Philippine Metals

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Department of Science and Technology
METALS INDUSTRY RESEARCH AND DEVELOPMENT CENTER

HYBRID ELECTRIC ROAD TRAIN

AUTOM
(AGT) S

HYBRID ELECTRIC TRAIN

ACILITIES (ATF) OF MIRDC

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Galvano Test

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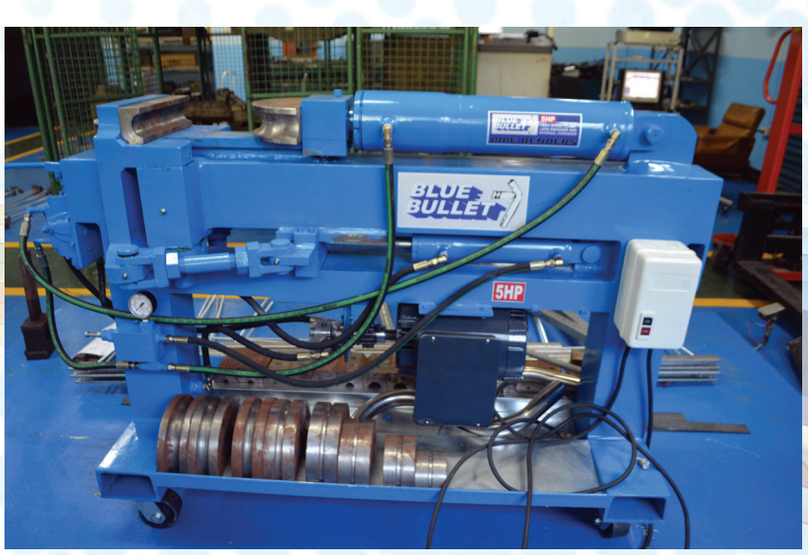

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MATED GUIDEWAY TRANSIT SYSTEM

AUTO-PARTS TESTING FA

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Friction Materials Test Machine ("Chase" machine)

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UT Thickness Gauger

X-ray Fluorescent / (PMI)

Portable Coating Thickness Tester

Retractor Tilt Locking test stand

Philippine Metals

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Preface

The Department of Science and Technology – Metals Industry Research and Development Center (DOST-MIRDC) remains assertive in disseminating the results of our R&D outputs through publications like the Trends and Events, the Annual Report, and technology brochures, among others. The Philippine Metals is a very special publication because it contains a collection of technical papers on recently completed projects, and is thus a very important channel that allows us to realize our mission concerning information exchange.

We are privileged to present to you Volume 4 of the Philippine Metals where we have a proud compilation of technical papers on the Automatic Trash Rake, the Tent System for Emergency Applications, the Eyelet Riveter, and the Test and Evaluation of the 120-passenger per Coach Capacity Automated Guideway Transit (AGT) System. In addition, Vol. 4 also features the results of the industry study, focusing on the welding subsector, in the publication's Metals Review section.

The technical papers contained in this publication convey our vehement support to the industries. We intend to provide R&D-based solutions to real world problems. Our end goal is to arrive at relevant outcomes, which can only be realized through the M&E industries' adoption and commercialization of the output of these R&D activities. True to our mandate, we will do all that it takes to create significant impact to the metals, engineering, and allied industries.

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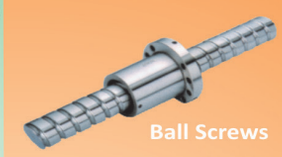

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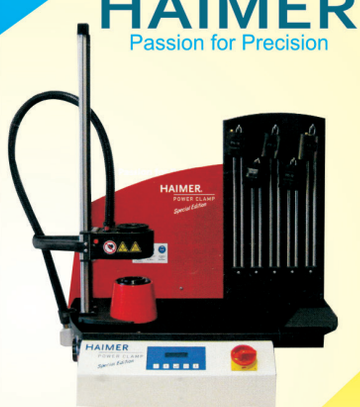

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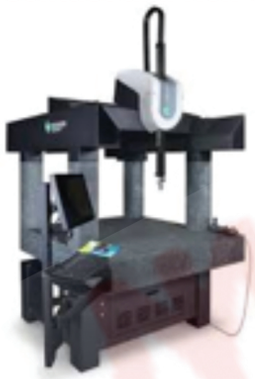

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The Philippine Welding Industry: In the Light of Modern Application

Ma. Rodessa Grace A. MERCADO*[1]

Abstract

Given the expectation that the welding industry will prosper through the numerous opportunities offered by the various sectors it serves, it is therefore important to solidify the basic foundation of the industry – manpower and technology. The 2014 Investment Priorities Plan (IPP) points to a further strengthening of manufacturing activities that may be linked to welding processes, particularly that of motor vehicles, shipbuilding including parts and components, and aerospace parts and components. The marked improvement in business climate also echoes the need for stronger performance from the welding industry. Welding, as a key element in producing most of the necessary products in the manufacturing industry, plays a vital role in maintaining its precision and cost effectiveness. The local welding industry, therefore, needs to advance its technical capability in order to keep up with the boost of demand from the different industries.

I. Introduction

Welding, in a modern-day sense, can be pictured as a key process that is subsequently beneficial for all metal-working industries. As a labor-intensive process, welding is considered as one of the most important methods of joining metals to produce various products widely used by manufacturers from different industries. As these industries are expanding continuously and new technologies are applied to produce more reliable products, welding processes are also projected to undergo evolution to adhere with the most critical requirement in manufacturing operations.

As part of the Philippines' streamlining activities, a remarkable increase in Foreign Direct Investment (FDI) inflows also resulted to rise in manufacturing activities that positively affects the rise of demand for welding consumables and products. In the context of the new trend in manufacturing which is more technology-driven, there is an evidence of emerging mismatch in terms of the existing dynamism in local welding activities. The Philippines still has to do more to catch the next wave of opportunities offered by the various industries.

Basically, welding is the principal means of fabricating, repairing and obtaining permanent joint of metal products through application of suitable combination of temperature, pressure and metallurgical conditions. The choice of appropriate welding process depends on how the industry needs it in their operations. For small businesses utilizing single-item fabrication, manual joining using shielded metal arc welding (SMAW) is employed. For series fabrication, automated process or robotics may be used; metal arc welding is used for metal construction and plant engineering; and beam welding for the manufacture of precision parts or friction stir welding in aluminum processing (Hofe, 2015).

The trend in welding that demands a game-changing fleet of new technologies to come up with new products is the redesigning needed by the whole industry to be globally competitive. Much of the industry's potential remains untapped and needs steering to come up with insightful strategy in welcoming opportunities as it unfold.

This review provides an insight into the dyamics guiding the welding industry. Also included in the discussion are the local welding industry's current market and technical profile and the challenges that stagnates the development of the industry. The data provided in this review are based on the result of the survey of the welding industry conducted by the Metals Industry Research and Development Center from 2015 to 2016. The next section will highlight the growing trend in industries catered to by the welding industry and its impact to forward projections for the Philippine welding market.

II. Overview of the Philippine Welding Industry

The largest number of welding establishments are found in Region IV-A and NCR, both known to be highly industrialized areas. Most industrial sectors are utilizing welding in their operations, thus attracting local welders to establish businesses in these regions. The Philippine welding indus-

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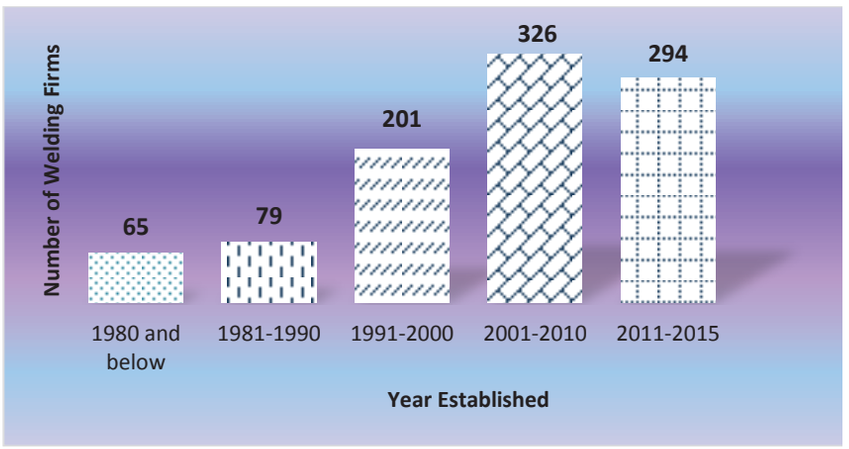

Figure 1. Welding Businesses Established Per Decade

try continued to expand at a relatively rapid pace particularly in the beginning of the 1990s. Figure 1 illustrates the growth in number of welding establishments in the country.

As illustrated in Figure 1, the spur of growth in the number of welding business continued from 2001 to 2010 with 326 additional welding establishments. In a span of five years (from 2011 to 2015), 294 more welding businesses were started, which is an indication that more people were interested in the welding industry. What can easily be noticed in Figure 1 is the sudden increase in the number of emerging welding businesses in the beginning of 1990s which coincides with the time when foreign investments quadrupled to more than US$200 million, coming from a US$50 million average during the 1970-1980s. The development was believed to be a result of positive political and economical trend in the 1990s (Nolan, 1996).

In the Philippines, welding firms that belong to micro, small, and medium enterprises (MSMEs) occupy a large market share in the industry. The prevailing trend particularly for micro enterprises is the establishment of a one-man shop managed by a skilled welder that is into the fabrication, jobbing and repair type of business. For most welding businesses in the MSME, the focus is more on the exisitng domestic-oriented market, hence they are more inclined in improving products and services through innovative measures (i.e. using reliable materials) in order to keep more regular customers and not very particular on upgrading welding equipment to create new products. Entrepreneurs in the welding industry believe that process improvement leads to customer satisfaction. For manufacturing and export-oriented firms, usually belonging to medium and large enterprises, a more reliable welding solution through automation is seen as an important measure for a long-term manufacturing activity. These companies are capable of providing services to growing industries like automotive, construction and shipbuilding industry.

Out of the 18,779 total manpower reported by the respondents of the MIRDC's recent welding survey, 8,798 are classified as production personnel which includes Managers, Engineers, Supervisors, Quality Control Inspector, Welders, Technicians, Operators and Maintenance Workers. It was reported that the number of production personnel with formal training (e.g. through TVET program) is higher compared to those without formal training (i.e. skills acquired through experience). The welding industry, although dominated by micro enterprises, is still dependent on the large enterprises' contribution in terms of employment as they are found to employ more than half of the total welding workforce.

The welding workforce in the country is stengthened by trainings provided by various welding education and training groups. The MIRDC, for one, provides training on TIG Welding on Carbon Steel Plates and Gas Metal Arc Welding (GMAW) / Metal Inert Gas (MIG) – Metal Active Gas (MAG) Welding on Carbon Steel Plates. The Technical Education and Skills Development Authority (TESDA), on the other hand, being the Technical Vocational Education and Training (TVET) authority in the country, ensures that the economy's required number of trained manpower is met. TESDA offers training courses on welding, particularly Gas Tungsten Arc Welding (GTAW), Electric Arc and Gas Welding, Thermoplastic Welder, Submerged Arc Welding, Flux-Cored Arc Welding (FCAW), GMAW, SMAW and Welding Carbon Steel Plate Pipes Using SMAW.

Through welding associations, the local welding workforce becomes systematically advanced in technological know-how of the welding processes. The Philippine Welding Society (PWS), for instance, aims to empower the Philippines' welding workforce by providing seminars and trainings for welding engineers, welding inspectors and various welding practitioners. Such trainings are developed to be eligible for international standards and qualificaton. The international linkages of the PWS to different associations, such as Asian Welding Federation (AWF), American Welding Society (AWS), Japan Welding Engineering Society (JWES), Singapore Welding Society (SWS), Welding Technology Institute of Australia (WTIA), and Pacific Ocean Coalition of Welding Associations (POCWA) make the technical updating amenable for the local industry. Alliance with international associations keeps the local industry abreast of the information on current global trends of welding.

In terms of import and export data[1], the import of representative products of welding processes has been consistently high from 2011 to 2015, but the export activities counter its impact on local welders' busi-

[1] Import and export data are summarized from the 2011-2015 Foreign Trade Statistics of the Philippine Statistics Authority

Table 1A. Export Data (4-Year Comparison)

Export	2011	2012	2013	2014	2015
Gross Weight (Kg)	1,079,821,754	1,511,942,578	938,827,359	1,677,523,547	2,163,654,648.25
FOB Value (Dollars)	1,282,980,085	1,794,963,872	1,869,474,719	2,852,950,896	2,944,913,797.00

Table 1B. Import Data (4-Year Comparison)

Import	2011	2012	2013	2014	2015
Gross Weight (Kg)	887,701,409	1,011,511,846	1,128,895,761	1,260,410,100	1,833,655,689.05
CIF Value (Dollars)	4,020,910,646	5,751,658,523	7,367,910,586	7,588,594,140	8,514,711,713.00

Table 2A. Top 5 Imports on Representative Products of Welding Process (2015)

Rank	Code	Commodity	Gross Weight (GK)	CIF VALUE Dollars
1	870323	Vehicles, of a cylinder capacity exceeding 1,500cc but not exceeding 3,000cc, with spark-ignition internal combustion	113,115,219.12	1,187,989,876.00
2	880240	Aeroplanes and other aircraft, of an unladen weight exceeding 15,000 kg	820,282.45	772,569,537.00
3	870421	Motor vehicles, g.v.w. Not exceeding 5 tonnes, with compression-ignition internal combustion piston engine (diesel or semi-diesel)	77,659,112.85	446,640,913.00
4	870322	Vehicles, of a cylinder capacity exceeding 1,000cc but not exceeding 1,500cc, with spark-ignition internal combustion	42,424,831.64	426,145,126.00
5	870210	Motor vehicles for the transport of ten or more persons, including the driver, with compression-ignition internal combustion piston engine (diesel or semi-diesel)	57,920,159.74	378,564,821.00

Table 2B. Top 5 Exports on Representative Products of Welding Process (2015)

Rank	Code	Commodity	Gross Weight (GK)	FOB VALUE Dollars
1	890190	Other vessels for the transport of goods and other vessels for the transport of both persons and goods	1,889,702,629.71	1,538,207,728.00
2	880330	Other parts of aeroplanes or helicopters	18,551,426.63	450,645,831.00
3	841590	Parts of air conditioning machines, of subheading 84.15	7,560,674.41	150,055,044.00
4	732410	Sinks and wash basins, of stainless steel	43,455,632.22	119,539,093.00
5	870894	Steering wheels, steering columns and steering boxes	2,777,898.35	56,829,167.00

ness outlook. As seen in Table 1A, the export activity from 2011 to 2015 impose positive increase in four consecutive years.

A high volume of import, as seen in Table 2A, were realized for vehicles (of a cylinder capacity exceeding 1,500cc but not exceeding 3,000cc, with spark-ignition internal combustion) typically imported from Thailand, Indonesia and Japan; and aeroplanes and other aircrafts (of an unladen weight exceeding 15,000kg) mostly coming from France, Germany and Republic of Korea. A stable growth path for export activities must be monitored by identifying the fast growing market demand and diversifying products to ensure that domestic market will be able to set foothold in the global market.

For the industry's technical profile, the most commonly used welding equipment in the Philippines are those that employ an electric power supply to create an arc which melts the base metals to form a molten pool. These are SMAW, GMAW and GTAW which are also universally known as the most popular welding equipment. Very few companies are using automatic welding and robotics in their operations. The traditional welding processes employed in various industries is expected to hold its dominant position due to its extensive use in various manufacturing operations, but will gradually decrease if the industry will pave the way in improving productivity through automation.

A number of pre-existing issues and challenges still pose threat to the welding industry's positive development. Some of these entrenched challenges are stiff competition, lack of customers and high cost of production. In terms of production problems, most business owners enlisted limited capital, difficulty in sourcing materials and shortage of skilled workers to be most prevalent. Relevant to stiff competition, local welders are losing customers in two ways: for those in the manufacturing business, surge in supply of imported welded products overshadows the local products resulting to a tepid demand condition. For those in the jobbing business, competition is usually distorted by unpredictable demand from customers.

Local welders are also aware of the opportunities that arise in the

manufacturing system, however, the high cost of production in contrast to their limited capital for equipment and technology upgrading hinders their plans for business expansion. Filipino welders are described as highly trainable workers, but their knowledge are mostly limited to the basic trainings that are offered locally. As a result, there seems to be a shortage in skilled welders who can effectively manage the much needed welding and fabrication technologies that are essential to accomodate the trend in the welding industry.

Future of the Local Welding Industry

Based on the present condition of the local welding technology as compared to the foreseeable future of welding demands in manufacturing industry and other sectors that it serves at present, it seems that not all welding operations are a good candidate for automation. In the welding processes applied to various manufacturing activities, it comes to a critical consideration what methods are employed by specific companies. For instance, there are companies that assemble only limited quantities of products and focus more on the accuracy of welds, full automation doesn't seem like a perfect solution. In some cases, applying human judgement on the welding process is more important to ensure accuracy. If it is not through automation, the existing conventional welding processes may need to go through innovative upgrading to improve capabilities.

Although there is a slowdown in upgrading the welding technology in the country through automation and robotics, local welders are catching up through initiatives in innovation for the predominant welding equipment in the country. As an example, the MIRDC, in close cooperation with the PWS, designed, fabricated and localised a heavy-duty DC SMAW-GTAW inverter welding machine for the small and medium enterprises. Its innovative features are presented in the following table:

Table 3. Innovative Features of the DC SMAW-GTAW Inverter Welding Machine

Feature	DC SMAW-GTAW welding machine
1. Dimensions	(L) 475mm x (W) 215mm x (H) 305mm
2. Type of Operation	For both SMAW and GTAW
3. Types of Electrodes	E6011, E6013, E7018
4. Arc Stability	Good
5. Spatters	Less
6. Cooling system	Effective
7. Open circuit voltage	60.7 V
8. Length of time used	10 minutes (continuous)
9. Duty cycle of lab prototype	100% in 125A

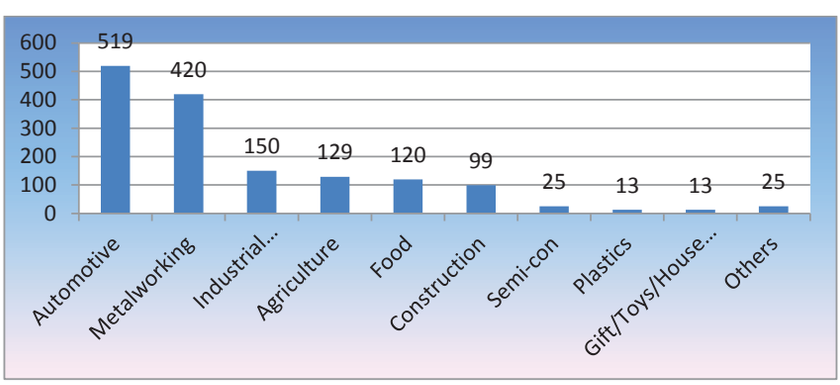

Figure 2. Sectors Served by the Welding Industry (MIRDC, 2017)

Welding processes done locally are commonly applied to industries like automotive, metalworking, industrial machinery, agriculture, food, construction, semicon, plastic and gifts, toys and houseware. In previous surveys conducted by the MIRDC, the aerospace and shipbuilding industries tend to fall under 'others' category since these are emerging industries that demand more sophisticated welding techniques and products not commonly offered by local welders in the MSMEs. Figure 2 shows the sectors served by the welding industry.

In both studies conducted by the MIRDC (1994, 2017), results show that welding is most extensively used in the automotive industry. With the automotive industry's full integration with the region's production network targeted from 2016-2020, there is a possiblity of continuous activities for the assembly process that also rely on welding processes. According to Devarasiddappa (2014), there is a growing necessity to develop new technologies for welding in automotive applications as manufacturers are focusing on the development of a more fuel-efficient vehicle made of light, yet strong materials.

In a paper prepared by Sturgeon et.al. (2016), they discussed that some of the automotive suppliers in the Philippines have begun selling products in the aerospace

value chain. Such activity requires extensive shifts in operations, from low regulatory control of half a million pieces for less than ten product parts in the automotive sector to high regulatory control in the thousands with ten pieces per unit in the aerospace sector. For the aerospace industry, lighter metals such as aluminum, magnesium and titanium are used in fabrication. For these types of metals, new processes of welding that decrease material consumption as well as labor intensity are required. One example provided by Ermanchenko, Lutfullin and Mulyukov (2011) was combining superplastic forming with pressure welding (SPF/PW) which is very efficient for processing titanium alloys and can produce complex profile light-weight structures required for aerospace industry.

In order to meet the stringent demand of the automotive sector and the rise of new materials needed for the aerospace sector, the table below is provided to show the industry drivers related to joining and key technologies needed for both sectors.

Table 4. General Trends and Key Needs in Manufacturing Industries[2]

Industry	Drivers Relate to Joining	Key Technologies Needed
Automotive and road transport	• Increased pre-competitive • cooperation on technology • development • Cost reductions • Faster time to market • Lower fuel consumption • Recycling of components	• Real-time sensing and adaptive control • Resistance spot welding (RSW) process control, electrode wear, and equipment design • Joining of lightweight metallics • Joining of coated high strength steels • Joints between dissimilarmaterials (plastic/metal, etc) • Improved adhesives • Magnetic pulse welding • Mechanical jointing • Brazing by MIG or laser • Laser processes/tailor welded blanks • Laser hybrid processes/tailor welded blanks • Structural adhesive technology • Welding design and processmanagement tools. • Microelectronics – process development and reliability • Repair of Al alloy structures
Aerospace	• Improved manufacturing efficiency • Welding to reduce mass • Greater accuracy of assembly • Reduced inspection and qualification costs • Improved structural monitoring • Improved repair and refurbishment methods • Increased emphasis on affordability (cost as an independent variable) • Shorter product development cycles • Greater reliance on integrated manufacturing concepts, increased product life	• Welding of new Al, Ti, and Ni alloys • Solid state joining and brazing processes • Polymer/composite joining • Design tools include residual stress and distortion control • Process modelling and control • In-process non-destructive testing • Friction stir welding of airframes • Laser cutting and welding • Adhesive bonding of composites • Repair of gas turbines • Linear friction welding for aero engines

[2] Excerpt from Kah and Martikainen, 2011

In addition to the foregoing sectors served by the welding industry, more industries create a promising future for the welding activities. The shipbuilding industry, for one, is expected to benefit both the welding workforce and welding activities through investments in shipbuilding facilities. If the trend in welding will be given viable attention, what can be expected are the prevalence of new materials that are relatively smaller, lighter and more reliable.

Summary and Recommendation

Despite the stagnation to conventional low-technology welding processes, there is a compellng reason that the Philippines may still pick up the pace of increasing demand in welded products from emerging industries in the manufacturing sector. The dichotomy of having increasing demand for sophisticated welding products and technology, and stagnation within the low-technology processes of the local welding industry doesn't mean that there is no possibility of accommodating the myriad of needs of various industries that heavily rely on welding processes. Welding will always be a sought after process regardless of the country's economic status – from repair of cars, manufacturing of simple products to construction of buildings and other infrastructure, welding will always be a necessity. Moreover, the local welding manpower is considered as one of the welding industry's strengths as Filipino welders are known to be highly trainable. Since the welding workforce is seen as the most important fraternity in the welding structure, unlocking their full potential through an advanced knowledge system in terms of training in automation and robotics will prepare them for more opportunities to innovate. The important focus in order to make the local welding industry globally competitive is to first resolve the mismatch between the ongoing manufacturing trend linked to welding and the status of both the technological capability of the welding industry and the skills of local welders.

With the foregoing investment in the automotive, aerospace and shipbuilding industries in the Philippines, domestic producers of welded products are now likely to increase their capacity in order to meet the anticipated demand for production. The question, however, is pinned to whether or not the local welders can keep up with being self sufficient in the future in terms of supply of such products if there is lack of initiative in scaling up to automation. Nevertheless, the Philippine welding industry should ramp up its effort to accommodate the increasing demand of the sectors it serve. Innovation and R&D initiatives are a good start in addressing the lack of technical capability of the local welding industry, however, automation and robotics as demanded by the emerging industries, such as aerospace, electronics, shipbuilding and motorcycle is still considered as the cornerstone of a more achievable progress in taking the welding industry to a higher notch in bringing precision and high quality to new products. To maintain the positive impact of the 2014 IPP linked to welding industry, local welders must be able to upgrade business activities. To address challenges relating to sourcing of materials, it is important to establish connection with domestic suppliers in order to ramp up capacity in stocking raw materials needed to veer away from disruption in the supply chain. The progress of welding technologies and processes is also highly dependent on the use of advanced steel materials, hence its availability through local suppliers is indespensable.

A broad-based business plan to achieve a long-term solution in keeping up with the more competitive environment includes stronger cooperation among the government, welding associations and institutions and core industries to come up with a more advanced manufacturing system to further ramp up investment activities in the country. In order for local welding businesses to function effectively, it is important to ensure that they operate in a supportive environment. Specifically, the following initiatives from both government and private sectors are highly suggested to intensify the boom of activities in the welding industry:

- Strengthening support to MSMEs through government programs, such as Small Enterprise Technology Upgrading Program (SETUP) of the Department of Science and Technology (DOST). The said program aims to assist MSMEs in improving productivity and competitiveness through technology transfer; technology needs assessment; technical advisory and consultancy services on productivity improvement, process and product standardization, food safety, cleaner production, MPEX, energy audit and intellectual property concerns; technical trainings; package labeling; testing and calibration and information system. One of the program's priority sectors is the metals and engineering that covers the welding industry. The SETUP program will be a great help to the industry as it will enable companies to be more competitive. Acquiring new equipment to improve production and availing technical training courses for workers will also be possible. Since not all entrepreneurs in the welding industry are aware of the existence of such program, it is necessary to extend information through promotional materials. Support from government is one effective strategy to encourage the industry to widen the scope of their business.

- Encouraging all welding firms and institutions to be members of welding associations like the PWS. One of the objectives of the PWS is to promote the advancement of the science and practice of welding and to advise and support government entities whenever possible on matters of standardization, public safety and health. Welding associations are important avenue in exchanging ideas and opinions on deciding which technologies for welding will be most applicable for the industry.

- Reviewing the existing curriculum for trainings on welding and updating its knowledge base by applying the most suitable technology needed by the industry. Training institutions like the TESDA may be tapped in this area.

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Development of Tent System for Emergency Applications

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Abstract

The tent system is developed to aid preparations for emergencies; the design can be adapted, and thus provide immediate shelter to people who may be displaced. A tent system can serve as temporary warehouse, field hospital and command center. Currently, no emergency tent designs are readily available in the market in the Philippines. This project researches on the various fabrics, textiles, tent design, and welding techniques that are locally available and make recommendations for an emergency tent system that can withstand at least 75kph wind. This enables groups, such as local government units or civil societies mitigate disaster risks in their areas. Tests like water resistance, water permeability, tearing, and tensile, are conducted on fabrics and textiles; while high quality welding and GI pipes are recommended for the design structure. The tent prototype undergone actual wind testing of 75kph. The use of bamboo to replace GI pipes is mentioned as one of the recommendations. Polycotton fabric performed best among locally available tent canvas materials effectively repelling water and contributing to a lighter tent system. Due to some constraints, the tent is designed and tested to only withstand a maximum 75kph wind speed and 2000 mm rainfall.

I. Introduction

In a report by the United Nations University's Institute for Environment and Human Security and the German Alliance Development Works, the Philippines is named as one of the top 10 countries facing the highest risk due to climate change together with Vanuatu, Tonga, the Solomon Islands, Guatemala, Bangladesh, Timor-Leste, Costa Rica, Cambodia and El Salvador.[1] As a result of climate change, more frequent extreme weather disturbances are expected.[2]

When typhoon Yolanda (international name Haiyan) strucked the Philippines in November 2013 forcing thousands of people out of their homes, a great need to provide emergency shelters to affected populace arose. Available temporary shelters immediately deployed after typhoon Yolanda mostly came from foreign stockpiles such as those from the United Nations High Commissioner for Refugees (UNHCR. However, because of the large number of affected people, available tents are not enough to meet the requirement.

The Department of Science and Technology then came out with a project entitled, "Development of Tent System for Emergency Applications" under its Quick Response Program. The project aimed to develop tent systems that can be used in case of emergencies to provide immediate shelter to people displaced by the calamity or disaster. A multipurpose tent will also be developed to serve various functions such as temporary warehouse, field hospital and command center. The tent systems manufacturing is meant to be fast and done not just by specialized tent manufacturers, but also by other manufacturing sectors such as the metalworking and the garments sector.

The tents must also be cost-effective and durable enough to serve as temporary shelter while the displaced residents are rebuilding their homes.

The availability of cost effective and easily produced tents will strengthen the country's capability to respond to emergencies especially on addressing critical needs such as shelters. Stockpiles of these tents can be set-up and ready to be deployed as the need arises.

General Objective:

To develop cost effective and easily produced tent systems for emergency use.

Specific Objectives:

To design, develop and evaluate tent systems for the following applications:

a. Shelter for a family with maximum 5 members;
b. Shelter for a family with maximum 7 members; and
c. Multipurpose tent

II. Stakeholders expectations and technical requirements

The project team met with a few of the target stakeholders such as the Philippine Red Cross that are mostly involved in the distribution of emergency shelters during calamities; and

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people affected by typhoon Yolanda who are still living in temporary shelters six (6) months after the calamity in affected areas of Leyte and E. Samar such as Tacloban, Guian, etc.

In the Leyte and E. Samar areas, where after ten (10) months since typhoon Yolanda strucked the Visayas, few families still resides in temporary shelters donated by the United Nations; these shelters are designed to be used for only six months.[3] The project team consulted some of these families and asked for feedbacks as to their experience living in such emergency tents more than the designed ideal usage time. The respondents mentioned that the reason for their prolonged stay in these shelters is that the local government has not provided them of a permanent housing. They are part of the illegal settlers who used to live near waterways, while others used to live near what the government now considers as permanent danger zone. They say a tent with high headroom is what they prefer since they have to duck to get in and out of the UNHCR tents. At noontime, they have to stay outside these tents because the heat accumulates inside and becomes unbearable.

III. Materials Testing

A. Fabrics

Six fabrics for the canvas were evaluated. Choosing the canvas for testing relies mainly on its availability in the Philippine market so that the goal of carrying out the production and fabrication anywhere in the Philippines is highly possible.

a.1) Cotton/Polyester Mix

This fabric has 35% Cotton, 65% Polyester mix combination with strong texture and good strength. This fabric is readily available in Divisoria, Manila in a variety of colors. Its mass per unit area is about 200 to 400 g/m2.

a.2) Taffeta

Taffeta is a 100% woven and coated polyester fabric. It is typically used as car cover, bag, luggage, tent, beach-chair, etc. It is known to be waterproof and lightweight.

a.3) Rubberized Taffeta

Rubberized taffteta has the same property as that of the taffeta fabric. The difference is that the other side of the rubberized taffeta is coated with rubber making the fabric more durable and less prone to tearing and greatly increasing its waterproofing properties.

a.4) Vinyl Tarp

Vinyl tarps are mostly for industrial use and are waterproof. It has high abrasion resistance. They resist oil, acid, grease and mildew. The vinyl tarp is ideal for agriculture, construction, industrial and trucks. They also have a high tear strength.

a.5) Polyethylene tarp/Laminated Sack

A polyethylene tarp is a laminate of woven and sheet material. The center is loosely woven from strips of polyethylene plastic, with sheets of the same material bonded to the surface. This creates a fabric-like material that resists stretching well in all directions and is waterproof. When treated against ultraviolet light, these tarpaulins can last for years exposed to the elements, but non-UV treated material will quickly become brittle and lose strength and water resistance if exposed to sunlight.

a.6) Heavy duty canvas

Canvas fabric is an extremely heavy-duty plain or duck woven fabric, ideal for making sails, tents, marquees, backpacks, tarpaulins, and other items for which sturdiness is required. It is also naturally breathable, and its ability to regulate temperature and moisture makes canvas fabric unique. This fabric though not readily waterproof has to be coated.

The fabrics have undergone testing as shown in Table 1. The results show that, for tensile test, it is the polycotton fabric and the heavy duty canvas that meet the minimum breaking force requirement of 650 Nm based on specifications of the UNHCR tents. This fabric is not readily available with waterproof coating, hence, preparations have to be done on the fabric. This material is particu-

Table 1. Summary of results for tests conducted on all fabrics

Fabric	Tensile 650Nm	Tearing 100N	Water resistance	Water vapor absorbed
Polycotton	√	√	√	√
Heavy Duty Canvas	√	√		
Vinyl Tarp		√	√	√
Rubberized Taffeta			√	√

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larly considered because of the information provided by the UK Aid regarding their tent canvas as a cloth with applied coating that performed well per their specifications.

Tensile test for sewn assembly was also conducted. Most of the tents deployed according to feedbacks from LGUs tend to fail on the sewn parts of velcro-canvas and canvas connection. This test is governed by ASTM D-1683. Table 2 illustrates the results of the tensile test for sewn assembly.

As illustrated, it is best to sew the polycanvas fabrics twice and use adhesive to join them; it has a seam breaking strength of 467 N. A strap sewn on the polycanvas fabric with heat press has a breaking strength of only 266 N. There is no standard available to compare the above results. It can only be used as benchmark for the various strength the sewn assemblies can provide. The sewn assembly breaking strength test made it clear that, to ensure any strap remains attached to the fabric, it should be sewn tracing the perimeter of the strap or velcro and heat pressed.

Table 2. Results of tensile testing of sewn seam assembly

Sewn Assembly Sample	*Seam Breaking Strength, N*
Folded, twice sewn	392
Sewn only	206
With adhesive only	146
Twice sewn with adhesive	467
Sewn with adhesive	321
Sewn strap with heat press	266
Plastic material	510
Velcro strap with adhesive 8 inches	1491
Velcro strap with adhesive 4 inches	1251
Velcro strap with adhesive 2 inches	125

IV. Availability and Cost

Materials used are readily available in the Philippine market as this is the primary direction of this project - to use materials that are easily sourced locally. The materials are sourced in Binondo, Manila widely known for tent materials. While there is no standard name for fabric/canvas the best way to acquire the canvas is to bring a sample. The price range of the fabrics/canvas varies from 80 to 130 pesos per yard (Php 80-130).

Figure 1. Assembled Emergency Tent System

V. Design Realization Process

The Project Management and Engineering Design Services Office (PMEDSO) of the Department of Science and Technology (DOST) has the sole task of providing the working design for the project. They will be further referred to in this paper as the designers. They worked under the following design considerations and criterion: First, the design is based on the UNHCR standard except for some specifications, i.e. the use of GI pipe as frame material, use of fabrics that are commonly available in the country. The main advantage of the design is that labor and materials can be sourced locally.

Second, the designers performed a structural analysis to test the structural integrity of the tent in the conditions specified in the standards that the project team agreed to follow. Unfortunately, not all conditions and factors can be included in the analysis i.e. interaction between frame and fabric, interaction between fabric and wind, etc. and that is where actual testing comes into play and where the designers can learn practical things about the design so that they can modify them accordingly.

Third, adjustments to the height of the tent were considered when this issue was raised during the 2014 midyear planning meeting. The design intent is to standardize the length of the leg, rafter and ridge for easier fabrication and interchangeability.

Fourth, the design team decided that the straps and other mounting implements between the fabric and frame, tent and ground, rope and fabric will be determined as the project goes along the fabrication process.

VI. Tent Manufacturing Guidelines

The first part of the manufacturing guidelines discusses the shape, type, size and construction of the tents: Three (3) types of tents that varies in size designated as R-22 with maximum floor area of 22 m2; R-32 with maximum floor area of 32m2; R-50 with maximum area of 50m2. The variation in size of the tents is made so as to address different uses and functions such as for small family of at least 5, at least 7, atleast 9 or as hospitals, headquarters, command centers. The tent consists of two (2) major layers, namely: the outer canvass and the main canvas. Ideally, there should be a continuous distance of 135 mm between the outer canvas to the main canvas for ventilation purposes. But based on demonstrations the project team conducted, the availability of space to where the tent is pitched will determine if this distance is achieved.

The outer layer of the tent should be made ideally from a polycanvas having a ripstop weave. The ripstop weave is essential because in manufacturing jobs where stitiching is required, the stitch adheres and stays on the canvas better.

Figure 2. Interior of the Emergency Tent System

VII. Bamboo Tent

A tent design where bamboo replaced the GI pipes was included in the terminal report. Though not fabricated with an actual prototype, the design will give an option to institutions who may choose to adapt the tent design and to replace the GI pipes with indigenous material such as bamboo.

There are many advantages of using bamboo instead of GI pipes. First, it is better in terms of reducing the overall weight of the tent assembly. Second, it is readily available in many areas in the country. The design takes into consideration the specie of bamboo that is thick enough and is strong enough to carry the weight when the tent is full function. Bamboo is the tallest perennial grass that belongs to the Graminae family. Due to the long cylindrical woody stem strength and ease of workability, bamboo is a versatile material for a variety of economic uses: handicraft and furniture; farm implements; fishpen, fishcages and other fishing gears; banana props; musical instruments; pulp and paper; and house construction. Aside from these, young bamboo shoots of some species are edible.

Demand for bamboo in the Philippines is steadily increasing. However, the demand is not being currently met. Bamboo production is, therefore, a potential source of income for agroforestry farmers.

Though bamboo, as a construction material is widely used in the Philippines, no data is available as to the tensile strength of various bamboo with considerable diameter such as intended for the tent prototypes.

VIII. Conclusion

The DOST-MIRDC's emergency tent prototype is made of polycanvas fabric which is composed of a waterproof plastic based fabric on one side and a woven fabric type on the other, that can be sewn or heat pressed. The fabric undergone testing such as: tensile test, tearing test, water resistance and water absorption tests. The polycanvas fabric lead all locally available fabrics in terms of exhibiting the best value in almost all the tests conducted. Using GI pipes as one of the main materials for the emergency tent also provides advantage as it can be easily sourced locally.

The development of emergency tent prototypes allowed the possibility of a more effective way of putting forth preparedness during disasters in the country. The DOST-MIRDC's initiative to develop emergency tents does not only address the needs of Filipinos in emergency situations but also increases their awareness on the availability of local materials that can be used by different localities and municipalities during unwanted circumstances brought by unpredictable changes in their environment.

Moreover, the project allowed both the national government and the Local Government Units to have a more reliable emergency preparedness plan by adopting the emergency tent prototypes to provide temporary shelters to people displaced by calamities.

IX. Recommendation

Due to several issues that emerged during the testing of the emergency tent prototypes, the following recommendations are provided:

- Improve the strength of the straps by tracing its perimeter while stitching to ensure that the stitches are more secure. It can further be strengthened with the use of adhesive or heat press.
- Ensure the detail and accuracy of the welding and size of the GI pipes to allow interchangeability of pipes when assembling the frame of the tent. This will make the assembly process faster.
- Localizing the manufacture of the tents by encouraging the LGUs to weld their own GI pipes and sew their own fabrics. This process will not only lessen the cost of production but will also make the availability of the tent in every LGU possible.

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Prototyping and Pilot Production of Eyelet Riveter/Eyelet Machine

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Abstract

This research project was conducted by the Department of Science and Technology – Metals Industry Research and Development Center (DOST- MIRDC) in collaboration with the Department of Foreign Affairs (DFA) - Authentication Division – Office of the Consular Affairs (AD-OCA) to address the pressing problems encountered by the AD-OCA personnel particularly in binding their documents. Specifically, this research project was conducted to: 1) support other government agencies such as the DFA by providing solutions to problems during the performance of their duties as public servants; and 2) support local industry by fostering the availability of low-cost locally-made products.

1. Introduction

1.1 Significance

Eyelet riveter has been deemed important to the DFA ADO-CA's operation. It has been part of their daily task to process, bind and attach ribbons to documents which makes up their overall output. However, over a period of time, their ageing eyelet riveter shows symptoms of defects which require replacement.

With this, AD-OCA has no choice but to replace their long-serving eyelet riveters. Nevertheless, due to the failure of local suppliers to comply on several occasions with the bidding procedures, DFA directed the process to research and development.

The MIRDC, being a research and development institution which has the expertise of providing the required services, was tapped by DFA to cater their needs to continue their quality services to the Filipino people locally and abroad.

The realization of this project will help AD-OCA keep the authenticated documents secure and presentable using an eyelet riveter.

Furthermore, this project will promote local development to save on the high cost of importation and improve its accessibility to all the DFA satellite offices in the Philippines and embassies abroad.

1.2 Objectives

General Objective:

- Develop an eyelet riveter that could bind documents as required by the Department of Foreign Affairs' Authentication Division-Office of Consular Affairs (AD-OCA)

Specific Objectives:

- Support other government agencies such as the DFA by providing solutions to their encountered problems during the performance of their duties as public servants.
- Support local industry by fostering the availability of low-cost locally-made products.

2. Review of Related Literature

2.1 The Eyeleting Machine Models[1]

Steinmetz Eyeleting Machine (a.k.a. Lipman Unit Eyelet Machine)

This machine was patented in 1860 (Steinmetz). It was advertised in 1886 by Lipman Manufacturing Co., Philadelphia, PA

The 1860 US patent (No. 27,974) states that this machine will

[1] All images and descriptions used in this section, except for Bates Model 40 Automatic Eyeleter, are from Early Office Museum Website available at www.officemuseum.com or www.earlyofficemuseum.com

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"cleanly cut holes in several thicknesses of paper and then insert eyelets into said holes and clench the same all at one operation."

Lipman's Tri-Patent Eyelet Machine

Several patents of this machine was approved on 1854, 1854, and 1865. This machine is in the Elli Buk Collection that was sold at auction in 2013 by Grogan & Co.

Challenge Eyelet Press No. 1

This machine was introduced in 1887, and patented in 1887-1907. This eyelet machine was advertised until 1940 and the company registered the "Challenge" trademark in 1947. The company was still producing the "old eyelet machine" in 1961, although the company had moved into production of components for missiles and nuclear submarines. The company still existed in 1965. However, as of 2013, the "Challenge" trademark had expired and there was no evidence that the company still existed.

Ajax Eyelet Fastener (a.k.a. Bates Ajax Eyelet Fastener, Bates Automatic Eyeleter)

This machine was patented in 1916-18 and advertised 1917-23 (Ajax), 1923-26, 1928 (Bates Ajax), 1927 onward (Bates). This was manufactured until 1999 by Machine Appliance Corp., New York, NY (Ajax, 1917-23), Bates Mfg. Co., Orange, NJ (1923-99).

This machine has a reservoir for 150 eyelets. It was sold for 82 years and was widely used for fastening papers.

Bates Model 40 Automatic Eyeleter

The Bates Standard Manual Eyeleter inserts, punches hole, crimps and re-loads on every operation. It is made of cast iron and light weight (5 Lbs.) Commonly used on legal papers, ribbons, tags, anything where permanent binding is desired.

Bates eyeleter was discontinued in 1999 after GBC purchased the company. Many units are still available in the marketplace. However, no warranty for this product is offered by the manufacturer because parts are no longer kept in stock.

3. Conceptual Framework

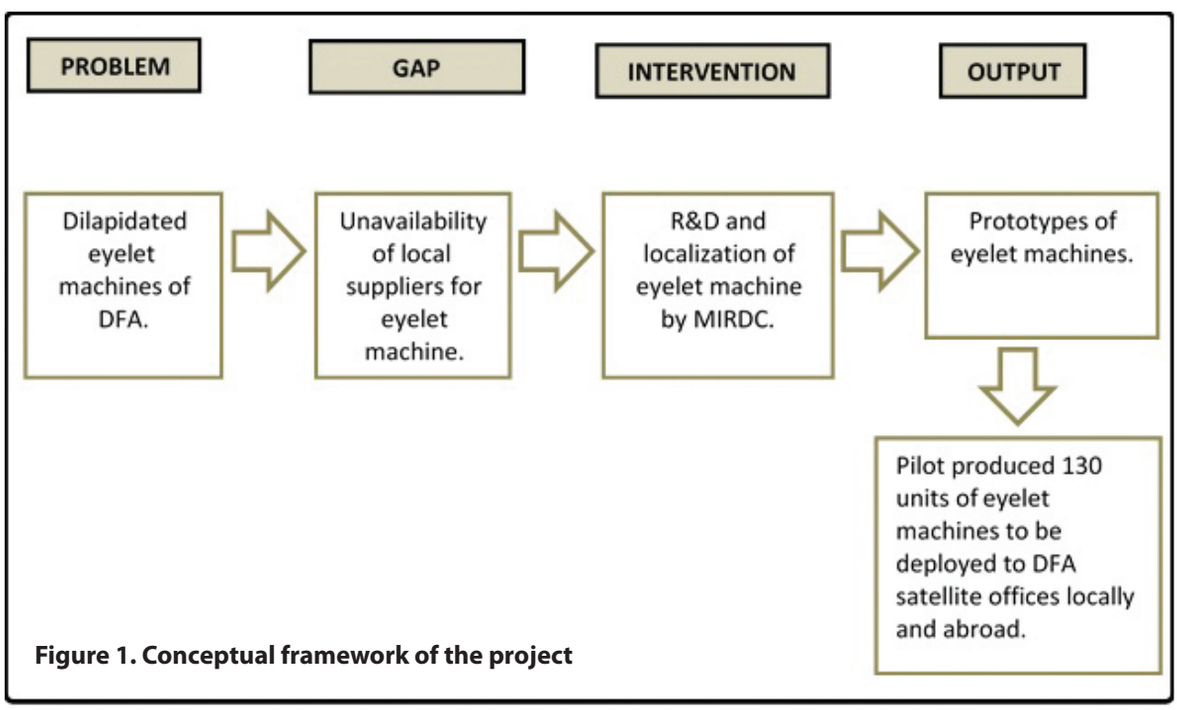

Figure 1. Conceptual framework of the project

4. Methodology

4.1 Problem Identification

Prior to the conduct of the study, existing issues and concerns were examined and evaluated to identify corresponding problem that needs to be addressed accordingly. Necessary documents were prepared. Base data, which are requirements in formulating the drawing, and other documents vital to acceptance and carrying out the project were also secured.

4.2 Gap Determination

In this phase, the immediate solution to answer the pressing problem encountered by AD-OCA personnel was evaluated. Factors that hampers the application of the immediate solution was also assessed. In this phase, answer to the existing problem was presented and carried out to help AD-OCA in the performance of their duties as public servants.

4.3 Development of Eyelet Machine

Since the existing machines are already obsolete and not available in the local market, the immediate solution that was seen vital to address the issues encountered was the development of the same machine with improved performance.

4.3.1 Design Development

This includes identification of machine parts and preparation of detailed drawing. This was accomplished through thorough evaluation of the machine to be re-engineered. Design development was conducted in MIRDC's Prototyping Division, Design Section office.

4.3.1.1 Reverse Engineering and 3D Modelling

The design of the eyelet riveter was based on the original machine used by the DFA's AD-OCA. One set of the machine was secured from DFA to perform reverse engineering using appropriate instruments. Results of reverse engineering process were converted into a 3D model in order to simulate the scaled model of the machine which was also useful during the fabrication and assembly.

4.3.1.2 2D Drawing

Using the developed 3D model, the 2D drawing of each manufacturable component was prepared and subjected for checking of concerned personnel in Prototyping Division, Design Section. Suggestions were considered and incorporated into the design of the machine. Final design of each component was readied in preparation for the fabrication/manufacturing of machine components.

Table 1. Project Workplan

Objective	Expected Output	Activities or Work plan	2015		2016		
			Q3	Q4	Q1	Q2	Q3
Develop an eyelet riveter that could bind documents as required by DFA AD-OCA	Production Drawing	Background review and review of related literature.	X				
		Fabrication of first prototype (3 units)	XXX	X			
	133 Units of Eyelet Riveter	Evaluation by DFA of the first prototype		X			
		Modification of the first prototype		XX			
		1st Tranche (Delivery of 50 units)			XX		
		2nd Tranche (Delivery of 50 units)			XX		
		3rd Tranche (Delivery of 30 units)				XXX	
	Terminal Report	Terminal Report Writing					XXX

5. Discussion of Results

5.1 Machine Fabrication

After completing the design requirements needed, machine fabrication commenced. Several processes were conducted to complete the prototyping and pilot production of the machine.

Some machine components required casting process which involved several tedious processes, some requires simple machining, and other components i.e. standard components are readily available in hardwares. Fabrication and pilot production of the machine was conducted in MIRDC.

5.1.1 Casting

Some parts of the machine such as body, handle, and magazine assembly requires casting process. Depicted in the following pictures are among the processes involved during casting of certain eyelet riveter parts.

5.1.1.1 3D Printing

The advent of 3D printing technology paved the way for a more efficient and easy way of pattern development particularly for investment casting. Patterns of cast parts in this study were made through 3D printing. This was conceived to be the faster way to create a model of machine parts which will be produced in large scale through casting. Figure 2 shows some 3D printed models of the machine.

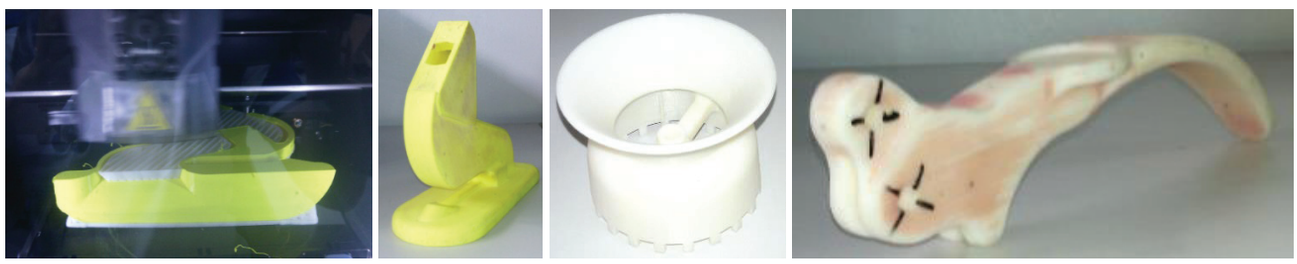

Figure 2. 3D printing of patterns

5.1.1.2 Rubber Mold Development

Rubber molds were developed after the preparation of the 3D printed patterns. The rubber molds were essential for the production of wax patterns used in investment casting. Presented in Figure 3 are rubber molds of some riveter parts.

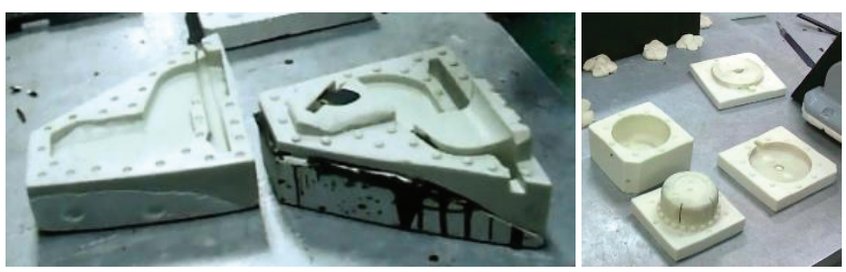

Figure 3. Preparation of rubber mold

5.1.1.3 Wax Pattern Development

Wax patterns were necessary for the casting of machine parts. In investment casting, wax patterns usually resemble the actual form of the machine parts or product. However, in some instances, it is necessary to machine some faces of the cast parts, hence appropriate machining allowance should be observed. During this process, it was observed that defects occur on wax patterns which need to be repaired. Deformities particularly on the riveter body patterns were also noted. Figure 4 shows the wax patterns of some parts of the machine for casting while Figure 5 shows wax patterns being repaired.

Figure 4. Wax pattern development

Figure 5. Repairing of wax pattern

5.1.1.4 Clustering and Ceramic Coating

Predetermined numbers of wax patterns were attached into a runner to form a cluster. Wax patterns were grouped into clusters to facilitate pouring of molten metals. Figure 6 depicts the clustering of wax patterns.

Several coating (Figure 7) process were employed to the prepared clusters to make it ready for wax melting.

5.1.1.5 Melting, Removal of Ceramic Shell, and Heat Treatment

During the casting process, molten metal was poured into the ceramic mold and after cooling down, the ceramic shell coating were hammered down to separate from the cast components (Figure 8). Unnecessary ceramics clinging to the cast object are removed in a process called fettling. In some cases, cast components that require machining process was subjected to stress relieving (Figure 10).

5.1.2 Machining

Machining is necessary for proper fitting of parts. For this project, several components, such as the pin assembly, turner trigger, handle roller, and eyelet seat were subjected to machining process. As necessary, some cast parts also undergone machining to fit properly.

Figure 6. Clustering of wax pattern

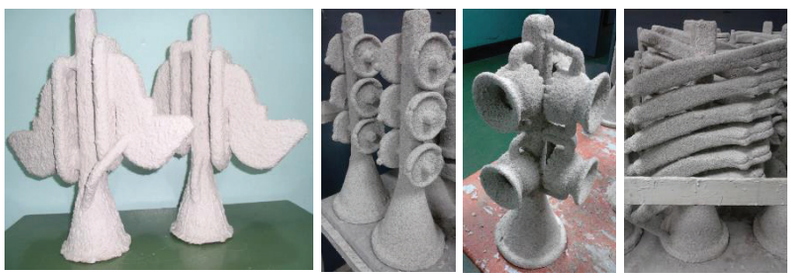

Figure7. Coated wax pattern

Figure 8. Melting and removal of ceramic shell

Figure 9. Cast parts after fettling

Figure 10. Stress relieving of some cast parts

Figure 11. Machining of some eyelet riveter parts

Figure 12. Functional testing of eyelet riveter machines

Figure 12. Functional testing of eyelet riveter machines

5.2 Functional Test

To evaluate the machine performance, the assembled machines were individually tested. Appropriate adjustments were made in malfunctioning riveters.

5.3 Performance Test and Evaluation

The actual performance of the machines was evaluated by DFA ADOCA. Their findings and observations were properly documented and given prior attention. Figure 12 portrays some of the actual performance tests and evaluation conducted by AD-OCA personnel.

5.4 Packaging and Delivery

The machines were properly packed for delivery to the DFA. Each box contains an operation and maintenance manual, spare of most wearable parts, and lubricating oil. Figure 13 shows the packaging of the eyelet riveter machines.

The deliveries of the machines were made in tranches. Depicted in Figure 14 are the deliveries made to complete the 130 sets of eyelet riveter machines.

Figure 14. Packaging of eyelet riveter machines

Figure 15. Deliveries of eyelet riveter machines

6. Summary and Conclusion

The unavailability of local suppliers to provide an eyelet riveter for the DFA AD-OCA's operation led to the conduct of the joint research between MIRDC and DFA. Three major phases were undergone to complete this research. These phases involved 1) problem identification; 2) gap determination; and 3) development of eyelet machines.

The development stage of eyelet riveter machines comprised several steps: 1) design development; 2) fabrication of the first prototypes; 3) testing and evaluation; 4) pilot production of machines; and 5) preparation of operation and maintenance manual.

Few problems were also encountered during the conduct of this research. Among which are casting-related problems which also affected the machining process. Nevertheless, the 130 units of eyelet riveter were completely delivered on September 30, 2016.

Based on the results of this research, it is concluded that the project team was able to provide the required machines to the DFA AD-OCA to perform their duties particularly in the binding of documents as required by their operations.

It is also concluded that with the inter-government agency cooperation, MIRDC was able to cater to the needs of one agency at lesser cost.

7. Recommendation

The base of the riveter body was slightly thin that there was smaller room for adjustment for the eyelet seat, resulting to the protrusion of the adjuster set-screw at bottom of the base of some units. This was the result of higher shrinkage rate of the said units during casting. It is therefore recommended to increase the base thickness to 3-4 mm to provide enough space to accommodate the adjuster set screw. It is also recommended that a follow-through study and intensive testing should be conducted to improve the developed Eyelet Riveter Machine and ensure minimal issues in production.

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Improvement of Flood Control Facility through the Development of Automatic Trash Rake

Gharry M. BATHAN*1

Abstract

In response to the flooding caused by excessive garbage in the waterways, the Department of Science and Technology (DOST) through the Metals Industry Research and Development Center (MIRDC), and in cooperation with the Metro Manila Development Authority (MMDA) and the Local Government of Quezon City, developed the Automatic Trash Rake Facility, which is seen as an effective garbage collection mechanism. The Local Government of Quezon City expressed its desire to rehabilitate the San Juan River. Quezon City is one of the first local government units in the country to develop a Disaster Risk Reduction and Management Plan that elaborates the city's preparedness, response, prevention, mitigation and rehabilitation during calamities and disasters.

1. Introduction

The DOST, through the MIRDC, implemented the project entitled, "Improvement of Flood Control Facility through the Development of Automatic Trash Rake (ATR)." The trash rake facility was installed at the Balinghasa Creek along Gregorio Araneta Avenue corner Mauban Street in Barangay Manresa in Quezon City. It is an inclined conveyor-type garbage collection mechanism intended to improve garbage collection, which is a better version as compared with the manual method used in the past. The ATR was developed by a group of engineers from the Metals Industry Research and development Center (DOST-MIRDC), Project Management and Engineering Design Services Office (PMEDSO), the Metro Manila Development Authority, Quezon City's Department of Engineering (DOE), Special Design Group (SDG), Environmental Protection and Waste Management Department (EPWMD), and Task Force Waterways (TW). The use of this technology has enabled the collection of waste in waterways faster and easier, especially during the rainy season.

The facility is capable of collecting an average of 5.1 cubic meter of trash in an 8-hour shift and has its own backup generator and three trained operators. It was installed to collect garbage before the water goes to adjoining major creeks leading to the San Juan River. The Balingasa Creek is a main tributary to the San Juan River and 86 percent of the wastes from upstream pass through it.

The setting up of the facility has remarkably abated clogging of the San Juan River and reduced the amount of debris washed out in Manila Bay during typhoons. Quezon City environmental management executives believe that the clogged Balingasa Creek was the cause of severe flooding in Barangays Masambong and Manresa, and also as far as Talayan Village and along the stretches of Araneta Avenue. During the initial 2 months of endurance and performance testing of the facility, which ran from October to December 2014, the ATR has already collected an average of 4 cubic meters per day during dry season and 6 cubic meters per day when it rains. The Quezon City government initially provided 3 personnel to undergo training on operation and maintenance of the facility. These personnel are part of Quezon City's commitment for the sustainability of the facility after the turnover.

2. Review of Related Literature

Trash rakes have existed since the first hydroelectric power plants were developed. Used to clean the intake racks that prevent debris from entering the plant, trash raking can be done as either a manual or automated process. While manual cleaning is still commonly used, automated systems are becoming more widely used because of their increased efficiency and lower operational costs.

Trash rack cleaning poses many challenges to the operators of hydroelectric plants. As outlined in Civil Works for hydroelectric facilities, published by the American Society of Civil Engineers (ASCE) in 2007, these problems include:

- Siltation, which occurs when twigs, branches and leafy materials are not removed properly, causing an increase of sedimentation on the trash rack.

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- Lower efficiency, caused by a damaged raking arm or misaligned trash rake.
- Damaged cables or pulleys.
- Inadequate lifting capacity.
- Inability to reach the bottom of the trash racks. (Hand raking is limited to depths of 6 to 8 feet below the water's surface.)

2.1 Design of Automated Trash Rake Cleaning Systems

Automated trash rakes can handle debris with great efficiency, either by dumping it on the fore bay or intake deck, or through a conveyor or trough. Automated raking systems can be initiated based on time or a head differential. A buildup of trash creates an increased differential head across the trash rack; the rake begins operations when a specific level is reached. Automated systems can also be initiated manually by an operator who can watch for certain conditions and trigger the rake, when necessary.

Lives and properties are lost and destroyed every year especially at coastal areas and at seas due to destructive waves, strong winds, and storm surges that is brought about by the inclement weather conditions.

2.2 The Benefits of Automated Trash Rakes

The San Juan River straddles Quezon City, San Juan, Manila, and Mandaluyong. Its entire basin including its tributaries has a catchment area of 90.4 sq. km. comprising the lower half of Quezon City, the City of San Juan and parts of Mandaluyong City, Pasig City and Manila City. Of the total area, about 78 sq. km. is located in Quezon City.

The San Juan River is approximately 10.581 kms starting at Quezon Avenue in Quezon City, passing thru Manila and San Juan City and ending at the Mandaluyong City part of Pasig River. The City of San Juan occupies roughly 2 kilometers of the river. The barangays located beside the river are Salapan, Rivera, Progreso, Balong-Bato, and Batis.

The main cause of flooding in some barangays in the city is the heavily-silted San Juan River where most of the garbage that flows from upstream Quezon City travels down to San Juan, Mandaluyong, and Manila, and eventually ends up in Pasig River. A certain amount of thrash and garbage from the last three cities also pose a problem. With the construction of the Automatic Trash Rake Facility, upstream garbage can be collected before it enters the other tributaries, creeks and canals downstream. With this technology, the risks of flooding brought by clogged drainage system can be reduced.

2.3. Binondo Pumping Station

President Benigno S. Aquino III inspected the Binondo Pumping Station and discussed alternative means to improve its operations to mitigate flooding problems in the city. He instructed Metro Manila Development Authority (MMDA) officers headed by Chairman Francis Tolentino, to seek alternative measures to de-clog waste materials caught in the drainage system. He further suggested to the agency to seek alternative technology from the Department of Science and Technology (DOST) to help solve flooding problems.

Manila, being at sea level, is prone to flooding during rainy season, with areas being submerged in just few hours of rainfall. Although much of its flooding problems can be attributed to its land feature, i.e. its flood-prone areas are below sea level, Manila's poor waste management has been the identified primary cause. It's pumping station's performance is down to 60% due to accumulated waste materials from informal settlers residing in the creeks and canals.

The MMDA currently operates and manages 51 pumping stations - 21 large pumping stations, 10 small pumping stations and 20 relief pumping stations.

2.4. Project Management Team

The Project Management Team was composed of the following with their corresponding responsibilities:

1. Metals Industry Research and Development Center (MIRDC) - The agency assigned to implement all the activities from materials/suppliers procurement for the construction and development of the Automatic Trash Rake Facility; hiring of manpower, design, coordination with Quezon City Local Government Unit and other stakeholders, and overall project management.

2. Project Management and Engineering Design Services Office (PMEDSO) - In-charge in the specification requirements of the Automatic Trash Rake Facility and assisted in the project management and coordination with different agencies and other stakeholders.

3. Philippine Council for Industry, Energy and Emerging Technology Research and Development (PCIEERD) - The agency tasked to monitor the overall progress of the project and assisted in the coordination with different agencies and stakeholders.

3. Methodology

3.1. Consultation with partners, stakeholders, and beneficiaries of the Project Output

Engineers from PMEDSO and MIRDC collaborated with the Quezon City Engineering Department and Metro Manila Development Authority to establish a structural design of the automatic Trash Rake Facility. The initial prototype was installed at the center of G. Araneta avenue corner Mauban street, Quezon City which was identified by the by the MMDA and Quezon City's Task Force Waterways and Environmental Protection and Waste Management Department (EPWMD) as one of the main contributors of garbage which was coming from Balintawak market and nearby residence. The project Improvement of Flood Control Facility through the Development of Automatic Trash Rake aims to collect the garbage from upstream creek before it goes to major creeks of the San Juan River.

The Site

Balingasa Creek

Figure 1. Vicinity Map of Automatic Trash Rake Facility

3.2.Conduct research and development to address the technology inputs needed

In coordination with the Metro Manila Development Authority, the Project team conducted meetings with the MMDA-Quezon City officials for the identification of possible site location for automatic trash rake. Several locations were visited to finalize the location and determine the final specification of the trash rake. The possible sites are Balingasa Creek, Culiat Creek, Pasong Tamo Creek and Dario Creek.

For every site inspected, the project team conducted basic data gathering, such as measuring the creek's width, length and depth for documentation and for the design of the proposed automatic trash rake facility. Also, the team considered the sustainability of the facility, such as storage of garbage collected, accessibility of garbage truck during collection, and number of barangays served.

The team visited several pumping stations of the MMDA for bench marking. These include Binondo, Taguig, Buendia, Libertad and others. Visiting the pumping stations will reduce the design development timeline since the existing trash rake of MMDA is already proven as working. Initial design were discussed with the MMDA engineers for their comments and suggestions prior to finalization. Together with the MMDA staff, the final location was identified.

3.3 Identification of final location

The MIRDC Trash Rake Team had a presentation of the Automatic Trash Rake design to be constructed in Balingasa Creek, Quezon City to the Engineering Department and the Environmental Protection and Waste Management Department (EPWMD) of the Local Government Unit of Quezon City (LGU-QC).

The site, the creek located in the center island of Gregorio Araneta Avenue and intersection of Mauban Street, was surveyed and studied for suitability of installing the trash rake facility. The data collected are to be used for the documentation, preparation and planning of the design of the proposed automatic trash rake and structural design of required civil works.

3.3.1 Site General Information:

The Balingasa Creek is located in the center island of Gregorio Araneta Avenue and intersection of Mauban Street in Quezon City. The site descriptions are as follows:

- The width of the creek is 6.30 meters;
- The depth of water level from the ground level is 2.70 meters;
- The creek's wall is lined-up with concrete hallow blocks (CHB) wall;
- A steel pipe is installed, along the creek;
- The creek is in between the two (2) roads;
- Possible access for dump truck;
- The proposed site is surrounded by numerous inhabitants.

According to some respondents, the accumulated garbage in Balingasa Creek is from Balintawak Public Market as shown in Figure 2.

Prior to the start of the final structural design, a soil test analysis was conducted to determine the soil bearing capacity of the location. The result of the said test is the basis for the final design of the foundation of the facility.

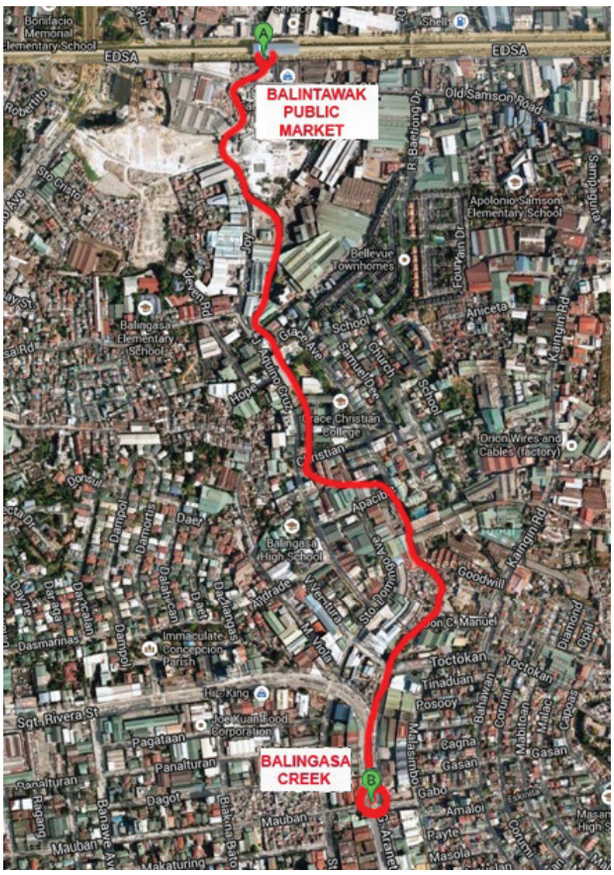

Figure 2. Source of Accumulated Garbage in Balingasa Creek

3.4. Design of the Automatic Trash Rake Facility

The initial design of the Automatic Trash Rake Facility passed through a series of review before it was finalized. With the support of Quezon City's Special Design Group headed by Architect Virgilio Regala, the final structural design based on the results of the soil test analysis was completed. Aside from structural and construction design, the mechanical side was completed by the MIRDC project team in coordination with the PMEDSO.

3.5 Construction, fabrication and installation

Prior to construction, the Quezon City LGU required the project team to present the proposed facility to the Quezon City ManCom to further review the design and to raise any concerns on the facility. Through a Memorandum of Agreement, the MIRDC represented by then Asec. Robert O. Dizon and the Quezon City LGU represented by Honorable Mayor Herbert M. Bautista signed the said MOA which identifies the roles of both parties during and after the duration of the project.

The NORTHWELL CORPORATION was awarded the contract amounting to Six million four hundred ninety eight thousand five hundred Pesos (Php 6,498,500.00). The construction, fabrication and assembly must be completed to the satisfaction of MIRDC within 120 calendar days reckoned from the date of receipt of the Notice to Proceed.

Because of construction delays, the Northwell Corporation requested for additional 26 days (September 5 to September 28, 2014) extension period; the delay is due to intermittent working schedule during construction caused by the rainy season and typhoons. The construction was completed within the approved extended duration.

3.6. Testing and Training

After the completion of construction, fabrication and installation last September 30, 2014, the project team conducted initial testing of the equipment. Together with the PMEDSO, the team conducted functional testing for 1 week and was witnessed by the Quezon City Engineering Department. After the functional testing, the project team requested the Quezon City LGU to provide personnel to be trained parallel to the testing of the equipment. The Quezon City LGU provided 3 personnel for the operation and maintenance of the facility. The training is planned for 3 months starting November 2014. During the 3 months operation of the facility from November 03, 2014 to February 03, 2015, the automatic trash rake facility already collected an average of 5.4 cubic meters of garbage even if there is no rain and 6.25 cubic meters when there is rain.

3.7.Launching of the Automatic Trash Rake Facility

The launching of the automatic trash rake facility was held on December 2, 2014 at the second floor of the Civic Center Building C of the City Hall compound.

The event was attended by Mayor Herbert M. Bautista, DOST Secretary Mario G. Montejo, Engr. Robert O. Dizon, OIC, MIRDC, Engr. Jonathan Q. Puerto, Deputy Executive Director for Research and Development, Dr. Teresita C. Fortuna, DOST-NCR Director, PCIEERD Executive Director Dr. Rowena Cristina L. Guevara, representatives from the Metropolitan Manila Development Authority (MMDA) and the Department of Public Works and Highways (DPWH), EPWMD head Frederika Rentoy, and other city officials and guests.

3.8. Economic Analysis / Viability

Based on the 2-month initial testing conducted by Quezon City's EPWMD and the MIRDC project team, an average garbage collection rate of 5.2 cubic meters per day was achieved by the ATR with only 2 personnel operating the facility. Compared to manual operation, the cost of labor incurred involving 20 personnel collecting 5 cubic meters a day of garbage from the water ways is greater than the cost incurred in operating the facility including the initial investment of Php 6,900,00.00 for five years operation.

4. Results and Discussion

The DOST-MIRDC implemented the project entitled, "Improvement of Flood Control Facility through the Development of Automatic Trash Rake" in response to President Benigno S. Aquino III's pronouncement identifying the DOST as a possible source of alternative technology to help solve the country's perennial flooding problem.

The primary objective of the project was to design and develop an automatic trash rake aimed to improve flood control that would function as a model unit for the demonstration of an operational Trash Rake Facility. At the end of the project, one trash rake facility was constructed at Gregorio Araneta Avenue corner Mauban Street, Quezon City.

Quezon City environmental management executives believe that the clogged Balingasa creek was the cause of severe flooding in Barangays Masambong and Manresa, and as far as Talayan Village and other areas along the stretch of Araneta Avenue. In coordination with the Quezon City LGU and the Metro Manila Development Authority, the project team was able to decide which is the ideal site and integrated this during the design phase.

The concept design of the Automatic Trash Rake Facility was planned through the collaboration of PMEDSO, MIRDC, Metro Manila Development Authority, Quezon City Local Government Unit. Construction of the ATR facility was done by Northwell Corporation.

5. Summary and Conclusion

Towards the completion of the project, in partnership with Quezon City LGU and Northwell Corporation, the Automatic Trash Rake Facility was designed and built at the center island of G. Araneta avenue corner Mauban Street. The automatic trash rake facility was completed through the collaboration of PMEDSO, MIRDC, Quezon City Engineering Department, MMDA and Northwell Corporation.

Since the project team already conducted a series of initial functional testing of the equipment together with the PMEDSO and witnessed by the Quezon City Engineering Team, the project is considered a successful one. The equipment completed its performance and endurance testing for a period of 3 months conducted by Quezon City personnel. The trash rake facility already collected an average of 5.8 cubic meters of garbage a day under a very limited 8 hour per day operation due to lack of personnel.

With the perceived success of the project, the Quezon City LGU expressed interest to construct another 2 facility to further improve its garbage collection performance.

The DOST-MIRDC has officially turned over the management and operation of the automatic trash rake facility to the Quezon City LGU during a brief ceremony held at the Civic Center Building C of the City Hall Compound.

The use of the technology will enable the collection of garbage in water ways faster and easier, especially during the rainy season. The ATR was installed to collect garbage before the water goes to adjoining major creeks leading to the San Juan River.

6. Recommendations to Future R&D Works

The Project "Improvement of Flood Control Facility through the Development of Automatic Trash Rake" is a research and development breakthrough in the Philippines. It is the first trash rake facility for creeks and tributaries built and developed by local engineers. As part of its continuous development, below are the recommendations for future R&D works:

1. The trash rake facility must be adopted and deployed in other creeks. The project is geared towards raising public awareness on the governments' research and development initiatives, as well as promotes the ATR as a machine that could help improve trash collection in the waterways.

2. Unmanned facility. A facility with no operator on site. It can be a remote controlled facility or can be operated on pre-programed operation or more complex continuous system operation.

3. A screen type apron plate design for wind and water resistance during typhoon is necessary. The Automatic Trash Rake Facility that was constructed and installed at G. Araneta Avenue corner Mauban St. is a demonstration of an operational automatic trash rake facility. Further promotion of the technology must be pursued.

Test and Evaluation of 120-Passenger Per Coach Capacity Automated Guide-Way Transit System

Jonathan Q. PUERTO*1, Joey G. PANGILINAN*2, Joseph Alfred V. GARCIA*3

Abstract

The Department of Science and Technology – Metals Industry Research and Development Center (DOST-MIRDC), in cooperation with the private sector and the academe, developed the Automated Guideway Transit (AGT) System. Two prototypes have already been built: the 30-passenger per coach AGT in UP Diliman, and the bigger 120-passenger per coach AGT in Bicutan. The results of the tests conducted and possible improvements in AGT UP were carefully considered in developing AGT Bicutan. The project entitled, 'Test and Evaluation of 120-passenger per Coach Capacity AGT System,' launched in 2014, aims to validate the improvements, identify areas for further improvement or modification, optimize operation parameters, and evaluate the system's response to certain conditions and loads. Moreover, the project aims to test and evaluate the performance of the AGT, particularly in terms of safety, energy consumption, and technical viability. Results obtained from each component and sub-systems of the AGT prove that the features installed render the AGT safe for the conduct of test runs, but more tests should be done to assure its commercial viability. The study revealed the following results: the AGT's breaking distance for crush load capacity is longer at straight and downhill tracks; the load greatly affects the rate of wear of guide-wheel and brass collectors; the noise levels inside the coach and on the passenger station fall within the acceptable range but may still be reduced; and energy consumption is computed to be at 0.016 kWh/passenger-kilometer. Although initial technical assessment is not yet conclusive, the AGT-Bicutan shows significant improvements compared with the technical assessment of AGT-UP. Considering restrictions brought about by limited resources such as length of test track, budget, and project duration, the AGT already shows encouraging and promising results.

1. Introduction

Traffic congestion in the Philippines remains a major obstacle to achieving sustainable economic growth. This is caused by many factors, such as overpopulation, inefficient rail transportation, and ineffective traffic control management (Man, 2015). In fact, the country is fourth among Asian countries and ranks ninth in the world in terms of negative traffic situation this year (Diola, 2015).

Air pollution also continues to be a serious environmental challenge. Based on the Philippine Republic Act 8749, also known as the Philippine Clean Air Act, the allowable total suspended particulates (TSPs) or amount of dust and solid pollutants in the air is only 90 ug/Ncm. However, according to the Department of Environment and Natural Resources-Environmental Management Bureau (DENR-EMB), the TSPs in Metro Manila for 2013 reached 118 ug/Ncm and is triggered by smoke-belching vehicles (DENR, 2013). According to Dr. Ocfemia of DENR-EMB (as cited by Macas, 2015), the air quality in Metro Manila gets even worse, with 85% of air pollution coming from vehicles. These problems should be immediately addressed as the country continues to gear up to be more competitive in the global economic race.

Through the Metals Industry Research and Development Center (MIRDC) of the Department of Science and Technology (DOST), with the help of the private sector and the academe, the development of an Automated Guide-way Transit (AGT) system was made possible. This is perceived to be a viable alternative mode of public mass transport that may address the problems on vehicular traffic congestion and environment pollution in the country.

MIRDC has developed two prototypes of AGT. First, an AGT (which is in now in UP Diliman) composed of two articulated coaches with a capacity of 30 passengers each. This is envisioned to act as a feeder system to major rail systems in the country such as LRT, MRT, and PNR; and is applicable to narrow streets owing to its small turning radius of 25 meters. Second, a bigger AGT System (in Bi-

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Figure 1. AGT Bicutan and the traffic situation along Gen. Santos Ave. during rush hour

cutan, Taguig City) comparable to the MRT in terms of size and capacity. It is also a two-articulated mass transit system capable of transporting 120 passengers per coach. Figure 1 shows the AGT-Bicutan, whose track is mainly built inside the compound of the DOST-Philippine Textile Research Institute (DOST-PTRI) and extends up to the DOST-National Research Council of the Philippines (DOST-NRCP) along Gen. Santos Avenue. The results of the tests conducted and possible improvements in AGT UP Diliman were carefully considered in developing AGT Bicutan.

In line with the development of AGT Bicutan, the project "Test and Evaluation of 120-Passenger per Coach Capacity Automated Guide-way Transit System" was launched in 2014. This project was intended to validate the improvements made, identify areas that need further improvements or modification as a result of the tests conducted, optimize operation parameters, and evaluate the response of the system to certain conditions and loads. Specifically, it aimed to test and evaluate the performance of the 120-Passenger per Coach Capacity AGT system in terms of safety, energy, and technical viability. For this project, tests were simulated on three different load conditions, namely:

i. No Load – with no passengers or load on board
ii. Full Load - with full load capacity equivalent to 120 passengers per coach
iii. Crush Load - with crush load capacity equivalent to 150 passengers per coach

The MIRDC, together with the Project Management and Engineering Design Services Office (PMEDSO), spearheaded the conduct of the test and evaluation. The DOST-Philippine Council for Industry, Energy and Emerging Technology Research and Development (DOST-PCIEERD) monitored the over-all progress of the project and funded also the six (6) months extension of the project.

II. Methodology

The tests were divided into three phases. The first phase is the functional test aimed to test and evaluate if each subsystem and component function are correctly based on the original intended design. This was done to correct assembly and integration problems that may cause unnecessary stoppage during test runs and to ensure safe implementation of the performance tests. A functional and safety test protocol was drafted to guide the engineers and technicians in conducting the functional tests.

This was succeeded by the second phase performance test by conducting 1500 runs each for no load and full load condition based on a performance test protocol drafted by PMEDSO. The protocol was adopted from Automated People Mover standards by the American Society of Civil Engineers (ASCE). It aimed to establish minimum set of requirements for the system to be acceptable in terms of safety and performance. It also included daily checklist wherein the operators and technicians inspect and monitor the integrity of each component prior to each test run. Mandatory dismantling and inspection were conducted every 250 and 500 runs and results were recorded to monitor progress of the AGT's performance.

The third phase was the validation of the system's performance on non-stop and long period conditions (endurance test) until the target number of runs was achieved or until a breakdown or failure took place. The team implemented a rotation schedule of drivers and staffs to keep the AGT running even on lunch breaks. The longest peri-

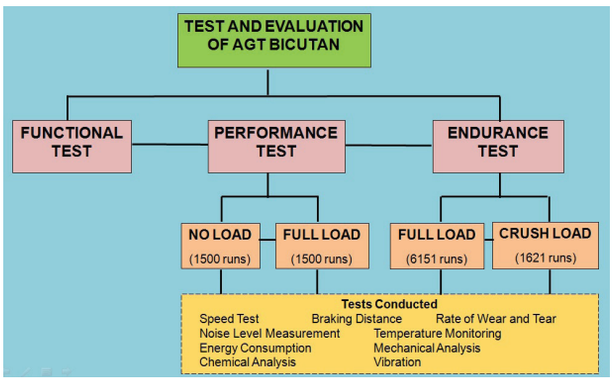


Figure 2. Test phases and activities

Figure 3. AGT personnel attend training and evaluation program

od the AGT was operated in a day was 14 hours. The AGT was then further evaluated at crush load condition for more than 1500 runs. Figure 2 illustrates the three phases of the tests. Figure 3 shows the AGT personnel during one of the training and evaluation sessions.

In the simulation of full and crush load conditions, a factor of 60 kilograms per person was used in determining the approximate total weight of load. A maximum speed of 25 kilometers per hour (kph) was used in the entire testing duration. An orientation and training program was conducted for newly hired technicians and operators to equip them in handling the operation and maintenance of the AGT. Current operators and technicians were also retrained and re-evaluated. As the approved extension period coincided with the rainy season, the performance of AGT on wet/rainy condition was also evaluated.

To date, the AGT has been tested and operated for an approximate of 6,000 kilometers.

As part of the continuous improvement process, several demonstration runs were conducted in 2015. To gauge the public perception and appreciation of the AGT technology and solicit comments and suggestions, feedback forms were handed out to passengers, rating the AGT in terms of safety and technical aspect. The first public demonstration was a three-day run conducted on 15-17 June 2015 coinciding with the Metals and Engineering Week celebration participated in by more than 500 passengers. The second public demonstration was conducted on 9-11 December 2015 as part of the Science Nation Tour of the DOST with more than 1500 passengers. Both demonstrations were successful and got positive response from the riders.

III. Results and Discussion

Table 1 presents the basic information, i.e. no load, full load, and crush load, gathered from the performance test and evaluation of the 120-passenger coach AGT Bicutan.

The results obtained from the tests of each component and sub-system of the AGT are presented below.

Table 1. Basic information gathered during the test runs

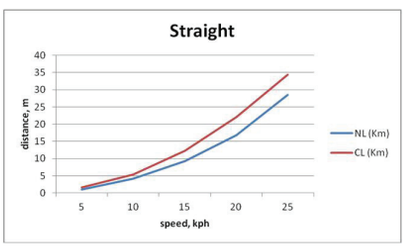
	No Load Condition	One Day Endurance Test Run at No Load Condition	Full Load Condition (approx. 7.2 tons/coach)	Endurance Test at Full Load Condition	Crush Load (approx. 9 tons/coach)
Number of Runs	1500	631	1500	6151	1621
Approx. Equivalent Distance Travelled, km	525	221	525	2153	567
Maximum Speed Used During Testing, kph	25	25	25	25	25
Average Energy Consumption, kwh per hour	62	-	79	81.3	87.9
Acceleration time from 0 to 25kph	13 – 15 seconds				

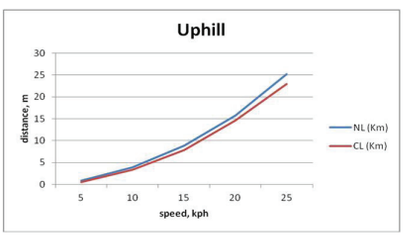
A. Braking Distance Using Electrical Braking (Dry Condition)

1. Effect of Load on Braking Distance at Different Slopes

The three graphs show the effect of load on the braking distance of AGT on various track grades. For straight and downhill direction, AGT at crush load capacity has longer braking distance than without load, while for uphill direction, the AGT at crush load capacity has shorter braking distance.

Three trials were conducted for each speed (increment of 5).



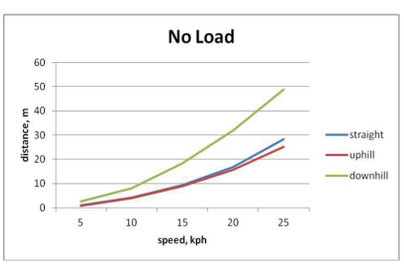


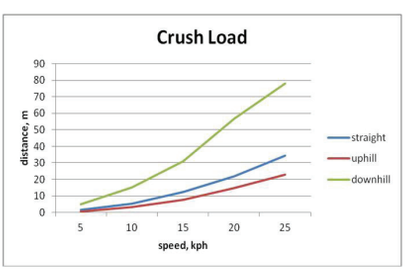
2. Effect of Track Grade on Braking Distance at Different Load Conditions.

Straight vs. Uphill (+3.5%) vs. Downhill (-3.5%)

The track grade greatly affects the braking distance of AGT. As shown on the graph, the braking distance at downhill with a speed of 25kph and crush load capacity is approximately 80 meters.

Three trials were conducted for each speed (increment of 5).

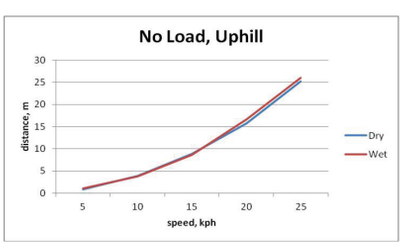




3. Effect of Track Conditions on Braking Distance (Dry vs. Wet @ No Load Condition)

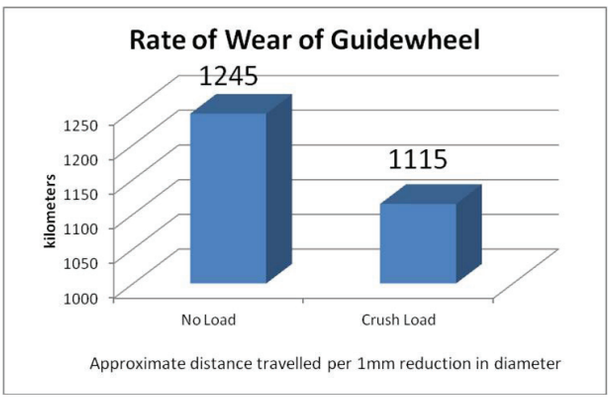
At No Load and maximum speed of 25kph, the dryness or wetness of the track has no significant effect on the braking distance of AGT. The applied speed may not be sufficient to cause a significant difference in the results. The project team, however, was not able to determine the braking distance of crush load capacity on wet tracks.

Three trials were conducted for each speed (increment of 5).



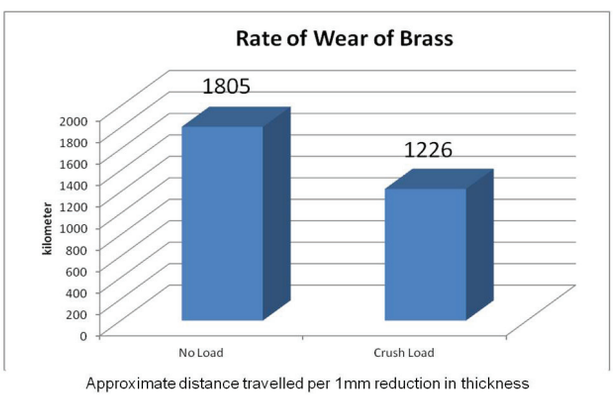
B. Rate of Wear of Rubber Guide Wheel

The graph shows that the load greatly affects the rate of wear of guide-wheel. For every 1 mm reduction in diameter, the average travelled distance is 1245 km for no load and reduced to 1115 km for crush load.



C. Rate of Wear of Brass Current Collector

Same with the guide wheels, rate of wear of brass collectors increases as the load increases.



D. Noise Level

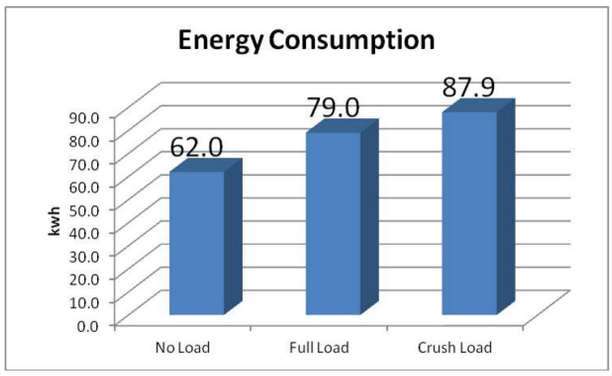
Location: Inside coach
Coach 1: 75.8 dB
Coach 2: 75.1 dB

Location: Platform/Station
Vehicle passing station: 83.7 dB

The National Institute for Occupational Safety and Health's (NIOSH) recommended exposure limit (REL) is 85dB at 8 hours, while the Occupational and Safety Health Administration's (OSHA) permissible exposure limit (PEL) is 90dB at 8 hours. The results seemed to be acceptable, but improvement to reduce the noise level may still be done.

E. Energy Consumption

The graph shows energy consumption of AGT Bicutan (kwh per hour) under different load conditions.
At crush load, the average cost per passenger-kilometer (assuming a Php 13/kwh electricity cost) is approximately Php 0.21.



F. Mechanical Analysis (Guide Wheel)

The following are the results of the mechanical tests conducted on the guide wheels. If the guide wheels satisfy the acceptable safety standards, then the mechanical properties obtained will serve as the minimum requirement.

A. Hardness Test Result of Various Guide Wheel Materials

Material	Hardness		Thickness, mm
	Mean	Std. Deviation	
Rubber A (old)	78.6	0.327	6.12
Rubber B (new)	75.7	0.451	5.89
Polyurethane	82.9	0.295	6.07

B. Compression Test Result of Various Guide Wheel Materials Materials

Material	Compression Set (%)	Dimension, mm	
	Mean	Orig. Thickness, mm	Thickness after exposure to set condition
Rubber A (old)	26.0	12.2	11.5
Rubber B (new)	26.2	12.2	11.5

C. Density of Various Guide Wheel Materials Materials

Material	Density at 23 deg C (g/cm^3)	
	Mean	Std. Deviation
Rubber A (old)	1.58	0.015
Rubber B (new)	1.58	0.005
Polyurethane	1.15	0.018

IV. Summary and Conclusion

This project was able to test and validate the performance of AGT Bicutan at different conditions. In terms of safety, the features installed in the system including the preliminary operation protocol proved to be sufficient in carrying out safe test runs. However, for commercial operations, more has to be done to ensure overall safety, comfort, quality, performance and compliance to standards.

In terms of energy, the computed energy consumption per passenger per kilometer is 0.016 kWh. Assuming a Php13/kWh cost of electricity, the resulting cost is Php 0.21 per passenger per kilometer.

In terms of technical viability, test results provide initial assessment only of the technical performance of the AGT hence, they are not conclusive yet. Comparing with the test results of AGT UP in 2012-13 however, a significant improvement was observed especially on the rate of wear of components such as guide wheels and brass current collectors considering the disparity in weight and size. A Value Engineering/Value Analysis study funded by the National Economic Development Authority (NEDA) and awarded to Systra Philippines, Inc. (SPI) has been conducted to assess the viability of AGT vis-à-vis other modes of transportation. Assessments were made on the technology by some French rolling stock experts. All observations and proposed improvements were documented and is planned to be incorporated on the pilot commercial design of the AGT.

Overall, given the limited length of track, budget constraints, and short duration of development and testing, the results are already encouraging and promising. Aside from providing an alternative mass transport solution, a self-reliant rail industry is hoped to be created, thus generating job opportunities and propelling inclusive economic growth.

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Philippine Welding Society started as a vision of various industry professionals whose aim is: to advance the science and professionalize the practice of welding in the country. On September 19, 1991, encouraged by the government, business sector, educators and practitioners, twelve founding members from construction, manufacturing and inspection companies bonded together and established the Philippine Welding Society, Inc. (PWS). On February 13, 1992, The Securities and Exchange Commission (SEC) registered the Philippine Welding Society Inc. as a non-stock, non-profit organization.

The Objectives of the organization are to promote the advancement of the science and practice of welding and to advise and support government entities whenever possible on matters of standardization, public safety and health; maintain among members' high ideals of integrity, learning, professional competence, public service and conduct; provide proper forum for meeting, exchanging of ideas and opinions, and to be involved in the solution of multifarious problems affecting the country in general and the welding profession; conduct workshops and seminars for purpose of keeping its members abreast of progress in the welding field; and promote consciousness among members of their serious responsibilities in helping our country move forward in our national development .

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Engr. Mark B. Villanueva:

Overcoming the Odds through Engineering and Entrepreneurship

Zalda R. GAYAHAN*1

Success is achieved when luck, ability to seize opportunity, and focus come together.

Having experienced a taste of how it was to attempt to put up businesses with his siblings when they were younger, Engr. Marcelo 'Mark' B. Villanueva (MBV) ventured into businesses of his own after more than 20 years of experience working in the industry. MBV is the Founder and President of three companies - the WITCO Inspection and Testing Corporation (formerly Welding Inspection and Testing Corporation), WITCO Construction and Development Corporation and Villcorp Resources, Inc. (VRI). He claims that his rise to become the accomplished man that he is now is backed up by three 'success secrets': luck, the ability to seize opportunity, and focus.

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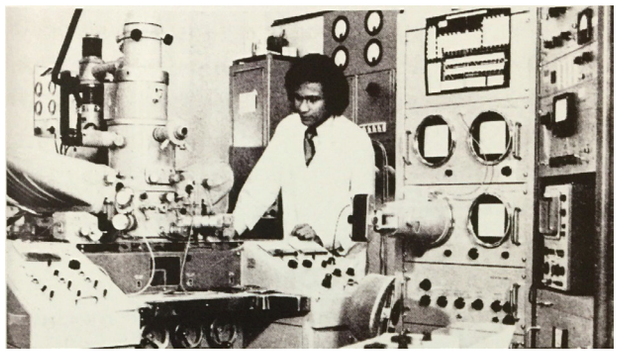
On luck. WITCO started in 1991, at a time when the country embarked into a massive Power Plant Construction Program as a result of the crippling power outages of the 80's. Big players in the power industry like MIRANT, ENRON, Asea Brown Boveri (ABB), Alstom, Fluor Daniel, Babcock-Hitachi, Mitsui Engineering and Ship Building Company (MES) came in a big way to design and build coal, diesel power plants as well as power barges as quickly as possible.

Suddenly there was a shortage of qualified contractors and skilled workers to do these projects at the same time. It was a once in a lifetime "sellers market" for contractors. Profit margins hit the ceiling, terms of payment were shortened. WITCO provided welding and NDT testing services among others. *'Nung panahon na 'yon, hindi na pinag-uusapan ang cost, ang tinatanong lang ay kung kaya mo gawin at kung kailan ka pwede magstart.'* It was indeed a perfect timing for a starting company like WITCO.

It was Babcock-Hitachi Philippines (BHPI), a Japanese company based in Bauan Batangas, who gave WITCO its first major welding contract in late 1991. BHPI was a world leader in the manufacture of custom-made boiler panels for big power plants. The project, which lasted for over three (3) years, involved fit-up, welding and testing (x-ray) of boiler pipe joints. This project was so profitable that it contributed a lot in funding WITCO's initial expansion.

For MBV, it was luck that shaped him to become the entrepreneur that he dreamed of becoming when he was young. *'May element kasi ng luck yan, kung saan ka napwesto. Graduate ako ng Metallurgical Engineering sa UP. Normally, ang direction ng career ay toward the mining industry kasi at that time boom ang mining industry. It so happened na nung grumaduate na kami, down na ang mining for the next 20 years. So wala ng choice. Initially I worked for a mining company, after one year I joined the MIRDC (Metals Industry Research and Development Center under the Department of Science and Technology). So dun ako napunta sa ibang industry.'* The DOST-MIRDC played a significant role in enhancing his technical expertise through hands-on practice and technical training opportunities both here and abroad. Here, he was Head of the Testing and Research Department, a position whose functions exposed him to various industry players, allowed him to develop linkages and strengthen his networks, and enhanced his managerial skills. Ten (10) years later he joined Atlantic Gulf & Pacific Co. of Manila (AG&P), one of the biggest engineering and construction companies in Southeast Asia. This opened up a new chapter in his professional career.

On seeing and seizing opportunity. The businesses that he is in now are really far from the career that he was expected to have had he decided to practice metallurgical engineering.



Engr. Villanueva as a young MIRDC Engineer, training on electron microscopy at Aachen Technical University in Germany.

'Yung inspection company was built dun sa expertise na na-gain ko sa MIRDC.' It was not only about being honed as a technical expert, but being able to know first-hand where opportunities lie. In MBV's case, his interactions with internal and external clients of the DOST-MIRDC helped him see the growing demand for quality testing services such as X-ray testing, Ultrasonic Testing (UT), and Magnetic Particle Testing (MPT). *'Yung construction company on the other hand, was built based on my expertise gained at AG&P,'* shares MBV.

Being successful requires observant eyes and a keen mind that comes up with solutions to clients' needs, solutions that are so practical that clients will tend to seek you out amid the stiff competition. MBV recalls how he was able to see opportunities from his previous experiences. At the MIRDC, he saw that the major drawback is the Center's inability to provide prompt service because of certain limitations such as lack of flexibility with regard to rendering overtime work and adjusting salary rates. *'Pero,'* says Engr. Villanueva, *'dun ko nakita ang opportunities. If you can put up something which will provide prompt service to the industry, may business ka diyan.'*

He spotted another opportunity when he was with the AG&P, which was at the peak of the construction business and was the biggest name in Southeast Asia at that time. *'Nakita ko naman dun, while we have that advantage of size, may mga pagkukulang din. You cannot respond very quickly to your customer. Halimbawa, the very simple ordering of consumables and materials, mejo natatagalan. May bureaucracy na. Oorder yung site, pupunta sa purchasing, maraming mag aapprove, it takes time. Sabi ko if you can cut this down, you're in business.'*

In the late 1990's the telecommunications business was liberalized resulting in the entry of new players such as SMART, GLOBE, SUN etc. The initial roll out of cell sites attracted contractors looking for higher profit margins and prompt payment terms. WITCO seized this opportunity and shifted its resources to building cell sites. The company constructed up to 200 cell sites for various telecommunication companies until it pulled out in late 1990's when profit margins dropped and payment terms extended to several months.

On focus. As a child, he would rather play than study but still ended up as valedictorian in elementary and high school. According to him, he was not the kind of student who opted to stay long hours to study but he would only focus on things that really matter. He brought that attitude with him when he became the Boss. *'Hindi ako yung type na magbabahad talaga.'* The one to two hours he spends in the office he makes sure that he has already done everything. He gets things done quickly because he is able to identify the important aspects of the business and stay focused on them rather than spending time on non-essential matters.

With WITCO's limited financial resources, it had to put its resources in projects which will generate the highest profit margin at lower risk. It has to choose its clients carefully and undertake a few good projects at a time rather than spend its resources thinly and get burned out in the end. MBV believes that one good project begets another as exemplified by the following stories.

(L) MBV (rightmost) leads the AG&P team in charge of pre-fabrication of modular structures; (R) MBV supervises commissioning of pre-fabricated modular lead-zinc processing plant at Red Dog Mines, Alaska, USA.

In 1997, after a successful venture in the power and telecommunications industry, WITCO found itself working at the Ninoy Aquino International Airport (NAIA) for the testing and inspection of a suspected leak in the underground fuel hydrant pipeline of Terminal 1. NAIA was losing thousands of liters of jet fuel a day. It was not only costly but also environmentally damaging. WITCO successfully pinpointed the leak and quickly plugged the hole and put the pipeline back in service. As a result of this, WITCO was recommended by NAIA Management to construct the new fuel hydrant system for Terminal 2 as a sub-contractor to TOKYU Construction Company of Japan. This also paved the way for its entry into the highly demanding oil and gas construction business.

Pilipinas Shell Petroleum Corporation (PSPC), who was managing the fuel hydrant system for NAIA at that time, took notice of WITCO's good performance in the hydrant project and immediately enlisted it as one of its accredited contractors. WITCO undertook dozens of projects for Shell for its various facilities nationwide. In 2006, it awarded WITCO a project to construct a 6 M liter-capacity diesel storage tank and related facilities in the Republic of Palau. This was considered a milestone project for WITCO since it was successfully done outside the Philippines.

In 2007, WITCO was awarded a contract by Leighton Contractors (Asia) Limited (an Australian Construction Company) to erect steel tanks and other plant facilities at Filminera's Masbate

MBV's WITCO team who were in charge of the six million liter-capacity fuel storage tank project in the Palau Republic.

Engr. Villanueva with his wife, Mrs. Alma Villanueva.

Gold Project. One of the reasons for the award was the company's good track record for constructing tanks for Shell which is known for its high standard of quality. This started WITCO's entry in the mining sector. Since then, it has successfully completed projects for other mining companies such as Greenstone's Siana Gold Project and FCF Minerals' Runruno Gold & Molybdenum Project – all foreign owned mining companies.

On WITCO's strong relationship with MIRDC. Aside from his 10-year stint at the DOST-MIRDC, Engr. Villanueva served as a Governing Council member of the Center for six years. His connection with the local metals, engineering, and allied industries has always remained strong. WITCO regularly avails of the Center's testing services. MBV is one of the founding members and a former President of the Philippine Welding Society (PWS), which happens to be one of the DOST-MIRDC's industry partners. According to him, WITCO's collaborative relationship with the DOST-MIRDC is instrumental in advancing the science and practice of welding in the country. On the other hand, WITCO Construction will soon be opening a new fabrication shop in Biñan, Laguna. The shop being constructed will be WITCO's new site for the fabrication of piping, storage tanks, structural steel members for plants/warehouses. The new fabrication shop will offer plate rolling, forming, cutting, and welding capabilities. Its operations will use automatic cutting, forming, and welding machines for the first time. With all the exciting expansions that the WITCO companies are going through, MBV envisions their continued collaboration with the DOST-MIRDC by means of availing the Center's laboratory services, as well as training and consultancy services in the field of automation.

Enjoying the fruits of his hard work. MBV is a hardworking man from the very beginning. His family is his motivation. *'The reason why I work hard is really more for the family, for the future of the kids. I was lucky with my family. I met Alma, my wife and business partner, in MIRDC. We have been happily married for 38 years now and we are blessed with six children, all of them are professionals. In fact, four (4) of them are working with me right now. My eldest, Cristina, is the Vice President for finance and administration. She is a graduate of Communications Technology Management in Ateneo De Manila University (ADMU); she also has a Master's Degree in Business Administration from UP Diliman. Eliza, my second child is a Civil Engineer. Like me, she also graduated from UP Diliman. She is an American Welding Society (AWS) – Certified Welding Inspector (CWI) and American Society for Non Destructive Testing (ASNT) Level III in 4 methods (RT, UT, PT and MT). She is now the General Manager of WITCO Inspection. My third child, Rosemarie finished Integrated Marketing Communications in the University of Asia & the Pacific (UA&P). She has established her career in media planning and sales in Singapore and has recently been promoted as a Senior Regional Sales Manager in Success for Mobile. My only boy, Gregory, finished Management Economics in ADMU. He is in charge of Business Development and Marketing for the WITCO Companies. He is also the General Manager of Villcorp, the trading arm of WITCO. My fifth child, Marianne, is a freelance Interior Designer. She graduated Cum Laude from the University of Santo Tomas (UST). She also manages the company's real estate properties and building/office improvements. My youngest, Nikki is also a Civil Engineer. Like me, she is also a graduate of UP Diliman. She will most probably manage WITCO Construction in the future,'* says the very proud MBV.

(Above) Villanueva siblings (left to right) Marianne Villanueva, Ma. Cristina Azana, Rosemarie Shorter, Gregory Villanueva, Ma. Eliza Mendez, Anna Katrina Villanueva.
(Below) Complete family photo with in-laws and grandchildren. Standing L to R: Marianne, Gregory, Rosemarie, Jonathan, Anna Katrina. Sitting L to R: Caroline, Adrian, Cristina, Olivia, Mark, Alma, Ma. Eliza, Paul, Audrianna.

'I was fortunate to have children who are interested to work for the family business. Others are not quite as fortunate. Before, I set just a modest limit to how WITCO will grow as a business concern. Now that WITCO has developed a young business management team to back it up, things have changed. With the new office and fabrication shop, the stage is set for the company to jump to a higher level.'

'Nakaka enjoy din ang business. It's not only the money. Nag-gogrow yung business mo at satisfied ang customers mo. Satisfied ka. From where I came from, ok na yun. I have no regrets,' he ends with a quiet, satisfied smile that reveals a man who knows how it is to work hard and feels the fulfilment that his own success story brings.

The Villanuevas on some of their favorite family trips (clockwise from top left): at the Louvre Museum Paris, France (March 2011); at the Swiss Alps (March 2011); at Barcelona, Spain (April 2011); in Macau (December 2013).

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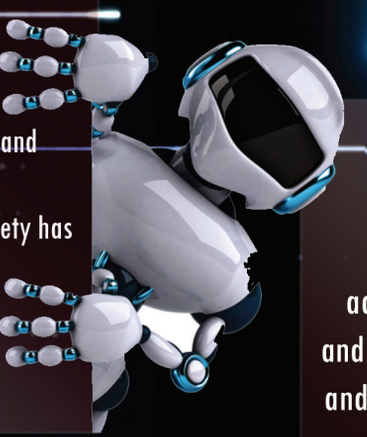

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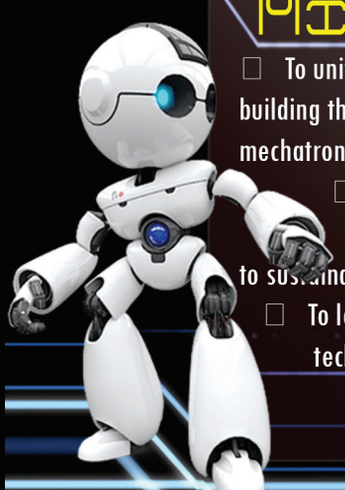

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The Die and Mould Association of the Philippines

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Bicutan, Taguig City, Metro Manila, Philippines
Tel Nos. (632)-804-2638 / 0925-8042636

PDMA Inc. is a Member of the Federation of Asian Die andMould Association (FADMA).

Annually, the PDMA, Inc. sends official delegates to the FADMA General Membership Meeting, which is usually held in any of its member countries ready to host the event. Other FADMA member countries are Japan, Malaysia, Indonesia, Taiwan, China, Singapore, India,Thailand, Korea, and China.

FADMA AGM 2017 - with Philip C. Ang and Virgilio F. Lanzuela

About PDMA

Recognizing the impact of globalization, the rationalization and modernization of the tool and die sector has become a pressing concern. Towards the holding of several ad hoc committee meetings, industry leaders decided to organize themselves and form the **PHILIPPINE DIE AND MOLD ASSOCIATION, INC. (PDMA Inc.)** duly registered with the Securities and Exchange Commission (SEC).

Immediately, the PDMA successfully gained affiliation with the FADMA, coinciding with the FADMA Council Meeting held on September 7, 1995 in Taipei, Taiwan. Its affiliation with the FADMA is one of the sector's gateway to global opportunities.

The DOST- Metals Industry Research and Development Center (DOST-MIRDC) assists the PDMA by providing secretariat services.

VISION

The PDMA seeks to promote the rapid modernization of the Philippine die and mold industry by fostering closer cooperation between and among the members of the industry, the academe, and the government by serving as catalyst in consolidating their efforts and in mobilizing available resources with the end in view of enhancing the capability of the die and mold industry to meet the demands of the local and export market under the standards of global excellence.

THRUSTS

1. Policy Advocacy and Support

- To formulate, initiate and advocate policies and strategies for the rationalization of the mold and die industry, review the existing industry policies and closely monitor the implementation thereof.

2017 OFFICERS & BOARD OF TRUSTEES

Officers

Philip C. Ang
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2. Industry Consolidation and Network Building
- To establish network or linkages with industry leaders, partnerships, corporations, associations, or persons engaged in die and mold making, here and abroad, for purposes of exchanging views and information, establishing bases for cooperation, or undertaking collaborative activities for the advancement of the interests of the die and mold industry.

3. Information Dissemination
- To establish a center for information dissemination on researches, technologies, and policies and programs pertaining to or affecting the mold and die industry.

4. Technical Capability Upgrading
- To promote closer collaboration between and among the industry, the academe, and the government in upgrading the technical capability of educational institutions offering subjects on tool, mold, and die making and in conducting training programs for skills improvement of people involved in the industry.

5. Establishment of Common Research and Technical Facilities and Creation of a Pool of Technical Consutants
- To establish common research and technical facilities for the industry and create a pool of technical consultants of such nature that may advance the common interests of the industry.

Membership Classification:

Membership to the Association is categorized into two: Corporate and Professional.

Sectoral Structure:

The PDMA is composed of seven (7) sectors.

Sectoral classifications are as follows:

1. Die Casting & Forging
2. Electronics & Semiconductor Tooling
3. Government (represented by MIRDC)
4. Metal Stamping
5. Plastic, Rubber & Packaging
6. Technological Resources
7. Machining and Equipment Fabrication

Technical Scholarship Program:

The PDMA, Inc. provides a FREE Technical Training program yearly in partnership with the DOST-MIRDC. This program is offered exclusively to the employees of PDMA member-firms.

Technical Training Programs Offered:

CNC Milling/Programming, CNC EDM Wire Cutting/ Programming and Operation, CNC EDM Sinking Programming/Operation, Plastic Injection Molding Ma-

During the actual Training/Seminar – (DM1 and DM2)

chine Programming/Operation, Basic Plastic Injection Mold Design, Dimensional Metrology, and Basic Coordinate Measuring Machine (CMM) Operation.

Skills Competition 2016:

In support of the Annual Metals & Engineering Week and the 50th Founding Anniversary Celebration of the DOST-MIRDC, the PDMA participated in the MIRDC 1st Skills Competition which is one of the highlights of the M&E Week program.

Skills Competition - Awarding of Winners

The PDMA skills competition focused on the trade areas of turning operation, milling operation, bench work and mechanical drafting using solidworks software. The PDMA aims to showcase the industry sector's skills capability and to foster closer relationship among stakeholders.

Among the highlights of the celebration is the awarding of winners, which is held at the MIRDC Compound on the 2nd week of June 2016.

PDMA, Inc. –Promotional Campaign

The PDMA, Inc. participates in the local and international exhibitions with the following objectives :

- To increase the number of both local and international PDMA, Inc. company membership;
- To promote the biennial PDMEX and to encourage possible participants/exhibitors;
- To organize delegation and business matching for PDMEX; and
- To open window of opportunity for the local and international market.

Skills Competition - Awarding of Winners

Die and Mold Solution Center (DMSC)

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The Die and Mold Solution Cenetr (DMSC) establishment is made possible through the partnership between the DOST-MIRDC and the PDMA, Inc., which was inaugurated on the 18th day of June 2014.

D2M2 Training Program

FREE Training Program on Die and Mold Designing and Making, (D2M2 Project).

The DOST-MIRDC, in partnership with the PDMA and DTI-BOI, conducted the Die and Mold Designing and Making (D2M2) training under the project entitled, *"Enhancing Tool and Die Industry Competitiveness by Expanding the Pool of Trained and Highly Skilled Die and Mold Designers and Makers (D2M2 Project)."*

The D2M2 training program was able to produce five (5) batches of training participants with a total number of 100 graduates in 2015 and 2016.

PDMA's Major Activity

The PDMA, Inc. formed and organized a biennial exhibition entitled **"PDMEX"** in 2003.

The participants of the PDMEX consist of both local and foreign exhibitors.

Come and Visit!

The forthcoming 8th Philippine Die & Mould Machineries and Equipment Exhibition (PDMEX 2017).

August 23-26,2017 at the World Trade Center, Pasay City.

Open to Public – *FREE ENTRANCE*

Advertisement Index

ACT Machineries & Metal Craft Corp.

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Email Add.: act.corp@yahoo.com/act.metalcraft@yahoo.com

BRANCHES

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Centro, San Guillermo, Isabela	0917-302-7390	Aquino Ave., Pob. South, Solano, N.V.	078- 326- 5667
Centro, San Mateo, Isabela	078- 664-2516	Nat. High., S. Jose City, Nueva Ecija	078- 353-0393
Ugad, Cabagan, Isabela	078-376-0017	San Nicolas, Candon City, Ilocos Sur	077-674-0697
Maligaya, Tumauini, Isabela	078-323-0081	Acosta, Batac City, Ilocos Norte	077-792-3984
Centro 1, S. Mira, Cagayan	078-396-9741	San Agustin Sur, Agoo, La Union	078-376-0486
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METALWORKING INDUSTRIES ASSOCIATION OF THE PHILIPPINES, INC. (MIAP)

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WHAT IS THE METALWORKING INDUSTRY SECTOR?

The metalworking sector of industry covers the activities in the transformation of the shape and properties of metals to produce products such as machines and equipment parts and components thereof, tools and dies, jigs & fixtures, handtools, kitchen utensils, farms implements, households appliances, etc. by employing any or all of the following processes:

- Metal casting
- Forging
- Die casting
- Machining
- Metal Joining (soldering, brazing, welding, riveting, etc.
- Grinding
- Press working
- Heat treating
- Finishing
- Metal Coating
- Assembly

WHAT IS MIAP

MIAP (Metalworking Industries Association of the Philippines, Inc..) is a trade association of firms engaged in metalworking and related activities that was organized in 1978 to answer the need for a body that can represent the metalworking industry sector.

ITS VISION:

A Metalworking Association that can provide services/ assistance to its members in order to effectively compete both in the local and global industry arena.

ITS MISSION

Work for the development of a truly progressive and dynamic metalworking association that can firmly support the needs of its members and stands as the backbone of the various industries.

ITS OBJECTIVES:

- To unite all entities involved in the field of metalworking and allied engineering industries.
- To achieve development and growth of the Philippine metalworking industry sector.

ITS ACTIVITIES

- Working for the stabilization and rationalization of the market for machines and fabricated metal products;
- Establishing product standards in cooperation with accredited technical/ professional societies and appropriate government agencies;
- Promoting exports;
- Disseminating industry information through seminars and symposium;
- Participating in local and international conventions and symposium, and trade fairs related to metalworking;
- Organizing/participating in exhibits/trade fairs (domestic and international);
- Compiling data and information on capabilities and market of the industry;
- Promoting and encouraging complementation in the use of production facilities thereby maximizing their utilization;
- Cooperating and working with government instrumentalities in the formulation of policies that will promote the development and growth of Philippine metalworking firms;
- Training industry personnel;
- Cooperating with educational institutions for more relevant curricula.

ITS STRUCTURE:

MIAP is a national organization composed of provincial/city chapters. As of January 2013 the chapters (in alphabetical order) are:

CHAPTERS	NO OF MEMBERS
1. BOHOL	10
2. BUTUAN CITY	10
3. CAGAYAN DE ORO	26
4. CAGAYAN VALLEY	10
5. CEBU	25
6. DAGUPAN REGION 1	10
7. DAVAO	23
8. GENERAL SANTOS	10
9. ILIGAN CITY	15
10. IILOILO CITY	15
11. KIDAPAWAN	10
12. METRO MANILA	75
13. NEGROS OCCIDENTAL	10
14. SURIGAO	10
15. ZAMBOANGA	12
TOTAL	271

HOW ARE MIAP CHAPTER ORGANIZED?

MIAP chapters can be organized in a town, city, province or region upon application to the National Board of Trustees by a minimum of five (5) organizing members each representing individually and separately a metalworking enterprise in the locality duly organized under existing laws of the Philippines.

Additional chapter(s) may be organized in a given locality where there is already an existing chapter upon favorable endorsement of the latter and upon determination by the board of trustees that such additional chapter(s) shall redound to the advancement and attainment of the objectives of the association and will contribute to industry development and progress.

A chapter can, if desired by the membership, incorporate itself by using the name ***Metalworking Industries Association of the Philippines, Inc. (MIAP)-*** (name) ***Chapter.***

WHO CAN BE MEMBERS OF MIAP?

Any firm or enterprise duly registered under Philippine laws that are engaged in, or involved with, metalworking activities and interested in contributing to the development and growth the metalworking sector can be admitted as a member of any MIAP chapter upon approval of the chapter board of directors/trustees.

Member financial obligations consist, among others, of a one time admission fee and annual dues as may be determined by the board of directors of the MIAP chapter concerned. ■

All chapters are autonomous and can pursue their own projects or activities for as long as such undertakings donnot, in any way contravene the Articles of Incorporation and By-Laws of the association. The National Board of Trustees provides coordination for all the chapters and linkage with the government on policy matters affecting the sector ■

MIRDC

VISION

Center of excellence in science, technology and innovation for a globally-competitive metals, engineering and allied industries by 2025.

MISSION

We are committed to provide both government and private sectors in the metals, engineering and allied industries with professional management and technical expertise on the training of engineers and technicians; information exchange; quality control and testing; research and development; technology transfer; and business economics and advisory services.

CORE VALUES

Professionalism	We adhere to the highest ethical standards of performance. We value our work and are committed to perform to the best of our ability.
Responsiveness	We spearhead implementation of projects that address the needs of the metals and engineering industries. We find solutions to real-life problems through science, technology and innovation.
Integrity	We act responsibly, work honestly, and encourage transparency.
Dynamism	We perform our jobs with vigor and enthusiasm. We welcome change as an opportunity for growth and continual improvement.
Excellence	We adhere to world-class performance and continuous improvement in all we do. We always do our best in every task/endeavor.

QUALITY & ENVIRONMENTAL POLICY

We are committed to provide products and services to both the government and the private sectors in the metals and engineering and allied industries with the highest standards of quality and reliability within our capabilities and resources and aligned to our strategic direction, to comply with applicable statutory and regulatory requirements, to plan and implement actions to address risks and opportunities and to continually improve the effectiveness of our Quality and Environmental Management Systems at all times in order to enhance customer satisfaction at all times.

We shall manage and control our activities in order to minimize adverse impacts on the environment, prevent pollution and safeguard the health and safety of all employees, stakeholders, customers, external providers and the surrounding community.

DEPARTMENT OF SCIENCE AND TECHNOLOGY
METALS INDUSTRY RESEARCH AND DEVELOPMENT CENTER

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