Metal, Leather, Paper, Pottery, Wood, Soap, Textiles, Stone, Glass, Bone, Horn, Shells and a combination of different materials and techniques.

The major exporters of handicrafts are China, India and Vietnam. China is the largest exporter of home accessories globally and in April 2005, China produced an estimated 70% of all home accessory products sold in the U.S. India total exports of handicrafts amounted to $3.5 billion in 2007 and 30% is exported to the U.S. Vietnam Handicraft exports in 2007 stood at US$824 million.

In terms of main trends in hand-

icrafts, it is growing commoditization of handicrafts production, shorter product lifecycles and an emphasis on creating new designs, the move from indigenous designs towards contemporary minimalism designs, the push to differentiate by focusing on luxury items and a significant growth in online sales.

(Source: USAID Handicraft Market Analysis)

2.7 Demand for Handicrafts in the Philippines

By far, exportation and tourists are one of the largest buyers of segment of handicrafts here in the Philippines. Tourism is affected by many economic and political factors and therefore the number of arrivals fluctuates from year to year as seen in Table 1.

As seen on the Fig. 4 visitors arriving here in the Philippines increase every year. 2010 to 2011 records shows a 12.71% growth rate of visitors arriving here in the Philippines. These means that demands for handicrafts made by locals is increasing every year. Handicrafts that were made by locals were mainly from indigenous material such as hemp, and natural fibres.

3. Scientific Basis/Framework

The basic concepts that have been considered to design the new type twining machine are as follows:

1. Simplicity at all stages. The prototype machine should be simple enough FOR that could install, operate and maintain easily.
2. Raw materials are readily available in the local market.
3. Reduction in weight, machine and power cost.
4. Portability of the machine

Based on the design consideration, the existing twining machine concept was revised in order to achieve portability without sacrificing the quality output; a concept of combining the slivering and twining process was made. Slivering is a process which twist raw material into a single strand. Twining is the process of combining the single strand rope into a two strand intertwines product rope. Below are the process diagrams for both conventional and conceptualized twining process, Fig. 16 is the conventional twining process developed while Fig. 17 is the conceptualized twining process.

Figure 11. Conventional Twining process

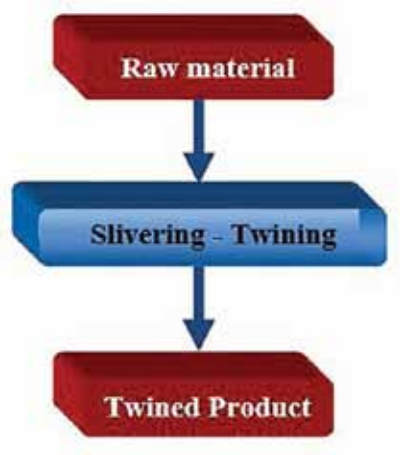
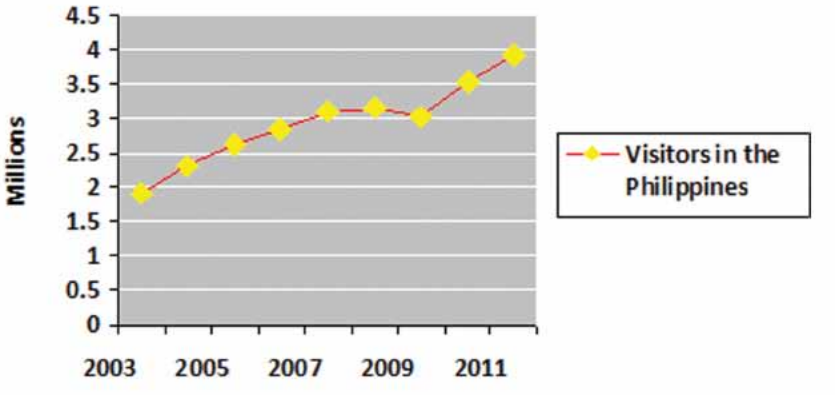


Figure 12. Concept twining process

Table 1. Tourism Arrivals in Philippines 2003 – 2011



Indicators	2003	2004	2005	2006
Visitors Arrival	1907226	2291352	2623084	2843345

2007	2008	2009	2010	2011
3091993	3139422	3017099	3520471	3917454

(Source: Department of Tourism from A/D Cards & Shipping Manifests)

4. Methodology

4.1 Project Development

The prototype design will have slivering, twining and spooling mechanisms. The tool bit for the slivering is interchangeable to allow change in rope diameter output.

The spooling speed may be modified by adjusting or changing the gear ratio of the spooling mechanisms.

The bobbin of the spooler is also interchangeable to allow replacement of empty bobbin when current bobbin is full.

4.2 Procedure

Having decided the concept, the activities that will be performed are as follows: finalization of concept; completion of the design; sourcing of materials; fabrication; assembly; initial testing; debugging; final testing; and terminal report writing.

4.3 Materials

Materials used in the base platform are mild steel angle bar and flat bar. For the slivering and twining subassembly, engineering plastic is used for the twining bit for low friction twisting, mild steel sheet for body and housing. For the spooling sub-assembly engineering plastic is also used for weight reduction to avoid excess vibration when in operation.

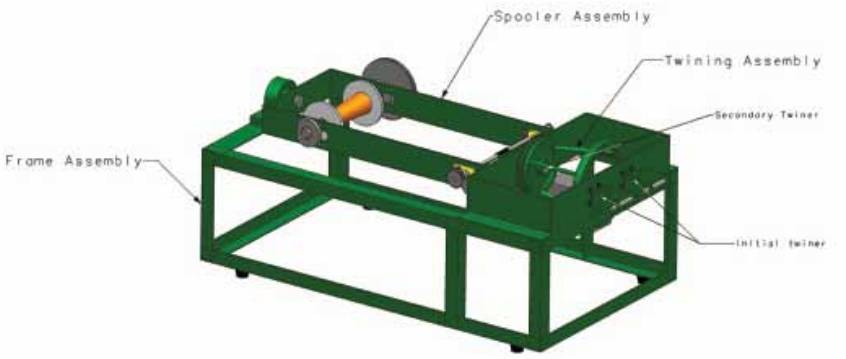
Discussion of Results and Findings

This machine is created primarily to twine a Japanese paper and make it into a two-strand string. Two Japanese paper strips were twisted simultaneously using a series of twisting process. The strips will be twisted initially in a pre-twisting mechanism and into the main mechanism, which twist and combine each strand to form the finished product. The finished product then goes to the spooling mechanism to spool the twined paper into desired volume.

Fig. 13. Actual Twining Machine Front View

Fig. 14. Actual Twining Machine Side View

Major Parts of Paper twining machine



The whole assembly consists of twining subassembly, spooling subassembly and the machine housing and motor.

Main Technical parameters:

- Speed of Winding and Twining: 10 - 20m/min
- Twined paper diameter: 2 – 9 mm
- Total Power: 120W
- Dimensions of Machine: 690mm x 400mm x 310 mm

Description of Major Parts

1) Twining Assembly– this is where the raw material, from a strip of paper is twisted to produce the first strand, then to the secondary mechanism combining them forming a two strand rope or twine. The twining assembly consists of a set of planetary gear that is coupled to a pulley, which is driven the motor.

Initial twiner – the initial twiner under the twining assembly is the first stage of twisting. In this part of the machine the strip of paper will undergo rapid twisting to form the initial twine required for the final rope diameter.

Secondary twiner – In this part of the machine the initially twisted small diameter strand undergo slow twisting to perform the twining or combination of the strand forming a two strand rope.

2) Spooler Assembly– the spooler assembly spools the finish product into a spool of rope. The spooler assembly consists of a set of gears and pulley and a bobbin where the spooling of the rope is being made. The whole spooler assembly goes into a circular motion with exact same speed with the secondary twiner. The circular motion is the essential component of the spooler assembly to address the counter twisting when creating the rope / twine which if neglected results in loosening of the rope creating an inferior quality rope or twine.

3) Frame assembly – the frame assembly holds both the twining assembly and the spooler assembly. The frame assembly comes with four rubber feat which is responsible to damp any vibration created by the machine.

4) Motor and speed controller – this part of the machine is the prime mover of the machine, coupled with a speed controller operator can reduce or increase the speed of the twining process.

Testing Japanese Paper

Random samples were taken from the paper rope totaling 6 ropes. That is, three ropes for rope diameter 2mm, and three ropes for rope diameter 3mm. Using a calibrated digital-type Vernier caliper, each rope was measured for its initial parameters length and width (before & after twining) at five strategic points in the entire rope length. *(See illustration on next page)*

Summary and Conclusion

A portable paper twining machine that is less expensive, portable, easy to operate and is eco-friendly due to small energy consumption was developed through this study. The machine is made up of locally-developed parts

and simple components. Being low cost, it can be afforded by small and medium enterprises. Its portability is attributed to tabletop machine's overall dimensions of 690mm x 400mm x 310mm. The machine's portability and simplicity render it eco-friendly as it consumes only 12W of power.

The paper twining machine which comprises of combined slivering and twining operation up to the spooling operation was an effective machine for rural and small organization. Due to its simplicity, portability, low energy consumption, and locally available parts, this machine can be a competitive machine that can be deployed around the country.

This machine that is primarily created for twining paper can also be used in any twinable material such as hemp, jute, fibres and other related material.

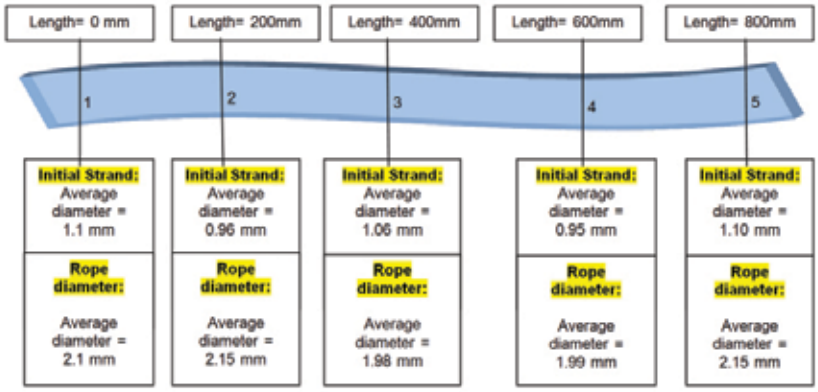
Recommendation for Future R&D Work

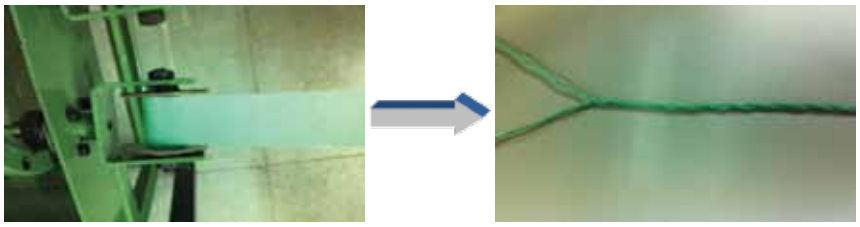
It is recommended that the acceptability of finished product be standardized based on every application, which is in need when the machine is in operation. In this manner the machine can be accurately configured to the exact speed and rate. To be able to produce high quality product at a maximum or allowable speed and rate.

Modifying the speed ratio of the gears especially in the spooler part of the assembly will allow the operator to adjust the quality of rope pitch produced. Also modifying parts such as the bobbin and the twining bit can greatly improve the durability of the machine thus allowing the machine to increase its performance and working hours.

To further improve the quality of the product being produced by the machine a synchronize twining and spooler assembly should be consider. Thus either having a gear ratio of 10:1 for the twiner or a gear ratio of 1:5 for the spur gear in the spooler assembly.

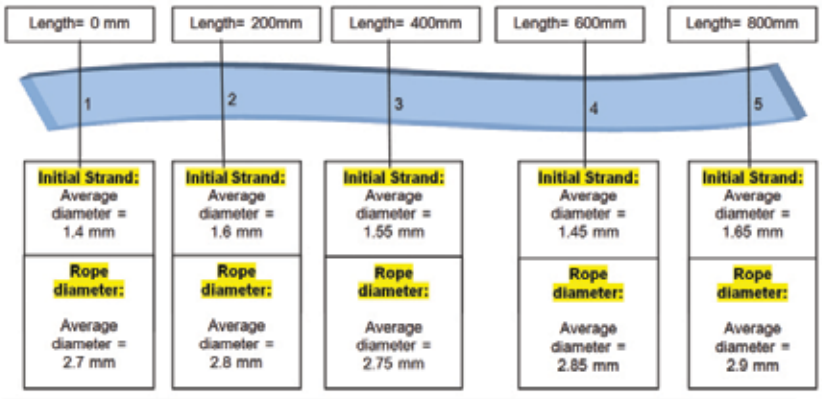
TEST PARAMETER No.1: paper width = 30mm

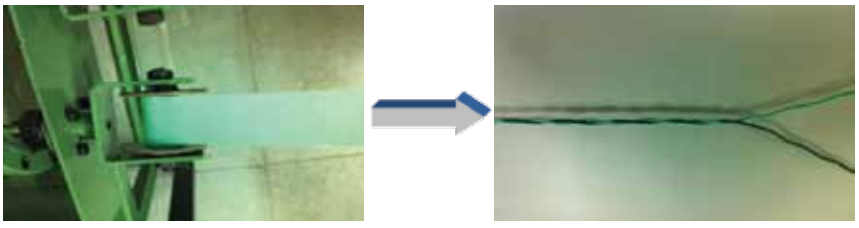




Before After

TEST PARAMETER No.2: paper width = 40mm





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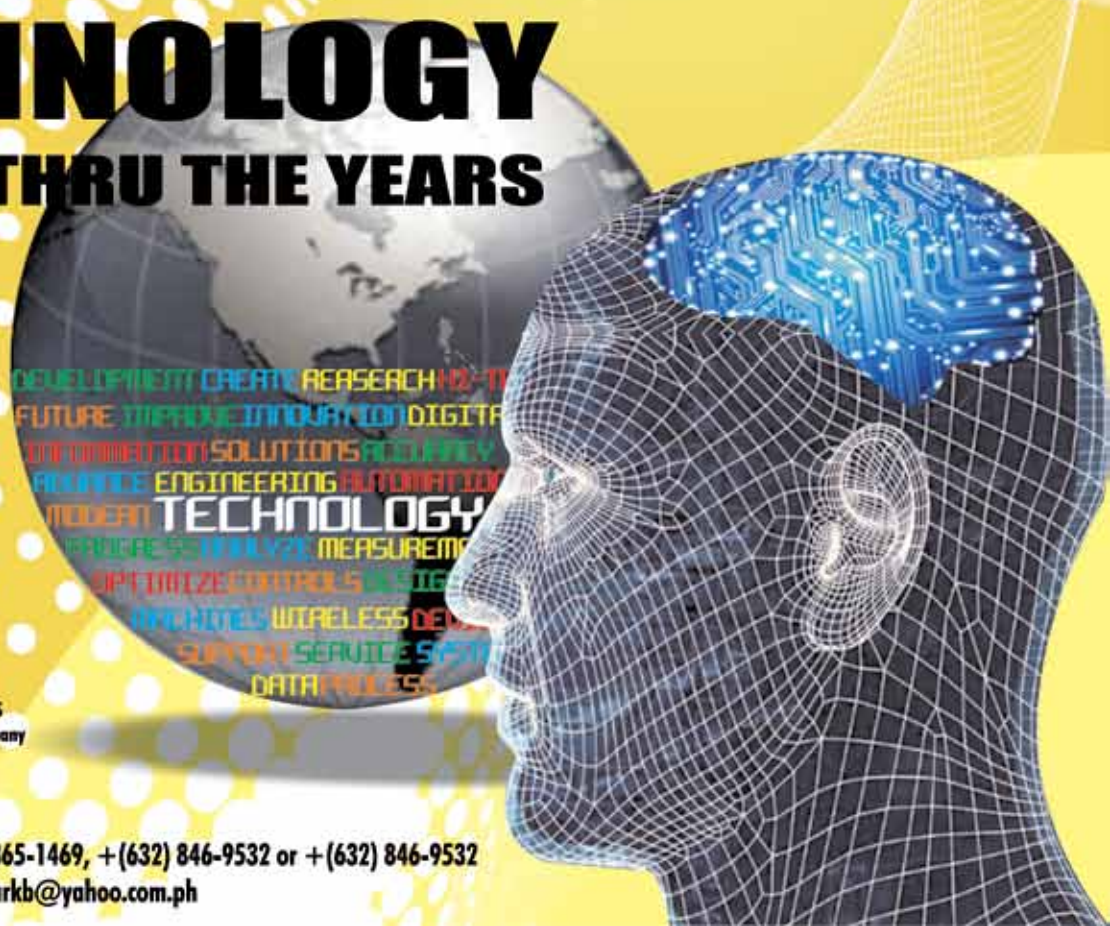

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Development of Biolog Extrusion Machine (Model II)

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Benjamin C. LOGICA,*7 Wilfredo M. RAMILO*8

Abstract

Basically the bio-log extrusion machine is a mechanical contraption that operates on the principle of lever to move the mechanisms forward and backward wherein rotary motion of spur gear is converted into linear one through the rack gear to complete the cycle and the work required. Its basic function is compression since as the lever assembly is rotated clockwise manually the rack gear with attached ram at the tip moves forward thus reducing the volume in the case, hence any soft material inside will be baled. To describe the machine's physical description, the cylindrical case lying horizontally on collapsible frame assembly is look like a hotdog. Thus, the end product will follow the shape of the machine like a punching bag. Said machine made of steel and cast iron in the form of casted product, plates and bars are machined, fabricated and joined by fasteners, hinges and welding.

I. Introduction

Coco coir, or fibers from coconut husks, can be a source of income for communities in the country's coconut-rich areas, according to the Foundation for a Sustainable Society (FSSI). However, the FSSI warned against the long term strategy of exporting raw coco fibers, but instead suggested the export of high-value products with coconut fibers. Exporting raw coco fibers from other countries will give them much boost on employment instead of local communities in our country will be benefitted in making coco fiber/pit by-products and then exported it in other countries as a finished product. The government is also bullish on the coco coir industry, approving the Philippine Coco Coir Development Plan 2011-2016. The government projects $6.5 million in exports of coco-fibers to China and other countries in the next five years. The coconut husk, for instance, is thrown away more than 99 percent of the time. It is considered farm waste—but when we think about it, there are actually so many things we could do with the coconut husk. As the saying goes, there is money and job opportunity in coconut husk waste. Farmers can make money by using its by-product – coco peat and coco coir. The government is encouraging coconut farmers to earn more by bringing their husks to plants that will process them into byproducts. The Philippines has 3 million hectares of coconut plantations in 68 provinces and 1,195 municipalities throughout the country, producing approximately 15 billion nuts a year. Some 6.6 billion husks are burned to cook copra; but some 8.4 billion husks are thrown away as farm wastes. Coconut-producing Aurora province for example recently installed three processing plants to convert husks. The coco fiber is made into twine which is woven into coco net used in erosion control. Southern Luzon, Bicol, Visayas, and Mindanao have 18 coco coir producers registered with the Philippine Coconut Authority (PCA) (Tempo, November 15, 2012). Coco coir or fiber extracted from the husk is a raw material for making high-value export products such as bed mattresses, mats, car seats, ropes and twines, grow poles for plant liners, wattles for orchids, pots, and geotextiles. Coco fiber is used by the Pasig River Rehabilitation Commission for erosion control in Estero de Paco in Manila, in slope rehabilitation in a Tagaytay subdivision, on the San Roque Dam embankment in San Manuel, Pangasinan, at Cherry Hills now Peace Village in Antipolo City, at bio-engineered slopes in the Subic-Clark expressway, and on Ambassador Point at Halsema Road in the Cordilleras. The Philippines exports the biodegradable and environment-friendly coir baled fiber to China, Taiwan, United States, Korea, Japan, and Europe. The processing of coconut husks into coco coir and coco peat is an income-earner for farmers and their families in the coconut-producing regions of the country. All they need are government and private sector's support and assistance (Tempo, November 15, 2012).

In support to Philippine Coco Coir Development Plan 2011-2016 and to Sustainable Engineering for Environmental Conservation the MIRDC will continue to develop project for the caring of environment in doing so, the development of improved biolog extrusion machine (Model II) using coconut fiber is hereby implemented.

Review of Literature

THE Philippine Coconut Authority (PCA) has set aside P160 million next year to purchase equipment that will boost the government's bid to develop the coco-coir industry. PCA administrator said a team from the agency went to Kerala, India to look for equipment that will be add value to coco coir fiber. The purchase of additional equipment for processing

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coco coir is part of the government's push for non-traditional coconut products which include coconut water and virgin coconut oil. Despite the huge potential of coco coir and coco peat, the Philippine Coco Coir Exporters Association (Philcoir) noted that the country could not take full advantage of opportunities due to low buying, high cost of transportation, limited market awareness and the lack of matured technology.The lack of financing support and program and policy support as well as inadequate research and development are also exacerbating the problems confronting players in the coco coir industry. During the National Coco Coir Summit held in April 2011, stakeholders sought exemptions from value-added tax (VAT) imposed on local sales, exemption from duties and VAT on the importation of machinery and equipment and income tax holiday for new investments and ventures.The PCA, an attached agency of the Department of Agriculture (DA), estimates that the country produces some 12 billion coconuts annually.

The DA noted that collecting merely one half or 6 billion coconut husks and processing these into coco geotextiles and organic fertilizers would yield at least $225 million in export receipts annually. DA said geotextiles or "cocomats" serve as erosion control material that are laid on mountain slopes, river banks and dam embankments. Coconut fibers are also transformed into twine or yarn, while fine coco fibers are used in making beds or mattresses. Coconut peat or dust is used as organic fertilizer, soil conditioner, or animal beddings. For every kilo of coconut husk, 30 percent or 300 grams of fiber or coir can be extracted, and the rest is coco peat or dust.Agriculture Secretary Proceso J. Alcala noted that China is "one big untapped export market. Other potential buyers of geo-textiles and coco peat organic fertilizer and soil conditioner are Hong Kong, Korea, Japan, Singapore, Taiwan, Canada, and the United States. Alcala said China alone imports 200,000 metric tons (MT) of coco fiber annually, driven by its increasing demand for mattresses. In 2010, the PCA noted that the Philippines exported less than 5,000 MT of coconut coir worth roughly $6.5 million. Sri Lanka is the leading exporter, at more than 150,000 MT.

The coconut industry is expected to get a further boost once it capitalizes on its potential to be a top exporter of cocopeat, a fibrous substance made from coconut husks.The Philippine Center for Postharvest Development and Mechanization (PhilMech) said that given the proper postharvest technology, the Philippines could easily make export-grade cocopeat and become its biggest supplier worldwide with the sheer size of lands devoted to coconut trees.PhilMech is mandated to conduct research on the ways farm waste could be put to good use. The agency said it had developed a two-step drying system with its partners in order to produce quality cocopeat. The Philippines has more coconut land than India and Sri Lanka combined but these two countries are way ahead when it comes to cocopeat exports. Cocopeat, a by-product of the coconut husk, is popular worldwide primarily as a growing medium for crops using hydroponics. It is primarily used in organic agriculture.Based on government data, India has one million hectares of coconut lands, while Sri Lanka has a coconut area only the size of the Bicol region. Meanwhile, the Philippines has 3.56 million hectares planted to coconut. Last year, the Philippines exported only 5,000 metric tons (MT) of cocopeat, compared to India's 400,000MT and Sri Lanka's 82,000MT. A research paper from the Philippine Center for Postharvest Development and Mechanization showed that if only 30 percent of discarded coconut husks are processed into cocopeat, the Philippines can easily beat India and Sri Lanka and become the top cocopeat exporter. Indonesia's coconut production is higher than the Philippines' but the former is not a top cocopeat exporter. The Philippines produced 15.2 billion nuts in 2011 while Indonesia produced 16.3 billion. Also, the Philippines still leads in overall coconut exports and product development compared to Indonesia, Sri Lanka and India. In his latest State-of-the-Nation Address (SONA), President Benigno Aquino 3rd boasted that the country's cocowater exports are increasing, and he committed to allocate funds for the development of the coconut industry. This boast is not empty since in the first four months of the year, cocowater exports increased by almost 200 percent to almost 6 million liters compared to the same period last year.In 2011, the Philippines exported $1.957 billion in coconut products, with coconut oil accounting for $1.40 billion, 20.30 percent higher than the $1.627 billion in 2010.While coconut oil exports increased in volume by 146 percent to 79,864 metric tons in the first six months of the year, other coconut products, like cocowater, registered hefty shipment gains abroad.But that does not mean that the Philippine coconut industry still leads in all fronts compared to its competitors.

Coir fiber logs are biodegradable logs or biologs (decomposed ground coconut husks pulp) which are tightly packed in tubular netting. They are 100% natural materials, excellent planting medium additives which add fertility to the soil after biodegradation, high tensile strength, high water absorbency, eco-friendly, and wildlife safe.

Coco coir biologs can be made in variety of lengths and densities to suit different applications. As the logs can absorb large amount of water, the logs can be used to slow down the velocity of storm water run-off, thus stabilizing slopes. They are great for shorelines/river embankment stabilization and forest slope rehabilitation.

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Figure 1. Previous Machine Developed by MIRDC for Coco Coir Biologs (2009) Prototyped Model

It also provides bedding where the seedlings and/or cuttings are inserted into logs with sediment. As the coconut fiber logs biodegrade, the plants develop a well-established root system in the shoreline sediment to retain the soil in place. Moreover, the logs are useful in catch basin protection, keeping unwanted pollutants from entering into sewer systems.

For maximum utilization of coco coir, the MIRDC developed a manual machine for coco coir biologs that compresses coco fibers while encapsulating it in a geotextile net, the so-called coir fiber biologs. The machine measures 1470 mm x 540 mm x 960 mm (L x W x H) and capable of producing 30 units of coco fiber biologs per day even by a novice operator. The manufacturing cost of the machine is approximately P48,000.00.

The machine for coco coir biologs is a promising technology for coir fiber since the Philippines is among the top coconut-producing countries. With this machine, it will not only generate employment for coco processors but also increase the utilization of coconut coir for commercial purposes.

Application Include:

-Slope Stabilisation for Roadways, highways,pathways and railway embankments

-Coir Bio-logs, rolls for lake & stream stabilisation

-Filtration in swimming pond,reed bed & holding resevoir applications

-Silt barrier, sediment control,spill containment contamination applications

-Lake ,pond, river, irrigation and drainage channel bank stabilisation / edging

Figure 2. Coco coir fiber used in making biologs.

Figure 3. Geotextile nets used in making biologs.

Figure 4. The machine completed with the project team.

Figure 5. Collapsible Frame Model BIOLOG Extrusion Machine.

Figure 6. Biolog product.

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Figure 7.1 & Figure 7.2 Biolog application in river embankments.

Figure 8. Biolog application on Hillside Stabilization.

Figure 9. Biolog application on Highway slope embankment.

Figure 10. Biolog application on Irrigation.

Figure 11. Biolog application on Canal embankment.

-Geo-cells for tree root protection,embankment stabilisation,vegetation containment

-Slopes with risk of erosion in new development sites,exposed slopes in amenity areas in parks, golf courses etc.

-Green roof matting/sedum & wildflower coir colls,geocells for vegetation containment

Improvements Made to the Modified Biolog Extrusion Machine (Model II) as Compared to the First Model

1. Use of standard pipe instead of a rolled one just to assure the concentricity of the inside diameter.
2. Revised Frame from bigger to smaller one (compact).
3. Gear Cover was simplified using casted product and serves as guideway in moving the rack gear in reciprocating motion (horizontally) through the rotation of spur gear for easy maintenance and for aesthetic purposes.
4. Second model uses standard latch as compared to fabricated one of the first model.
5. Simplified Handle for the spur gear and cover.
6. Provision of hooks (2 pcs.) which serve as stopper.
7. Simplification of Plug for easy operation and provision of handle.
8. Reduction of gears to the control mechanism of the equipment.

Figure 12. Biolog Extrusion Machine Model II compared to Biolog Extrusion Machine Model I (below).

Thus the final specifications of Coco Fiber Bio-logs Model II are:

Cylinder Length	:	1200 mm
Cylinder Diameter (Outside)	:	214 mm
Ram Diameter	:	198 mm
Length of Rack Gear	:	900 mm
Diameter of Spur Gear	:	40 mm
Number of Teeth of Spur Gear	:	18, Module 2
Length	:	1470 mm
Width	:	540 mm
Height	:	960 mm
Weight	:	95 kgs.
Capacity (for 1 operator only)	:	30 pcs. biologs per day

Summary and Conclusion

To address the concerns and recommendation for improvement of the BIOLOG EXTRUSION MACHINE – MODEL I, the following objectives were addressed:

1. The machine's height, weight and length is ergonomically designed.
2. All parts are designed for the purpose of strength such as the frame and cylindrical drum.
3. It is easy to operate because of its handle's clockwise and counterclockwise rotation.
4. Moving parts are properly located for easy maintenance purposes.

As such, reiteration of the improvements/modifications are the following:

1. Use of standard pipe instead of a rolled one just to assure the concentricity of the inside diameter.
2. Revised Frame from bigger to smaller one (compact).
3. Gear Cover was simplified using casted product and serves as guideway in moving the rack gear in reciprocating motion (horizontally) through the rotation of spur gear for easy maintenance and for aesthetic purposes.
4. The second model uses standard latch as compared to fabricated one of the first model.
5. Simplified Handle for the spur gear and cover.
6. Provision of hooks (2 pcs.) which serve as stopper.
7. Simplification of Plug for easy operation and provision of handle.
8. Reduction of gears to the control mechanism of the equipment.

For future undertaking in modifying this machine, motorized model should be incorporated if possible, but we have to consider the operation costs such as fuel or electricity and see if it is viable and feasible.

Physical properties of Coco-net

Properties		Coconet 400	Coconet 700	Coconet 900
Thickness, mm		10.0 Min.		
Width, m		1.0 Min.		
Length, m		5.0 Min.		
Unit Weight 1g/m^2		400±20	700±35	900±45
Diameter of twine, mm Hand spun		5.0 mm ± 0.50mm		
No. of Twines/m	Crosswise Direction	40 Min.	40 Min.	70 Min.
	Length wise Direction	40 Min.	70 Min.	70 Min.
Material		Woven netting made from high strength 100% coconut fiber twine		
Color		Natural Earth Tone		
Tensile Strength, N/twine		150 Min		
Elongation	(*Machine Direction*), %	26 Min.	34 Min.	42 Min.
	(*Cross Machine Direction*), %	32 Min.	38 Min.	32 Min.
"C" Factor		0.002		
Water Velocity, m/sec		2.7 Min.	3.35 Min.	4.26 Min.
Water absorption, %		163 Min.	146 Min.	132 Min.
Slope Inclination, H:V		≤ 1:1	1:1 to 60	75

"C" Factor – Safety Factor

Standard grades of Coir

Letter Designation	Name of Grade	Description
CH-1	Coir Good	Fiber (bristle) is good for cleaning, with little or no pulp content; color is light to almost dark brown; length is not less than five inches.
CH-1	Coir Fair	Fiber (bristle) is of fair cleaning; fiber are stuck together and considerable pulp are presents; color ranges from dull brown to dark brown or black; length is not less than five inches.
CH-1	Coir Mixed	Mixture of brisille and mattress fibers, generally crumpled and tangled ; of good and fair cleaning, free from coir dust and hard undefibered husk; color range from light brown to dull brown
CH-1	Coir Mattress	Consist mostly of short crumpled fibers with an average length of not less than half an inch; from coir dust and hard undefiberd husk
CH-1	Coir Waste	Consist of coir dust and fiber not fitted in any regular grades of coir, with length of less than two and a half inches long.

Physical Properties of Coco-log

Type of Coco-log/ Fascine	Diameter (mm)	Weight (min.) (Kg/m)
Cocolog 100	100	2.0
Cocolog 200	200	4.5
Cocolog 300	300	10
Cocolog 400	400	20
Cocolog 500	500	30

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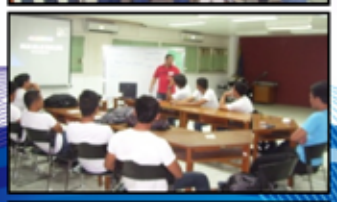


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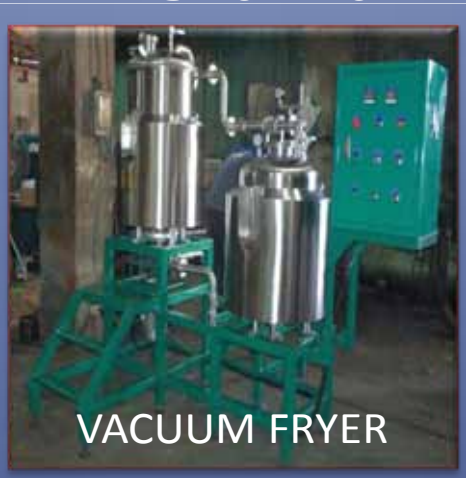
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Moringa Oil Expeller

Remartin S. MAGLANTAY*1

Abstract

The project presented focuses on the development of a harvesting tool for the extraction of oil from the seeds of the moringa trees. Moringa have an extraordinarily nutritional potential that can help, at least short-term, to solve problems associated with poor nutrition in the area. Furthermore, moringas naturally prosper all over the archipelago, making it an accessible and inexpensive resource. One of the major concerns regarding the extraction process has been the reabsorption of the oil due to the elastic property of the seeds. This factor is important because a significant percentage of the oil extracted can potentially be reabsorbed, consequently limiting the efficiency of the extraction process. I consequently selected a continuous system that could better ensure a constant pressure, which seems desirable. Moreover, inevitably the design is a compromise between efficiency and cost. Therefore, it was necessary to select a design that could be cheaply produced, limiting also the necessity to produce the whole design from scratch. The final design consists of a meat grinder that ends with a shaft attached with a choke assembly for compressing the cake to extract oil. Fresh seeds are inserted in a cone shaped feeder, while the cake flows out the smaller end of the cage and oil is collected in a container. This project represents a first step into the development of an extraction tool that maximizes the extraction of oil from moringa seeds, and consequently the consumption of the seeds themselves, not exploited so far.

1. Introduction

1.1 Significance

1.1.1 Local Conditions

Moringa, which is locally known as "malunggay", has been a part of the Filipino lives for a long time. Moringa can be planted virtually anywhere with minimum supervision and care. It can be seen growing almost in every backyard and vacant lots around the country. It is sometimes revered as a miracle tree. „Malunggay" leaves have long been believed to have abundant nutritional value. Moringa seeds, in the other hand, get less attention and value. Recent studies show that essential oils from Moringa seeds are highly in demand especially in the skin care and cooking industries. To tap this abundant source of income, we need to have equipment that is affordable, locally available and east to operate that will serve the purpose of extracting essential oil from moringa seeds to give farmers added value to their products.

1.1.2 Global Conditions

According to the "Development Potential for Moringa Products" in 2001, India is the world's largest producer of moringa fruits with an annual production of 1.1 to 1.3 tonnes of fruits from an area of 38,000 hectares. As for moringa seeds, traditional methods whereby powdered seed is boiled in water and the released oil is skimmed off the surface of the water have, in the past, produced very low yields. Attempts using other manual expression systems (e.g. hydraulic presses) have resulted in similar poor yields. Therefore, there does not yet appear to be a definitive solution to the question of which type of press is the most effective to get acceptable yields.

1.1.3 Activities in the Philippines

In 2004, Sen. Loren Legarda champions the popularization of Moringa. She proposed that the Philippines, being an agricultural country, make Moringa one of the priority crops. Legarda urged to noodle makers such as Universal Robina Corp., Nestlé Philippines Inc., Monde Nissin Corp. and Uni-President Philippines Corp. to find ways to add malunggay and other nutrients to noodles, for which Filipinos now spend P13 billion a year. This is, in essence, because locally manufactured instant noodles were included in the "basic necessities" category under the Price Act.

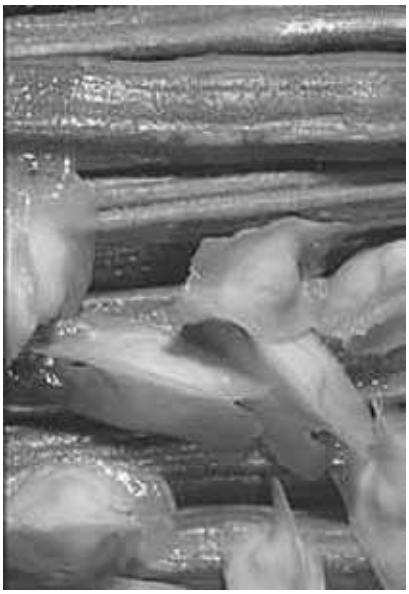

Figure 1. Moringa Oleifera seeds

1.2 Objectives

- To develop an equipment that can get at least 30-40% yields of oil from moringa oleifera seeds that is locally available, affordable and easy to operate.
- To provide means of extracting moringa oil to harness its nutritional properties and other properties that can benefit the Filipino people.

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- To increase the potential income of our local farmer from cultivating moringa trees.

2. Review of Literature

2.1 Scientific Framework

2.1.1 Oil Extraction

Most of the available oil extraction machines require the seeds to be heated to lower the viscosity of the oil and allow it to escape easily from the seed during compression.

Types of Oil Extraction Machines

a. Screw Press (Expeller)

An expeller consists of a helical thread (worm assembly) which revolves concentrically within a perforated cylinder (the cage or barrel). The barrel is usually formed by a series of axially-placed lining bars contained within a robust frame.

This type of press is more commonly used nowadays due to that a screw press oil expeller allows for continous feeding unlike other methods of pressing.

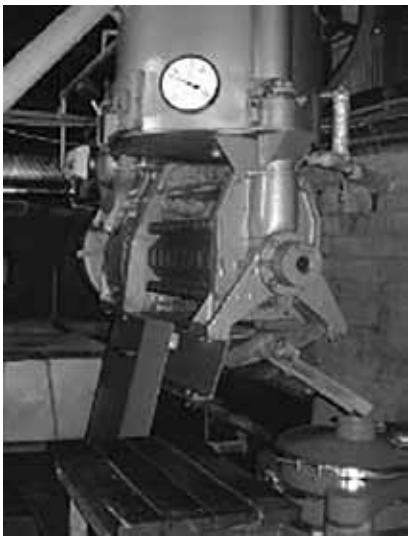


Figure 2. Large scale screw expeller

- Variable Diameter

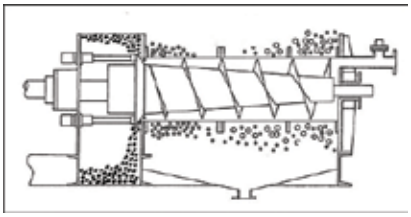


Figure 3. Variable Diameter Screw Press

This type of expeller employs a screw that has an increasing minor diameter. The varying diameter provides the compression needed to expel the essential oil from the seeds. The minor diameter is inversely proportional with the cross-sectional area between the screw and the cylinder, thus, pressing the seeds and extracting oil.

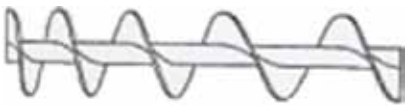


Figure 4. Variable Pitch Screw

This type of expeller employs a screw that has a decreasing pitch along its entire length. This provides the compression needed to expel the essential oil from the seeds. The pitch of the screw is directly proportional with the cross-sectional area between the screw and the cylinder, thus, pressing the seeds and extracting oil.

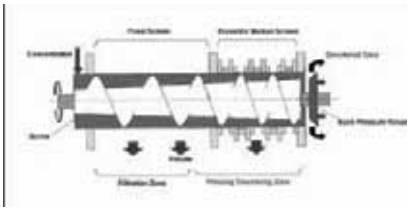


Figure 5. Variable pitch and variable diameter screw

This type of expeller employs a screw that has both a decreasing pitch and an increasing diameter along its entire length. The decreasing pitch and the increasing diameter simultaneously provide a much larger compression ratio compared to the other types of screw expeller given the same geometric proportions.

b. Ram Type Press

A long pivoted lever moves a piston back and forth inside a cylindrical cage constructed from metal bars spaced to allow the passage of oil. At one end of the piston's stroke, it opens an entry port from the seed hopper so that seed enters the press cage.

When the piston is moved forward, the entry port is closed and the oilseed is compressed in the cage. As a result, oil is expelled from the oilseed and emerges through the gaps in the cage. Compressed seed is pushed out through a circular gap at the end of the cage.

Figure 6. Ram Press

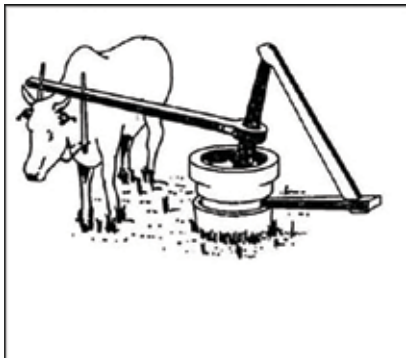


Figure 7. Example of a Ghani

c. Ghani

The ghani consists of a large mortar and pestle, the mortar being fixed in the ground and the pestle being moved within the mortar by animal traction (donkey or mule) or (more commonly) a motor. Oilseeds are placed in the mortar and the pestle grinds the material to remove the oil. The oil runs out of a hole in the bottom of the mortar and the cake is scooped out by hand. This method is slow and requires two animals, replacing the tired one with another after about 3-4 hours of work. Motorized Ghanis are now also being used to replace the animal and increase productivity.

2.1.2 Moringa Oleifera

Moringa oleifera is the most widely cultivated species of a monogeneric family, the Moringaceae, that is native to the sub-Himalayan tracts of India, Pakistan, Bangladesh and Afghanistan. This rapidly-growing tree, was utilized by the ancient Romans, Greeks and Egyptians; it is now

Figure 8. Illustration of moringa leaves and fruits containing moringa seeds

Figure 9. Moringa Oleifera

widely cultivated and has become naturalized in many locations in the tropics. It is a perennial softwood tree with timber of low quality, but which for centuries has been advocated for traditional medicinal and industrial uses. It is already an important crop in India, Ethiopia, the Philippines and the Sudan, and is being grown in West, East and South Africa, tropical Asia, Latin America, the Caribbean, Florida and the Pacific Islands. All parts of the Moringa tree are edible and have long been consumed by humans. This study will focus on one of the many parts of the moringa oleifera, which is its seeds, most especially in the moringa seed oil (yield 30-40% by weight).

Moringa seed oil, also known as Ben oil, is sweet non-sticking, non-drying oil that resists rancidity. It has been used in salads, for fine machine lubrication, and in the manufacture of perfume and hair care products but, the seeds are also eaten green, roasted, powdered and stepped for tea or used in curries. This tree has in recent times been advocated as an outstanding indigenous source of highly digestible protein, Ca, Fe, Vitamin C, and carotenoids suitable for utilization in many of the so-called "developing" regions of the world where undernourishment is a major concern.

Sulviculture

Moringa oleifera is easily established by cutting or by seed. Seed can be sown either directly or in containers. No seed treatment is required. The rapidly germinating seedlings can reach 5 m in one year if sheltered from drying winds and provided with enough water.

Plants rose from 1 m cuttings beat pods from the second year of growth onwards, with maximum production at 4 to 5 years. In a favorable environment an individual tree can yield 50 to 70 kg of pods in one year.

Harvest and Yield

Perennial types raised by cuttings take nearly a year to bear fruit. The yield will generally be low (80-90fruit/year) in the first two years of fruit-bearing. This gradually increases to 500-600 fruit/tree/ year in the fourth and fifth years. The pods are harvested mainly between March and June. A second crop is normally harvested from September to October.

Annual moringa types are seasonal in terms of fruit- bearing and the crop sown during September comes to harvest within six months. Fruit of sufficient length and girth are harvested before they develop fibre. The harvest period extends for 2-3 months and each tree bears 250-400 fruit depending on the type.

Market Awareness

The oil for cosmetic use this is generally a low volume high value market. Although this is a market that can be opened up, it can take a number of years for the cosmetic industry to accept that what is being offered has qualities of some unique benefit and to then develop consumer products based around it. This is a potential market for Moringa oil but it is one that may take several years to develop. With respect to the commercial edible oil market this will probably be the most difficult market to target. Firstly, the oil comes into competition with the commodity oils such as palm and sunflower oil and, as such. If direct competition were to be considered then it would have to compete on price, which is unlikely. Moringa oil could be produced to match this price, if production is expanded a great deal. Secondly, this is new oil that has not been previously offered for sale as an edible product. Whether or not it will be accepted on the market will depend very much on the consumer and how the product is marketed to persuade the consumer to alter their purchases.

3. Methodology

3.1 Benchmarking

The prototype in this study was compared, with respect to its output with a commercially available multi-seed oil expeller, the piteba oil expeller.

Figure 10. Piteba Universal Expeller

Piteba is not rated for use with moringa oil, but due to its compact for our testing results, design and relatively easy operation we used this product as benchmark of comparison for the prototype being develop in the project. Piteba Oil Expeller was tested using Jatropa seeds with a yield of, approximately, 27-40% oil.

3.2 Testing

The test followed testing procedures used for the Piteba Universal Oil Expeller. This allowed easier benchmarking between our new prototype and the said universal oil expeller.

The test is designed to monitor and record the mass of pressed cake and the volume of oil extracted during a specified amount of time and from a specified mass of seeds. Jatropa seeds, which are readily available, will be used during the initial testing. This verified the capability of the prototype in extracting oil from seeds given that a decorticated jatropa seed and a moringa seed has the same consistency making it suitable for the experiment.

After verification, Moringa seeds were used to determine the prototype's actual capacity and output efficiency. Testing was separated into two batches, one batch of decorticated seeds and one batch of non-decorticated seeds. Recommendations was made, based on testing data gathered from the actual moringa seeds testing, to optimize the efficiency of the prototype and enhance quality of oil produced by the said prototype.

As reference, the following are the results from the Piteba testing done by the Engineering for Developing Communities Uganda Project Team under the Columbia University's Engineers without Borders (CU-EWB) Uganda program, in collaboration with Pilgrim, a Ugandan NGO.

Table 1. Raw Data

Run	Time (minutes)	Time (hours)	Mass of Input (grams)	Volume of Output from Oil Slit (mL)	Mass of Output from Oil Slit (grams)	Volume of Decanted Output (mL)	Mass of Output from Screwcap (grams)
1	5	0.083333333	100 ± .05	15 ± 1.25	17 ± .05	8 ± 1.25	59.9 ± .05
2	3.966666667	0.066111111	100 ± .05	17 ± 1.25	16.8 ± .05	9 ± 1.25	79.8 ± .05
3	2.35	0.039166667	100.1 ± .05	17 ± 1.25	13.9 ± .05	10 ± 1.25	77.5 ± .05
4	2.566666667	0.042777778	100 ± .05	22.5 ± 1.25	21.8 ± .05	11.5 ± 1.25	77.8 ± .05
5	20	0.333333333	500 ± .05	84 ± 1.25	82.2 ± .05	32 ± 1.25	356.8 ± .05
6	8.733333333	0.145555556	280 ± .05	20 ± 1.25	20.8 ± .05	7 ± 1.25	211 ± .05
7	8.166666667	0.136111111	283 ± .05	46 ± 1.25	45 ± .05	10 ± 1.25	231.5 ± .05
8	8.333333333	0.138888889	283 ± .05	42 ± 1.25	40 ± .05	8 ± 1.25	236.8 ± .05
9	18.55	0.309166667	179.7	85 ± 1.25	85	22 ± 1.25	65.8 ± .05

Table 2. Data on rate of expulsion

Run	Extrapolated Volume of decanted oil/ Hour (mL/ Hr)	Extrapolated Volume of total oil/ Hour (mL/ Hr)
1	96	180
2	136.1344538	257.1428571
3	255.3191489	434.0425532
4	268.8311688	525.974026
5	96	252
6	48.09160305	137.4045802
7	73.46938776	337.9591837
8	57.6	302.4
9	71.15902965	274.9326146
Average	122.5116436	300.2062016
Standard Deviation	83.24110321	120.4597041

Table 3. Data on amount of oil the settles out of the original output

Run	Volume of Output from Oil Slit (mL)	Volume of Decanted Output (mL)	Percentage of total oil output that is actually oil
1	15	8	53.33333333
2	17	9	52.94117647
3	17	10	58.82352941
4	22.5	11.5	51.11111111
5	84	32	38.0952381
6	20	7	35
7	46	10	21.73913043
8	42	8	19.04761905
9	85	22	25.88235294
Average	38.72222222	13.05555556	39.55261009
Standard Deviation	28.23020447	8.398081792	15.08985652

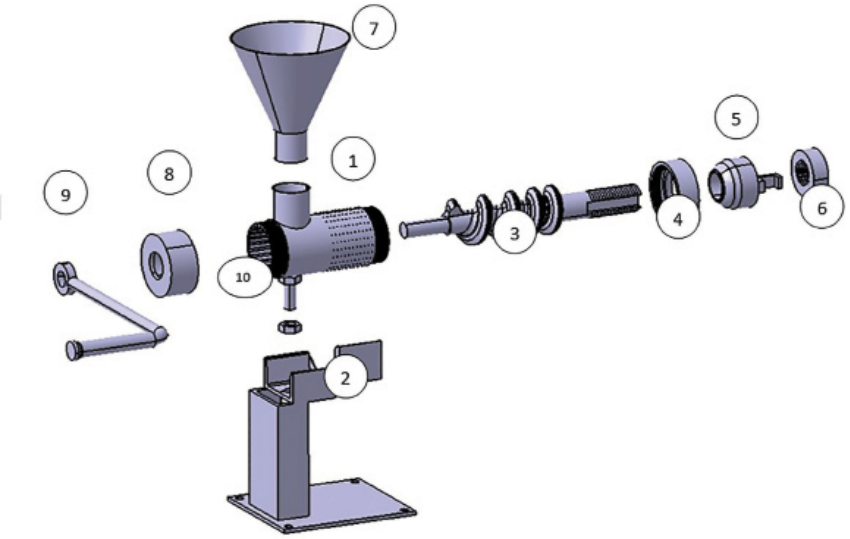
Table 4. Data on the percentage of input and output pressed cake

Run	Percentage of mass unaccounted for
1	23.1
2	3.4
3	8.691308691
4	0.4
5	12.2
6	17.21428571
7	2.296819788
8	2.190812721
9	16.08235949
Average	9.508398489
Standard Deviation	8.070556294

Table 5. Data on percentage of the input that is not found in either the seedcake mass or oil output mass

Run	Mass of Input (grams)	Mass of Seedcake (grams)	Percentage of Input that is Seedcake
1	100	59.9	59.9
2	100	79.8	79.8
3	100.1	77.5	77.42257742
4	100	77.8	77.8
5	500	356.8	71.36
6	280	211	75.35714286
7	283	231.5	81.80212014
8	283	236.8	83.67491166
9	179.7	65.8	36.61658319
Average	213.9777778	155.2111111	71.52592614
Standard Deviation	136.3871766	106.6677721	14.85060161

4. Design of the Oil Expeller



Parts:
1. Barrel
2. Stand
3. Screw
4. End Cap
5. Choke
6. Choke Adjuster
7. Hopper
8. Front Cap
9. Bearing
10. Handle

5. Discussion of Results and Findings

Tests resulted positively, however, due to heat application using kerosene as fuel ads impurities to the extracted oil which results into discoloration.

Moreover, accumulation in the exposed part of the barrel was observed during the test.

Due to the bigger diameter of the barrel, a bigger amount of force should be applied to turn the screw and compress the seeds inside the barrel.

Materials used in the fabrication of the parts were steel which resulted to rusting after use.

The cake thickness varies with the settings applied. The thinner the setting of the cake, the greater amount of force should be applied in turning the screw.

The stand should be properly mounted in a flat and stable surface.

Table 6. Result of Testing

TRIAL	SEED QUANTITY (g)	OIL QUANTITY (mL)
1	200	18
2	200	19
3	200	17

6. Summary and Conclusion

A screw enclosed in a barrel with groove on the walls created an impact in crushing the seeds inside the barrel which causes the extraction of oil upon compression of the screw towards the choked area at the end of the screw. Continues application of heat to the barrel significantly improves the extraction process while reducing the residual oil on the cake produced.

7. Recommendation

I recommend that since the oil extracted will be used for human consumption, metals with direct contact with the seeds and oil therein should be food grade metal to increase the quality of oil produced.

To further increase the quantity of oil extracted, a longer screw should be used and increase the quantity of holes in the barrel for better oil flow.

Denaturalized alcohol should also be used as fuel in heat application for cleaner and carbon free process.

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Capability Building: An Approach for the Development of a Locally Made Single Cylinder Diesel Engine

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Abstract

The Metals Industry Research and Development Center (MIRDC) under its study entitled "Capability Building: An approach for the Development of a Locally Made Single Cylinder Diesel Engine", has initiated a technique vital to the development of a single cylinder diesel engine in the Philippines. The main objective of the study is to build capability of the local industry for the development of a single cylinder diesel engine. Results of this endeavor can be utilized to develop various engine designs suitable for varied applications in agriculture and other industries, improve engine efficiency by enhancing some engine parts, encourage local manufacturers to develop a home-grown single cylinder diesel engine, and open the portal for a more advanced research in engine technology. Various activities have been conducted to assess the capability of the local industry for the development a single cylinder diesel engine. Among which are commitment building for capable entities and assessment of locally available machines, training on diesel engine mechanic and the utilization of reverse engineering facilities, dimensional checking, proximate chemical analysis, and acquisition of reverse engineering and CNC machines. The data gathered by MIRDC from 955 respondents revealed a partial number of 8,991 quality control facilities, 5,617 general metal machines, 303 specialized metal machines, and 157 other specialized machine tools. The researchers conclude that the local industry has the capability to develop a single cylinder diesel engine. The researchers further conclude that the capability of MIRDC as support agency has been enhanced through trainings and acquisition of new facilities.

I. Introduction

The use of single cylinder engine is widely recognized in the world. Its application encompasses transportation, industrial, construction, agricultural and many more. It is the generally used prime mover of farm machineries not only in the Philippines but also in other developing countries. It is extensively used from field preparation to post-harvest operations. Nevertheless, after more than a hundred years from invention, still, no Filipino company has been successful in manufacturing it in the country despite the dependence to this kind of prime mover in the production of agricultural and industrial goods and services.

Imported heavy machines and prime movers portray agricultural machinery industry in the Philippines along with local assembly and fabrication of small equipment. However, locally assembled machines are composed mainly of imported parts which costs more than a half of the total machine cost (Peeyush Soni and Yinggang Ou, Undated). Part of these machines are the single cylinder engines.

As estimated by Agricultural Machinery Manufacturers and Dealers Association (AMMDA), sales of single cylinder engine in 2013 is about 167, 000 units (Heng Dong T. Lim, 2014). Taking into consideration the high demand of single cylinder engines in agricultural operations and high cost of imported machines, MIRDC is now taking its initiative towards technology self-reliant country. With a move to promote a low-cost locally made technologies, MIRDC is engaged in several R & Ds and projects which focused on facility enhancement, services improvement and capability development vital to the needs of the growing local industry.

Objectives

The main objective of this study is to build the capability of the local industry for the development of a single cylinder diesel engine. Specifically it aims to:

1. Evaluate the capability of the local industry to develop a single cylinder diesel engine; and
2. Assess and enhance the capability of MIRDC as support agency for the development of a single cylinder diesel engine.

Materials and Methods

Materials

The materials used is the conduct of this study were 3D scanner and lap top computer, design computers with 3D modelling softwares, coordinate measuring machine (CMM), working tables, Vernier and digital calipers, computer numerical control (CNC) machines, manual lifter, height gauge, torque meter, wrenches, puller, hydraulic press, and single cylinder diesel engine.

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Methods

Commitment Building

The research team conducted a focus group discussion with the prospective team player for this study. The former carefully studied the capability of the latter and after affirming their cooperation, the researchers proceeded to the succeeding activities. Committed partners are assigned for the development/manufacturing of engine components/parts based on their expertise. Commitment building is vital to the initiation of this study.

Assessment of Locally Available Machines

Available machines in the local industry and within MIRDC have been assessed to determine their capabilities in supporting the development of single cylinder diesel engine in the country. Understanding the capabilities of the said machines helped in the selection of parts for local fabrication.

Training

Researchers and staff involved in the study have undergone training on diesel engine mechanic and the utilization of reverse engineering facilities. They have learned to disassemble and assemble engine parts, identify engine components, and understand the basic function of each component. They also earned capabilities in using the reverse engineering facilities such as the 3D scanner, 3D printer, design computer and software, and other instruments.

Disassembly of Engine Components

The model engine has been disassembled for documenting purposes. This step was necessary for modelling each component and for other vital activities. All parts have been labeled individually, per sub assembly, and per assembly so that it will not be difficult for the researchers during the reassembly of the engine.

Acquisition of Reverse Engineering Facilities

MIRDC acquired a portable 3D scanner to strengthen further its documentation capabilities as support to local industries not only for machine fabrication purposes but also for research and development. The handy device allowed the users to easily scan engine parts and comfortably transport it from one place to another without strain.

MIRDC also obtained a 3D printer to assist the designers in designing machine parts. It allowed the creation of a 3D-printed parts which could be assembled to form a mechanism. This gave a clear visual to the designers about their designs and on how to enhance it further. Moreover, MIRDC has upgraded its design computers which permitted the smooth creation of 3D models and other design activities.

3D Scanning and Documenting

A leading brand of a single cylinder diesel engine was selected as model for the study. The choice was based on the quality of the product. The selected model was disassembled and the selected parts were subjected to 3D scanning. In this study, all engine components having complex profiles were scanned. This method helped the researchers easily develop a 3D model at a more precise dimension. Simple-profiled parts on the other hand were manually documented using calipers, gauges, and other appropriate measuring devices.

With the 3D scanning technique, the research team avoided the tedious way of measuring and drawing profiles of irregular shape engine parts. Positioning targets were properly attached to the appropriate area on the subject to avoid unwanted results. Unscanned area was easily detected and corrected using the attached computer. The process was performed using Creaform REVscan 3D scanner.

3D Modelling

After scanning, generated data underwent a cleaning process through Geomagic DesignX software. This process removed geometric points which are not necessary for 3D modelling. This gave a clearer view to the designer about the subject. 3D modelling was done to create a solid body which mimicked the scaled size of an object. It helped in easy visualization of complicated profiles and allowed viewing from different angles. In this study, the researchers used NX8.5 software for that purpose.

2D Drafting

2D drafting was vital in manufacturing process. Critical views of each part were carefully presented in a drawing paper. Dimensions and tolerances were also placed on the drawing. This process allowed the designer and checker to verify the data with the actual model parts.

Dimensional Checking and Updating

To verify the dimension of the drawing, actual engine parts were subjected to quality assurance process. Precision devices such as the Coordinate Measuring Machine (CMM) and other appropriate devices were used for this activity. Any discrepancy in dimension depicted in the drawing was automatically corrected by updating the 3D model.

Proximate Chemical Analysis

Major engine components were subjected to proximate chemical analysis. This technique was done through a device known as XRF (X-ray fluorescence spectrometer) which is already available at MIRDC. This method provided information to the researchers regarding the chemical properties of each component. This was necessary to guide the researchers regarding appropriate materials to be used for a particular component.

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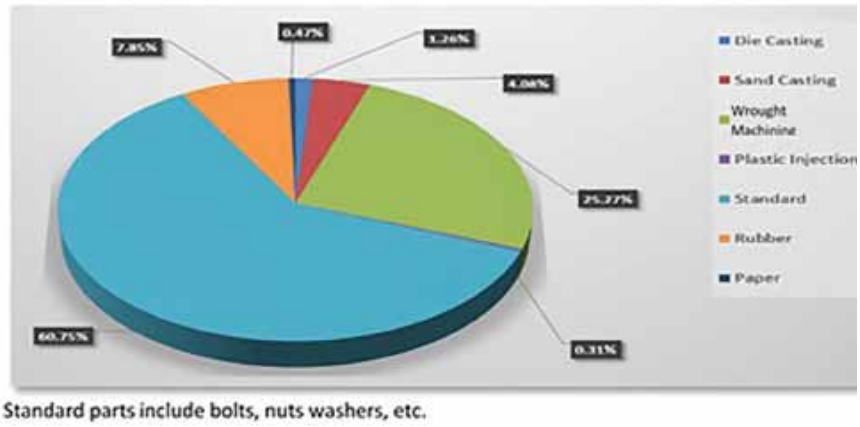

Figure 1. Composition of a single cylinder diesel engine.

Results and Discussions

Engine Composition

A leading brand of a single cylinder diesel engine has been disassembled to evaluate each component and found out that 60.75% were standard parts, 25.27% underwent wrought machining, 7.85% were rubber parts, 4.08% underwent sand casting process, 1.26% underwent die casting, 0.47% were gasket paper parts, and the least parts were made by plastic injection (Figure 1). It could be noted that the highest percentage belongs to standard parts which are readily available in the local market implying a promising prospect for the single cylinder diesel engine assembly. Other parts on the other hand can be produced locally based on the researchers' assessment on the capability of the industry.

Reverse Engineering

MIRDC has acquired reverse engineering facilities which played vital role in documenting of selected engine parts. Such facilities are essential for machine development and related research and development activities. One important facility in reverse engineering is a 3D scanner.

3D scanner was used to create a copy of a certain object. However, the output was stored in a computer in the form of facet bodies. These facet bodies were converted into solid bodies so that the data generated could be utilized for technical drawing and other design purposes. Figure 3 shows a trained research staff scanning the engine block.

After scanning an engine part, the data generated underwent the enhancement process. This process removed the scattered points around the subject which made it easy to the designer to model the said subject. Figure 2 displays a sample data image of a newly scanned part (a), cleaned data image (b), and the 3D model (c).

All engine components were modelled using NX8.5 CAD software. Scanned data were exported to the NX environment for 3D modelling. With this process, the research team was able to mimic and assemble engine parts in a computer. This also aided in the automatic 2D view generation, hence avoided the possible error in manual drafting process. On the other hand, 2D drafting was vital for dimensional verification and fabrication. Figure 4 shows an engine part in a clearer 3D model made by a highly trained designer. In addition to the existing design facilities, MIRDC is planning acquire a more sophisticated design facilities which could further strengthen the manufacturing industry of the Philippines.

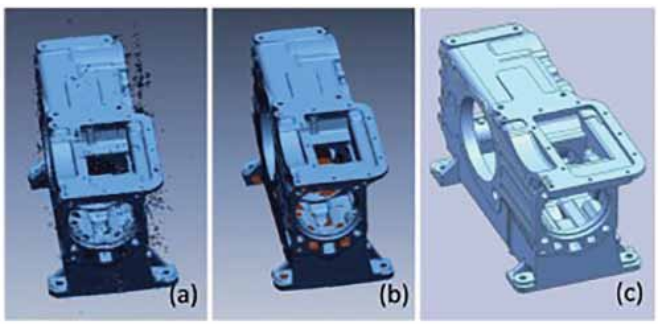

Figure 2. The newly scanned data image (a), cleaned data image (b), and 3D model (c) of a cylinder block.

Figure 3. 3D scanning of an engine block.

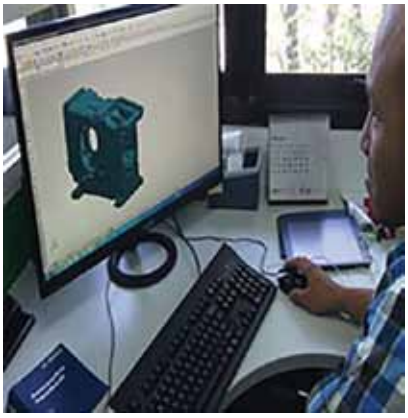

Figure 4. 3D modelling of an engine part.

Dimensional Checking

The data gathered by MIRDC from 955 respondents revealed a partial number of 8,991 quality control facilities in the Philippine machining industry of which, 99 percent are measuring instruments (Table 1) which allows a variety of methods for data verification. This also implies that high percentage of accuracy could be generated using the diversity of these measuring instruments.

To assess the capability of available instruments and personnel, actual dimension of engine parts was measured and verified with the generated technical drawing. Discrepancies in the dimensions were automatically corrected by updating the 3D models. Figure 5 shows the actual dimensional checking conducted.

Table 1. Quality Control Facilities in the Philippines

Equipment	No. of Units
Hardness Tester	72
Atomic Absorption Spectrometer (AAS)	3
Measuring Instruments	8,916
Caliper	3,885
Micrometer	4,419
Height Gauge/Master	230
Coordinate Measuring Machine (CMM)	23
Toolmakers' Microscope	23
Metallurgical Instruments	15
Vision Measuring Machine	321

Source: MIRDC. The Philippine Machining Industry A 2009 Study (Data from 955 respondents out of the estimated 1350 machine shops in the country).

Table 3. Industry Associations

Name of Association	No. of Members
Philippine Metalcasting Association Inc.	78
Regular Members	53
Affiliate Members	19
Institutional Members	6
Metalworking Industries Association of the Philippines	293
Philippine Die and Mold Association	No data
Motor Vehicle Parts Manufacturers Association of the Philippines, Inc.	126
Agricultural Machineries Manufactures and Dealers Association	No Data

Table 2. Machines Available at the Philippine Machining Industry.

General Metal Machines	No. of Units	Specialized Metal Machines	No. of Units	Other Specialized Machine Tools	No. of Units
Lathes	3,153	Electrical Discharge Machines (EDM)	84	Crankshaft Grinding Machines	86
Milling Machines	957	Jig Boring Machines	8	Line Borers	53
Boring Machines	342	Profile Grinders	29	Valve Refacers	18
Grinding Machines	1,011	Tool and Cutter Grinders	162		
Shapers	132	Gear Making and Hobbing Machines	17		
Planers	8	Honing Machines	3		
Power Hacksaw/ Bandsaw	14				
TOTAL	5,617		303		157

Source: MIRDC. The Philippine Machining Industry A 2009 Study (Data from 955 respondents out of the estimated 1350 machine shops in the country).

Figure 5. Dimensional checking of a flywheel.

Figure 6. Selected parts for manufacturing.

Manufacturing

As presented in Table 2, there are about 5,617 general metal machines, 303 specialized metal machines, and 157 other specialized machine tools in support to the machining industry of the Philippines. These values denote sufficient facilities which are more than enough to sustain the development of a single cylinder diesel engine in the country backed by prominent industry associations listed in Table 3.

In order to verify the capability of the local industry, selected parts which have prospect for localization were assigned to them for manufacturing based on their expertise. Displayed in Figure 6 are among the engine parts intended for localization which were made by the local industry.

Support Facilities

In support to the metals and engineering industry, MIRDC has acquired CNC machines capable of manufacturing selected engine parts and other products related to metals industry. A sophisticated gear making facility is also expected to emerge before the end of 2015 aside from the already existing die and mold making facility, mechanical and chemical testing facility, foundry, heat treatment facility and surface finishing facility. These facilities are available in service of the industry in the event of mass production and for training purposes. Depicted in Table 4 are additional machines acquired by MIRDC which could be used for the fabrication of selected engine parts.

Table 4. MIRDC facilities in support to the development of a single cylinder diesel engine.

Machine Type	No. of Units
CNC Machines	23
Plastic Injection Machines	4
Quality Assurance Machines	5
TOTAL	32

Summary and Conclusion

Summary

MIRDC conducted a study entitled "Capability Building: An approach for the Development of a Locally Made Single Cylinder Diesel Engine", with the main objective of building the capability of the local industry for the development of a single cylinder diesel engine. Specifically it aims to 1.) evaluate the capability of the local industry to develop a single cylinder diesel engine; and 2.) assess and enhance the capability of MIRDC as support agency for the development of a single cylinder diesel engine. Various activities have been conducted to assess the capability of the local industry for the development of a single cylinder diesel engine. Among which are commitment building for capable entities and assessment of locally available machines, for the manufacturing and casting of parts; training on diesel engine mechanic and the utilization of reverse engineering facilities, necessary for trouble shooting, disassembly and assembly of engine components, precise data generation and presentation; dimensional checking, for data verification; proximate chemical analysis, which is necessary for determining the chemical properties of various parts; and acquisition of reverse engineering and CNC machines as support facilities.

The data gathered by MIRDC from 955 industry respondents revealed a partial number of 8,991 quality control facilities of which 99 percent are measuring instruments. In addition are 5,617 general metal machines, 303 specialized metal machines, and 157 other specialized machine tools in support to the manufacturing industry of the Philippines.

As support agency, MIRDC has die and mold making facility, mechanical, metallurgical and chemical testing facilities, foundry, heat treatment facility and surface finishing facility.

Moreover, MIRDC has 23 CNC machines, four plastic injection machines, and five quality assurance machines with a total of 32 machines in support for the development of a single cylinder diesel engine. A gear making facility is also expected for establishment before the end of 2015.

Conclusion

The researchers conclude that the local industry has the capability to develop a single cylinder diesel engine. The researchers further conclude that the capability of MIRDC as support agency has been enhanced through trainings and acquisition of new facilities.

Recommendation

Based on the results of the study, the researchers recommend a follow through research on the development of a single cylinder diesel engine.

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Yantrika (India)	Test Gauge (Digital and Analog Type), Light Weight Comparator
Wahl (USA)	Multifunction calibrator, Digital Test Gauge
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Mario G. Montejo:
An Engineer, Entrepreneur, and Public Servant Coming Full Circle

Zalda R. GAYAHAN*1

As DOST Secretary, Mario G. Montejo (SMGM) strengthened a positive culture of creativity and self-reliance.

'Bakit hindi na lang si Mario?' was the question asked by the then newly-elected President of the Philippines, Benigno S. Aquino III, upon assuming office in Malacanan in 2010 and filling in the post for the Secretary of the Department of Science and Technology (DOST). He says he always shares this story about how his stint as DOST Secretary began. It has been six years and the DOST has taken significant strides toward becoming more aggressive in harnessing science, technology and innovation in shaping the country's economy.

As DOST Secretary, Mario G. Montejo (SMGM) strengthened a positive culture of creativity and self-reliance. This is manifested through the programs and projects implemented by the DOST itself and the various agencies attached to it. Individual efforts of each agency assigned to take the lead in a particular branch or specialization in science and technology are recognized and at the same time, taken together to move toward the central direction that the Department has vowed to achieve for the nation known as the DOST Eight (8) Outcomes.

Playing a pivotal role in the realization of several of these outcomes is the DOST-Metals Industry Research and Development Center (DOST-MIRDC). The DOST-MIRDC continually deepens its

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cooperation with the metals, engineering and allied industries. In fact, the Center was the lead implementing agency behind the Makinarya at Teknolohiya para sa Bayan (MakiBayan) initiative of the DOST. Spearheaded by the Secretary, the MakiBayan aims to generate more jobs, create opportunities for advancement of skills, encourage more businesses, and spawn higher income.

The DOST-MIRDC envisioned that the MakiBayan will be a platform that will effectively harness Public-Private Partnership (PPP). True enough, the MakiBayan served as stimulus that paved the way for a more purposeful PPP. Since its launching in 2012, the list of MakiBayan partners expanded to include the: Philippine Die and Mold Association, Inc. (PDMA); Metalworking Industries Association of the Philippines (MIAP); Engineering Research and Development for Technology (ERDT); Electronics Industries Association of the Philippines, Inc. (EIAPI); Original Equipment Manufacturers Association of the Philippines (OEMAP); Philippine Metalcasting Association, Inc. (PMAI); Philippine Welding Society (PWS); Aerospace Industries Association of the Philippines (AIAP); Motorcycle Development Program Participants Association (MDPPA); Motor Vehicle Parts Manufacturers Association of the Philippines (MVPMAP); and the Mechatronics and Robotics Society of the Philippines (MRSP).

The partnerships formed under the MakiBayan saw the implementation of several programs where the MIRDC and the M&E industries played central roles. Inspired and motivated by the 'Local technology works' mantra of SMGM, the M&E industries found itself actively engaged in a wide variety of activities related to Machine Building, Facility Upgrading, Advanced Transportation Systems, and Capability Building Programs. These are just some of the most recent programs launched by the DOST-MIRDC, and SMGM was with the M&E industries every step of the way.

The Machine Building Program led to the design and development of agricultural and food processing equipment. Going beyond just development, the food processing equipment are deployed to the regions to be part of Food Innovation Centers. Also part of the Machine Building Program are projects that developed industrial or special purpose equipment such as the CNC Plasma Cutter and the CNC Laser Machine. There were also projects for Disaster Mitigation like the Trash Rake and the Met Buoy.

SMGM leads the panel, composed of QC Mayor Herbert Bautista, ASec. and MIRDC Executive Director Robert O. Dizon, Engr. Jonathan Q. Puerto and Engr. Gharry Bathan, during the Q&A at the Trash Rake launching.

(L) SMGM inspects the Hybrid Road Train at the MIRDC; (R) SMGM shows the smart card for the Automated Fare Collection System during the Demo Run of the AGT in UP Diliman.

Projects under the Facility Upgrading Program include, among others, the establishment of the Die and Mold Solution Center and the Auto-Parts Testing Facility. The Advanced Transportation Systems is the program that has captured considerable public attention, especially because the Automated Guideway Transit (AGT) System, the Hybrid Road Train, and the Hybrid Electric Train offer the much-needed mass transportation alternatives. They are products of green technology, and proudly homegrown. SMGM himself keeps track of the progress of these projects.

Looking back at the six-year term of SMGM, he deliberately led the MIRDC and its industry partners to collaborate and build an environment that is enabling for engineers, innovators, and businesses. His kind of leadership is an attribute that did not grow overnight. A turbulent college life where he earned a Mechanical Engineering degree and a passion for innovation molded him to become the kind of leader that he is now. It was, in fact, the situation in the country during the Martial Law period that opened his eyes to the reality that he can make use of his engineering background to help the country.

Before being appointed as DOST Secretary, SMGM served as an employee in some engineering firms. Later, he put up several businesses with his lovely wife, Mrs. Maria Rosario O. Montejo. As entrepreneur, he was able to fulfill his heart's desires – come up with fascinating ideas, turn them into something with market value, and enjoy doing business while offering products, services and solutions to address the needs of the market. His most recent professional record in the private sector includes being President of Northwest Steel/MK Screens, Inc. from 1986-2005, President of NWSteel Technologies, Inc. from 2000 – June 2010, and President of Tree Top Adventure, Inc. from 2008 – June 2010.

A lot of his experiences from the private sector can explain why he is so passionate about making local technologies work. This battlecry has already inspired so many of us at the DOST-MIRDC and our faith in our capabilities shines through so that it is felt by the M&E industries. One of SMGM's most significant legacies to the M&E industries is the confidence that we can do it.

The industry sees a lot of SMGM when he is at work. Scenes of SMGM talking with top government officials, foreign consultants and businessmen, and local industry players are commonly seen in the news, but we rarely get a glimpse of SMGM wearing his other hats: a businessman and employer, a husband, a father, a grandfather.

The Secretary with his partner in business and in life, Mrs. Maritz Montejo.

Below are selected portions of the MIRDC's conversation with SMGM. If one reads carefully between the lines, one can perhaps decipher how SMGM is able to come up with all his ideas, convince other people of the soundness of these ideas, and steer industries toward the same direction where he goes. Behind the stories is a great man who finds fulfillment in constantly innovating and spreading the inspiration to serve the country.

MIRDC: How were you as a boss when you were in the private sector?
SMGM: We treat employees like extended family. *Pag* private *kasi, pag sinabi mong* family, *parang* extended family. We have employees who stayed with us for 10, 20, 25 years. *Mahaba na din*. Our relationship is like having an extended family. That kind of relationship is what we are trying to cultivate.

MIRDC: Were there instances that you felt ineffective? How do you deal with failure?
SMGM: *Madaming klaseng* failure. *Sa* technical *kasi, dapat* relentless *yun e*. You don't stop at failure. Always *naman,* you have to rise up. If you experience bankruptcy, *yun ang mas mabigat na* failure *kasi mas maraming* failure *yun. Pero* it happens, because those are lessons in life. It is a humbling experience. *Kaya nga pag naisip mo,* one of these days *pwede ka din ma*bankrupt. *Kaya hindi ka pwedeng magyabang. Kasi umiikot ang mundo, mamaya ikaw naman ang nasa baba e.*

(SMGM shared that he and his wife are soft-hearted to those who run to them for help because they can understand the situation. They know that in running a company, sometimes it happens that the business badly needs help but there is no one to run to for help.)

MIRDC: Although ours is unique in its own way, to what country can we best pattern the local metals and engineering industries so that it can gain competitive advantage, vie for market share and play head-to-head with other countries' move to globalize?
SMGM: China. Under our constitution, *dapat talaga* we develop our own self-reliance in the important sectors. For example *ang* mass transport. *Kahit tayo bumili ng* train *kasi wala pa tayong* capability, *dapat kasabay nun* we develop our own capability to make our own trains – which we did not do previously *kasi* government policy, *kasi nakalagay sa* constitution *e. Ang* China *bumili sila ng* magnetic levitation[1] (maglev train). *Kasabay nun gumawa na sila ng sarili nila. Kasama sa program nila* to have the budget, *para "ako din gagawa ng* train."

Ganun din dapat tayo. As a policy of the national government *na kung hindi natin kaya* at the important areas, *ok lang bumili. Pero kailangan ng* budgetary support for us to develop the capabilities and have the facilities to make whatever it is.

MIRDC: How did your years of experience in the private sector help now that you are a public figure?
SMGM: I am an innovator. I am used to having limited resources, limited logistical support. If you are an innovator, *matutuwa ka sa* DOST *dahil napakarami ng pwede mong gawin, at sagot pa ng gobyerno. Kung bata ka, para kang napunta sa* candy store. *Mahihirapan kang pumili. Dati hirap na hirap ka dahil sagot mo yung paggawa ng* candy *e. E ito ang dami mong pwedeng i*-offer *na mga* candy.

MIRDC: What important lessons did you learn during your term as DOST Secretary? Lessons that were perhaps not so obvious to you before.
SMGM: Innovator *ako,* so *dapat* optimistic. If you develop a product, only 15% will be successful, the remaining 85% will be failures. *Kaya maraming* risk-averse, *dahil ito ang* reality.

What he learned in his stint as the DOST Secretary is if the government takes care of the 85% risk, more innovators will be encouraged to develop new products. This is especially true because we have to realize that this is what they practiced in Iran, in Israel. Their government really supports R&D projects, for encouragement and promotion of innovation.

SMGM: *Yung* funding support, *galing sa* government. *Kung mag*-click, *kung maging* successful, private *naman ang mag*take over. Statistics show that for every peso you invest in R&D, *ang bawi nun mga* P30.00. *Kaya yan ang sabihin natin sa* DBM *lagi.* (He flashes that engaging smile at his comment.)

1. A train that uses the physical properties of magnetic fields generated by superconducting magnets to cause it to float above a solid surface.

Mr. and Mrs. Mario G. Montejo with their children, Jose Mario (Kiko), Maria Katrina (Katrina), and Maria Camille (Kookie).

He further shares some more lessons he learned:
'Tinuruan natin ang mga scientists *natin* how to write a business model. For instance, there is this product, *mga* P15 – 20 million *ang ating* investment. *Ang* value *ng kanyang* enterprise now because of that product is P300 million. *Kaya ngayon tinuturuan natin ang ating mga* scientists to be able to give business value *sa kanilang mga* outputs.

In addition, SMGM excitedly shared that in the recently held DOST Technology Transfer activity, 'We showcased 74 technologies, and a big fastfood chain expressed interest in 26 out of the 74.

In SMGM's standpoint, we are of age to finally accept that entrepreneurship and technical background can make a business successful. *'Kailangan ilagay sa* mindset *ng ating mga* scientists and technical people, *na pag hindi mabenta, walang* value. *Kaya kailangan din tingnan ang* mindset *ng* market.'

MIRDC: If you were asked to rate your own performance as Top Leader of the DOST, what grade will you give yourself? (1-10, 10 being the highest). Why?
SMGM: (Hesitant to answer at first) 8. First, because we are not perfect. Secondly, we work in the government and there are a lot of things beyond our control.

MIRDC: Can you describe a typical weekend in the Montejo household? (assuming you do not work on weekends)
SMGM: *Maaga ako gumising, mga* senior citizens *maaga gumising e* (He gives us that heartwarming smile again.). Well, thinking of ideas is not work *naman, kasi may* fulfillment *naman e.* Before, we used to go to Subic, *kasi sa* Manila traffic *e. Dun kami sa* nearest mall, *manood ng sine tapos kain sa labas.*

MIRDC: Do you consider yourself 'rich'?
SMGM: Relatively we have a simple lifestyle. We have more than enough for our lifestyle. Some people may look at us as rich, *pero kami, ok lang kami.* We are comfortable.

MIRDC: Are you a strict father?
SGMG: *Hindi masyado.*
MIRDC: If you had it your way, do you want your children to be in the private sector? Or do you want them to be public figures like you? Why?
SMGM: Choice *nila yun e.* I do not want to influence.
MIRDC: What reminder do you always tell your children?
SMGM: Sa financial, be careful on your lifestyle. Second, do what you love doing. And also, *wag maging mayabang. Palagay ko naman na*-instill *naman yung* values. At *syempre,* hard work.

His family has grown to include five grandchildren who fondly call him 'Pops.'

MIRDC: What are your plans after your term as DOST Secretary?
SMGM: *Babalik sa* private. We have a plant in Bulacan. We have two theme parks, one in Subic and the other one is in Baguio. Just like in any business, *yung aming mga*

attractions *e naluluma na din*. So we have to innovate. *Yun ang gagawin ko. Humihina ang benta. Kailangan mag* introduce *ng bago.*

'Part of me is excited to go back, in a way. In doing business in the private sector, you are very focused, very hands-on, and you get immediately the results. I am also looking forward to that,' tells SMGM.

He says he will always be hopeful that the 'local technology works' will remain as the people's mindset.

MIRDC: What are your parameters of 'happiness' and 'success'?
SMGM: (He took a longer time to think of an answer.) *Hindi ko nga alam e* (Flashing the warm, arresting smile once more.). *Siguro dapat tumawa* more. To be more light.

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MRSP Revitalized

Franklin D. QUIACHON,*1 Joel B. BAJADOR,*2 Gamaliel F. ITAO*3

The Mechatronics and Robotics Society of the Philippines (MRSP) is a group of people who are committed to the advancement of mechatronics and robotics technology in the Philippines through research and development, innovations and sharing of expertise, information and experience.

This society has a multi-level membership to ensure the integration of mechanical, electrical, electronics and computing technology, skills and knowledge in the production of automated and intelligent machines and equipment.

Brief History

Founded in 2006, MRSP has grown its membership nationwide and include companies, institutions, schools, professionals and students. MRSP conducted technical seminars, organized mechatronics, and robotics competitions attended national and international conferences, linked industry and schools, to mention among others, some of its activities. In addition, MRSP developed close working relationships with some government institution and eventually became formal partners with Technical Education and Skills Development Authority (TESDA) and Metals Industry Research and Development Center (MIRDC). TESDA provided an office space for MRSP and was given the task to develop the Training Regulations (TR) for Mechatronics and Automation NC II, NC III and NC IV. TRs for NC II and NC III have already been promulgated while NC IV will follow very soon. Currently, MRSP is also developing the TR for NC V. MRSP played a major role in the training and establishment of Mechatronics and Automation Training Center in TESDA and later the establishment of HRDI-PKTT in Taguig City.

MRSP reorganized and elected its new officers last June 16, 2015. On June 18, MRSP signed a partnership MOA with DOST-MIRDC to establish an Advanced Mechatronics and Automation Laboratory at MIRDC's facility in Taguig City. This Laboratory facility funded by DOST is currently being constructed. A budget provisioned for

Induction of new officers.

Advance Equipment and Instruments for research and development purposes is in the pipeline. The new officers and directors are enthusiastic and committed to revitalize the organization because they believe that the goals of MRSP have become even more relevant with the current times in terms of sharing information on new development in technology, improving the availability of qualified manpower for industry needs, and preparing the country's competitiveness towards the implementation of the ASEAN integration.

In a short span of time, memberships have grown substantially including Companies, Schools, Institutions, Professionals and Students; having Batangas State University

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Bicutan, Taguig City

*3 *President*
Mechatronics and Robotics Society of the Philippines
Bicutan, Taguig City

MRSP's first convention at MIRDC in Bicutan, Taguig City.

as the first School Chapter with more than 300 members and other schools like Lyceum of the Philippines – Laguna, University of Perpetual Help – Molino and Calamba Campus, Emilio Aguinaldo College – Manila, and De La Salle – Dasmariñas as institution members

Convention

MRSP held its historic first Convention in December 11, 2015 with more than 150 participants in attendance at the Platinum Auditorium in MIRDC. Aside from the plenary session where amendment to its By-Laws were approved various activities were held such as induction of new officers and directors, CPD seminars, competitions in mechatronics and in robotics, MIRDC facilities tour and its Christmas Party. Guest speakers were none other than Robert O. Dizon, Assistant Secretary of DOST and Executive Director of MIRDC and Atty. Teodoro C. Pascua, Deputy Director General of TESDA. A delegate describes his experience as "the first convention I attended that is challenging, educational and enjoyable".

Strategic Planning Workshop

In January 30, 2016, all officers and directors met again at the Platinum Auditorium of MIRDC to develop the plan of activities for the year 2016. These activities include conducting free and paid seminars, assessments and certifications on mechatronics and automation, holding of competitions in mechatronics and robotics, quiz bee contest, participation in MIRDC's 50th anniversary celebration in June 2016, Annual Convention and many others. MRSP also defined its new Vision and Mission statements as well as its Core Values.

MRSP Certification

In addition to the TESDA National Certification, MRSP has developed an advance level of qualification to become certified and competent Engineer and Specialist. An examination will be given to those who want to advance their level in Mechatronics field:

- Mechatronics and Automation Engineer (**NC IV** +PRC Registered Engineer (REE, RME, RECE) + **(MRSP Certification Exams);**
- Mechatronics and Automation Specialist (**NC IV**+BS Engineering /Technology degree Course , Vocational Course with 5 years' experience);
- Mechatronics and Automation Master Technician (**NC II–NCIII** +BS Engineering /Technology Course + Vocational Course with 2 years relevant experience); and
- Mechatronics Technician (**NC II** + Any Vocational Technical Course)

Strategic Planning Workshop participants.

MRSP

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The Mechatronics and Robotics Society of the Philippines is a group of people who are committed to the advancement of mechatronics and robotics technology in the Philippines through research and development, innovations and sharing of expertise, information and experience. This society has a multi-level membership to ensure the integration of mechanical, electrical, electronics and computing technology, skills and knowledge in the production of automated and intelligent machines and equipment.

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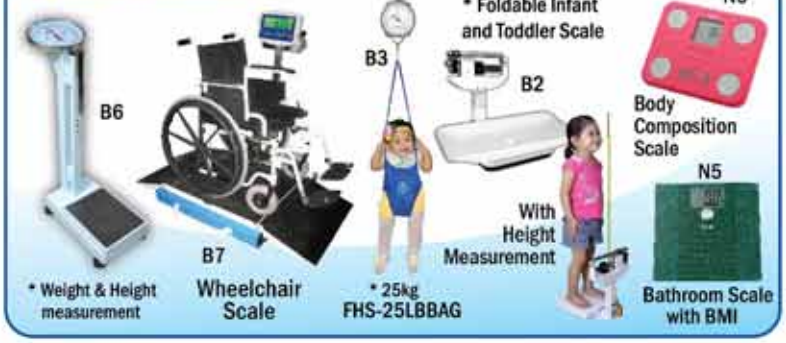

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