The advanced manufacturing technology strategy economics essay

Academic institutions need to exhibit the appropriate flexibility to meet the demands of industry. This descriptive study seeks to identify the problems both in the private sector and in the education sector with regards to engineer training and to utilise the strengths of both to provide a solution. The study highlights the current growth of the manufacturing sector and the continuing skills gap. It identifies the problems faced by the manufacturing industry and also changes that can be made to the further education training curriculum. Investigations of the impacts of the engineering training and the factors affecting training and that inhibit or facilitate the engineering training were done. Based on experience and many discussions with the private and education sector with regards to the particular problems currently being faced by those wanting to use advanced manufacturing technology it is hoped this document will generate a lively debate between the private and public sector. This paper fulfils an identified training need and offers a practical solution to overcome a national skills shortage.

Introduction

Manufacturing is important to South Africa. It contributes over 15% of the national gross domestic product (GDP),[1], over half of all exports and is the second largest employer. As important as it is, there are signs that the manufacturing sector is in decline, as evidenced by:

- A declining value-add from the sector (5. 2% in 2007 compared with 2. 6% in 2008)

- A declining rate of change in manufacturing export growth

- A dramatic decline in gross domestic fixed investment in the sector between 1991-1996 and 1996-2005

- A low labour intensity

- A decline in employment across the sector

The South African Government, in recognizing the importance of manufacturing in the economy, recently developed two strategies: the National Research and Development Strategy (NRDS),[2] and the Integrated Manufacturing Strategy (IMS),[3]. The former, released by the Department of Science and Technology (DST),[4], aims at ensuring that technology resources are better developed, focused and utilized. The latter, by the Department of Trade and Industry, recognizes that South Africa's future competitiveness will depend on the capacity of the manufacturing sector to master advanced technology domains, to innovate and to meet the precise needs of customers.

The IMS recognizes the need to move from raw material-intensive manufactured goods towards increasingly knowledge-intensive goods and services. The NRDS regards Technology and Innovation Missions as central elements for accelerating economic growth, the creation of wealth on a sustainable basis, and the improvement of quality of life of South Africans.

South Africa's traditional industries have been resource based, particularly in minerals. Today most minerals are exported in primary metal forms, the main exception to this being fabricated steel structures. This prevents South Africa from reaping the full benefit of its very rich resource base.

Manufacturing can add value to these exports by converting ores to primary metals and primary metals to higher value-added manufactured products. Manufacturing will also complement the service sector. High-value manufacturing will generate demand for the provision of technology-intensive services. On the other hand, failure to upgrade resource-based industries will make South Africa vulnerable to the global trend of deteriorating terms of trade for commodity producers, which has been evident over the last few decades. Thus manufacturing can be seen as an important catalyst for the upgrading of the entire economy.

The goals and objectives of the National Advanced Manufacturing Technology Strategy are to:

- Develop a vision of the technological profile of the industrial sector in the year 2014

- Identify priority sectors which have the greatest potential for supporting relevant goals contained in the IMS and the NRDS. These goals include national and social goals such as job creation and equity

- Stimulate technological upgrading in industry

- Facilitate the flow of technological resources to industry through new knowledge networks to foster innovation

- Facilitate the building of an environment conducive to innovation, particularly through the supply of skilled manpower, technology infrastructure and funds.

The strategy was developed through extensive consultation within the private, public and education sectors, and care was taken to ensure strategic fit with other national strategies and the avoidance of unnecessary duplication. The approach (see Figure 1) ensured:

- Wide consultation with industry, local and international science councils, Tertiary

Education Institutions (TEIs), labour and government; and

- Learning from international best practices and processes – successes and failures.

The need for human resource development is critical in each of the three key requirements

for developing the manufacturing sector. This is demonstrated in Figure 1.

The available evidence indicates that there is indeed a significant demand for people with skills,[5], which is not matched by their availability. Factors such as economic growth, sectoral levels of labour intensity, projections of net migration, sectoral age profiles, the business cycle, government expenditure decisions, projections of HIV/AIDS morbidity rates, industrial policy and foreign direct investment, all affect this supply and demand dynamic,[6]. Without an understanding of the dynamics of the skills environment, it is not possible to plan appropriately. The consequences of skills imbalances are undoubtedly negative. This needs to be corrected through a focus on industry-driven and academic institution supported human resource development.

A well developed Further Education and Trainining (FET) sector in South Africa will no doubt make a considerable contribution to the envisioned economic growth of the country,[7]. The reason for this is that this sector is situated at the intersection of a wide range of government policies, which are critical to the new information-based economy [7]. These include macro-economic, industrial, labour market and human resource development policies. Government coordination across these domains is key to their success and to the establishment of a policy framework which will promote the development of the human capacities, knowledge and skills of our people.

Moreover, as we approach the 21st century, FET is fast becoming an important strategic force, in a context where a country's ability to compete effectively in the global economy increasingly depends on the knowledge and skills of its people, [8]. The pace of scientific and technological advancement, and the challenges and opportunities of the information age, mean that high quality education and training, and lifelong learning, are essential if South Africa is to keep abreast of changes in the nature of knowledge and in methods of production.

Skills education training authority (SETA) research have identified middle level skills needs in their sectors and put in place strategies to address them, particularly through the use of the public FET colleges and universities of technology working in partnership with employers providing workplace-based training.

LITERATURE REVIEW

A definition of Further Education and Technology (FET)

The public FET college system is central to the government's programme of skilling and re-skilling the youth and adults. Its transformation is key to the integration of education and training and responding to the skills needs in our country. In recent years, FET colleges have been striving to make the transition from their former status as technical colleges to being responsive and vibrant post-school institutions for vocational education.

FET consists of all learning and training programmes from National qualifications framework (NQF) Levels 2 to 4, or the equivalent of Grades 10 to 12 in the school system. It is the band within the NQF which follows directly on General education and training (GET) and precedes higher education (HE). Learners enter FET after the completion of the compulsory phase of education at Grade 9 or Level 1 of the NQF. 3. 2 FET is not compulsory education,[9]. By definition, it has no age limit. Its goal is to promote lifelong learning and education on-the-job. FET is provided directly or through distance education by public schools, public colleges, independent colleges and on-the-job trainers. This research only focussed on public college FET.

The mission of FET is to foster intermediate to high level skills, lay the foundation for HE, facilitate the

transition from school to work, develop well-educated, autonomous citizens and provide opportunities for

lifelong learning through the articulation of learning programmes.

State of the industry – forecasts

In the Industrial Development Report for 2011 of the United Nations Industrial Development Organisation (UNIDO), the competitiveness of 87 countries was determined using an index called the Competitive Industrial Performance Index or CIPI. South Africa's rating in 2009, somewhat below Brazil and India(CIPI ratings of 0. 202 to 0. 206) BRICS counterpart,[10]. An increasing competitiveness is the reason that justifies technological upgrading; the principal element of the Technological Vision for South Africa must be the achievement of a substantial upgrading of the CIPI index by 2014,[11]. The most appropriate indicator for this strategy is technology intensity, defined as technology spending per capita. The latter includes domestic Research and Development R&D as well as the acquisition of foreign technology.

Much attention has been focused on the use of computer-integrated manufacturing systems (CIMS) and advanced manufacturing technology (AMT) as possible solutions, in part, to the much discussed problem of the of competitiveness of South Africa manufacturers.

Advanced Manufacturing Technology

The benefits of CIMS and AMT such as increased flexibility, increased quality, shorter product development times, etc [12]. Have been widely accepted, however, SA manufacturers have been slow to adopt these technologies.

Computer-integrated manufacturing systems (CIMS) have been commonly defined as the use of computers, information technology, automation, and people in the integration of manufacturing systems. A specific definition for CIMS that all interested parties can agree upon has been elusive. A representative definition for CIMS is given by [13]:

Computer integrated manufacturing (CIM) is the term used to describe an integrated automation of the factory. Its aim is not full automation, but running a profitable business by: (1) achieving a productive balance through the integration of people and automation, and (2) using such technologies as a database and data communication to integrate the design, manufacturing, and business functions that comprise the automated segment of the factory.

This definition allows some flexibility in determining whether a specific facility constitutes CIMS. Such flexibility is necessary due to differences in individual characteristics of implementing companies. An alternative definition is given by Gunn [14]:

Computer integrated manufacturing (CIM) represents the integration of all information involved in manufacturing from product and process design through manufacturing planning and control, production, distribution, and after-sales service and support. CIM is absolutely vital to achieve world class quality, speed, flexibility, and productivity.

This definition represents the more narrow view of what constitutes CIMS. Regardless of what specific definition is used, CIMS can generally be considered to be the use of computers, automation, information technology, and people used in an integrated fashion.

The following represents the technologies and components most often used in CIMS implementations:

Computer -aided design (CAD)

Flexible manufacturing systems (FMS)

Cellular manufacturing

Group technology (GT)

Computer numerical control (CNC)

Computer aided manufacturing (CAM)

Computer aided process planning (CAPP)

Automated materials handling

Robotics

Just-in-time (JIT)

Manufacturing resource planning (MRPII)

Material requirement planning (MRP)

The same problems found in defining CIMS are also uncounted in defining advanced manufacturing technology (AMT). In particular when comparing definitions for AMT it becomes unclear whether AMT is part of CIMS or CIMS is part of AMT, for the purpose of this study, AMT will be defined as the use of technology in manufacturing in such a way that the integration requirements of CIMS are not met. In other words AMT is similar to CIMS in the technologies used but falls short of CIMS in terms of integration. Therefore a company that has implemented anything from a single CAD station to extensive islands of automation is using AMT.

The literature generally agrees that AMT can be defined widely as a group of computer-based technologies, which includes computer-aided design, computer-aided manufacturing, manufacturing resources planning, robotics, computer aided process planning (CAPP), material requirement planning (MRP II), group technology (GT), flexible manufacturing systems, automated materials handling systems (AMS), computer numerically controlled (CNC) machine tools, and bar-coding or other automated identification techniques, [15];[16];[17];[18];[19]; [20][21];[22]. The authors' research applies the existing definition of AMT but extends this to include any technology, which is new or advanced to a company when compared to its previous or current manufacturing technology. The study focuses on the hard form of AMT as well as soft technologies when they are embedded in hardware rather than being transferred independently.

Methodology

A purposive sampling procedure was employed and prior knowledge was used in selecting the respondents or FET colleges to be sampled. Questionnaires were prepared and sent to targeted individuals by e mail and in print form. The data collected were analysed by using an Excel Spread sheet and charts. The differences observed between the groups were then attributed more to the variable of interest.

Findings and Discussions

The South African FET sector faces a number of challenges; one of the challenges facing the FET sector is one of perception that FET colleges are inferior institutions producing low-status qualifications. Despite noble attempts by the government to improve the FET system the uncertainty remains in the country about the extent to which FET colleges should be viewed as suitable alternatives to higher education. Another challenge facing the FET sector is the fact that a significant number of teaching staff at FET colleges are either under-qualified or unqualified. According to available statistics, in 2002, eight percent of FET educators were not in possession of a recognised tertiary qualification,[23]. Lecturers in FET colleges with the necessary trade and industry experience generally do not hold formal teaching qualifications, [23].

The research shows that there is evidence of AMTs technologies being taught in FET institutions, the graph Figure 2, shows the number of AMTs technologies per institution, FET 1 has three AMTs namely AMS and MRP, and FET 8 has the highest number of AMTs. The research shows that there are no CNC courses being offered in all FET public colleges and there is no consistence in the number of AMTs taught per institution. Most of the FET laboratories consist of islands of AMTs, with only one institution (FET 8) showing a higher level of integration in Figure 3. Level 0 – means that there is no integration, Level 1 – integration of 2 AMTs, Level 3 – integration of 3 AMTs. The level of AMT integration in FET institutions shows the level and depth of appreciation of advanced manufacturing technologies curriculum in further education institutions.

Figure 2. AMTs per institution

Figure 3. Level of integration

Conclusion and Recommendations

Expertise in FET teaching staff is a necessary precondition to meet the advanced manufacturing technology strategy objectives. An advanced manufacturing technology focus in FETs requires a significant resource commitment to derive suitable economies of scale or scope; this is likely to apply to capital equipment intensive innovation and critical interactions between technology providers. Developing a consistent curriculum in-line with advanced manufacturing technology strategy is also very important in FET engineering programmes.