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A Success of University–Industry Partnership

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Abstract

In the fast-changing world, the success of engineering education depends not only on sound engineering knowledge, but also on the ability to apply it in practice from the moment young graduates enter the real industry. In order to be successful in industry, learners need interaction within the real industrial environment from the beginning of their studies. The importance of close links between engineering educational programmes and industry is shown in the example of industry–university collaboration between the Nelson Mandela Metropolitan University (NMMU) and General Motors South Africa (GMSA). The local automotive industry and GMSA, in particular, have been supporting the engineering programmes at NMMU for decades. However, with the establishment of a bachelor degree programme in mechatronics in 2005, GMSA decided to play an even more prominent role, as this was the first such degree programme in the Eastern Cape. This initiative has resulted in the establishment of the Chair of Mechatronics, fully sponsored by GMSA. Over the years, this industry–university partnership became an important platform providing a vital link between theory and practice in engineering education. The results of this partnership can be seen in an increased number of graduate and post-graduate students' projects being based on real industrial cases provided by GMSA, reflecting the latest developments and trends in engineering. Working with engineers in solving industrial problems enables students to gain valuable experience in dealing with colleagues, managers and workers. Exposure to the latest technologies strengthens the theory and better prepares graduates for their future careers in industry and commerce. The partnership is also important for GMSA, as it increases its competitiveness and facilitates the company's significant contribution to human capital development, which is very important for the growth of the South African economy and the community at large.

Keywords: Industry collaboration, human capital development, educational chair, training.

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1. Introduction

The importance of human resource development globally is reflected in a number of resolutions of the United Nations, such as 33/135 of 1978 and 44/213 of 1989, where the emphasis is placed on the broad concept of the development of the full potential of human beings so that they may, individually and collectively, be capable of improving their standard of living ('United Nations Programme in Public Administration and Finance,' 1995). Since the establishment of a free and democratic South Africa in the 90th century, the lack of skills has been identified as one of the most important challenges for the economy ('Skills Development Act,' 1999). The South African government introduced a number of initiatives to tackle the problem of skills shortage in the country, including the Skills Development Levies Act, and strategic plans for basic education. The South African human resource development strategy was introduced in 2001 and it included a number of strategic interventions. This was followed by the human resource development strategy for 2010–2030, emphasising its importance for economic growth and development ('Human Resource Development Strategy for South Africa 2010-2030.' 2009), which highlighted the importance of the contribution of education and training to economic development demonstrated in various aspects of society, with experience and systematic research noted as important aspects of a qualification. According to the South African strategy, its priority is accelerated training in the areas of design and engineering, as well as in science and technology, which are critical to the manufacturing sector which, in turn, contributes the most to job creation. In addition, education, skills and problem-solving abilities of people are important in order for a country to be competitive globally (Hershberg, 1996).

University–industry relationships have been the focus of many researchers. It has been shown by Henaff (1989), Marimuthu, Arokiasamy, and Ismail, (2009) and Soon (1990) that university–industry partnerships are mutually beneficial because, at universities, they facilitate research and development activities, which are dedicated to problem-solving of real industrial problems, while the creation of new technological knowledge benefits industries by making them more competitive. Industry–university collaborations build these vital human ties which count the most, as they produce graduates capable of thinking and acting across the cultural divide, connecting with the key interests of a company and working towards common strategic goals ('Making industry-university partnerships work,' 2012).

Prigge and Torraco (2006) state that in order to establish and maintain mutually beneficial relationships with industry, universities must proactively manage their relationships with industry, putting processes and organisational structures in place. Also, benefits to both the university and the company are deemed essential in maintaining a long-term relationship. Various university–partnership models developed over the decades, such as teaching–learning or qualification-specific support programmes, contract research using university staff and lab workspace, interdisciplinary research involving a number of universities and business incubators, which are ideal for start-up and spin-off companies. According to Corzo (2015), long-term strategic partnerships that focus on a specific area of study carry the greatest risk, but have the greatest potential for impact because this model has a number of advantages, such as inherent efficiency, transparency between partners, combined human resources and a streamlined intellectual property rights process.

Engineering education in the modern era requires fast adaptation in order to address the rapid changing of industry and commerce due to highly competitive markets and globalisation. One of the ways to achieve this goal is to bring education closer to industry where modernisation is vital, for example, the automotive industry. Advanced technologies and innovation are continuously introduced at automotive companies striving to improve their competitiveness and customer satisfaction. There are many examples of global partnerships between automakers and academia around the world.

The Nelson Mandela Metropolitan University (NMMU) has long-term partnership with South African automotive companies, which have factories in the Eastern Cape, such as General Motors SA (GMSA), Volkswagen, Ford and Daimler. Since the introduction of a bachelor degree programme in mechatronics at NMMU, GMSA has been closely involved in providing an industrial platform in support of the engineering programme. This initiative evolved into a formal partnership and establishment of the Chair of Mechatronics with the aim to strengthen the educational engineering programme and facilitate the knowledge transfer between industry and academia. Over the years, this partnership has contributed significantly to effective human resource development by means of interaction with industry and by providing the practical knowledge and skills to young graduates. This was achieved through research and projects, which are presented in this paper.

2. Model of the University–Industry Partnership

Right from the beginning, NMMU and GMSA put in place the processes and organisational structure to manage their relationships proactively in order to foster a long-term, mutually beneficial collaboration between the university and the automotive industry, in meeting their strategic objectives. The processes and structures were formalised in a detailed, mutually beneficial agreement signed by the both parties. The Chair office was then established and staffed accordingly. A steering committee, comprising of the company's top engineers and university management, was formed in order to govern the Chair in line with the strategic objectives.

The initial step for the Chair was formulating the scope of activities and the project plan. The activities were identified as follows (Figure 1): identifying critical projects suitable for academia and the company, facilitating the supervision of students' projects with the help of industrial leaders, developing new knowledge by conducting research, commercialising research outcomes, marketing of achievements and supporting of students. Each activity was assigned a leader, a priority and a timeline to adhere to.

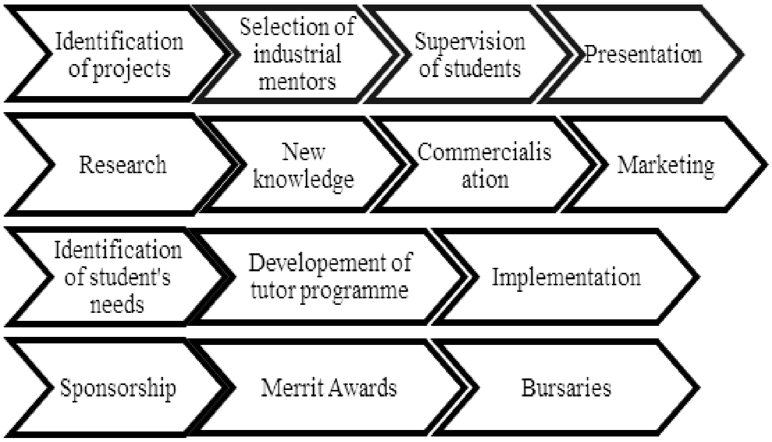

Figure 1. Chair activities list

Extensive work is carried out annually, together with the company engineers, to identify projects that are important for the company and its suppliers, which are then grouped according to the priorities, resource requirements and complexity. Along with a project selection process, the company engineers are invited, based on their expertise and qualification, to supervise students jointly with academics. A synergetic combination of theory and sound practical knowledge is the requirement for developing working concepts for successful implementation in the industrial environment. Hence, besides mastering new professional skills, students gain valuable practical experience as a result of the exposure to professional expertise in the real industry on a regular basis. From the company's point of view, this partnership provides additional resources which can be used for short-term, as well as long-term, projects.

The post-graduate students are involved in projects which fall under the company's long-term objectives and which require deeper theoretical knowledge and experimentation. These activities are primarily directed towards low-cost automation, material handling and improvements in ergonomics and working conditions. The implementation of such projects is discussed with and monitored by the plant managers at regular meetings, as these initiatives may have a significant impact on quality, productivity and sustainability of the manufacturing processes. In addition, these projects usually require substantial support of shop-floor staff and workers, a coordination of tasks, as well as significant resources.

As indicated above, GMSA, as a local manufacturer, strives for a bigger impact on human resource development. Therefore, increasing the number of engineering graduates is seen as an important criterion for the company. In order to address this issue, the Chair introduced a support programme for junior students, especially those from previously disadvantaged communities, to help bridge the knowledge gap between school and university in mathematics and science, as well as to better prepare them for engineering courses. Stemming from poor schooling, this gap has been identified as a major factor in contributing to the high student failure rate of engineering programmes. In the mentorship programme, senior students tutor junior students on a regular basis, which helps them to acquire the necessary learning skills to master courses. As a result of this initiative, the throughput of the mechatronics degree programme has improved significantly.

The Chair is actively involved in international collaboration with partner universities worldwide, providing support for research and facilitating student exchange. The Chair hosts scientific seminars and guest lectures for students and industry members that are important for skills development and knowledge transfer. Research projects usually lead to the commercialisation of viable products and processes by means of establishing companies as spin-offs of the research and development activities in order to facilitate innovation. The Chair facilitates extensive marketing activates to promote the achievements of the partnership by participating at exhibitions, conferences and publishing articles in media.

3. High Impact Project

The project described below shows how the Chair accomplishes the key strategic objectives and assists industry with problem-solving and facilitates support for engineering education. The project was initiated at a local GMSA in the area of material handling. A car assembly line was supplied with parts loaded on trolleys, which were delivered to the assembly workstations by a worker, as shown in Figure 2. It was envisaged, by an engineering manager, that the process of material handling could be improved with an introduction of a low-cost mechanisation platform. Students, together with the company engineers, conducted a study and applied systems engineering analytical tools in order to generate working concepts suitable for the specific process and workshop conditions of the local plant.

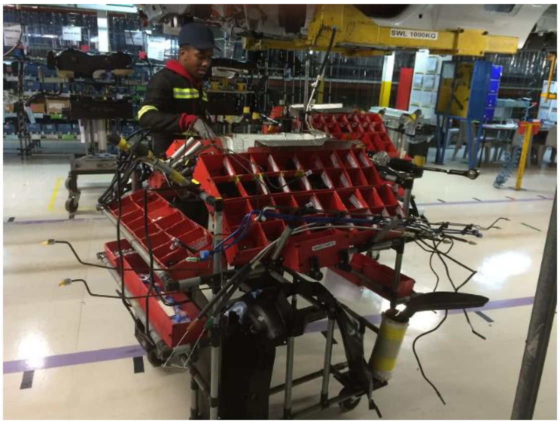

Figure 2.Photograph of the material handling trolley to be delivered to the assembly line

As the result of the study, it was decided to develop an autonomous vehicle to transport materials for the assembly line. This was followed by an extensive market search to find an economically viable solution, which resulted in a recommendation to develop a low-cost solution. However, the long-term solution was seen as developing a flexible automated transport system, which could be financially viable and applicable to the whole South African automotive industry, as well as to similar low-volume production plants worldwide.

Hence, the product had to be simple and low-cost, yet there should be the possibility of enhancing certain features depending on the requirements of a particular production facility.

The project was accomplished in stages by a number of graduate and master's students, who worked individually and in a group to develop various concepts of an automated guided vehicle (AGV). A comprehensive analysis of the material handling process and other relevant information, at the first stage, resulted in a detailed specification for the AGV. During this phase, the students worked closely with the production engineers and safety managers in order to ensure a sound design, which meets all the requirements.

The first version of the AGV, shown in Figure 3, employed a line following navigation principle and induction sensors, which were used to detect a metal strip track laid down in the plant. Based on the sensor readings, the AGV is steered to follow the track using a differential drive system with the driven rear wheels. In order to allow for easier maintenance and possible reprogramming, the control function of the AGV was implemented on an industrial PLC. The unit was powered using two car batteries, and was designed to run for a full shift without recharging.

Figure 3 Photographs of the first-generation AGV prototype (Cawood & Gorlach, 2015)

The first-generation AGV prototype was demonstrated to the maintenance team and showed promising potential as it met the cycle time constraints and was capable of towing a 200-kg trolley for a duration of an 8-hour shift. However, the AGV movement along the path was slightly unstable, which was attributed to the limitations of the sensor array at the front of the AGV. Hence, the next group of students was given the task of improving the design and performing a reliability assessment.

In the second-generation AGV prototype, the sensor array was replaced with a magnetic sensor, and the metal strip with the magnetic tape, which improved the AGV's tracking capabilities (Figure 4). A number of control functions, requested by GMSA engineering staff, were also implemented. The second prototype differed in several ways from the original prototypes, with the primary changes being as follows:

a. redesign of the mechanical frame to improve aesthetics and manufacturability;
b. implementation of a smart motor controller that incorporates a microcontroller and directly accepts inputs from the magnetic guidance sensor; and
c. implementation of more powerful drive motors and an integrated drive train.

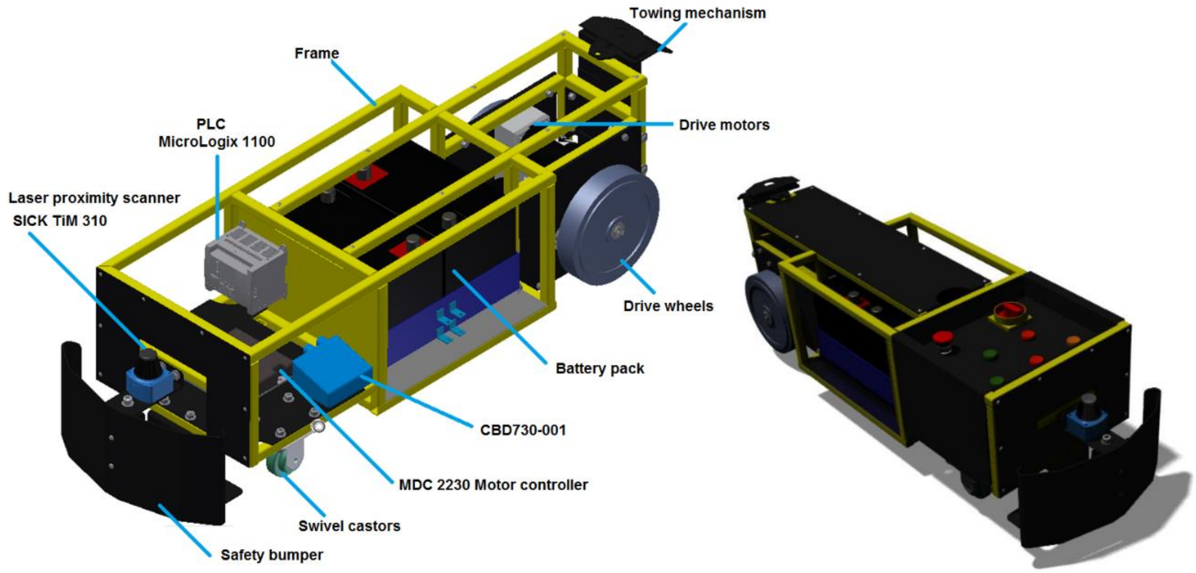

Figure 4. Model of the second-generation AGV prototype (Henbrey & Gorlach, 2016)

In order to reduce cost further, it was decided to redesign the AGV and produce a third-generation prototype. The next group of students tackled this problem and produced a completely new design of AGV (Figure 5). The AGV control was achieved with a single PLC capable of stable motion control, and other functions such as route branching, safety and docking. The design team improved the ergonomics of the AGV and incorporated new features to satisfy the stringent safety requirements. Regular batteries were replaced with deep cycle batteries, which provided reliable operation for the required duration. It was decided to test this prototype on the actual production line for a period of 6 months.

During the extended industrial trials, students obtained valuable experience in working with the company staff and feedback from workers. Hence, this generation of the AGV incorporated a number of further modifications. In addition, the layout of the track was improved to ensure a safer environment for workers. Since exchange of batteries for re-charging needs to be performed after two working shifts and the battery set is heavy, it was required to design a special mechanism to facilitate this operation and improve ergonomics of the AGV. This issue inspired another project aiming at the battery swapping process. This topic was assigned to an undergraduate student, who designed a semi-automated station for the AGV battery swapping and charging. When a voltage monitoring circuit on the AGV detects that battery voltage level is low, the AGV is automatically directed to the station where the battery swapping cycle is performed.

Figure 5. Photograph of the third-generation AGV prototype at the GMSA plant

In order to explore other means of navigation, it was decided to utilise a vision system instead of the magnetic sensor, which in some instances produced a fault signal due to magnetic interference. A graduate student worked on this project and generated a new design of AGV (Figure 6). In addition to the vision system, the new features of the AGV include the microcontroller based on a Raspberry PI computer with RIO board, wireless communication functionality and the remote station controller with the Web HMI. The new design also exhibits improved ergonomics as well as a lower cost.

Figure 6. Photograph of the latest AGV prototype (Gregan, 2017)

For the AGV to be resourceful in real industrial environment, it must be easily reconfigurable to allow for its design, functions and capabilities to be altered as required. Therefore, a master's student worked on the concept of an intelligent AGV, where a number of AGVs would be communicating with the central controller wirelessly and performing complex material handling tasks in cooperation with other machinery and equipment. These advanced control and communication features would enhance the whole material handling system, as they would allow new sequences of action for the AGVs to be remotely reprogrammed. Another feature would be the automatic 'teaching' of an AGV using this advanced controller.

This and all the above-mentioned projects were evaluated by experienced GMSA senior engineers, who acted as external examiners. This approach can be considered as another important aspect of the partnership with industry as students are exposed to real commissioning practice. Feedback from engineers is a good indication of success or failure of a project. It also better prepares students for their future careers and challenges that may lie ahead. As mentioned above, commercialisation is one of the important Chair activities. Therefore, the cost of AGV as a major factor had to be kept below the benchmark value in all design and modification phases in order to make the product financially viable. This development was taken further by the university innovation office to assist with commercialisation and marketing of the AGV. Hence, a group of post-graduate industrial engineering students was given the task of developing a business plan for the AGV as part of their MBA studies. The students performed an extensive literature review, a market survey and a SWOT analysis, and the results of which showed that there is good potential for a sound business case if the product is introduced to a variety of companies in South Africa, which would take the project beyond the automotive industry. This would be accomplished with a spin-off company, which will produce AGVs and generate an additional income and benefit the university.

4. Conclusion

This paper presents the success of university–industry partnership, which benefits the university, students, industry and the community at large. This partnership has made a significant impact on human resource development and engineering education by supporting the establishment of a bachelor degree programme in mechatronics and addressing the problem of skills shortage in the country.

Since the commencement of the Chair, a large number of joint projects and initiatives have been successfully accomplished in industry and at the university. The example of the project shown in this paper demonstrates how a university–industry partnership creates many possibilities for universities and companies to achieve mutually beneficial goals. The project was initiated by the company to address certain needs. A number of students of different levels, from undergraduate to post-graduate, were involved in solving the industrial problem through a number of phases and in cooperation with the company engineers and technical staff. The main project has provided topics for a number of complementary projects in various fields of engineering, which encourage students to work in groups and in constant interaction with industrial supervisors.

The main goal of the project was successfully achieved. The developed automated vehicle was implemented at the company in real production, demonstrating mutual benefits. There is an initiative to commercialise the product locally and internationally and form a spin-off company. This case study shows that combining theoretical expertise of universities, students' drive and enthusiasm with practical expertise from industry and industry strive for competitiveness can lead to significant achievements for all parties involved.

University–industry partnership in the form of active participation of staff and students can enhance engineering education and human resource development and, therefore, drive research and development, strengthen company's competitiveness, create jobs and improve wellbeing of communities.

Acknowledgements

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References

Cawood, G. J. & Gorlach, I. A. (2015, November). Navigation and locomotion of a low-cost Automated Guided Cart. In *Pattern Recognition Association of South Africa and Robotics and Mechatronics International Conference (PRASA-RobMech), 2015* (pp. 83-88). IEEE.

Corzo, J. (2015). *How academic institutions partner with private industry*. Retrieved from http://www.rdmag.com/article/2015/04/how-academic-institutions-partner-private-industry

Gregan, J. (2017). *MPU-based AGC with remote-monitoring capabilities* (Final-year proejct report). Port Elizabeth, South Africa: NMMU.

Henaff, J. (1989). Engineer's education: University-industry interactions. *Proceedings of the MELECON '89 Electrotechnical Conference,* (pp.721–725). Lisbon, Portugal: IEEE.

Henbrey, J. & Gorlach, I.A. (2016). *Enhancment of an automated guided cart.* Proceedings of the 2016 PRASA-RobMech International Conference, (Number 36), Stellenbosch, South Africa.

Hershberg, T. (1996). Human capital development: America's greatest challenge. *Annals of the American Academy of Political and Social Science, 544*(1), 43–51.

Human Resource Development Strategy for South Africa 2010–2030. (2009) Retrieved from http://www.cathsseta.org.za/wp-content/uploads/2013/04/hrds-sa-edited-final.pdf

Making industry-university partnerships work. Lessons from successful collaborations. Science/Business Innovation Board AISBL. Retrieved from http://sciencebusiness.net/Assets/94fe6d15-5432-4cf9-a656-633248e63541.pdf

Marimuthu, M., Arokiasamy, L. & Ismail, M. (2009). Human capital development and its impact on firm performance: evidence from developmental ecomonics. *The Journal of International Social Research, 2*(8), 265–272.

Prigge, G. W. & Torraco, R. J. (2006). University-industry partnerships: a study of how top american research universities establish and maintain successful partnerships. *Journal of Higher Education Outreach and Engagement,11*(2), 89–101.

Skills Development Act. (1999). Department of Labour, Republic of South Africa. Retrieved from http://www.labour.gov.za/DOL/downloads/legislation/acts/skills-development-act/Act%20-20Skills%20Development%20Levies.pdf

Soon, C. T. (1990). University-industry collaboration: current practices and future directions in education and technological development. *Journal of Materials Processing Technology, 23*, 1–6.

United Nations Programme in Public Administration and Finance. (1995). New York, NY: United Nations Secretariat.