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Internationalization of Higher Education and Research in Manufacturing in Asian Region

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Internationalization of Higher Education and Research in Manufacturing in Asian Region

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Abstract

During the past few decades, a number of Asian economies have experienced spectacular growths of twentieth century. The rapid expansion of the manufacturing sector based on mainly low and medium technology has contributed significantly in these economic growths. In order to maintain their competitiveness and enhance their exports, these nations are realising the need of a multi-pronged approach involving development of new high value products, unmanned manufacturing employing sophisticated machinery and better manufacturing management.

Unable to meet the vast demand of scientists and engineers expected during implementation of this strategy, many countries of this region are looking for assistance and collaboration for expanding their higher education in manufacturing engineering as well as research and development capability. Australia, amongst many developed nations can play an active and key role in the development of higher education and research in many countries of the Asian region. This paper first explores the scope of such collaborative opportunities and then details how the universities and research organisations from developed countries including Australia can employ networking and establish collaborative research projects benefiting all the participants.

Introduction

Manufacturing of products has long been considered as a wealth creating activity [1, 2]. However, increasing globalisation and falling tariff levels are resulting in intense competition for industries all over the world. A strategy based on a number of factors involving introduction of new products on the markets, use of advanced manufacturing technology, better educated personnel both on the shop floor and senior engineering and managerial positions and innovative management need to be employed for enhancing productivity and competitiveness of industries [3]. Such an approach relies heavily on research effort directed towards development of better management methods, new products, agile plants, new and improved manufacturing processes and hence requires significant research and development resources. In fact those countries which invest large money on research and development of new products as well as technology [4] have relatively high per capita GDP and large exports particularly of manufactured products [5] as clearly evident form Figures 1 and 2. It is this benefit of high wages as well as the desire to move on to higher domain of technology that is

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forcing many developing and newly industrialising nations to establish or expand research and development infrastructure. There are therefore many opportunities for Australian universities and research organisations to export their expertise and know-how in research and development, particularly in design and manufacturing of engineering products to the countries in Asia and Pacific. Such opportunities are not going unnoticed by many European and American universities having significant R & D expertise. However, the close vicinity to the Asian region and many established links with other universities in this region give Australian universities an added edge in export of such knowledge-based services.

Higher Education, Research And Technological Capability

The basic education of the people of a nation is considered a foundation for national economic growth. The higher education of people particularly in science and technology areas plays a key role in building innovation, research and technological capability of a country. Apart from pushing forward the frontiers of technology and knowledge, such skills of the people enable continual development of new products as well as technical know-how to manufacture them at competitive costs. Thus a strategy based on a higher education system which produces large numbers of scientists and engineers, promotes sustained growth of national economy and living standards of people reflected by high per capita income (Figure 3).

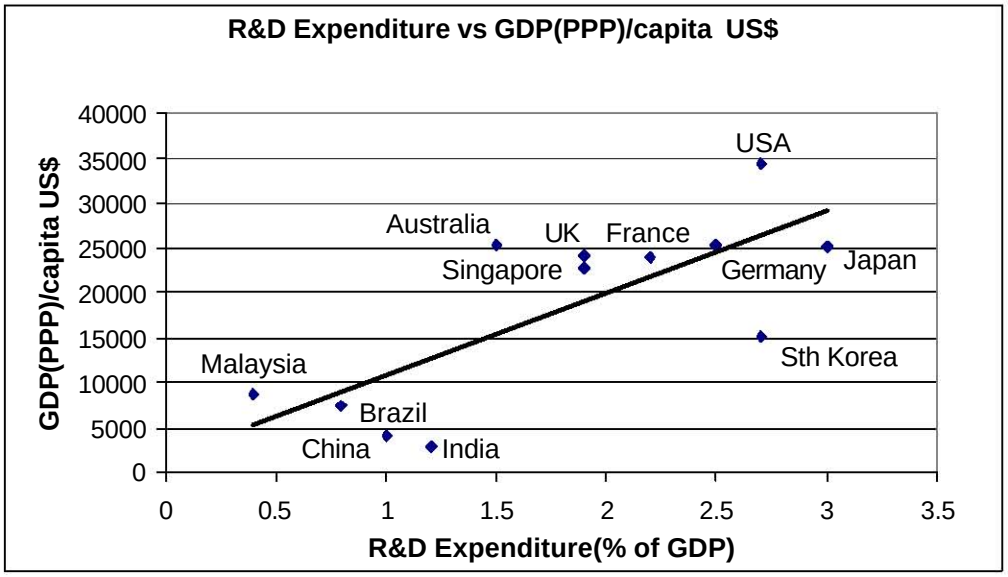

Figure 1. Research and development expenditure versus GDP/capita for selected countries [5].

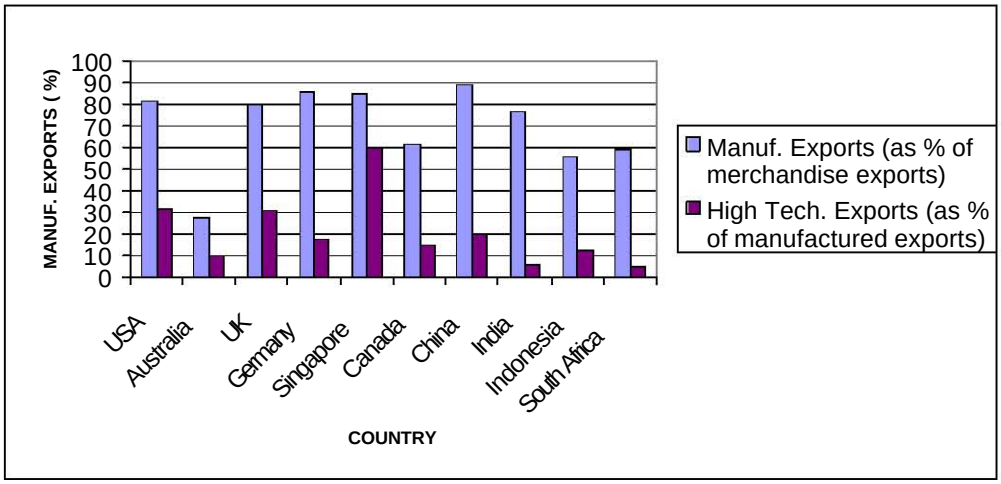

Figure 2. Manufactured and high tech. exports for selected countries [5].

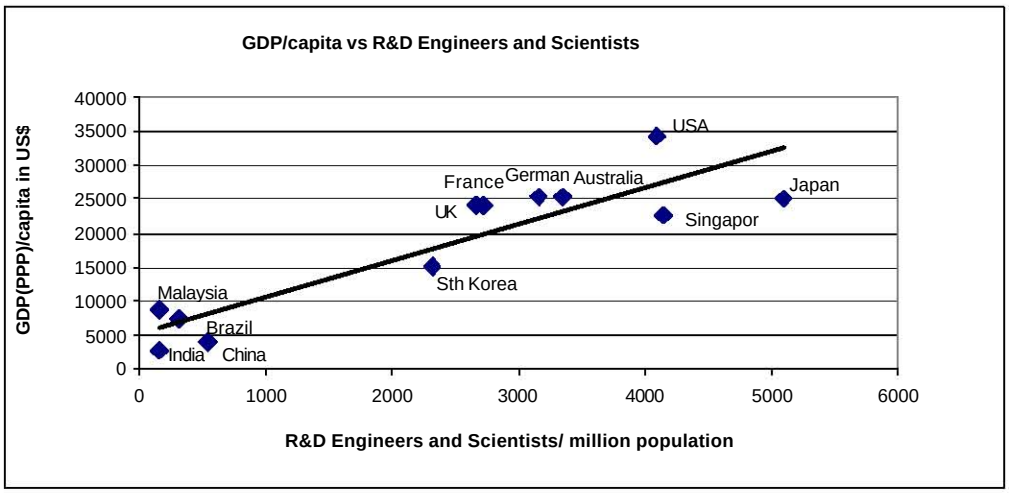

Figure 3. R&D engineers and scientists versus GDP for selected countries [5].

The transformation of innovative ideas to products or processes becomes far easier and quicker if the organisation or country has abundant expertise in both the fundamental and applied research in fields related to that product. The higher education programs in science and technology including Manufacturing Engineering contribute significantly towards developments of such expertise in research. Higher education in Manufacturing Engineering, which includes significant percentage of research, is offered at several levels viz PhD, Master of Engineering, Master of Science, Master of Engineering Practice, Graduate Diploma and Graduate Certificate. The way these programs are offered varies from country to country as detailed in a number of key papers [6,7,8,9] presented a recent international conference in USA. For example PhD and Masters programs are offered purely by research (Thesis) or by a combination of research Dissertation and some coursework to enhance the student's background in a specific area related to his research project. The Graduate Diploma or Master of Engineering Practice Programs involve successful completion of a number of

subjects and a minor dissertation. A common observation of these education systems from various countries is that most of the research under higher education umbrella is carried out in PhD or ME research programs. The way such research programs at the universities contribute towards national research output is presented in Figure 4.

The importance of higher education, research and technological capability for sustained growth and economic development has not been universally acknowledged in Asia. A number of countries including China, India, Korea, Singapore and Taiwan have developed significant research expertise either by their own efforts or via collaborative assistance from developed countries. However, after the 1997 Asian Economic slump many countries of this region are realising that rapid economic growth through labour intensive manufacturing cannot be sustained for long. They are recognising that a strategy based on strong technological capability will allow them to develop products and industries which can compete strongly in international markets. In order to pursue this strategy, many developing countries including those in Asia are looking for assistance and technical collaborations, and directing significant financial and personnel resources for development of research programs and organisations.

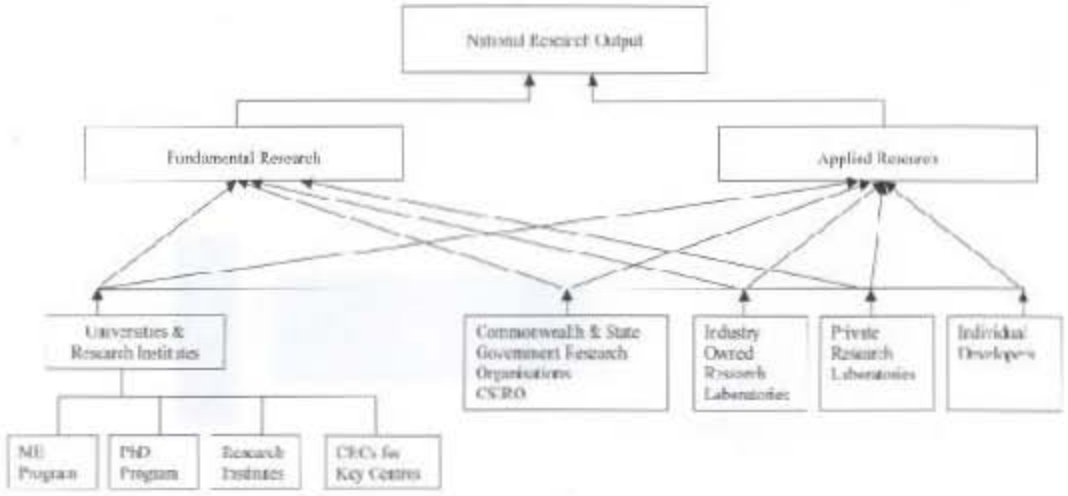

Figure 4. Contribution towards national research output [5].

An Overview Of Engineering Education In Asia

In the recent past the engineering education sector in the Asian region has expanded dramatically. The natural science and engineering degrees awarded in six countries of Asia (China, India, Japan, Singapore, South Korea and Taiwan representing 77 percent of Asian population) in 1990 exceeded more than one-half of million, approximately half of which were engineering degrees. Advanced degrees (Masters and Doctoral) awarded in engineering in these countries in 1990 totalled 48558. Huge demands of skilled personnel fuelled by GDP growth rates ranging from 5 to 12% in this region have resulted in an extraordinary increase in enrolments for science and engineering degrees. In the year 2000 about 2 million natural

science and engineering degrees were awarded in the six countries (China, India, Japan, South Korea, Thailand and Indonesia) representing more than 80 percent population of Asia.

Figure 5 shows percentage variation of 22 year olds holding natural science or engineering bachelor's degree in selected Asian countries (1975-2000). In the year 2000, China, India, Japan, South Korea and Taiwan were expected to have 95, 89, 8.5, 3.9 and 1.9 million people respectively in the college age (22 yr) population. Although over the past 15 year period (1985-2000), the Asian countries have quadrupled their annual production of engineering degrees, with the participation rates as shown in Figure 5, it will be a vast and difficult challenge for these countries to meet the demands of expanding engineering education infrastructure. Similar scenarios on engineering education infrastructure are also expected to develop in countries such as Malaysia, Thailand, Indonesia, Philippines and Vietnam of this region.

Long-term forecasts indicate that Asia in particular China and India will be the key drivers for the global education growth [10]. The global demand for international higher education is estimated to grow from 1.8 million international students in 2000 to 7.2 million international students in 2025 [10]. Asia will generate some 70 percent of this total global demand and in particular India and China together will contribute over half of the global demand within the next 20 years [10].

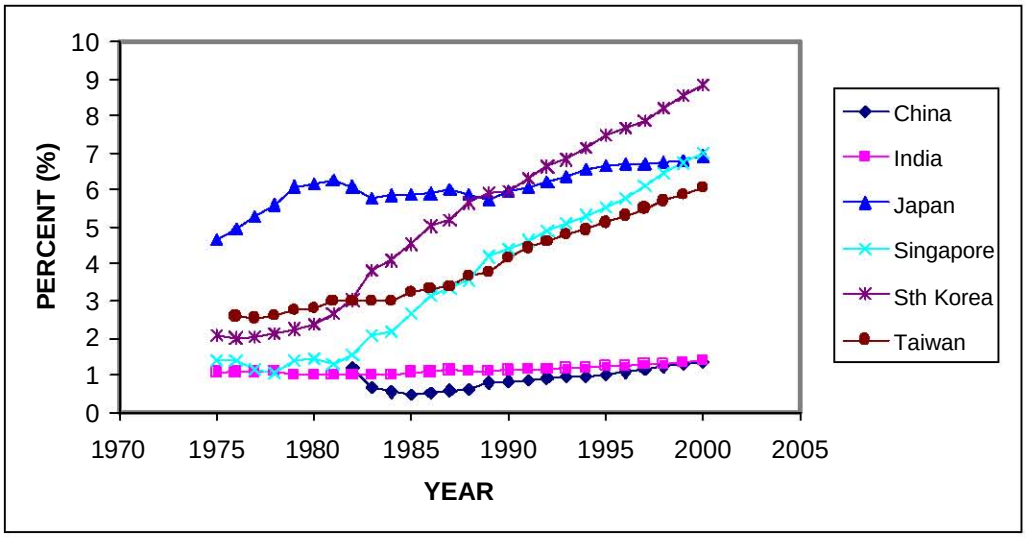

Figure 5. College age population holding science or engineering degrees [11,12].

The increased demand of engineers in Asian countries emanates from several factors including rapid economic growth, increasing technological sophistication and their attempt to go beyond quality engineering and low cost production to design capability and knowledge based innovation products and processes [11]. This scenario presents vast opportunities for Australian universities to use their distance education initiatives, research facilities as well as expertise to meet the higher education and research demands of many tertiary education and research organisations of the Asian region.

Internationalization Of Higher Education And Research In Manufacturing Engineering

A number of developed countries including USA, UK, Australia, Japan and France are very active in Asia recruiting students for enrolments in engineering postgraduate programs at their universities. These students pay requisite fees and do their undergraduate or postgraduate programs, as they require. In fact the universities as well as other willing research organisations from these countries can collaborate with and assist the universities of developing countries in establishing higher education and research infrastructure as well as appropriate training programs which impart necessary research skills to the scientists and engineers. The universities from developing countries participating in collaborative research can then act seeding institutions and spread their skills and techniques acquired to other institutions in those host countries.

The bilateral technical collaborations between governments from developed countries and the governments from developing countries for training via student scholarships and exchange of limited personnel are not new and neither are those agreements/collaborations which are done when a developing country organisation buys some specific advanced equipment and associated training from an organisation from a developed country in order to produce a product. Such collaborations, however, are not very widespread and involve training of limited personnel only via staff exchange programs.

Major participants of manufacturing engineering research in developed countries include universities, government research organisations and industries and their associated laboratories. A typical relationship between such organisations in Australia is presented in Figure.6.
The relationships between such organisations in other developed countries such as USA, Canada, UK, Germany or Japan are not much different than those shown in the Figure 6 above. Clearly in this relationship industries benefit by way of fruitful research output, universities and research organisations receive collaborative funding from industries and commonwealth government agencies as well as some student fees. The students of course receive their higher degrees and valuable research expertise.

As globalisation spreads further, higher education and research is an area which will come under close scrutiny for internationalisation. It is in this perspective that universities and research organisations from developed countries such as Australia can initiate and establish collaborative research projects which have commercial interests of both countries. Research on large projects can involve several universities and research organisations from both the developed and developing countries. An outline of such collaborative relationships between research organisations from several developed and developing countries is presented in Figure 7.

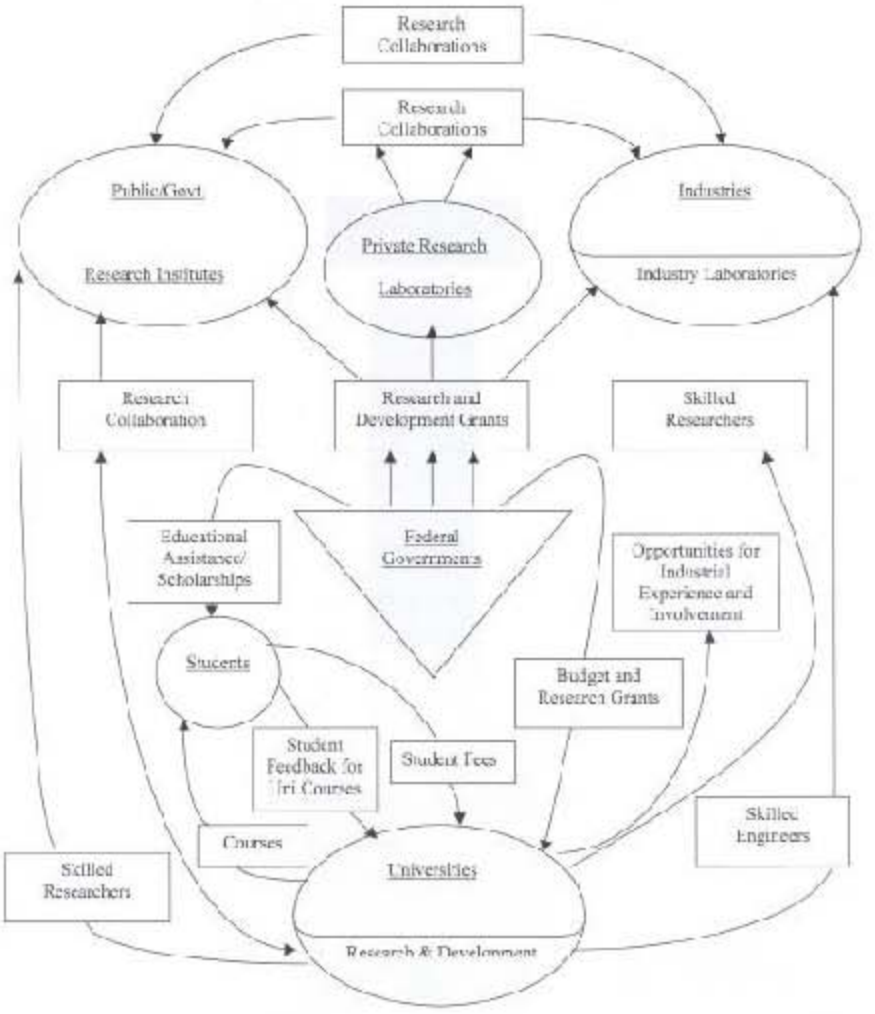

Figure 6. Relationship between universities, research organisations and industries.

In order to succeed, run smoothly and provide benefits to participant research organisations, such relationships need to consider a number of factors which include full backing and support from the management of these organisations and their national governments, fair and honest contribution of resources and an awareness, appreciation and mutual respect of participant's cultures and religion. The participants can be made aware of these factors in a number of ways including seminars which deal with such factors.

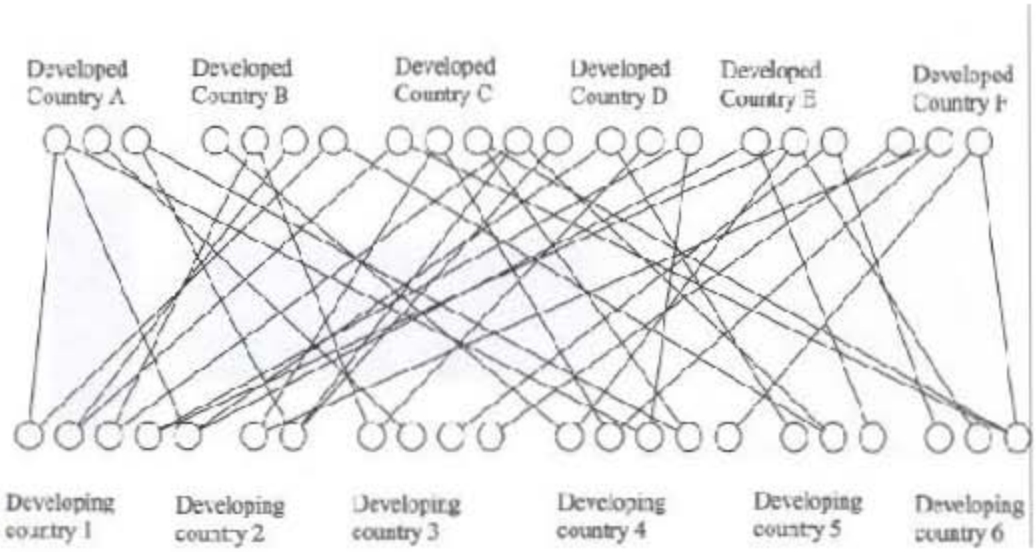

Figure 7. Collaborative relationships between research organisations from developed and developing countries

Facilitation Of Internationalization (Collaborative Agreements)

Globalisation of industrial production has significantly expanded during the last two decades. In order to reduce the production costs, now-a-days all the components of a product are rarely produced by the parent organisation. In medium and large size products many of their components or subassemblies are subcontracted to other organisations or parent company subsidiaries located in a number of countries around the world. However, such practice of widespread involvement in research concerned with the development of a new product is not yet prevalent. This is perhaps due to factors such as keeping the research, design and development details confined to well guarded locations in the parent company for avoiding possibility of leakage via commercial espionage, staff turnover or brain drain. Efforts, however, need to be made to devise ways to overcome such obstacles, which can hinder establishment of collaborative research projects between tertiary education and research organisations of several nations. A number of steps as listed below can be taken for evaluation or facilitation and smooth running of such collaborative research projects.

- Development and signing of legally binding agreements or contracts detailing the financial resources, manpower, equipment etc. to be provided by the participants, as well as the division of benefits both monetary or otherwise generated due to collaborative research and development.

- Establishment of fast communication facilities such as video and desktop conferencing, telephones, e-mail or fax machines.

- Provision for exchange of relevant personnel for short as well as long durations.

- Clearance of projects from relevant federal as well as state government departments or agencies.

- Governments and appropriate international bodies and societies should provide encouragement and incentives for such collaborative research projects.

- Make industries aware of the benefits of such research and persuade them to participate in joint research projects.

- Provision of regulations for research supervision of PhD and ME students from other universities.

Conclusions

During the last two decades, globalisation in product manufacturing has significantly expanded. The main driving factors behind this were the reduction in production costs and subsequent enhancement of organisation's profitability. This paper puts forward arguments for internationalisation or globalisation of higher education and research in manufacturing engineering. Several challenges as detailed earlier may slow the advancement towards globalisation/internationalisation. However, if planned properly and implemented with genuine interest, the collaborative research programs and higher education in manufacturing engineering would generate a number of short term and long term benefits for all the participants including universities, research organisations and associated industries. Moreover the engineers trained in such higher education and research programs in manufacturing engineering would be in a position to tackle demanding technical problems confidently.

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