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MODERN MANUFACTURING: A BLEND OF PEOPLE AND MACHINES*

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Modern manufacturing requires an effective balance between humans and machines. To achieve this balance it is essential that the inherent nature of the people be understood thoroughly. In addition to the basic human needs, many specific cultural aspects must be considered. The paper concludes with some suggestions as to what needs to be done to get developing countries, like Estonia, back into manufacturing, both in terms of competing with the best, as well as meeting local requirements.

OVERVIEW

This is a very personal excursion by an engineer, who is strictly NOT a social scientist, into the problems which face developing countries, such as Estonia, as they attempt to restructure and compete in the new era of world manufacturing. The paper takes as its underlying premise that modern manufacturing requires, not the isolated adoption of automation, but, in each and every situation, an effective balance between humans and machines. The paper suggests that to achieve this balance, which will change from situation to situation, the inherent nature of the people needs to be understood as thoroughly as the design engineers have to understand the technical tools available to them. The developing countries have many special cultural aspects which must be understood in order to design successful integrated systems. Understanding these aspects, though, is a question of not just looking at the indigenous cultures, but of studying the transient effects of the past decades of "imposed" cultures. The paper concludes with some suggestions as to what needs to be done to get developing countries back into manufacturing, both in terms of competing with the best, as well as meeting local requirements.

1. MANUFACTURING IN THE 1990s

Manufacturing in the 1960s and 1970s was dominated by dreams and predictions that people would be replaced by machines. This was driven, not by the seemingly endless achievements of technology, but by the apparent impressions given by technologists, economists, and politicians alike, that the only way that we, in the West, could compete with the amazing manufacturing efficiency of Japan (rapidly being followed by

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Taiwan, Singapore, and Korea), was to automate whenever and wherever possible. Somehow we perceived that this was the magic potion which we were lacking. There cannot be any doubt that there was, and still is, much truth in this impression, and the defenders of this "automation theology" who claim that automation has *not* put people out of work, are simply closing their eyes to what is happening throughout the world. Certainly, Japan has no unemployment, and Singapore has a massive shortage of skilled engineers. Employment, though, must be viewed on a global scale; together with improved transportation, the adoption of automation in the clothing industry in Europe has, for example, devastated manually-based production facilities in a host of developing countries. Japan and Taiwan have become net exporters of unemployment!

Of course, no one should ever doubt the importance of automation in every aspect of production: the rule is simple—technology is universal and available to all nations. Those who utilise the available technologies, which have been developed solely to support lower-cost and more rapid production, will win. Failure to produce an article more cheaply, more quickly, and of better quality than one's competitors, will simply result in there being no market for that product. The tumbling of protective politically-inspired walls, combined with genuinely open trading, taken against a background of rapid bulk transportation right across the globe, simply results in truly open competition.

Against this, it is irresponsibly naive to fail to recognise that we are faced with a sociological problem relating to work, the like of which we are only now beginning to appreciate. There can be no doubt that a significantly increasing proportion of virtually every nation is out of work and the prospects of this changing are extremely slight. This applies not only in mainstream manufacturing—the same picture is seen throughout every aspect of our lives: look, for example, at the mining industry. Why can Australia and South Africa ship coal to the UK more cheaply than it can be produced locally? Just visit a modern coal mine and the associated materials-handling facilities, and the answer is obvious. A totally automated coal-handling plant at Richards Bay in Natal loads coal at rates and costs previously believed impossible.

That we will change the very nature of work is often mentioned as the way ahead for the future. Whilst this premise is true, and most of this paper will address that issue, we have to be very careful as to how we interpret it. The very serious worry is that we continually see claims that there will be a massive shift of workers into the so-called "service industry". Somehow we think that the real opportunities will lie in working in restaurants or painting all the buildings we are going to build with our new-found wealth (which we will earn by automating industry). This is a very dangerous thought, since some of the most-advanced research is tackling these very so-called "service" areas. Automated fast-food outlets will be springing up all over the globe, automation in the construction industry is already being seen in many aspects of routine tasks, window-cleaning robots crawling up multi-storey buildings are at the prototype stage, and many so-called "developing" countries are well into exploring the use of robots, automated guided vehicles, and computer vision in agriculture. What, for example, will the impact be for secretaries when direct voice-input into computers becomes available (not in ten years, but maybe in two)?

It is not an emotional outburst to say that the whole fabric of our society stands at the brink of a new era. This has, of course, been claimed many times down the years, but it has never been more evidently true, and probably never before so misunderstood. Naive statements by politicians about job-creation schemes simply illustrate the gross misconceptions.

The blame for this, though, must be laid fairly and squarely at the engineers' feet; we are the creators of the technology and should be able to predict its consequences. The very low number of engineers in Parliament further exacerbates the gross misunderstanding. The only voices raised on this subject tend to be those of behavioural scientists, who so often present cases which are flawed scientifically, and hence defeat their own objectives; certainly, they are not listened to by engineers.

As professional engineers we have a moral and ethical duty to ensure that the situation is understood both by our politicians and by our industrial leaders. We also have a duty to ensure that our future engineering leaders understand the issues at stake.

This paper sets out to examine the problem in general terms, but will focus rapidly on the situation in the developing world; here the situation is seen at its worst and even the AIDS crisis is minor when compared to the economic problems, many of which can be laid at the feet of automation.

2. CHALLENGES FACING EUROPEAN INDUSTRY

The important summary report,[1] resulting from the European MONITOR Project, undertaken through the FAST (Forecasting and Assessment in Science and Technology) Programme states that world-class manufacturing is setting new standards of competition, based on the following production parameters:

"* Decline in mass production and increased importance of product variety, diversity and flexibility.
* Shorter lead times.
* Shorter product life cycles.
* Greater knowledge and service content of products.
* New links and demands between suppliers and customers in the production chain.
* Increased internationalisation of production and R&D."

Whilst these factors are now widely accepted as the driving forces behind modern production, it is relevant to read further through the report to see, firstly, how the multi-disciplinary team who compiled the report view the challenges to Europe and, secondly, how they suggest the challenge should be taken up.

The report suggests the seven major challenges facing our industry are:

"* Declining significance of price competition.
* Increased importance of product quality.
* Increased importance of product variety and customization.
* An ageing population coupled with a skill shortage in certain sectors of manufacturing.
* New demands for environmentally friendly products and processes.
* Increased intra-EC trade and competition post-1992.
* Increased social demands for socially compatible technology and more rewarding work, industrial participation and opportunities for the less skilled."

In addressing these challenges, it is suggested that a key lies in a new (?) approach to manufacturing. This attempts to combine the skills and creative ability of humans to make the most effective use of the potentials of new automation technology. The concept, which is really

[1] APS—Anthropocentric Production Systems: Modernising European Industry. Report from the MONITOR Project, FAST Programme, DG XII of the Commission of the European Communities, 1992.

simply sound engineering anyway, is referred to as comprising "Anthropocentric Production Systems". Disregarding the unpronounceable name, the vitally important concept lying behind it is a design philosophy which accepts that humans have, on the one hand, abilities which it is often difficult, too expensive, or even downright impossible, to replicate with machines. On the other hand, though, humans have a fundamental *need* to work. This question of need will be looked at in the next section. The first point, though, is important to address here: whilst there are a few areas of industry in which it is clearly desirable to operate without any human intervention (one can think here of the nuclear industry and many aspects of mining), in so many cases we see the need for using the human's ability to cope with certain situations in which even the most "intelligent" computing systems are at a loss. An obvious case is the handling of unexpected events. Many attempts at so-called "lights-out" operations have been unsuccessful or very difficult to justify financially. Most industrialists will admit that their best operators will always do better than any robot—the problem is to get the person to perform at that optimal level on a continuous basis, and to get other operators to work as well as the best. Thus, whilst a human inspector can inspect electric lamps far more comprehensively than any computer vision system,[2] even the most dedicated person can seldom continue to function fully effectively for more than a short period of time.

There are, of course, a host of other aspects of manufacturing which can be subjected to the "to automate or not to automate" debate, but it simply must be recognised that there will always be a choice—a choice which can be based on sound engineering design principles. Also, in most cases, the choice will not be a simple binary decision (humans or machines); a mixture is often the most effective solution. Hence, a properly supported plant operator is probably better equipped to handle a plant failure than either the operator or a computer alone. The whole question of design choice is, of course, much broader, since a design philosophy involves selecting objectives at their highest value-laden level. As Martin et al.[3] point out, the purpose of people in a system should not merely be to "staff" the system; the purpose of the system should be to support the people in achieving their objectives. As Martin suggests, we should choose a design philosophy which simply says that people are in charge. This leads to three primary design goals:

* Helping humans overcome their limitations (e.g., by coping with human error)
* Helping humans to enhance their abilities (e.g., their pattern-recognition skills)
* Fostering user acceptance[4]

Whatever the approach, the key is that there is always an opportunity to design systems which are a mixture of people and machines. It is just not acceptable to take the Luddite line that machines must not be used because they put people out of work (*that* will just put the whole country out of the manufacturing business), or the perceived Japanese line, that we should replace people by machines whenever possible.

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[2] **Rodd, M. G., et al.** Report on Research Project: Automatic Inspection of Electric Lamps. An ACME/SERC sponsored project report, University of Wales, Swansea, July 1992.

[3] **Martin, T., et al.** Appropriate Automation—Integrating Technical, Human, Organizational, Economic and Cultural Factors. Proceedings, IFAC World Congress, I, Pergamon Press, 1990.

[4] Ibid.

3. TOWARDS HUMAN-CENTRED AUTOMATION

If we accept the thesis that it makes good engineering sense to strive for a combination of people and machines, one of the most important issues in producing such systems must be to understand the driving force, that is, the human components. The point is simple: when we start to develop the solution to any engineering systems we have to understand fully the capacities, the inherent nature, and all the operational characteristics of the component parts available for constructing the final, total system. This immediately forces us to understand the inherent nature of our component parts—the people who will be part of the final systems. We know their physical attributes, but have, in so many cases, ignored the aspect which uniquely differentiates them from machines: their human nature. This is naturally a very complex subject, and well beyond the understanding of a mere electrical engineer. Thus, we need to look at what we are told by our professional colleagues—in the same way, maybe, that we can use advanced electronic devices that only a skilled physicist can fully understand, but which we can quite happily utilise in day-to-day design.

Of importance too, especially in the context of this current paper, is the very evident fact that each person is an individual and each national grouping has its own distinctive characteristics.

3.1 Why do we work?

This complex question has received much attention down the ages. One can argue that work is a vital aspect of satisfying our need to feel part of the community. Or, that there is a basic need to justify one's existence in the eyes of those to or for whom one is responsible. Or, that we simply have a basic need to do something other than sit around and contemplate our navels. Perhaps work is simply a logical and fair way to distribute wealth. Debates on these issues are best left to the professionals in the field. The definitive work by Maslow[5] provides many clues to understanding human needs; these are observed to include psychological needs, and needs for social security, for belongingness, for self-development, and for knowledge for its own sake. We will just choose here to take an engineering approach and adopt suggestions which seem to fit our own experience and observations.

Thus, following the lead of one of IFAC's (the International Federation for Automatic Control) leaders in this field, Lena Martensson, spelt out in her forthcoming paper on the roles of operators in manufacturing[6], it seems appropriate to look at the work carried out at the Royal Institute of Technology in Stockholm, Sweden. Edgren et al. present the resources and needs of humans as follows:

"Human beings have a real and an experienced capacity at (the) 3 resource levels: the creative, the perceptual-cognitive and the sensory-motoric. If this capacity is not being used at work, it becomes a need within the individual, a need that is being satisfied outside work instead of at the work place."[7]

In essence, it is suggested that individuals need to have three aspects satisfied in the workplace if they are to be content and fully contributory:

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[5] **Maslow, W.** Motivation—Personality. Harper, New York, 1954.

[6] **Martensson, L.** Operator roles in advanced manufacturing systems, to be published in Proc. IFAC World Congress, Pergamon Press, 1993.

[7] **Edgren, B., Islo, H., Johansson, G.** Computer Modelling of Manufacturing Systems. Report ISRN KTH/AVR/FR-91/4-SE, TRITA-AVF 1991:4. The Royal Institute of Technology, Stockholm, 1991.

they need physical activity, to be able to learn and logically deal with problems, and to be creative. Clearly, the level at which these activities are performed will be a function of the individual, but the principles make good common-sense, and provide us with a valuable insight into what we have to look for in matching people to the workplace.

This is, however, only one side of the issue; we must also examine the question of *why* people want, or indeed need, to work. Here the answers are not so clear and maybe one can best go on the basis of personal experience and observation. The problem is that the driving forces underlying the work ethic seem to be deeply culturally rooted, and so often simple theories do not match everyday observations. If one grows up in a family in which it is simply accepted that the norm is to go out to work five days a week, then that will be deeply ingrained in persons emerging from such an environment. So, for the Welsh valley men, with many generations of parents and grandparents going off to the pits or the steelworks every day, to have that pattern suddenly changed must be very difficult to cope with.

The young man desperately in love with the mother of his new-born baby, has a tremendous need to support the family unit he has created. The fishing-mad boy soon learns that he needs to earn money to allow him to pursue his hobby. The authoritarian little horror at school will clearly make an ideal hanging judge, and the child who loves to fiddle with transistors is going to have fun being an electronics engineer.

Others, though, will be brought up to see work as merely a means of getting sufficient money to lead a reasonable life. Not for them any idealism: work is simply a necessity of life, and should require as little effort as possible. Ensuring the time-sheets are maximised each week and that not a second is spent at work more than is absolutely necessary, or for which overtime pay is not available, is the order of the day.

Of course, all this sounds very cynical, and a slight on our humanity! However, as long as we assume that people are all fundamentally the same, and that we (as the fortunate 5% of the population who have had the opportunity to see work as more than a way to a wage) are representative of the rest of the population, will not be able to tackle many of the real issues of workplace satisfaction.

3.2 The reality of work

What is being said here is that it is vital that we accept people for what they really are; the models of the behavioural scientist may be all well and good in the ideal, but we engineers have to deal with the practical observations we make. What we do know is that the most powerful human characteristic is that of survival; and the way that most people in this highly complex world survive, is by earning money. Very few of us can do that and also find satisfaction and enjoyment in the money-earning process.

The statements made earlier about the three aspects which must be satisfied to ensure job-satisfaction are self-evident, but we first have to get motivated people to the workplace. The critical point being made here is that getting people to work, and then subsequently ensuring that they perform at their best, is a complex issue. It is clearly a function of the inherent driving/motivating force behind the individual. This, in turn, indicates the essential role that a person's cultural background plays in this process. This role of culture will form the basis of the rest of this paper.

4. THE NEEDS OF DEVELOPING COUNTRIES

That the world is in an economic mess is self-evident to even the most casual observer. But whilst we think our problems in the developed world are serious, we need to look at many developing countries to see the real disaster facing humanity. Most African, and many South American, Asian, and Eastern European nations are on the brink of total economic breakdown (and, indeed, many are over it). Devastating droughts, senseless political/ethnic/religious wars, inept or corrupt leadership and above all, non-viable economies, have led to famine and hardship as never seen before. This is exacerbated, tragically, by the wonders of modern medicine which have reduced infant mortality and increased life-expectancy. Whilst it is not the role of this paper to tackle the many critical issues hinted at above, it would be wrong to plunge into comments regarding production, etc., without first acknowledging that this is only one aspect of a far greater subject.

Turning, then, to industrial production, there can be no doubt that advances in manufacturing technology have, in so many cases, resulted in activities which had been labour-intensive (and hence, seemingly, appropriately undertaken in less-developed countries) having their fundamental basis shaken to the core. Twenty-five years ago it made sense to manufacture radios, largely by hand assembly, in Bulawayo, Zimbabwe—now it is cheaper to produce them by machines (with very limited, highly skilled labour), in Taiwan or Swansea. Likewise, with modern transport and automation, it is cheaper to produce a shirt in Spain than it is in Zaire. And the advanced computer-controlled greenhouses of the Netherlands can probably grow African flowers at a cost which is less than that of indigenous production plus the associated shipping and handling costs.

The key to understanding the shift must lie in the fact that technology is global and available to whoever wishes to exploit it. One of the few advantages any country can claim must lie in its natural resources and in its people. Even poor access to markets can be largely overcome, especially for smaller consumer products. The "people" question is very important; as has been said before, modern manufacturing increasingly relies on an effective blend of people and machines. Thus, in each situation this mixture has to be carefully examined. The consequence must be that, in any specific situation, the mixture could well be specific, too! Labour costs do, of course, matter, but equally so does the level at which people can operate. In many cases machines *have* to be employed in a country with the most desperate need for jobs—simply because the local labour force, maybe for reasons to be discussed below, cannot produce products to compete. It bears repetition here: manufacturing has changed, cost is no longer seen as the only important aspect of a product, and modern transport may well render the initial local production costs irrelevant in the final cost equation.

The bottom line is that manufacturing technology must be seen as universal: it is available to whoever wishes to use it. Individual nations have few inherent advantages—those which they have must be exploited to the full. One of these advantages lies in possession of natural resources, and it is here that many developing countries do have a potential edge, being, in many cases, the prime sources of many strategic raw materials. In so many cases, though, such raw material are now purchased from developing countries, at prices set by the *purchaser*, processed in the purchaser's country, and then returned to the country of origin at orders of magnitude increases in price. In the case of steel products, for example, stainless steel can cost up to a hundred times the original raw-material price.

However, getting any developing country, or indeed any country, back into the manufacturing game, will require a recognition that any production facility must be optimised to produce products which compete on a global scale, and must be designed to take into consideration all local factors. In searching for the appropriate mix of humans and machines, the local situation is critical, and so is the need to understand, and subsequently to use as the basis of the design of a manufacturing system, the *cultural aspects* of the humans who will be involved.

5. SOME PRACTICAL REALITIES OF CULTURAL ASPECTS OF DEVELOPING COUNTRIES

As a precursor, it must be said that the comments which will be made below are based primarily on personal experience in African, predominately Southern African, countries. However, having made extensive visits to many Eastern countries, and having also being involved in several Eastern European countries, the author feels that many of the observations might well be transferable to other environments.

In examining the effects of culture on modern manufacturing, the three fundamental aspects which were suggested earlier, viz. physical effort, learning and reasoning, and creativity, are obviously key considerations in determining job content. The prime issue, though, is that the workers must first be brought into the work place, and then motivated so that the three factors become relevant. In most less-developed countries one cannot afford the luxury of assuming that potential workers are similar to those whom one might find in an advanced country—say, Sweden. (Even then, one must wonder if any simplistic assumptions are possible?)

Also, it should be pointed out that the problem is not just one of examining the inherent culture as it is usually understood. The reality is that most developing countries have only recently emerged from periods of "imposed culture"—which in the majority of cases has been in some form of colonialism. The politics of this will not be dealt with here, but the resulting consequences cannot be ignored. In so many cases these effects will be more significant than those of the original indigenous culture; what has been left in many cases is often the worst of both.

The starting point, though, is of course the indigenous culture: here it must be appreciated that there are major differences from those seen in, say, Europe and the East. In many cases, stable societies were largely devastated by the arrival of the colonialists, whether politically motivated or travelling in the name of God.

The colonialists set about to exploit the countries—largely to the benefit of the home bases. Likewise, the missionaries attempted to convert the indigenous people to their own beliefs and norms of behaviour. In both cases there was the assumption that these were somehow "better" and more "civilized". In theory, this should have led to a situation in which the indigenous population was "converted" to a point where they were at a similar level, in terms of perceived development, to that of their rulers. So, in theory, when (for one reason or another) the colonialists departed, they should have left countries in which there were a significant number of persons capable of functioning at a level comparable to those in the so-called "civilized" world.

The reality is very different: only in a few cases has this ideal occurred. Besides some very basic political differences, there are many other reasons for this, amongst which one can find the following:

* *Inappropriate education*
* *Perceptions of education*

* *Task-specific training*
* *Culturally inappropriate training*
* *Rejection of imposed culture*
* *Lack of suitable "role models"*
* *Inactive or inappropriate trade unions*
* *Total lack of life-skills education*
* *No concept of continuing education*
* *Lack of appreciation of modern economics*

6. THE WAY AHEAD

The point that must be underlined is that modern manufacturing is not just all about acquiring the right technology. Rather, manufacturing is now all about designing appropriate technologically-based solutions, based on a blend of the best possible technology with the best possible contributions from humans. The resulting solution should be optimal, both in terms of production efficiency, and in terms of satisfying people's basic need for work and a fair distribution of wealth. These objectives seem very attractive and can set the scene for a new, rational and humane approach to manufacturing. This approach is, it is suggested, one which can easily be transported to most other aspects of employment.

But when we are faced with applying these ideas in any real environment, it is painfully obvious that the inherent nature of the humans involved must be taken into consideration. We are not all alike and we do not all fit into any convenient sociological model of human behaviour. And yet we are all driven by some simple primary motives, though these may differ from age to age, from nationality to nationality, and indeed, from culture to culture. Any generic model will fail—simply because it ignores the most universal characteristic of our human race: the rich diversity.

When approaching the question of manufacturing in the developing world, then it is even more vital that these diversities are fully appreciated. European, Japanese or American models of people and their capabilities and potentials cannot necessarily be applied in other situations, even though the parameters which are used to construct those models can be. Any assumptions made on transferring norms will be false and may lead to disasters such as those we see throughout the developing world.

What is needed is no simple matter to determine; maybe, above all, we need to apply some good, practical human-engineering practices to each individual situation. The key, though, to solutions has to lie in the cultures themselves. Manufacturing systems must be designed with the local cultures in mind: the problem is that whilst the developed world can provide the technology, it cannot, from the outside, even start to understand the intricacies of cultures and particularly, the impacts the past centuries have had on them.

What is vital is, clearly, to assist in technological awareness and in the establishment and updating of training and educational establishments. We must extend programmes of staff training to assist in creating a truly local engineering infrastructure, and those staff whom we *do* train should be sent home with relevant training and education; what is really needed are skills in manufacturing and process control.

Likewise, research (which is vital in any university, not only for the production of new knowledge but also for staff development and training in research methods) must be relevant to the local situation. Indeed, this is an important message for universities in developing countries in general. Too many still believe that to justify their existence they must pursue research in the same areas as those in the developed countries. This is

a total misconception and misses the wonderful opportunity to do unique work. Local problems are not trivial and are of great significance, and are best tackled *in situ*. Indeed, the development of appropriate technological solutions, designed to meet special circumstances, can well become an exploitable and, hence exportable, commodity.

What is required, then, at the higher levels of education is much greater effort within the developing countries themselves. The role of the developed countries must be to provide appropriate assistance, which in many cases must be in the way of specialist courses and research guidance, enabling the indigenous academics to handle local, relevant research.

The question of appropriate school-level education is self-evident; an appropriate comment here is the need for sound, relevant mathematics and science teaching—and the greatest problem lies in the fact that these subjects can only be taught properly if adequate support tools are available.

Mid-range, artisan and technician training is naturally vital, and must be of prime importance. Again, the developed countries can provide much assistance here—with the proviso that local conditions must first be appreciated, not only in constructing curricula, but in determining teaching methods and support requirements, and also in selecting acceptable teachers.

Turning to the question of actually designing manufacturing (or any technological) processes, the single, critical plea which is made in this paper is that this requires an appropriate blend of advanced automation and human integration. One of the vital points which must be apparent is that this implies that the overall design must be done in the local context. The developing world is knee-deep in plants designed in Europe, Japan or the USA and simply locally bolted together. This is just not necessarily appropriate, and constitutes poor engineering practice, especially when many of the plants are merely "polished-up" old versions, or indeed actual plants designed much earlier. Often, such plants become a burden on the target countries, who find, when the designers withdraw or the contract expires, that the plant cannot be locally operated or maintained. Without local input, the suggested new approach to manufacturing simply will never become possible in any situation. Also, however good the engineers and sociologists from developed countries might be, they will never be able to fully appreciate the intricacies of any local culture.

To achieve success in modern production, and at the same time to address the problems of providing employment, this paper has suggested that a new approach to engineering design must be taken. The keys to achieving this lie in true joint ventures between developed and developing countries. The technologically advanced countries can provide the technology, but the local conditions can only be determined by people from that environment.

7. THE NEED FOR PRAGMATIC POLITICS

The previous chapter explored aspects of strategies appropriate to creating a modern manufacturing capability within a developing country. Indeed it is interesting to note that in fact the aspects which have been discussed are, in most cases, equally true for a first-world country and for a third-world one. The thesis which was deliberately adopted in that chapter was based on the need to be competitive at an international level. The point that has continually been made was that in order for a country to compete it has to acknowledge the level of the competition.

However, it is really not feasible for any country, particularly those

which are now suffering after decades of devastation, to leap suddenly from where they are into a totally free-market environment—however desirable and idyllic this might seem. The realities are somewhat different and we will need really pragmatic political decisions in order to seek economically viable solutions. Of course we cannot deny any person access to the brightest and best that can be produced anywhere in the world, but in reality the bulk of developing countries are in such perilous straits that only a very small minority of their populations have a demand for such products. The real needs are for much simpler and more basic manufactured goods.

Of course this is not saying that a country should dogmatically continue to manufacture articles which, with a technological change, can be produced much more cheaply and more simply. An example here could well be a telephone system; it simply makes no sense to continue to produce mechanically based systems when it is far cheaper and far easier to build modern digitally-based ones. However, in so many cases the real requirements of a population are for relatively simple practical solutions to support their day-to-day existence.

The consequence of such pragmatic thinking must inevitably lead towards creating, in developing countries, a two-tier approach to manufacturing and production, on the one hand using the most basic of techniques to produce articles which (although possibly inferior to those produced elsewhere) do satisfy the immediate needs of the population, without involving an expenditure of foreign exchange or affecting the country's balance of payments. Examples here could include agricultural implements or many basic domestic articles. Clearly, such products must be produced as cheaply and as simply as possible; naturally they have to be functional but do not have to meet the latest possible specification. The second tier of production would be to produce articles that do compete on an international basis, within very carefully selected niche markets. Again, as suggested in the previous chapter, these could well be in areas in which local natural resources are available or where the people may have some attribute that enables them to produce articles better than other nations do, perhaps because of cultural advantages.

However, such a dual economy would still clearly require a high level of protection, the point being that there are very few articles that can be locally produced (even if they are as simple and basic as possible) and still be able to compete from a price point of view with mass-produced articles from highly automated factories elsewhere. This is indeed where the pragmatics come in, and some form of market protection inevitably becomes necessary. Just as producing products that could well be inferior to those available elsewhere is political dynamite, so is the concept of any form of protection by means of, say, high import duties. Unless we can tackle these two issues, we are simply not going to be able to face the reality that is so graphically staring us in the face right at this moment.

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MOODNE TÖÖSTUS KUI INIMESTE JA MASINATE SULAM

Michael G. RODD

Nüüdisaegne tootmine eeldab inimeste ja masinate head koostööd. Selle saavutamiseks on oluline, et süsteemide loomisel oleks inimeste sisemiste vajaduste arvestamisel silmas peetud ka spetsiifilisi kultuuriaspekte. Artikkel lõpeb soovitustega, mis peaksid hõlbustama Eesti tagasitulekut majanduslikult arenenud riikide hulka.

СОВРЕМЕННОЕ ПРОИЗВОДСТВО — СОТРУДНИЧЕСТВО ЛЮДЕЙ И МАШИН

Майкл Дж. РОДД

Современное производство основывается на сбалансированном учете интересов людей и возможностей машин. Для достижения этой цели необходимо не только глубокое понимание основных нужд человека, но и полный учет специфики и культурных традиций конкретного общества. В статье дается анализ ситуации в развивающихся странах, каковой является и Эстония, и выдвигаются предложения по восстановлению и реорганизации производительных сил этих стран таким образом, чтобы они были способны конкурировать на международном рынке и в то же время удовлетворяли местным требованиям.