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An Enhanced Model for University-Industry Collaboration for Innovation in Trinidad and Tobago

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Abstract: *Economic diversification is a top priority in the nations of Trinidad and Tobago and the Caribbean region, which are heavily dependent on tourism and depleting oil and gas reserves. Product and process innovation leading to a wider range of manufactured goods is a vital response, but capability in the region is poor. The University of the West Indies (UWI) has a key role to play in facilitating innovation but historic attempts at university-industry collaboration have not been sustained. Good practice suggests that building relationships with industrial partners, mutual appreciation of capabilities by academic and industrial partners, and having clearly defined and well-managed projects are critical success factors in university-industrial collaborations. A new approach to collaborative applied research projects and to commercialisation of inventions, based on good practice, is being implemented in The UWI Faculty of Engineering. Much increased dialogue with industrial, commercial and government partners is at the heart of the new approach, with the objective being to gain an enhanced appreciation of the needs that exist in external partner organisations. These needs are matched to the capabilities within UWI in the Mechanical and Manufacturing Enterprise Research Centre (MMERC). The MMERC provides activation and coordination of projects of various scales, stimulating university-industry collaboration, and has the potential to significantly boost the innovative capacity in the Caribbean region.*

Keywords: *University-industry collaboration, innovation, Trinidad and Tobago, success factors, consultation*

1. Introduction

Developing the economy of a nation and increasing the purchasing power of its people is a complex affair, but an important element is the diversification of economic activity and the generation of income from exports. Hausmann& Hidalgo (2011) argue that there is a strong positive correlation between the Gross domestic product (GDP) per capita of a nation and the diversity of its exported products. Lucas (1988) postulated that "a growth miracle sustained for a period of decades thus must involve the continual introduction of new goods, not merely continual learning on a fixed set of goods." These arguments indicate that diversification of the base of exportable products is closely aligned with economic development in a nation. Hence, there is an urgent need for innovation, new product creation, the establishment of a wider manufacturing base, and exporting of an increasing diversity of goods as a nation progresses through stages of economic development. This could be seen as both a driver and a measure of economic development.

Governments, universities and industry are all actors in a dynamic interchange that engenders an innovative environment, in which University spin-off companies and strategic alliances between firms, with academic research groups and possibly government entities are formed. Etzkowitz and Leydesdorff (2000) describe this dynamic structure as the 'Triple Helix Mode 3'. Energy must be contributed by all actors to create and maintain the dynamism, but the primary initiator is the University. This is different from previous dispensations of national innovation model. In so-called 'Mode 1' innovation, the state was the primary actor, orchestrating relationships between academia and industry. In 'Mode 2' the entities were separated and remained ostensibly distinct. It is 'Mode 3' that we seek, therefore, as a relevant model for creating a dynamic, innovation-led environment which can lead to economic diversification, growth of exports and economic development.

Trinidad and Tobago (T&T) is a hydrocarbon-rich nation, which has been highly dependent on fossil fuel wealth for a number of decades. It is the most industrialised of all the English-speaking Caribbean nations, most others rely heavily on tourism for income and are highly sensitive to economic downturns. Depleting reserves and volatile commodity prices threaten the economic security of T&T. Consequently, the Government has declared that economic diversification is critical to future success of the nation. In its Budget of 2012, one of three major policy

platforms has been declared as "*creation of entrepreneurial opportunities and an innovation-driven economy to stimulate growth and competitiveness through public/private investment*" (Government of Trinidad and Tobago, 2011). This priority aligns with the need to increase the diversity of manufactured and exported goods as a driver for national economic development.

There is limited history of successful, commercialised, indigenous product innovation emerging from T&T or the wider Caribbean region. The regional market is small, which means that manufactured products generally need to compete globally to obtain access to larger markets. Foreign Direct Investment has brought global best practices to some sectors, but multinational companies have not been predisposed to active partnerships with the regional university, The University of the West Indies (UWI), in the development of indigenous innovative solutions to localised problems.

Copeland et al. (2008) identified that the innovation culture and capability that is critical to future economic success is lacking. Whilst there exists a profound need to create structures by which innovation capacity can be engendered in the region, there is very little native capacity to make it happen. The same authors proposed a hierarchical model for successful innovation, requiring developed activities at varying levels of the national economy. Cutting- edge scientific enquiry and discovery must be supported by product and process creation, product development, manufacturing of goods or delivery of services and, at the lowest level, commercial activity. Unfortunately, product and process creation and product development activities are almost entirely absent in the Caribbean context (Copeland et al., 2008). Scientific enquiry and discovery is thus impotent in its capacity to spawn meaningful innovation.

This scenario is not unique to the Caribbean, but is also true of many developing nations around the world (World Bank Institute, 2004). Emergence of these developing nations as economic players requires that indigenous innovation is engendered for economic diversification.

There have been initiatives from within UWI to bridge gaps between scientific enquiry and the manufacturing of goods and delivery of services. Pun et al. (2004) reported on a new "Enterprise Research Integration Centre" (ERIC), established in the Department of Mechanical and Manufacturing Engineering with the objective of encouraging closer university-industry collaboration and disseminating best practices. Six years later, there is limited success to report from the ERIC. In this paper, we:

1) Review good practice in University-Industry Collaboration (UIC) with examples from other parts of the world;
2) Assess current UIC involving UWI;
3) Propose a new model for future UIC to serve the Caribbean region, and which might also be relevant to other regions with similar economic characteristics.

2. UIC and Innovation Good Practice

University-industry collaboration is an important agent in innovation and developing a national or regional knowledge base (Van Looy et al., 2003). This is especially true if innovations are to be converted into locally manufactured finished goods. It is difficult to define "best practice" for UICs because each one is different. Direct emulation of successful practices from one collaborative partnership to another involving different educational institutions and companies may not always be advisable. Therefore, what is presented here is an examination of key success factors for UICs, drawn and distilled from relevant literature.

The categorisation used here is modified from that presented by Barnes et al. (2002). Critical success factors for UICs fall into eight areas: Universal Success Factors; Effective Partner Evaluation; Project Management and Manager; Ensuring Equality; Management of Outcomes; Accommodation of Academic Requirements; Cultural Gap Management; and Clear Agreements.

Barnes et al. (2002) advocated a host of *Universal Success Factors* that are corroborated by other researchers. These factors are: mutual trust between partners; commitment; continuity; flexibility; good personal relationships; and the presence of a collaboration champion.

Trust is defined by Santoro and Bierly (2006) as, "*the mutual confidence that no party to an exchange will exploit another's vulnerabilities because opportunistic behaviour would violate values, principles, and standards of behaviour that have been internalised by parties to an exchange*". Trust is therefore a major facilitator of open communication and knowledge transfer in research collaborations. Trust reduces transactional costs (Thune, 2011) and aids in conflict resolution. A reputation for trustworthiness was also found to be a competitive advantage for a university when being considered for potential collaboration for the firm. Massachusetts Institute of Technology (MIT), for instance, benefits greatly in the trust that industrial partners have in the quality of its faculty (O' Shea et al., 2007).

Commitment by partners to collaboration is imperative to see a project through to the achievement of its goals despite challenges that might be encountered (Barnes et al., 2002; Thune, 2011; Philbin, 2009; Hemmert et al., 2008). Commitment of the top management of both partners greatly increases the likelihood of success of the project, especially in areas of information sharing and staff engagement. On the part of the University, commitment may be expressed in practice by a well-staffed and supported Technology Transfer Office (TTO) and provision of incentives to

academics involved in the projects.

Flexibility is important in forming and maintaining university-industry collaborations. Flexibility on the part of the university in the area of duration and scope is important because the expectation of industrial partners is often of shorter timescales than what would be normal in academia. Flexibility in terms of budget can also be important as too high a budget may be deciding factor in the mind of an industrial partner. Finally, flexibility in organisational structure and intellectual property policies of a particular collaboration may be necessary to meet the needs of an industrial partner (Bozeman, 2000; Barbolla and Corredera, 2009; Philbin, 2009).

Good personal relationships and interaction between academics and representatives from industrial companies inform academics of areas that industry is interested in researching and can help universities to align their research agendas to the needs of local industry. This social interaction can also inform industry of the research capabilities and competences of universities which they can exploit by means of collaborations. Those within the academic community with experience and contacts in both the industrial and academic spheres can be particularly helpful in this regard (Santoro and Bierly, 2006; Philbin, 2009). A good example is the MRC Phosphorylation Unit at Dundee University, a world-class centre in its discipline, which uses its global reputation to get direct feedback from its industrial partners. This influences the direction of its research (Dooley and Kirk, 2007).

Effective Partner Evaluation requires that a university should consider a number of factors when evaluating a potential industrial partner. There must be *mutual understanding* of the goals of collaboration (Barnes et al., 2002; Thune, 2011). The industrial partner must have s*taff with complementary expertise/strengths* so that it will be able to apply the research outcomes. In fact, the technical capability of academic staff is often a driving factor for firms pursuing collaborations (Wright et al. 2008; Dooley and Kirk, 2007). The collaboration must be of *strategic importance* to the company. Barbolla and Corredera (2009) found that when the project has "high project usefulness" the partners tend to be more committed, stay the course until the end of the project and provide necessary resources. The university and the company must have *complementary aims and objectives* for the project; and previous collaborative experience (Pertuze et al., 2010). *Experience of collaborative* projects gives an indicator of the success of collaboration projects. Where experience is lacking, partnerships should be built up incrementally from small, low-risk projects to higher-value projects (Thune, 2011).

Many universities have established dedicated offices or research companies to provide both legal frameworks and concentrated experience. The University of Akron Research Foundation is one successful example, with revenues from grants and contracts doubling in the 10 years to 2008 (Watkins, 2011).

Sound Project Management with clearly defined objectives, responsibilities, and an agreed project plan that stipulates resource obligations and milestones is an important success factor (Barnes et al., 2002). Progress monitoring and frequent communication are necessary factors. In addition, an experienced *Project Manager* is required, with skills in conflict resolution and preferably multifunctional experience in both academia and industry (Petruze et al., 2010).

Equality between the partners in the collaboration should be sought. Research that is of mutual interest to both the industry partner and the academic partner should be the focus (Dooley and Kirk, 2007).

Management of Outcomes is a success factor which cannot be ignored. Barnes at al (2002) found that unless industrial partners feel that they will derive benefit which is commensurate with their contribution to the partnership it may lead to conflict or de-facto withdrawal from the collaboration (Barbolla and Corredera, 2009).

Accommodation of Academic Requirements is particularly important when there is involvement of postgraduate students in the collaborative research. Industrial partners must be brought to understand that the collaboration cannot be at the expense of the academic rigour that is necessary for postgraduate research. Effective knowledge transfer to the partner company is very critical, a process which might involve secondment or mobility of academic staff to industrial partners for a period to aid in the process. (Santoro and Bierly, 2006).

Regarding *Cultural Gap Management*, the distinctly different cultures in business and academia must be addressed, especially differences in priorities and timescales. Publication of research results supports dissemination of knowledge and protects the rights of the industrial partner to benefit from the research outcomes. Structured IP and confidentiality agreements are an important requirement. Dooley and Kirk, (2007) highlighted a case study where a university research centre accommodated its industrial partners by temporarily delaying publication of results. A system was implemented that ensured that, even where partners in a consortium shared certain resources, the results of their individual research projects were kept confidential. This is a good example showing how adaptations can be made to normal academic openness to facilitate the needs of industrial partners.

Clear Agreements between university and industrial parties are required, which encapsulate the issues discussed in the preceding points. They must be structured so that both contribute resources and both benefit from the research. The agreements, however, should not be so legalistic as to provide an obstacle to progression of the collaboration or limiting to the research.

It is evident from this discussion that a large part of establishing effective UICs comes down to relationship

building and expectation management. On these platforms, projects can be scoped and clear agreements between the parties can be established. Careful project management will help to ensure that expectations are met.

3. Assessing the Current State of UIC in T&T

The good practice assessment described in the previous section is complemented by some basic qualitative research undertaken at UWI, and both were used together to assess the current state of UIC at UWI. Consultations were held with senior leaders in industrial and utilities companies, including some 'Small and Medium Sized Enterprises' (SMEs). Inclusion of SMEs is significant because these companies are often drivers of innovation in the economic system. It is noteworthy that all the SMEs represented are significantly innovative, either in manufacturing processes, product development or business services. Three are also important exporters of manufactured goods or food and beverages.

The companies that were represented in the consultations are shown in Table 1. An initial four-hour evening workshop was conducted, at which one or two executives or senior managers from each company were present. The objectives of the workshop were to explore the perception held by industrial and government decision makers of UWI as a collaborative partner, and to identify possible opportunities for the future. It was a facilitated forum, in which questions were posed to executives and engineering managers that allowed them to express their perspectives and opinions.

The workshop was followed by a series of unstructured interviews and discussions with selected companies that served to broaden and clarify findings, and to identify potential collaborative projects. These took place with between one and four representatives from each company and lasted between one and a half and three hours.

The questions posed in the workshop and follow-up interviews are below, along with a brief summary of the responses received. The questions addressed the problem-solving capabilities and competitiveness of the companies involved, both of which can be enhanced by effective UIC. Links to the description of UIC good practice are identified in the summaries.

3.1 When facing a technical or operational challenge that cannot be easily solved in-house, where would you tend to turn?

For those problems that cannot be solved in-house, help would be sought from an external consultant. In many cases, consultants would be sourced internationally. UWI is not generally considered as a source of technical support or problem solving capability for the following reasons:

1) There is a lack of confidence that output will be provided in acceptable timeframes. This relates directly to a perception that UWI has to develop *project management* expertise and also implies that the *cultural gap* between the university and industry is very wide in the minds of industrialists. This has to be bridged by developing relationships.
2) There is a lack of confidence that the required expertise is available. This falls under *effective partner evaluation*. Informal evaluations, which are really no more than assumptions and misperception, lead industrialists to conclude that UWI does not offer the requisite capability to meet their needs.
3) There is a lack of awareness that UWI is both interested in and capable of helping to solve problems. A key issue identified here is the lack of *good personal relationships.* However, beyond the issue of personal relationships is a lack of

Table 1. Companies participating in industrial consultation with SMEs identified

Petrochemicals	*Beverages*	*Manufacturing*	*Utilities*	*Agencies*	*Other*
BHP Billiton Trinidad*	ANSA McaAlCarib Brewery	Metal Industries Company Ltd. ***(SME)***	Ministry of Works & Infrastructure*	Association of Professional Engineers of Trinidad and Tobago	Caribbean Airlines*
British Gas Company of Trinidad and Tobago	SM Jaleel Ltd. ***(SME)***	Trinidad Cement Ltd.	National Gas Company of Trinidad and Tobago	Caribbean Agriculture and Research Development Institute	Trinidad and Tobago Defence Force
British Petroleum		TYE Manufacturing Co. Ltd.* ***(SME)***	Power Generation Company of Trinidad and Tobago	Trinidad and Tobago Agri-Business Association	
Methanex Trinidad*		Langston Roach Industries Ltd.* ***(SME)***	Water & Sewage Authority	Trinidad and Tobago Manufactures Association	
Petroleum Company of Trinidad and Tobago*					

Remarks: * Further discussions and unstructured interviews took place with these companies.

consciousness among academic staff of how their skills could be put to good use in collaborative projects.

It was noted that the problems faced by regional industry are not only technical in nature. More innovative companies have faced significant challenges in obtaining support and financing for seed projects. The UWI could provide significant assistance in this regard. Evident in the responses to this discussion point is that collaborations between industry and UWI are currently weak, certainly among those represented.

3.2 When developing new products or services, what are the difficulties that you face?

Many large companies operating in Trinidad and Tobago are multi-nationals. Very little new product and service development takes place locally. SME manufacturing companies have difficulty sourcing research, information and personnel. Although these companies have a high potential for innovative products and process, their capacity is limited by a lack of resources. Retention of trained engineers and other skilled personnel is a challenge due to poaching by larger companies.

A significant opportunity for UIC exits with SMEs, as long as the key success factors are put in place. There tends to be greater reticence on the part of SMEs to invest in UIC because the risk to operational performance, in terms of time or financial investment, is greater than for larger companies. Therefore, *trust* and *good relationship* are particularly important. SMEs are looking for *flexibility* in their partners, so that projects can be adapted to their evolving needs. Where new products and services are involved, *management of outcomes* is critical and the University has to be able to deliver collaboration results according to the agreed timescales.

3.3 What do you see as the threats for the future competitiveness of your industrial sector in T&T and the region?

Most of the threats identified were related to human resource requirements. The availability of skills and expertise for future requirements or for new product development was a concern for the industrialists. This is exacerbated by the strong tendency to source expertise from outside the region rather than developing indigenous skills.

3.4 What needs to happen within your company or in the national/regional sphere to secure future competitiveness?

Responses received to this question emphasised the need for upgraded engineer's skills and capabilities to allow for innovative output. A critical factor in this regard is to create a more effective concentration of engineers and experts in specific fields. An example of this that was given by a participant was the need for specialists in manufacturing and recycling of glass, and specifically, the optimisation of the thermal processes associated with glass-making furnaces. This specific need illustrates the wider opportunity for UWI to meet the needs of local industry in a relevant manner.

It was felt that UWI should be the agent for creating suitable 'think tanks' in different subject areas. This emphasises the need to develop suitable *good relationships* between academic and industrial players with the objective of upgrading industry skills and capabilities. Through consultation with industry, it became clear that:

1) those companies consulted do not engage in UIC projects at present, or do so on a very limited basis;
2) there is a 'pull' from industry for UICs of different types to be established; and
3) the elements of good practice that we identified in literature are absolutely critical for the success of UICs in the context of Trinidad and Tobago.

A statement made and repeated during the consultations by the industrial participants was "we have projects, we have just never been asked". This illustrates that the appropriate departure point for UICs is to first examine and analyse problems being faced by companies. In many cases, conversion of a problem into a project will require a very integrated process with the University using proper techniques such as root cause analysis.

UWI has opportunities for applied research leading to innovation in collaboration with industrial partners who seem to be willing to establish stronger linkages. These consultations seem to show that, unfortunately, previous well-intentioned attempts at creating a platform for UIC have not been successful or sustainable in the long term. A modified approach is required.

4. A Region-Relevant Model for UIC

The consultations and interviews with industrial and utility companies illustrated the need for UIC. When technical problems are encountered by these organisations, foreign consultants are hired to help solve the problems. Processes which could be optimised remain sub-optimal due to lack of resources or expertise to realise improvements. Opportunities for growth and development that would give competitive advantage to these organisations go wanting because they do not have sufficient research capacity. Technologies are adapted and implemented, but with limited development of relevant local capabilities.

The ERIC was intended to facilitate collaboration between The UWI Faculty of Engineering and industrial partners. Based on the findings of the consultations the ERIC was founded with a commendable aim, but there is room to foster UIC for innovation in a number of areas:

1) The ERIC was initiated on the basis of emerging industry needs in niche areas. It was intended that

the ERIC should "…determine niche areas in product design and manufacture that the Centre can concentrate on" (Pun et al, 2004). However, to concentrate on niche areas in a small market such as the Caribbean region would not be sustainable without at least having committed industrial partners which would have a vested interest in the outcomes from the work. Otherwise, critical factors of *good relationship, agreed research aims and objectives,* and *experience of collaborative projects* would not be built, and the UIC efforts would fall in the 'ivory tower syndrome'.

2) Initial acquisition of equipment was constrained by the limited Faculty's budgets available to serve the emerging industry needs in manufacturing (and particularly in product design and development, prototyping and operations integration). Unfortunately, the regional culture of innovation and product development is weak, and *"…characterised by low levels of R&D in the business sector"* (Aubert, 2004), as is true in many developing regions of the world. Thus, the starting point for encouraging industrial partners to venture into research and development or innovation is to encourage innovative thought and subsequently to provide them with a facility in which to try-out their new product concepts. It could be argued that this approach taken by ERIC 'put the cart before the horse'.
3) Knowledge of the ERIC facility and capabilities in the regional industrial base was also constrained by the faculty's budgets, as well as a lack of coherent engagement and supports from faculty members.

A revised approach or model of engagement between UWI and industrial and utility companies is necessary in the future, which avoids the pitfalls experienced with the ERIC. Communication and building of relationship with potential partner organisations is an essential departure point. The resources that are available in UWI should be made available to those organisations in a way that matches their needs.

Other organisations, apart from industrial companies and utility companies, can benefit from collaborative relationships with UWI, especially commercial businesses and government ministries. 'Needs' can be grouped into: improvement of sub-optimal processes; solution of technical problems; exploitation of competitive opportunities; and technology implementation. The UWI has a set of resources to offer: time, ideas, knowledge and expertise, and innovative product concepts. Needs and resources have to be matched through coordination and interface, a vital function that is largely absent at the moment.

An emergent conceptual model for UIC in UWI, which captures these ideas, is shown in Figure 1. It implicitly incorporates the good practice described in this paper and focuses on identified local requirements. The model comprises (i) a 'top-down' dimension: collaborative research projects driven by identified needs, focused on innovation in the application of knowledge, and (ii) a 'bottom-up' dimension: product concepts, emerging primarily from academic research and student projects with the potential for development into feasible prototype products in business incubators. The model is new and is being implemented.

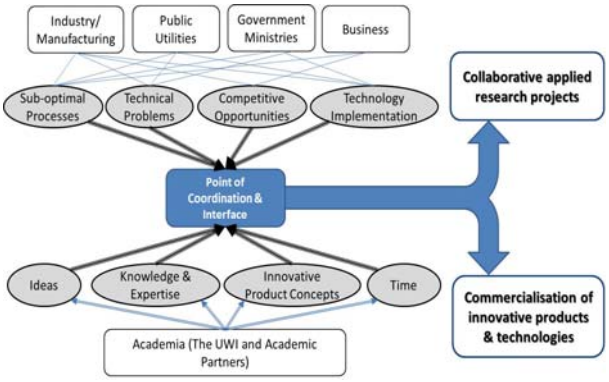

Figure 1. Conceptual Arrangement of UIC in the UWI Faculty of Engineering

In the 'Point of Coordination and Interface', the good practice factors for UICs will be carefully applied, especially aspects such as maintenance of relationships and effective project management. Flowing out of the point of coordination and interface will be (i) collaborative applied research projects, comprising one or more industrial partner(s) and in some cases other academic partners and (ii) commercialisation of innovative products and technology. Whilst some of these functions might typically be performed by a university's technology transfer office, this concept is that these functions reside firmly within the Faculty of Engineering of UWI. Of great concern here is that *relationships* with industrial and other partners be built and maintained – a function best performed by the Faculty of Engineering itself.

After a number of years of background activity, the ERIC had not been formally launched and had no established interface with industrial, government or utility partners. While the general mission, aims and objectives of the ERIC are relevant, there is a need to modify its strategic approach to achieve the UIC goals. A new entity has been formed: the 'Mechanical and Manufacturing Enterprise Research Centre' (MMERC). Table 2 depicts a comparison of ERIC and MMERC, the main difference being the revised strategic approach.

Table 2. Comparison of ERIC and MMERC

	ERIC (Pun et al., 2004)	***MMERC***
Mission	Promote research, innovation, teaching and training in manufacturing and to work closely with industry through collaborative projects to disseminate best practices in the region via fostering entrepreneurship and niche enterprises.	Help Caribbean industry to become more innovative and competitive through creation of collaborative applied research projects. Help to diversify the regional economy by assisting in the development of inventions to production.
Functions and Roles	• Research and Innovation – promoting innovation and a wider development of pure and applied research, individual and collective engineering projects. • Teaching and Training – supporting research activities and teaching programmes at UWI, and provide specifically designed company courses for industry partners. • Industry Consultancy – identification and assessment of research projects and technology commercialisation.	• Facilitate ongoing dialogue, think-tanks and network groups with manufacturing and utility sectors in the Caribbean region. • Identify and formulate potential university-industry collaborative projects. • Identify inventions arising from student or staff projects that have commercial potential and provide opportunities for their further development. • Liaise with The UWI Office of Research Development and Knowledge Transfer for drafting of contracts, patents and obtaining funding.
Strategic Approach	1. Design and establish an infrastructure for different functional areas in the Centre. 2. Develop specifications and descriptions for potential projects for undergraduate studies and postgraduate research 3. Identify and initiate projects 4. Execute projects 5. Document the process	1. Ongoing consultations with industry to identify their needs and sight of future opportunities 2. Specify collaborative projects based on agreed aims, scope and objectives 3. Seek and obtain funding to support projects 4. Initiate projects with a detailed project plan and specific objectives and timing, including acquisition of infrastructure if necessary 5. Execute projects 6. Document the process CONCURRENTLY: 1. Identify potential projects for commercialisation 2. File for patents on eligible inventions 3. Utilise a business incubator approach to pursue development of inventions to manufacturing readiness 4. License manufacturing-ready technology or move into production

The strategic priorities of the MMERC contrast with those of the ERIC. Engagement with potential industrial, government and utility partners through consultations and visits is absolutely necessary to bridge the gap between the academic and industrial sphere, to develop working relationships and to identify synergistic opportunities for collaboration (Santoro and Bierly, 2006). Having understood the challenges and opportunities faced by its partners, the MMERC can tailor projects or programmes to meet specific needs. A well-crafted project will include the fulfilment of both academic and partner objectives. A project or programme may be a perfect vehicle for investment in plant and equipment that will be used for specific work in the project and thereafter available as a general resource to the Faculty. Figure 2 shows the fit and interfaces of the MMERC with existing entities in UWI. The arrows indicate flow of information and resources.

The MMERC is a Division of the Engineering Institute, a well-established entity in the Faculty of Engineering which focuses mainly on consultancy and continuing education. This organisational structure allows the MMERC to expand the operations of the Engineering Institute in a manner that is absolutely aligned with its mission. The MMERC is a primary point of external interface with industry, public utilities and government ministries on engineering matters. Significant two-way flow occurs between these external partners and The MMERC in the form of dialogue and actual projects.

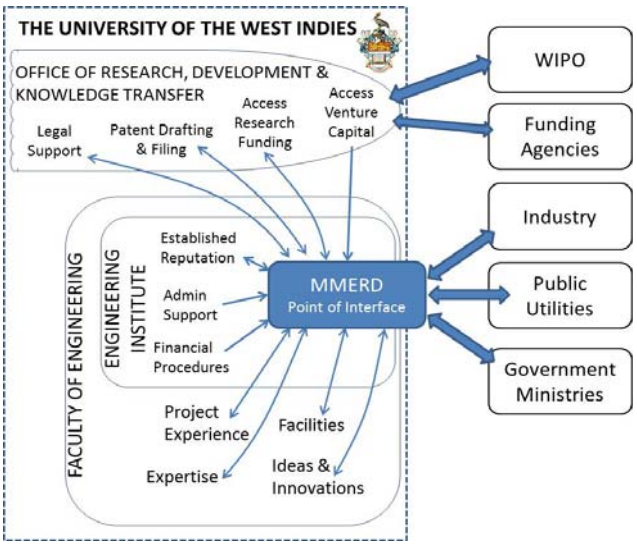

Figure 2. Organisational arrangement of MMERC

The MMERC links external partners to staff members of the Faculty, who supply expertise, project experience, ideas and innovations. The Office of Research, Development and Knowledge Transfer (ORDKT) works in close collaboration with the MMERC, providing a host of legal, funding and project management services.

The MMERC deliberately 'started small' on low-budget collaborative projects with timeframes of approximately six months to one year to build capability. Larger, more complex and higher value projects utilise the methods developed and capability acquired on smaller projects and are critical to fulfilment of the MMERC mission. As with any new initiative, establishment of the MMERC does have challenges. Historically, The UWI has not been proactive in engaging with external partners. Therefore, there is some scepticism amongst potential partners of the authenticity of the MMERC effort. Overcoming this challenge, in the first instance, requires intense communication with partners. As projects progress, successful project delivery will be the most important evidence that The UWI is a credible partner.

The role of the MMERC as a primary facilitator of successful project delivery is, therefore, vital. Internal resistance, reticence or uncertainty among Faculty is another challenge. Academics tend to be conservative and unwilling to participate in a new venture until it has become established. Therefore, the MMERC is encouraging full engagement internally through regular internal communication, reporting in Departmental Meetings, invitations for academics to participate in projects, and especially promoting the academic and developmental benefits of participation in industrial projects. Table 3 summarises the elements of Good Practice that are to be built into the MMERC approach.

Finally, limited financial and equipment resources are a challenge to effective project delivery. MMERC is addressing this pitfall by starting with small, low-budget projects that can be tackled by students. Successful projects give confidence to partners, and usher them towards larger projects that involve financial investment. Such projects might involve the contribution or purchase of research equipment, thereby enhancing the resource base of the University.

The MMERC has been established as a Centre within The UWI Engineering Institute. A Coordinator has been appointed and a Development Engineer is assigned on a full-time basis to the work of the Centre. Operational affairs are guided by a Committee and an Advisory Board provides input to the selection and emphasis of projects. At present, the Advisory Board is constituted of leaders of Departmental Research Groups, with the plan being to expand the Board to include industrial representatives. This governance structure helps to ensure full engagement within the Department.

Table 3. Good Practice elements of MMERC

Good Practice Elements	***MMERC Approach***
Trust between partners	A defined, well-structured interface between The UWI and external partners gives them confidence and trust – they have the assurance of engaging with a professional and organised entity.
Flexibility	Using students to execute projects as part of their programme of study provides a low-cost, low-risk, flexible approach that has benefit for both the UWI and corporate partners. Small-scale low-budget projects can grow larger and more valuable.
Good personal relationships	Projects within the MMERC are initiated on the basis of dialogue with industrial partners, and the continuous building of relationships.
Effective partner evaluation	Dialogue with potential external partners provides an understanding of the value and requirements of a project, and determines whether it is a feasible MMERC undertaking.
Collaboration champion	The MMERC provides human resources that are focused on building and maintaining collaborations with industrial, commercial and government partners.
Project management capability	Academics need not concern themselves with project management, since this is a service provided by the MMERC.
Management of outcomes	An archive of projects, their objectives and their outcomes is maintained in the MMERC. Project management helps to ensure that necessary outcomes are delivered. Partners understand that there is no guarantee of outcomes from low-budget student projects.
Accommodation of academic requirements	At the outset of project deliberations, partners are made aware that publications are the primary objective of academics. Projects are scoped to accommodate academic requirements of students engaged on the projects and publication for academics. Partners are usually willing and able to accommodate these requirements.
Cultural gap management	Academics with a strong industrial background provide awareness of industrial imperatives to the MMERC and other academics involved in MMERC projects. Internships for students who are engaged on projects with partner organisations help to minimise cultural gaps.
Clear agreements	Collaboration with The UWI Office of Research, Development and Knowledge Transfer (ORDKT) facilitates the preparation of appropriate memoranda of understanding, confidentiality agreements and contracts are developed.

5. Conclusion

This paper describes the efforts of a developing nation with a plethora of economic and developmental challenges to discover appropriate models to stimulate product and service innovation through UIC. Stimulating innovation, especially that which will lead to locally manufactured goods and economic diversification, is of central importance to the future prosperity of T&T.

UWI is conceptually held in high regard by industrialists, but seen as irrelevant to the future competitiveness of their manufacturing and service industries. Despite a long history of attempts at project collaborations with industry, UWI still has much opportunity to improve in this area.

A more thorough understanding of good practice in UIC, and applying it in the MMERC by deliberately re-focusing its strategy towards identification, scoping and initiation of collaborative applied research projects, gives UWI a sustainable role in facilitating innovation and economic diversification in the nation and region. Although there are challenges in the execution of this approach, well-considered mitigating actions provide an improved chance of success. The most important mitigating actions are intensive communication with external partners and Faculty, and careful execution of projects so as to prove that UWI is a viable partner.

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