

Multifarious roles of modern industrial technical training

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ABSTRACT: Modern technical training in industry is an integral part of engineering education development. It aims at providing the technical knowledge and/or skills required for industrial operations. It is through technical training and technological research that industrial organisations are able to generate knowledge that will assist them in achieving economic prosperity. In the face of unprecedented changes in technology and global competition in industrial businesses, which characterise the new global economy, both the modes and roles of technical training in industry are evolving. The trend is towards knowledge creation. In developed countries, technological training has created a human resources base that satisfies the continually changing demands of society. This achievement has been partly driven by the IT revolution, which has made conducting technical training and business operations easier. In developing countries, this is just beginning. The article presents the main aspects of modern industrial technical training and the important roles it plays in further developing engineering education and the economic development of a nation. It is concluded that developing nations must embrace new IT in technological training to advance economically and be able to compete globally.

INTRODUCTION

The UK experienced great changes in the organisation of industry and the methods of manufacturing between 1780 and 1850. These changes are now often referred to as the Industrial Revolution. The development of factories in the 19th Century brought a large number of people to work together at regular and monotonous jobs. From Europe to North America, the Industrial Revolution has spread to other parts of the world.

Industrial training has been a product of the Industrial Revolution, which is a continuous process and is unlikely to stop while new methods and products are continually being invented and spread all over the world. Industrial training has been evolving, along with the Industrial Revolution, and will continue to exist as long as industries exist.

Industries produce the goods and services that a society uses. This includes manufacturing, mining and quarrying, and the generation and supply of electricity, water and gas. However, the word *industry* is often used to describe the factories that change raw materials into finished goods. All of these processes that go on in industries need skilled human labour to carry out various operations using different types of machines. Nowadays, most developing countries have established industries based on their raw materials.

Today, many industrial executives know that an important source of competitive advantage is *knowledge*, which for industries is generated through industrial training and research. Industrialists attach a great deal of importance to industrial training because it is a means of enhancing performance and improving productivity. Intensifying industrial training together with the use of IT will be very crucial for the development of appropriate human resources that future industries will require for prosperity. The continuous training of human labour,

through the organisation of periodic industrial training, is therefore an important activity in any industrial operation.

THE NEW GLOBAL ECONOMY AND TRENDS IN INDUSTRIAL TECHNICAL TRAINING

Currently, the focus of the global economy is on knowledge: how to develop, share, leverage and measure it to create more value for customers, employees and shareholders. The global economy is knowledge-based and knowledge driven. Peter Drucker, for example, has suggested that knowledge is now becoming the main factor of production, sidelining both capital and labour [1]. Whereas, according to Ratchford, natural resources and physical capital are much less important in the new economy [2].

Industrial managers need to understand how to exploit the unusual characteristics of the knowledge economy and how to manage knowledge effectively. Today, the world economic landscape is not the same as it was two decades ago, nor is the pace of global economic change expected to slacken in the next decades to come. On the contrary, change is likely to accelerate. Thus, industrial entities must understand what globalisation is, what drives it and what the implications are for them.

In recent years, there have been substantial changes to industrial operations throughout the world. Industries have experienced dramatic shifts in their regulatory and business environments. These changes include mergers, government actions and dramatic market changes that have been driven by technological change. New demands from customers, with greater emphasis on quality products, environmental protection and sustainability, and enhanced relationships between suppliers and customers, have all reconfigured the customer interface. As a result, new ways of doing business have

developed (eg e-business communities), new ways of competition and alliances (eg cooperation), new ways of operation (eg automation and the increasing use of intelligent machine systems), which have all become a norm of industrialised operations today. All of these activities require either the recruitment of new highly trained personnel or the retraining of currently employed personnel in order to be able to tackle these new challenges [3].

As such, in the world today, there is a strong demand from industry for engineers who have specific training in new technologies. Such graduates are needed now in order to plan, design, install and maintain the many new technological systems that are going into service all around the world. Although there are several courses that have been in existence for many years, these are still insufficient to meet the current needs of industry.

The engineering educational sector, which has largely been driven by student demand, is just beginning to respond to this situation. Some universities and technical colleges have developed new courses that specifically meet industry needs and also cater for those persons who may already be employed and wish to train further.

Such courses are flourishing, but there are still issues to be resolved including standards, content, access and continuing professional education. Industrial training is presently one of the world's fastest growing businesses, and the so-called *edutainment* – a mixture of learning and training – has become the central principle for adult training.

NEEDS FOR INDUSTRIAL TECHNICAL TRAINING

The need for industrial technical training may come from the employee's individual desire to increase his/her competency and/or can be the result of organised industrial training programmes for the workforce. In industry, technical training usually addresses specific topics that help achieve business objectives.

Technological development has been the driving force behind productivity improvements. As technology becomes more sophisticated, the acquisition of skills by workers to ensure that they remain relevant to the demands of industry has become a key objective of employers.

Industrial technical training helps to keep workers' skills in line with new technologies and business practices, which, in turn, help businesses increase productivity, reduce costs, improve quality and boost competitiveness. In industry, technical training is carried out to help company employees understand how to carry out their jobs as effectively as possible in the new environment, usually resulting from the decision of management to apply new technology or approaches in operations. The environment will not change abruptly; it will change over a long period. Consequently, industrial technical training is not an on-off activity, but a continuing one.

Industrial technical training involves the crucial task of empowering employees to face life's challenges through their employability and their qualitative service. It is advantageous for employees to integrate into their activities the constant changes in technological processes and information processing, rather than ignore them. It is the duty of industrial management

to facilitate this process, so that perceived threats are transformed into innovative and productive opportunities.

Technical training is of particular interest to industrial management because the results of using a new technology are closely related to the quality and quantity of training. It is the responsibility of the management to define how much training employees need and to ensure that such training is available and given. Due to the importance of technical training, management will seek to implement procedures to determine whether or not the training is having the desired effect.

Technical training in industry should be aligned with corporate objectives in order to add value to the business, otherwise the exercise could be a waste of resources. Technical training should focus on the critical knowledge and skills that employees need in order to meet their performance goals. In addition, there is a need to build on the knowledge and skills foundation that already exists to make sure resources are not spent on unnecessary training activities [4].

Good industrial technical training programmes are tailored to address specific business needs and deliver specific business applications that are easily transformable into action plans. Further, they are conducive to measurable results that positively impact on business. Typical examples of plant-specific training include hands-on skills, qualification programmes, classroom training, self-study and e-learning.

Around the world, wide-ranging changes in management and technology have been adopted by various industries. Downsizing and rightsizing programmes have led to a large proportion of the highly trained and skilled national workforce being retrenched, retired or simply declared redundant.

Automation and more efficient methods of production have also replaced many jobs. There has been intensive recruitment of new personnel with superior qualifications and a broad range of skills to match, as new industries and jobs emerge in response to expanding global consumer requirements and new product designs. Certain jobs are being phased out, as persons become multi-skilled in order to adapt in response to new methods of production and materials used in industry. Industry now demands greater multi-skilling than specialisation. Engineers now need training in IT and how to run a business successfully. Industry has to invest more in technological research and skills development.

In order to prepare workers for these challenges, technical training will have to be intensified as a matter of necessity. Training needs identified in the past may no longer be valid. Ready-made programmes that were developed for some time in the past cannot be relied on to meet current requirements and expectations, or to address continually changing business needs. Training programmes that have been considered adequate are being rendered obsolete by the changing demands of the global industry and commerce.

The effective development and utilisation of human resources through an ample supply of multi-skilled human labour has never been more in demand than now. Past training needs assessments must now be reviewed so as to formulate a relevant and harmonised technical training curriculum and syllabi for every type of industry. These changes in industry will call for more demand-driven training in operational and management levels of the industry spectrum.

INDUSTRIAL TECHNICAL TRAINING INSTITUTIONS

Worldwide, universities and technical colleges have been mainly responsible for managing engineering education and training, but industries also conduct specialised training for their employees. An industrial technical training programme usually starts at universities as industrial attachment and is an integral part of an undergraduate engineering programme [5].

Most universities and technical colleges have programmed systems of industrial attachments so that students are exposed to the work environment in order to inculcate in them a sense of industrial discipline. It is usually sandwiched with theoretical programmes during undergraduate studies.

Technical training institutions must continue to play their role in upgrading the skills of the labour force. For the effective development of human resources, the roles of both universities and industries as engineering training institutions need to be complementary. The partnership between universities and industries is therefore important in order to realise good industrial training.

MODES OF INDUSTRIAL TECHNICAL TRAINING

With the continual evolution of technology and business needs, industrial technical training must be adapted to these changes. The following forms of training should take precedence over traditional training practices, which have mainly focused on full-time students' needs:

- Use of distant learning to increase effectiveness while being at the workplace;
- Tailored technical training programmes developed and/or delivered by company personnel.

Technical Training through Distant Learning

Throughout the world, many aspiring industrial employees fail to access university education due to their career commitments. Yet today, many universities around the world have made arrangements for distant learning programmes to enable interested industrial employees to acquire university degrees through the open-learning concept. Open-learning offers trainees the opportunity to learn wherever, whenever and at whatever pace is suitable. It uses video- and audio-tape media, as well as written materials in the form of notes and exercises.

This means that trainees can study in the car or on the train while travelling to and from work, as well as at home or work. It encourages the concept of training partly on company time and partly in the trainee's own time. Learners are sent comprehensive study packages, tutorials and assignments, and also receive tutorial visits. They are guided through various course units to acquire a level of knowledge equivalent to classroom instruction. Even more critically, it will need the commitment of the trainees themselves in acquiring new skills on the basis of life-long learning.

Distant learning education with a multimedia background has risen to prominence because it has the potential to address the social changes immanent to a modern society as an alternative education system. For example, the implementation of industrial technical training programmes for industrial employees has been enhanced by the use of Computer-Aided

Instruction (CAI) packages. CAI provides a comfortable training environment whereby each industrial trainee can take time to check references or to repeat particular sections of the training programme.

New distant learning systems that accommodate the time and space of industrial employees gives the opportunity to those outside metropolitan areas without a prominent education institution to have access to quality technical training and to be exposed to outstanding professional specialists [6].

Tailor-Made Industrial Technical Training Programmes

Some industries prefer to give courses at their own sites, arguing that trainees, who are also employees, will benefit from being free of everyday distractions. The company may prefer to see these courses given on its own site, with the training orientated to the work encountered on real projects and carried out in the real environment, helping to make possible the easy identification and correction of any problems that may occur.

The company may decide to build its own training force. This method can be effective because trainers will understand the company's needs, speak the language of their colleagues and can develop training to meet specific requirements. If trainers only have a part-time training role and continue part-time with their previous responsibilities, they will not run the risk of their skills and knowledge being overtaken by those of their students.

On the other hand, the company may not have sufficient resources to invest in its own internal training force (even if it is only part-time). An added problem is that those persons selected to be trainers may not have really mastered the subject themselves or, for some other reasons, are not effective trainers. In this case, management will need to select the most suitable sources of training and periodically check the quality of the training given.

On-the-Job Training (OJT)

In an industrial set-up, learning need not necessarily imply the discovery of new technical or scientific principles, but can equally be based on activities that recombine or adapt existing forms of knowledge. In turn, this implies that certain activities, such as design and trial production, market research related to new product development and the acquisition of patents and licences, are both training and knowledge generating activities.

Such activities require On-the-Job Training (OJT). OJT trainers need the understanding of how people learn on the job and best practices for OJT. Broad topics in OJT include: effective OJT, understanding adult learning processes, appreciating adult learning behaviour and motivation, effective OJT communication techniques and systematic OJT practices [4].

PUTTING INDUSTRIAL TECHNICAL TRAINING INTO PRACTICE

There is a need for transition phases between training and the unsupported everyday use of new technology. The progression starts with a theoretical introduction to the use of a new machine or system, followed by hands-on training. From there, the trainee must then be able to practise with examples that are drawn from typical use, but are not actually part of the current workload. During this period, support should be available on

call. Similarly, in the next phase, that of starting to work on real tasks, support needs to be at hand. If a problem arises, the trainee needs to be able to find assistance rapidly; otherwise, time will be lost, mistakes will be made and despondency will set in.

Management needs to develop plans so that, at the end of the training period, new resources and suitable work are available for trainees. In some cases, this may imply that a programme be scheduled for this activity. The speed with which knowledge gained during technical training can be forgotten has implications for the number of employees to be trained. There is little point in training vast numbers of employees if they are not able to put their training into practice.

EVALUATION OF INDUSTRIAL TECHNICAL TRAINING

In industry, technical training suffers from difficulties and ambiguities in evaluating its results. This can be a big flaw of any company that spends lots of money on training but cannot measure or assess the actual returns of investment in training on the real company business. Training evaluations should identify those factors that can sanction updates or changes to a company's training programme, and provide trainers with the proper tools to continually evaluate training programme effectiveness and identify any necessary changes.

In order to increase employee awareness of assessment factors, the following should be addressed for each technical training programme: tracking and isolating the impact of training on business and measuring the returns of training on business (an equivalent to return on investment, since training is an investment in a broad sense). When considering the cost of training, it should not be forgotten that there may also be a cost arising from not carrying out training.

Technical training costs contain a component that is directly related to the cost of training and a component due to the loss of production during training time. Because the amount of industrial technical training will depend on the complexity of the training course, and the cost of the trainer will depend on the contents of the course, it is not possible to give an average value for the cost of training.

Management needs to clearly identify and quantify the training required for a particular company. Only well-trained people will be able to deliver the promised increase in productivity. Many managers invest years of effort in selecting new technology, yet few invest such efforts in defining training requirements and selecting training solutions, although it is clear that these are also very necessary actions. Feedback between customer companies and technical training institutions also helps improve training services so that they can cope with the continuous changes in industry. Without feedback, services could easily become obsolete.

INDUSTRIAL TECHNICAL TRAINING IN DEVELOPING COUNTRIES

Most developing countries are experiencing problems arising from globalisation; therefore, the fierce competition for world markets has led to rightsizing, downsizing and retrenchment, which directly impact on industrial technical training. Certain companies, which have previously appeared formidable, have crumbled and released hundreds of workers into the market to

compete for dwindling employment opportunities with thousands of unemployed workers already out there.

Industrial Training Levy Fund

In recent times, some governments of developing countries have introduced departments that administer technical training in industry through the payment of levies. The concept to make industries pay small monthly contributions is to make the activity sustainable (see Figure 1). This approach has been very successful in a number of developing countries, but is now threatened by industrial closures resulting from globalisation. As a result of downsizing, employers are training fewer employees to perform more tasks, and are therefore multiskilling them through training. In this scenario, training costs are actually rising at a time when levy collection is falling. As a result, the percentage of training costs reimbursed has declined.

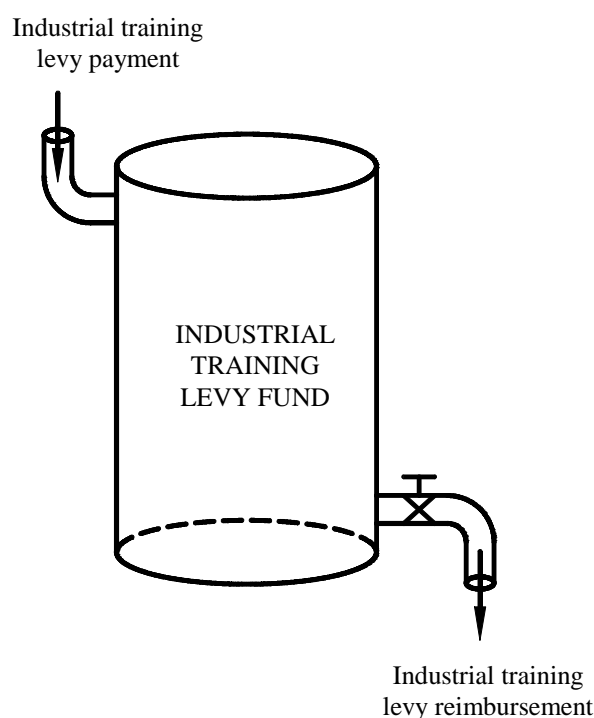


Figure 1: A conceptual approach to the sustainability of an industrial technical training levy fund.

This means that the industrial training levy fund, which companies have been paying as per number of employees, cannot be financially sustained. New approaches have to be adopted in order to sustain the training levy fund. There is a need to review the mode of levying – to move away from per head mode to another method, for example, percentage of the wages bill, so as to ensure that the amounts collected are able to finance the technical training needs of the industry.

With the prevailing global trade pattern, companies in developing countries should seek to implement a more sustainable industrial training levy mode in order to make technical training a continuous industrial activity.

Industrial Technical Training as a Technology Transfer to Developing Nations

In most developing countries, the lack of technical human labour is acute. Therefore, governments, in consultation with

industry and in collaboration with donors, have set up government departments in order to assist industries with their various training needs. However, such bilateral or multilateral donor support is not always a guarantee of achieving the desired results.

Upgrading Skills as an Industrial Technical Training Activity in Developing Countries

Those employees targeted for upgrading skills are those employed with a limited skill level and who wish to increase their knowledge and skills in the technical occupation they are engaged in. The courses are offered in three different levels: basic, intermediate and advanced.

Typical courses to upgrade skills currently in high demand in developing countries include: motor vehicle mechanic, motor vehicle electrician, panel beater, fitter general, turner, welding general, electrical installation, electronic mechanic, refrigeration and air-conditioning, masonry general, carpentry and joinery, plumber pipe fitter, painting and decoration.

These courses are usually non-resident and run during the evening at designated centres. Fees for such training courses are heavily government-subsidised in an effort to develop a skilled workforce that is able to make industrial enterprises more productive.

IMPACT OF THE IT REVOLUTION ON INDUSTRIAL TECHNICAL TRAINING

The use of IT in global business has brought new opportunities and challenges for engineering and business professionals. New concepts have emerged that have revolutionised industrial technical training. A variety of computational and communications technologies have enabled companies and engineering institutions to utilise specialised professional skills at a distance.

One future scenario is where engineering educators and industry leaders form a team of cross-cultural and cross-sectoral members, ready to challenge those technical training issues that are closely related to the actual industrial environment. Companies are already interacting with global partners and customers, as well as conducting operations in various countries, both in face-to-face meetings and via networks.

Along with the IT revolution, one obvious outcome for developing nations is that industries have been prompted to become part of global business community by using modern IT in order to become linked to global partners. This trend towards globalisation has meant significant changes in approaches to industrial operations and technical training. This also has direct implications for the knowledge and competences that employees need to acquire during their industrial training.

CONCLUSIONS

The new global economy is irrevocably different from the old economy. Knowledge is the primary resource, displacing

capital and natural resources. Intellectual property displaces real property as the essential ingredient of new economy companies. Human resources remain essential and even increase their importance in the new economy. Furthermore, human resources have become the enabling ingredients for the new economy.

This means that both good engineering education and technical training in industry are crucial and that their character and structure are evolving rapidly in order to meet the demands of new economy. Good industrial technical training leads to industrial development. Furthermore, the benefits of a well-organised industry are shared among all the people concerned. The living standards in every country are then improved. Individual employees also benefit from industrial training, as their skills are improved and their income boosted.

Through the use of new information and communication technologies in industrial operations and technical training, developing countries can achieve a higher level of modernisation, thereby becoming more productive and inventive in their industrial enterprises.

Industrial technical training is crucial to engineering education profession development, and it is evolving along with other new economy institutions. The evolutionary trend of technical training emphasises knowledge generation and the diversification of distant adult learning methods for industrial employees. This presents a profound challenge for engineering educators and industry leaders in order to understand better the process of generating knowledge for innovation and to find ways of utilising that knowledge that are both efficient and humanitarian.

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World Transactions on Engineering and Technology Education

A Call for Papers

Current events have impacted upon the arena of international conferences and academic travel, impinging on the freedom of intellectual movement to conferences and the like that are so important for the advancement of engineering education internationally and regionally and, indeed, the development of humankind now and into the future. Wars, threats and diseases affect the physical presentation of ideas at conferences, fora and seminars; however, the liberty of thought and the exchange of educational ideas cannot be bordered, blasted and subdued. To this end, the UNESCO International Centre for Engineering Education (UICEE) has established the *World Transactions on Engineering and Technology Education* (WTE&TE), which is open to everyone around the world who is interested in the progression of engineering and technology education. Current unfortunate circumstances have meant that the *World Transactions* offers a safer and cost-effective alternative to conference participation.

The first volume of the WTE&TE presented a range of papers from across the spectrum of engineering education and from around the world, including over 50 very interesting and insightful representations from many countries worldwide. From this, it can be seen that the WTE&TE contribute strongly to the publication of engineering and technology education papers globally, which is essential for academic life and the continued growth and evolution in humanity's store of knowledge and understanding across nations, cultures and continents. Work is underway on Vol.2, No.2 of the WTE&TE, with the objective to release the issue in early August.

Therefore, a call for papers is made for the next issue of the WTE&TE, **Vol.2, No.3**. The very nature of the *World Transactions* is open to every facet of engineering and technology education and is not confined to traditional views about science, engineering and technology. As such, there are no overriding engineering or technology themes, but rather the overarching principle of the globalised expansion of engineering and technology education that is not confined to borders or regions; instead the WTE&TE seeks to benefit all those involved in the engineering and technology through the wider dissemination of knowledge.

The deadline for this issue is **30 September 2003**. Authors should indicate their interest as soon as possible. Additional information can be found at the UICEE's homepage under *World Transactions* at <http://www.eng.monash.edu.au/uicee/>

Interested persons should submit their original, previously unpublished papers to the UICEE for consideration to be included in the WTE&TE. Authors should be aware of the standard formatting structure, which will essentially be the same as for other UICEE publications. Papers are to be submitted in MS Word format in 10pt font, single-spaced, double column, and a **maximum of 4 pages** in total, including abstract and figures (additional fees will apply for extra pages). Fees are based on cost recovery for editorial and publishing work, and every submitted paper will cost \$A450. Also, within the cost structure is the delivery of one copy of the WTE&TE per paper submission by airmail postage to anywhere in the world.

The electronic kit for authors, incorporating standard formatting details and submission forms, covering copyright, will be supplied on request. Potential authors should notify their intention of submitting a paper at their earliest convenience and earlier submissions than **30 September 2003** will be particularly welcome. Further correspondence via e-mail should be directed to Mr Marc Riemer on marc.riemer@eng.monash.edu.au