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# The Training of Tomorrow's Engineers – Challenges of Change*

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This paper looks at forces for change, such as globalisation, technological advances and the modification of value-added chains, and the opportunities these bring for engineering education in Germany. Four main requirements that must be implemented for the successful training of tomorrow's engineers are proposed. Firstly, internationalisation reflects the global nature of business and that it is essential for university education to bridge cultures across the world. Secondly, process orientation builds on the integration of knowledge and thinking in terms of process chains. Thirdly, modularity will grant life-long flexibility as modular training infrastructures offered by learning institutions will provide the opportunity for learning to be an on-going process. And fourthly, practical orientation can be achieved by intensifying the integration of education and application. In conclusion, the knowledge of customers' needs and requirements will lead to satisfaction and economic success. However, a joint endeavour between industry and education must be realised to form a crusade of learning that will lead to viable products and solutions.

## INTRODUCTION

This paper addresses the major issues of education and training of our future engineers and looks at some of the challenges facing industry and educational institutions. I will then propose four main requirements that must be implemented for the successful training of tomorrow's engineers.

## CRUSADE

The time has come for those of us in business, manufacturing and education to join together in a crusade of learning that will excite and motivate young, talented engineers. In return, they will be inspired and empowered to produce commercially viable products and solutions for constantly expanding markets.

In order to anticipate and address the dramatic changes in customer value chains and the dynamic forces released by new technologies, innovative ideas must be encouraged and realised. As in any enterprise reliable financial resources and creative know-how are required. Corporate Europe is familiar with these challenges.

## FORCES FOR CHANGE

Despite high unemployment figures there is fierce competition among the global players for investment capital and the best human talent available. The economic success of the 21st Century will depend on education and the implementation of knowledge. Within the next few decades, the world population is expected to reach between 9-10 billion. How are we to respond? We anticipate needing a five- to tenfold increase of productivity in response. How can this be achieved? By discovering and investing in new sources of knowledge and talent.

Globalisation is a reality. The labour force is no longer restricted to the western world. Economic prosperity and quality of life will depend on education, leadership and suitable work environments.

It is important to look at the framework and the developments in which our industry is operating, as well as the conditions that lead me to my conclusions regarding the requirements for future training of engineers.

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It should come as no surprise when I say that *the capital goods industry is changing*. Information technologies and the Internet have opened up new opportunities and requirements for both customers and suppliers throughout the world.

Value-added chains have been modified in two respects; firstly, technologies now overlap, merge and generate intelligent systems, and secondly, labour division processes are being restructured as development, production and marketing activities are transferred to less cost-intensive regions. For example, there used to be quite a distinction between the various areas of technology. Today, modern machinery and plant manufacture represent intelligent, integrated production systems, such as where factory automation combines various segments and creates new ones. Robotics, image processing, power transmission, fluid power and micro-systems, software and elements from industrial communications such as sensors or field buses can thus provide new answers for the latest requirements.

The astonishing speed at which IT and Internet technologies penetrate the market allows access to and usage of data anywhere in the world. At the same time, expectations rise with respect to existing service business units such as tele-services and the so-called *b-to-b solutions* that have become major successes.

Customer services outside the IT sector indicate how important this area of business has become. Customer service is paramount. We now need to offer engineering and consulting services, and training for our clients' personnel. Service and holding companies need to be established and maintained. Products need to be supplemented, improved, and tailored to meet the requirements of the most diverse customer groups. There is a new tendency amongst our customers to lease productions units or pay for their usage on a pro-rata basis rather than purchasing the units outright. This requires on our part a sophisticated knowledge of financing and operation. In 1991, this new approach accounted for 18% of the total turnover, and the VDMA expects this figure to reach 60% or higher.

Against this background, it is easy to understand why manufacturing is so dependent on a highly motivated and well-trained work force – especially its engineers. About 120,000 experts from virtually all engineering sciences work for machinery and plant manufacturers. This figure represents 12% of the sector's workforce. These engineers come from such diverse fields as IT, electronics and mechanics. Their market value is bound to increase as the latest VDMA surveys show that most companies intend to expand their engineering capacities.

How do we go about recruiting and training the young men and women who will become the engineers of tomorrow? It is envisioned that four requirements as centres of education must be provided. These are:

- Internationalism
- Process Orientation
- Modularity
- Practical Orientation

## INTERNATIONALISATION

Why is it necessary to internationalise curricula and how can this best be achieved?

At the risk of overusing the word, we must admit that the world of international business has become global. If industry is to succeed, it is vital that university education addresses this reality and immerses its students in an internationally comprehensive approach that creates bridges to cultures throughout the world.

As stated earlier, the progress made in the field of information technologies has shifted value-creation processes to less cost-intensive regions. The effects for the technology experts and management are twofold: increased local presence internationally, and cross-cultural cooperation with culturally diverse partners. Individual customer care rests on these two pillars. It is clear that global players need internationalised engineers.

Pioneering strategies are required and universities can make a powerful impact in their approach to the education of their students. If companies are to be successful in the global market, employees must be able to speak languages other than their native tongue and be culturally aware and adept. In terms of university training, this means that foreign language training must become an integral part of technological studies. Lectures, seminars and practical lessons in every subject must be conducted in English, the language of international business.

At this point I would like to say a special thank you to Professor Grünwald and the rest of his team at Hochschule Wismar who have been involved in this event. By creating this opportunity for us to meet and share our visions and ideas you have set the standard for all other learning centres striving to shape the future of internationalism.

We cannot expect individual universities to carry the responsibilities as set out above without support. That is why we need a worldwide network interconnecting cooperation, information and education. Practical training and theses done with the help of industry or university partners throughout the world are as indispensable as is the exchange of teachers and professors.

What will result from this approach will be internationally adaptable systematic engineering studies. The higher-level degrees such as the Anglo-American Masters degree and the German *Diplom* must become inter-compatible through clear-cut and transparent rules and amendments.

## PROCESS ORIENTATION

The term *systematic* leads to the second challenge all technology universities face: namely *process orientation*. The 21st Century will rely on the integration of hitherto independent processes. Educators must be encouraged to integrate their knowledge as opposed to pursuing independent, individual goals. The example cited earlier of factory automation shows this clearly enough; isolated solutions restricted to one technology are being replaced by complex and integrated systems drawing their sources from the most diverse fields of knowledge.

Universities will be called upon to join and intensify integration of mechanical engineering, electrical and electronic engineering and information technology to plant the seeds for a new kind of thinking: thinking in terms of process chains.

This can be achieved by:

- Implementing interfaculty research projects that offer the different contributors the possibility to integrate their particular areas of expertise and develop innovative processes. For example, a working party consisting of mechanical and electronic engineers and their peers from the biology and neurology departments could devise a new solution for machine controls.
- Re-assessing existing curricula; rather than relying on standard practice a fresh approach might bring about new lines of studies.
- Integrating modules of study that address the subject of economics as economic knowledge is vital for success. Sound technology is no longer enough if we are to compete successfully in the market.

## MODULARITY

In addition to internationally competitive strength and interfaculty co-operation, new concepts for engineering studies call for another vital component: *modularity*, which will grant life-long flexibility.

Dynamically developing technologies and competition are simply not possible without life-long learning. Modular training infrastructures offered by learning institutions will provide the opportunity for education to be an on-going process. Again, let us look at the framework in which the capital goods industry acts. Stiff competition within the industry and rapidly changing technologies require engineers to be quick to react. The relatively new flexible working environment offers the working individual the opportunity to be creative and personally responsible. It also means that life-long jobs are becoming obsolete. Modular university courses will provide the tools each individual will require to adapt to these changes.

Let me give you an example of why I believe it is vital that life-long, modular learning be available. A business partner had been active in the operational side of his firm for many years. When circumstances required his move into the holding of the company, he had to acquire detailed financing knowledge. He was able to do this by taking courses offered by a continuing education institute affiliated to a university.

Through intensive training in a short amount of time, talented engineers with basic knowledge and adequate degrees can acquire additional qualifications and degrees, thus making them highly desirable partners anywhere in the world. Ultimately, both the providing universities and the individuals stand to profit from this type of cooperation.

In this era of the Internet, I am convinced that virtual studies from the workplace are already a significant tool to gather knowledge. Online course studies offered by universities may well grow into a second, equally important pillar of academic training for engineers. Examples of this phenomenon can be seen at the *Lübeck Virtual University*, an adult-education Internet portal to be launched by the British Pearson Group and AOL. Universities in the USA are also offering full operations of this sort.

## PRACTICAL ORIENTATION

The fourth main component is a matter of concern I would personally like to highlight; the need for universities and industry to join forces wherever possible to give young engineers the practical orientation and guidance they need. Technology, education and leadership go hand in hand and need a synergistic network of universities and industry. I appeal to all those involved in value-creation processes to use every possible channel of cooperation available to support development and implementation.

Just as isolated solutions have been replaced by integrated processes, so will academic training be enriched by continuously intensifying the integration of education and application.

Translated into the political context, this will result in a significant expansion and flexibility of industry-oriented research. The capital goods industry is well

prepared and looking forward to enhancing the dialogue with scientific knowledge providers in Europe and throughout the world. Developmental projects must be brought back to the heart of science – the universities – and receive fresh impetus from that quarter. This will infuse engineering studies with application of know-how and will feed scientific methodology back to industry. Such close cooperation might also lead to temporary exchanges of staff.

Because of the breath-taking rate of change some topics are experiencing, it is difficult to find university staff capable of teaching them. It is vital that educational institutions be kept abreast of new findings. The Schröder administration of Federal Germany is considering amending German university laws to allow the appointment of 28 year-olds as professors. This alone demonstrates the urgency of the situation.

Another point of interest that needs to be addressed is the start-ups of businesses, the motor propelling the development of the new economies. I believe that engineering studies fail to offer sufficient content and structure to enable the top junior engineers to start up their own businesses. It takes courage, knowledge and initiative to do so. Not everyone has those qualities or is interested in building their own companies, but those who do would benefit from appropriate university courses. In turn, our economies would benefit by receiving fresh and significant impetus and our academic institutions would prosper by offering dynamic and innovative studies.

## CONCLUSIONS

In concluding my remarks on practical orientation and guidance, I will reiterate an often-heard demand: we must focus on the customers' requirements. Engineering studies must not rely solely on continually perfecting our knowledge of the basics and their applications. Carefully compiled and taught marketing knowledge is the key to controlling the fantasies of over-exuberant engineers. Properly used, knowledge of our customers' needs and requirements will lead to satisfaction and economic success.

We have explored some of the issues surrounding the education and training of future engineers and the challenges facing industry and academic institutions. We have looked at what I believe are the four main requirements needed for successful training programmes.

Before closing I would like to briefly address a considerable concern that all companies in machinery and plant manufacturing face, namely the lack of junior engineers! Only through joint efforts between universities and industry can this situation change. Talented junior engineers will have to be encouraged and motivated to choose to study for a technological university degree. The four requirements of internationalism, process integration, modularity and practical orientation must be taken seriously if the full potential of our future engineers is to be realised. Young talents eagerly seek both creative leeway and long-term prospects. The engineering industry is unique in being able to offer a wide variety of opportunities.

Today, I have requested that the dialogue between university and industry be intensified. Let us also focus on integrating the junior league into this game. How might universities be affected? They may have to stop required anonymous mass events for which attendees receive *listener certificates*. Instead, let us concentrate on small-scale and highly efficient projects capable of producing fruitful dialogue. If we want universities to generate knowledge dynamically, we have to teach dynamically. In Germany, we still have a lot of catching up to do in this regard.

We, the representatives of the industry, also have our homework to do. We must communicate to students the manifold exciting and challenging prospects we have to offer. The on-going recruitment campaign named *Think Ing. – Think like an engineer*, sponsored by the VDMA and other trade associations, is a beginning that will hopefully lead to great success.

At the beginning of my remarks, I elicited your support in forming a crusade of learning, one that will lead to viable products and solutions for ever-expanding markets. There are no alternative routes and there is no time for hesitation. If we are to succeed, our joint endeavour must begin now.

## BIOGRAPHY

Mr Rolf R. Kuhnke is the Vice President of the Verbandes Deutscher Maschinen- und Anlagenbau (VDMA). Born in August 1944, Mr Kuhnke studied at the University of Geneva in Switzerland, achieving Dipl.-Kfm. (licence études science commerciales), and then becoming an assistant at the same university from 1971 until 1975. From 1976 to 1981, he was involved in Business Planning at Motorola's European Headquarters, as well as in

Kuhnke GmbH in nations including Switzerland, England and the USA. He has been a Managing Partner of Kuhnke GmbH in Malente, Germany, since 1984.

Mr Kuhnke also maintains a diverse range of important memberships; he is a delegate of the VDMA Northern Region, and is on the board of management for ZVEI Northern Region. He is on the board of management for the Working Association of Independent Entrepreneurs Schleswig-Holstein, a member of the Plenary Assembly for the Industry and Commerce Association (IHK) Lübeck, and on the Board of Directors of various firms and organisations, including the Technical Centre Lübeck.

## *4th Baltic Region Seminar on Engineering Education:* Seminar Proceedings

edited by Zenon J. Pudlowski & Hans Peter Jensen

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