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THE KNOWLEDGE BASE OF AN INDUSTRIAL ECONOMY

by
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THE INDUSTRIAL INSTITUTE FOR
ECONOMIC AND SOCIAL RESEARCH

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The Knowledge Base of an Industrial Economy

The true method of discovery is like a flight of an aeroplane. It starts from the ground of particular observation; it makes a flight in the thin air of imaginative generalisation; and it again lands for renewed observation rendered acute by rational interpretation.

Alfred North Whitehead

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Foreword

This project was initiated in 1983 by the Directorate for Social Affairs, Manpower and Education of OECD. The institute was asked to evaluate the educational and employment consequences of the emergence of a knowledge based information economy, especially the modern manufacturing firm. The modern manufacturing firm had been studied in several IUI projects, notably those carried out for the Swedish Computer and Electronics Committee (DEK). This paper from the Expert Group of Technological Change and Human Resource Development, also published in 1987 as Part I (Chapters I through IV) in "The Human Factor in Economic and Technological Change", in OECD Educational Monograph, Series No. 3, summarizes the results from several IUI projects.

We are particularly grateful to Dr. Jarl Bengtsson for valuable comments.

Stockholm in December 1987

Gunnar Eliasson

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Chapter I

A CONFLICT OF CONCERNS

> Central economic theory has to incorporate the four fundamental ideas of interdependency, value, process and institutions.
>
> Johan Akerman (1950)

Two items dominate the agenda of political leaders in the old, industrial world: a mounting open unemployment and an ominous loss of industrial competitiveness and hence, in the longer term, a decreased economic well-being and more unemployment. Many are worried about the unemployment trap from which a large fraction of laid-off workers will never escape. In some political circles it is even argued that the tens of millions of open unemployment in the OECD world has been caused by the introduction of new electronics-based information technologies in industry. At the same time there is widespread belief that the electronics "revolution" in its various manifestations will kick the economies of the industrial world onto a new, long wave of economic expansion.

The two concerns are political and social and in apparent conflict. The problem is economic. One could summarise the dilemma as that between the competence to renew and the ability to adjust, together making up the economic and structural flexibility of industries. It is important for what follows that both these abilities relate to firms as well as individuals. The time dimension is critical since it determines conditions of welfare and equity during the transition. Are those who absorb the adjustment cost the same as those who will later benefit, or are those who gain from preventing or postponing the adjustment of industrial and human structures to new technologies the same as those persons who will later have to be satisfied with a relatively lower material standard?

Competitiveness -- as we will demonstrate in what follows -- depends importantly on two factors: the ability of the economy to adjust both relative prices and industrial structures, the latter through the scrapping of commercially obsolete activities and the development of new, viable businesses. Scrapping releases labour. New development often requires more skilled or educated labour. If it is not available, new recruitment takes much longer than normal, and unemployment may follow.

Higher quality labour -- as we shall also argue -- promotes flexibility and adjustment and hence competitiveness, and consequently contributes to the solving of the unemployment problem.

Most of us would instantly agree that knowledge and human skills are what matter for economic welfare. Such a general proposition is trivial until we have defined empirically what we are talking about. Few of us would, however, venture a more exact hypothesis about the properties of the relationship between industrial knowledge and industrial output. And no attempts of the latter kind would be right since we simply do not possess, by any scientific standards, the necessary empirical knowledge.

This paper attempts to bring explicit awareness of the significance of human capital to bear on, and to develop a conceptual framework for, economic reasoning. This sounds pretentious, and it may be, but the implications are of a different kind. The removal and addition of small, seemingly innocent assumptions traditionally made in economic analysis simply destroy or change standard results on how (in economic terms) things work and what should be done. The modifications we will make relate to the nature of microeconomic processes (dynamics) and the fundamental instability of institutional and organisational forms as a consequence of economic processes. This makes the analysis of economic efficiency a comparison of new and old organisational forms, and welfare analysis the study of the adjustment process.

1. A Working Hypothesis for Policy Making

Lacking a concept of the whole of a dynamic economic system, the policy debate has focused on easily observed details and taken some of its participants into sometimes extreme or absurd positions. Unfortunately, we have got, as a consequence, a debate on robotics in process automation and what to do about chips manufacturing rather than a discussion of the educational needs to cope with emerging, unknown industrial technologies and adjustment problems. The quality of labour and its selection for various tasks in working life is an unavoidable problem in a study of how human resources are used in production.

The task before us is, of course, much too large for the compass at our disposal. We intend, therefore, to outline the policy problem as a whole rather than present a collection of separate pieces of evidence. And we offer the paper as a working hypothesis for policy makers for later checking and careful testing.

The observations and systematic evidence here presented are predominantly centred around the industrial firm in a broad sense -- an important restriction to keep in mind since manufacturing and private industry are rapidly becoming statistically blurred concepts. Even though private industrial firms represent only a limited part of the whole economy, it is there that technological transformation is initiated and where the demands on (and for) human resources will first be felt. Even within that limited sector, however, evidence is very fragmentary, so any conclusions drawn are necessarily a synthesis of fact and assumption. This is of course the traditional method in formulating a set of working hypotheses, and we will be

explicit where particular assumptions are critical for the conclusions and where more evidence is needed if decisions of any importance are to be carried out.

Within our area of inquiry most facts brought together concern the use of information technologies in factory production and how they affect workers. The reason for this is the great concern voiced in the 70s about automation, robotics, jobs and competitiveness. (For reasons of balance, this report is presented in two parts, the wealth of literature on automation and factory production being dealt with by Paul Ryan in Part II.)

Part I gives emphasis to the accumulation of high-level industrial competence needed to co-ordinate, control and transform entire business organisations. We focus in particular on the nature of the transformation process and its consequences for the inhabitants of the organisation at all activity levels and work stations. We highlight the growing service content of industrial production and the growing looseness of institutional forms. Non-process activities in the large, sophisticated manufacturing firms already use up more than half of the labour resources, measured by hours of work. Most of these non-processing activities concern the collection, analysis and use of information. In the Swedish economy, for instance, these firms dominate the manufacturing sector and export trade. It is, therefore, interesting for our purposes to study them as indicators of future structural development.

In this a lot of important guesswork has to be done before we can generalise from the fragmentary evidence available from these very sophisticated firms. To what extent, and when, will these patterns be typical for industry at large?

Our emphasis on the industrial firm can also be justified on other grounds. In our reasoning, it is the engine of the economic growth process. This assumption is in part a reflection of the industrial firm as being the initiator and carrier of new technologies. We also conclude that the generalisation to the entire private sector from sophisticated manufacturing firms will probably be reinforced if more evidence on the provision of information services is gathered. This assumption about the engine of economic growth is traditional in economic growth analysis. It is, however, based on some specific notions about the nature and relative efficiency of protected domestic production activities. In those it is implicit that protection per se, notably from competitive, innovative entry and market-forced exit, deprives the protected sector of qualities that are crucial for the macroeconomic growth process to occur. With free competitive entry and free pricing, for instance in the public sector (privatisation), the approach of this paper would have to be modified. In applying the conventional framework of discussion we can, however, keep our problem reasonably narrow, and deal with government as an infrastructure builder that supports (or blocks) the free market forces in the private sector.

However, a major part of our concern in this paper is a typical public, and regulated, activity in most western countries, namely schooling. It is tempting to ask what would be the result on educational output and economic performance if free competitive entry into schooling was permitted and

encouraged, allowing private enterprises to engage in previously public teaching, in competition with public schools, but retaining public financing of the schooling system.

We are asking this question bluntly and provocatively because two indications of this study are: first, that the most important human capital accumulation occurs before school (upbringing) and after school (on the job); second, new knowledge and skill requirements in emerging new industries make on-the-job accumulation of knowledge through varied professional careers relatively more important for productivity performance and personal job success. We are discussing aspects of learning that cannot efficiently be performed at school. Hence, privatisation of important elements of the educational process may be taking place endogenously, as part of the reorganisation of production towards structures that incorporate a constant upgrading of human skills on the job as a necessary cost of efficient production (see Chapters III and IV). It is therefore appropriate to ask to what extent this development is explained by the nature of knowledge requirements on the job, or as a result of an inefficient organisation of knowledge production in the schooling system.

This finally, leads on to an obvious restriction of our analysis: we are discussing the relationship between human resources and economic performance, meaning essentially economic growth. For reasons of time and practicality we have not, however, been able to concern ourselves with other important matters such as equity, fairness of income distribution or intergenerational problems, except for the financing of certain forms of education.

We do, however, bring in the notion of economic and political stability. Large shifts in wealth and income distributions, opportunities provided, and the like may cause instabilities in the political system that are detrimental to economic performance. If such shifts depend on the way schooling is carried out in an industrial society, the results of our analysis become even more important.

2. What Kind of Capital Matters?

Capital and labour have long been thought of as separate factors of production in economic conflict. Traditional economic analysis views higher capital intensity (machine and construction capital) in industry as the vehicle for economic growth. Hence, much economic planning has been based on the notion that more machine capital (or even cheaper financing of machine capital) is enough to trigger economic growth. As labour, enriched by skills and knowledge, is growing in importance as a productivity-enhancing factor, while pure capital inputs in the form of machinery and constructions are increasingly associated with negative economic signals, the relevant question is to what extent human capital confers productivity on both hardware capital and man-hours.

A notion present in much policy discussion about labour market problems is to what extent the economic value of the human capital endowment of an individual depends on what task he happens to be allocated to. A standard theoretical assumption is to make the productivity of labour independent of the task (the homogeneity assumption). Our study indicates that this

assumption is false and leads to misleading conclusions. Hence, in our conceptual framework, an employee behaving as a passive agent waiting for a well defined job to approach him, or for a labour market agency to take care of him, is going to experience a reduction in the value of his personal human capital compared to the potential open to him in alternative occupations. Three theoretical notions that are standard in much modern labour market analysis should therefore be mentioned here. The first is again that of the individual as the sole, active search agent in the labour market, regarding search time as an investment that will eventually yield a higher life income. Representatives of this view often argue that a higher open unemployment signifies longer search and, hence, may even be a positive welfare signal, a theoretical result that has not even been recognised in the political debate.

The second theoretical notion is that human beings have a well defined skill endowment that produces the same output and fetches the same price wherever it is employed.

The third notion is that the price paid for a unit of labour input measures the value of its marginal product.

All three notions are empirically suspect in their extreme versions and, while this may not matter in some contexts, it certainly does when we attempt to understand what goes on in a labour market. However, the fact that such assumptions are frequently present in theory and reasoning, and hence often in policy advice, means that any relevant discussion of human capital in the production process has to be theoretically and empirically explicit in distinguishing between schooling and the labour market process as a filter on the one hand, and as an investment activity on the other.

If selection rather than skill improvement and knowledge accumulation is what matters for individual and macro-labour market performance, then the standard post-war views on labour market policies and/or on the nature of unemployment are wrong.

The supply and demand situation in the job market is characterised by extreme diversity, both as regards demand for talent and skills, and as regards supply of talent and skills. In addition, the structure of skills demanded is constantly changing. This means that a tremendous matching problem exists in the labour market and that this may be as important a problem for individual welfare as the investment in human capital. The selection mechanisms matter and active search in the labour market is what effectuates efficient matching. The potential welfare gains from a reallocation of labour on jobs may be potentially very large.

We even venture to propose that the educational process at home, at school and on the job may be the major vehicle for search, partly because it shapes the attitudes to the job market and partly because it enhances the efficiency of search and of evaluating and capturing diverse job opportunities.

With this approach both human capital and economic search theory broadly defined carry an explanatory power to individual labour market performance. And their respective explanatory power has to be ascertained before we can say anything sensible about policies. In addition, what links the two extreme versions of theory together is the organisation of the labour

market process. This, then, with the dynamics of the process, becomes a critical, welfare-determining factor.

We have also inquired into the relationships between the educational process, knowledge creation, the rate of technical change and macroeconomic growth. We observe that technical change, as conventionally measured in macroeconomic production function analysis, is really related directly to the rate of (market-guided) structural adjustment of the economy.

On this score we have concluded that fast and stable macroeconomic growth requires two things:

-- A steady increase in the knowledge base of industry;

-- The acceptance of significant micro instability and diversity.

We will demonstrate in the next chapter that the second "item", being a side effect of the dynamic market resource allocation process, is a necessary condition for knowledge and technical change to be transformed into macroeconomic growth.

Educational policies have traditionally focused on the first, investment-oriented conclusion. The second, however, has become a pressing reality during the 80s. There is a positive and a negative side. Diversity is created through active innovative behaviour in existing firms and innovative entry of new firms. The exit function, on the other hand, can be a very destabilising experience for the individual affected. As a rule the skills required on existing jobs and on new job openings differ significantly.

There has been heated discussion in some circles on "deskilling" as a consequence of new technologies; the standard example is that handicraft jobs disappear and robots take over. What remains -- it is argued -- are simple supervisory jobs. So it is possible that, if simple menial tasks or menial craft jobs disappear, middle-aged job holders who have done nothing else in their lives are pushed down the job quality scale, because going the other way requires too much in the way of reschooling. We may have to face a generational problem here, but it is not a new one. We know, however, that there is no upper limit to the demand for skilled and educated labour. The evidence to be presented here is rather that lack of skills, knowledge and flexibility on the job is what holds back investment and production growth.

The conclusion, then, is that the educational and the labour market processes are critical for macroeconomic growth. They create and allocate knowledge and talent, and they help to reallocate and recreate talent and knowledge wherever these have become obsolete. It remains, however, to identify what "the knowledge base of an industrial society" is and what the educational process that creates it looks like.

To say anything with empirical content about these matters, we have to demonstrate how the modern industrial firm functions as a vehicle for national industrial growth and general economic wealth creation. This can be done with some ease, since most of us tend to accept this as a fact without argument. Nevertheless, it is a pedagogical oversimplification which in some organisational contexts is simply wrong, and in others, misleading -- if not elaborated with care.

The next step is to explain the nature of the modern industrial firm, its knowledge base and its implications for the human beings. This is more difficult.

A first notion to bring home is the continuing development toward a more abstract job environment and more abstract work tasks, removing the workers more and more from direct manual operation. This is nothing new: it has been going on since prehistoric times. But many observers are worried that an accelerated change will accompany the so-called electronics revolution and that an increasing fraction of people will be unable to cope with this new environment and will be forced into low level jobs (deskilling). We conclude that this prediction is wrong.

In support of our objection, it is illustrative to compare the so-called electronics revolution of today with the invention of the printing process. The printing process presented mankind with a new technique of communication that speeded up scientific development, which in turn preceded the industrial revolution. The use of this new means of communication, however, did not disseminate faster than the development of a parallel skill, namely, literacy. Communication is the essence of an innovative, industrial market economy. Electronics-based information technologies provide an enormous future communications potential. However, it will not be exploited faster than the complementary literacy requirements grow. The benefits will accrue first and fastest in those societies that develop this complementary human capital first. This is a typical educational problem. While the learning process has already started at the micro level as a response to demands felt in the market, educators and policy makers have begun to discuss "computer literacy" (see Moonen and Wuite-Harmsun, 1984). It is illustrative again to observe that this is often taken to mean the same thing as the "rote learning" of how to use a terminal. So the educational issue is as much a problem for the teachers, the educators and the politicians as it is for the young at school and the people at work.

A second aspect is the increasing professionalisation of the firm. It is both a matter of increased specialisation on difficult tasks and a matter of generalised operational knowledge. In both instances the career becomes the important educational vehicle and especially in the latter, where a varied career is the critical promotion path. The relative importance of education or career as an investment and a selection device is almost impossible to assess, but we can at least see that the higher in the management hierarchy a person climbs, the more compelling a varied career experience becomes in his selection. Experienced and successful executive people are a far scarcer resource at all levels than recently graduated electronics engineers, the difference lying in a combination of selection of the talented, and the learning experience acquired during one's career.

A good supply of such talent is what constitutes much of the industrial knowledge base of a society. It is not obvious what policy makers can and should do about this; but it is clearly beneficial if they never lose sight of the importance for an individual of education acquired through a varied job career experience.

An entirely different question is whether a development into a different "information society" is indeed desired. Are people ready for it? Such a question has, of course, no scientific answer; but we do know that a

gradual transition into a different society has been an ongoing process at all times, that human preferences are very flexible and -- contrary to the postulates of economic tradition -- are in fact an endogenous part of the economic process.

Culture, or the cultural tradition of a nation, has often acquired a design that contributes to a particular economic system or philosophy. This "culture" is an integrated part of our thinking, reinforced through the public schooling system to the extent that even "objective" researchers cannot abstract their analysis from their own cultural heritage. This is a trivial observation. In that sense cultural change is an element in the important economic information and indoctrination process of a society that this paper is concerned with, and an integrated part of the steady change of individual preferences that takes place. This is indirectly obvious from the ways formal schooling is designed.

As we will suggest, it is impossible to discriminate between cultural indoctrination and human capital investment in the schooling process. The economy may change faster than the culture can accommodate. The culture may change to facilitate or disturb the economic process. Part of the changes may be exogenous, but there certainly is a great deal of mutual endogeneity involved. These may not be appealing conclusions for the scholarly and educational worlds, but for the policy maker it should be natural to use the working hypothesis proposed here, namely, to see education and human flexibility as a pair and a means of solving the political equity and stability problems that are always critically present in a growing economy.

3. Who Benefits and Who Pays?

A political, cultural and moral superstructure has always existed in all organised societies. It is designed to monitor and control the more basic economic processes, concerned with the production of goods and services. However, the earlier dominant hardware production processes based on unskilled labour are losing competitiveness in advanced industrial nations. The information economy is mixing with the traditional production economy, creating an unfamiliar institutional float. At the same time new types of jobs with high skill requirements are opening up.

As a consequence, the labour market in the old industrial world is facing a difficult transformation problem. The main social problem appears to be located among the middle-aged, semi-trained people who have been in the market for an extended period of time and have acquired little or no experience from more than one job.

The young people are in a considerably more favourable position. Their education is new and they are prepared to learn a job. However, the search or experimentation phase may lead them astray, especially when the economy is in trouble and cultural preferences and values run counter to the efficient functioning of an industrial market economy. After a while the new entrants into the labour market belong to the middle-aged, semi-trained and less flexible problem group. There is even some evidence that children growing up in "unemployment families" tend to acquire a particular attitude to working life that makes them more prone to become unemployed themselves than the normal youth.

If there is a growing risk for certain, exposed groups of people to get caught in an unemployment trap for the rest of their working life, if they lose their job, what can be done about it? Is it an economic proposition for society to get these people back into work, or shall society accept the problem and bribe the unemployed into accepting their new role? Most of the jobs disappearing are low-skill jobs, heavy and not particularly healthy jobs. Helping these people over to new, educationally demanding jobs is very costly. There is ample evidence that the productivity of many industrial activities coud be greatly increased if work could be freely reorganised in such a way that total labour input would be reduced, but only unskilled labour laid off. There is also some evidence from Sweden that workers laid off from heavy, uninteresting routine jobs, when given a choice between a new, similar job and a generous early retirement arrangement, prefer the latter (Björklund, 1985a). Economic analysis often suggests that society pays people generously rather than attempting to solve an impossible adjustment problem and concentrates on avoiding a continuous repetition of the same problem. There is no comprehensive knowledge base to evaluate the social side of such policies and hence the whole spectrum of policy positions is represented. Whatever the position taken, job allocation is still a major problem and the task for the labour market must be:

-- To prevent (young) new entrants from getting stuck in low-skill, routine jobs (the labour market problem);

-- To provide for the development of new skills and necessary human capital (the educational problem).

It is unclear who is in charge of this undefined task beyond the individual himself, and we will develop that issue later. It is also unclear where and how the important investment in new skills takes place -- in the family, in the formal schooling process or on the job. That matter, too, will be given due consideration below.

4. What Can Politicians Do?

A concluding argument of this paper is that, together with basic societal services (legal system, defence, healthcare, etc.), attention to the educational infrastructure is probably the most important task of Government. The educational infrastructure also includes the rules of the labour market process. The scientific community, however, does not yet know enough to develop detailed policies related to the educational function. Perhaps this is the way it should be and the important public task is to attend to the orderliness of certain functions in an economic process, rather than guiding, monitoring and controlling them.

For one thing, the nature of human skills and knowledge that matters in the production process is extremely fragmented and for most practical purposes not known at any central level above the work place. Hence, the schooling or educational system as a whole cannot be deliberately redesigned as an automobile to improve economic efficiency. It can only be improved through gradual experimentation. Centrally imposed standardization of the schooling process is more likely to harm efficiency. This is especially so if local

experimentation with teaching methods is prohibited, the schooling system centrally controlled, and reforms hastily implemented, as has been the case in many countries.

Let me take a couple of examples. Suppose one can believe in education as an investment and that it takes place at school. Then one type of policy becomes natural.

However, if one believes, rather, that education is mostly a filter and that the most important educational experience occurs on the job in the form of a varied job career, then one would opt for entirely different policy conclusions.

If one believes that both the filter and the investment in learning matter significantly, together with upbringing and useful indoctrination at home, at school and on the job, then the policy issue becomes overwhelming if it is going to be run through a central authority. This is perhaps the most appropriate starting point for policy-making in the educational field.

A second observation to make is that most educational activities can be placed in the market. A free market schooling process as a rule, however, will present individuals with unequal opportunities. But there is a host of intermediate solutions between a centrally run, standardized educational system and a completely free market solution, and a number of them will both allow and stimulate micro-based experimentation that will eventually develop into a better system, at least from the point of view of economic performance.

One observation of this paper is that industrial technologies and skill requirements have always been changing. It is an open question whether they are changing faster now than they used to. However, information technologies may be opening up the opportunities to create a fundamentally different industrial environment, the details of which we cannot predict. We can nevertheless infer that the new work environment will be scientifically and educationally more demanding, requiring both the ability to work with abstractions -- in contrast to manual jobs and craftmanship -- and be flexible in performing diverse tasks. In addition to this, the ability to be creative and innovative will command a premium on future jobs, especially if the job development for talented people goes in the direction that we believe, away from wage- and salary-paying jobs in large organisations towards smaller-scale activities and self-employment.

Our conclusion is that this development will not be faster than the people affected will accommodate. Human capital and talent will be limiting factors. However, the speed of development will differ enormously between countries. And the major impact of new technologies will not come directly through indigenous investments in new technologies -- which rarely cause problems -- but indirectly in the form of competition from those firms at home or abroad that do it better than you. So whatever is done, the future work environment will be characterised by significant and unpredictable change when it comes to all those important details. The ability to improvise, to initiate change and to cope with change caused by others will be well compensated in the labour market.

This observation raises a third question: how do we prevent the formal schooling system from inhibiting initiative and destroying creativity among

the pupils? It seems a safe conclusion that the experimentation aspect, and search in the job market, will become an important characteristic of the future. The schooling system does nothing to facilitate that; rather the opposite, since it instructs you to be good at those things you are being taught, which is the knowledge base of the schooling system, and what teachers happen to know.

This introduction suggests the outline of the next few chapters. We begin in Chapter II with a well-rounded and quite speculative discussion of the nature and development of industrial knowledge based on published economic historical material. This allows us to focus in Chapter III on the emerging knowledge requirements of the modern firm, and to continue in Chapter IV with a discussion on how the human capital and industrial knowledge needed may be most efficiently created (produced) in modern society.

Innovative competitive entry in the form of new firms or new activities in old firms is the main vehicle for progress in industry, and for an education system that has gone stale from too much protection, repetition and subsidisation. Our conclusion is that if industrial policies are at all needed to help economic growth along, they should take the form of new labour market and revised educational policies.

Chapter II

HUMAN RESOURCES AND ECONOMIC PERFORMANCE: THE PROBLEM

1. A Few Observations

Recorded experience of initiating and operating "best practice" production establishments has inevitably been fragmentary and internationally dispersed. Ambitious nations have often believed that a faster transmission of those frontier technologies to their economies will speed up production growth. Literature, however, is rarely explicit about the complementarity between technology and requisite human knowledge. In the past some nations have gone quite far in encouraging the import of know-how and the immigration of entrepreneurs. It has also been common to send people to foreign advanced countries to learn about what is going on. Thus, the Swedish economist Westerman (1768) observed that Swedish shipyard performance in the mid-18th century was only half that in England and in Holland. He attributed it to the slower work process in Sweden, to lack of industrial knowledge, inferior methods of organising work and lack of "these new machines". What is interesting is Westerman's early emphasis on the importance of specialised industrial knowledge to know what to do with the machines and with labour. The literature has always recognised the critical importance of knowledge, but has rarely attempted to define what it is. It has been too difficult and, hence, has been passed over in economic analyses.

Statistics brought together by the United Nations and other international agencies offer a both interesting and frustrating picture of the current economic state of the world.

A not insignificant part of the world population still lives under technological and industrial conditions resembling those prevailing at the early stages of the industrial revolution in Europe some 200 years ago (Boserup, 1981).

While practically everybody can read and write in the industrially advanced nations, in countries of poor literacy the level of industrial technology is correspondingly low. In 80 out of the 130 non-communist countries in the world, encompassing the bulk of the population of the free world, literacy is below 50 percent (Boserup, op. cit., p. 13 ff.).

Table II:1

DISTRIBUTION OF COUNTRIES AND LITERACY AT VARIOUS TECHNOLOGICAL LEVELS CA. 1970

	Technology levels				
	I	II	III	IV	V
Percentage of literates 15 years old and over	12	29	46	80	89
Number of countries (per cent)	26	26	26	26	26
Percentage[a] of world population 1980	8	26	9	10	25
Dominant region	Africa excluding North Africa	Same	Arab region	America excluding North America	Europe and North America

V Highly industrialised

IV, III } Median technology

II Low or very low technology

I Pre-industrial or close

a A residual of 22 very small nations and China, making up 23 per cent of the world population, has not been classified by technological level.

Source: United Nations: Developing Countries and Level of Development, E/Ac 54/L81 Annex II (New York, 1975).

A high verbal literacy is of course not a good measure of the educational skill requirements to run an advanced industrial society, but it is a minimal requirement. And the simple numbers in Table II:1 illustrate what a basic, general education may mean for economic performance.

The percentage of a population qualified for higher education may shed some more light on the educational side of human capital requirements. Data put together by the OECD demonstrate for the industrialised countries that the wealthy industrial nations have a higher proportion of their age groups qualified for higher education. However, the correlation between economic wealth and higher educational achievements is not particularly high. The definitions of "education" are very diverse, and higher education is only indirectly linked to production. In wealthy nations education may even include a significant element of personal consumption.

What the relationships are between various forms of education and the economic performance of a nation is an extremely difficult question to answer. We will attempt later to add some precision to the concept of educational requirements and the content of human capital needed for industrial growth and to run a prosperous economy. In this chapter the discourse will be more general, attempting a frame for the later analysis. We will argue that the economic wealth of a nation is closely related to the private firm and particularly so to the modern manufacturing firm and we will proceed in the following two chapters to detail the nature of activities going on in such a firm and to outline the knowledge base and the skills required. It will, however, be useful to distinguish already here between the "functional literacy" that comes with a general education and training in a vocational school with the knowlege accumulated from, and the skills acquired through, on-the-job learning. We are already beginning to hear the term "computer literacy" referred to as a required endowment for careers in future labour markets. A study like this requires that we discuss what such a term may mean in the new "information society" that some social science philosophers claim they can see on the horizon. In the historic analysis of engineering education to follow, it will be very appropriate to discuss the need for "functional literacy" in the information society. It is illustrative to set this discussion against the perceived economic effects of "the printing press" over the last 500 years.

Before entering upon this, a few additional observations are appropriate.

The bulk of industrial (manufacturing) process techniques in mainstream engineering industries are based on metal-shaping machine tools, the principles and designs of which took form some 150 years ago (Hicks, 1977, p. 147). Around these tools a formidable capital structure of hardware installations and human skills has been built. At the same time, new combinations of new materials, shaped and fitted together with new tools and requiring new skills, seem to be developing. This has already made old traditional skills obsolete and forced them to exit where they have not been protected by government regulation or union practices. Since the growing, money-making firms are more frequently in industries using new materials and new tools, the old machine tool-making industries have lapsed into a situation of economic distress. The outstanding feature of recent advances in manufacturing technology, however, seems to be a shift from <u>process</u> towards <u>product technologies</u>, rapidly increasing skill and human capital requirements

and, as a consequence, significant increases of the service content of output (Eliasson, 1981, 1984a; Lindberg and Pousette, 1985).

A small delay in adapting to, or the inability of an (earlier) advanced nation to seize upon, this new combination of industrial techniques may rapidly throw its lagging economic structures into a situation of economic distress (Eliasson, 1979).

The road of economic history is littered with business ventures, national economies and economic policies that have not made it. Lack of appropriate knowledge, know-how or skills is the explanation usually offered. For the social scientist, however, to define human capital and relate it to economic performance, is not only a formidable task. It takes us far beyond available standard economic methods into fields like engineering, economic history, business administration and education. To arrive at a conclusion, the content of human capital has to be specified and measured. Reasoning will have to be quite speculative at critical places, and based on important prior elements of pure assumption. The conclusion of this chapter will be a working hypothesis for policy makers, the assumptions of which we will proceed to elaborate and to test in the following three chapters.

2. Breakdown of Total Factor Productivity

Students of economic growth using macro-production function analysis have consistently observed that -- during the postwar period -- most output growth in manufacturing, or the whole economy, could not be explained by measured inputs of hardware capital (machinery and buildings) and labour in the production process. This total productivity factor was puzzling in itself, and the riddle doubled when total factor productivity growth suddenly disappeared after 1973, in the wake of the first oil price crisis (Denison, 1962, 1979; Griliches and Jorgenson, 1967, etc.). Numerous scientific articles and books have been published on this subject. A relevant question to ask is whether the macroeconomic production function technique, applied generally, is distorting understanding of the macroeconomic growth process. Essentially, this will be my argument. The economic growth process is a micro-economic phenomenon, with the dynamics of resource allocation in focus. Understanding economic growth requires an appropriate dynamic theory that has to be explicit about the ways the market processes co-ordinate economic activities. We will illustrate this by breaking down total factor productivity growth in Swedish manufacturing, 1950-76, into a number of well identified elements.

The traditional (production function) approach is illustrated in Table II:2a. It demonstrates how an increasing fraction of total output growth in manufacturing cannot be explained by increasing inputs of machinery and capital and of labour in the production process. By the mid-70s, more than 90 per cent had to be explained by some mystic technical residual. Then all of a sudden, after 1976, this "mystic" residual disappeared throughout the industrial world (see Table II:2b). To answer the question of why it disappeared, one has to know why it was there in the first place, and this is no easy task.

Denison (1962) in a much discussed study approached the residual in terms of factor qualities that are not measured properly in available

Table II:2a

PRODUCTION FACTOR INPUTS AND TOTAL FACTOR PRODUCTIVITY
IN SWEDISH MANUFACTURING, 1950-76

Period	Annual Percentage				Percentage of output growth attributable to total factor productivity growth
	Production	No. of hours worked	Capital stock	Total factor productivity	
	(1)	(2)	(3)	(4)	(5)
1950-55	2.5	0	5.5	0.9	36
1955-60	4.8	-0.2	4.6	3.6	75
1960-65	6.9	0	5.4	5.3	77
1965-70	5.1	-1.8	4.8	4.9	96
1970-75	2.4	-1.8	4.6	2.2	92
1950-76	4.2	-0.8	5.0	3.2	76
1976-80	-	-	-	0.9	-
United States non-residential business sector					
1948-73	3.6	1.0	2.9	2.2	61

Source: Carlsson: "The Content of Productivity Growth in Swedish Manufacturing", The Firm in the Market Economy, IUI 40 years 1939-79, Stockholm 1980, and Aberg (1984).

Table II:2b

TOTAL FACTOR PRODUCTIVITY GROWTH IN MANUFACTURING
IN VARIOUS OECD COUNTRIES 1953-80

Country	Output growth (per cent per annum)	Change in labour input (hours worked, per cent per annum)	Total factor productivity growth, per cent per annum	
			1976-1980	1953-1980
Canada	4.2	0.8	0.5	1.3
U.S.A.	3.3	0.6	0.8	1.3
Japan	10.1	2.7	1.7	3.1
Denmark	3.9	-0.7	1.5	2.9
France	5.2	0.4	2.1	2.7
West Germany	5.5	0.5	2.5	3.1
Italy	5.6	0.4	0.3	2.9
Netherlands	4.8	-1.1	1.3	3.1
Sweden	4.3	-0.5	0.9	2.6
United Kingdom	2.3	-1.1	1.4	2.0

Source: Aberg, Y., Produktivitetsutvecklingen i industrin i olika OECD-länder, 1953-80, IUI Research Report No. 25, Stockholm 1984, Tables 5:4 and 6:2.

statistics. By correcting labour input for educational levels and similarly for other factors, larger inputs in the production process are registered, and the residual factor is correspondingly reduced, but not eliminated. Furthermore, the problem is that quality correction is more or less arbitrary guesswork. The extreme version of this kind of corrections is found in Griliches and Jorgenson (1967). They correct for quality by imputing prices to factors that derive from a profit-optimising model in a static market environment. If factors are appropriately priced, factor prices should reflect quality differences. If factor prices are imputed backwards from data on measured output, factors will be given values that roughly correspond to their contributions to measured output. The residual factor more or less disappears in Griliches and Jorgenson's study. Under the equilibrium conditions, assumed quantities are mirrored by prices and vice versa (duality), and productivity change can be measured by prices. However, the problem remains. Quality corrections are still there more or less through guesswork and prior, unexplained, assumption. But the approach underscores one important element of the problem: prices and markets matter for the productivity performance of an economy. The problem is how!

We will start from this observation. The above calculations neglect the importance of the dynamics of resource allocation when the economy is operating out of equilibrium and the duality property does not hold (Eliasson, 1985b). More or less efficient institutional arrangements, skill applications and flexibility in adjustment characterise the various countries. The use of information and the actual process of change are resource-using activities, and our explanation of total factor productivity growth has to take the effects of the market adjustment process into account. We have attempted that on Swedish data in two ways. The first is illustrated in Figure II:1. Simulation experiments on the Swedish micro-to-macro model developed at the Industrial Institute for Economic and Social Research (IUI) make up the other illustration.

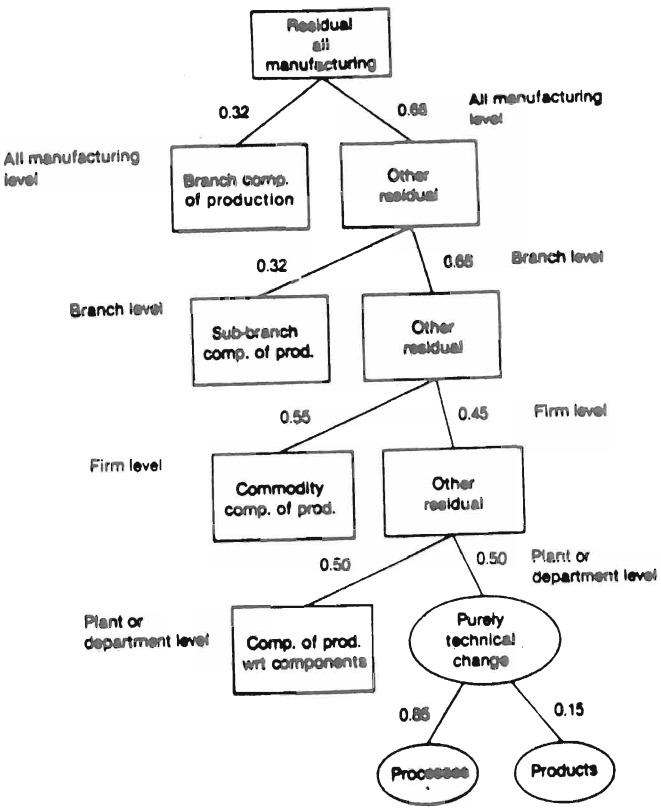
In the standard reweighing approach, traditional production function estimates were made on eleven individual sectors of manufacturing. We then found -- when comparing with the aggregate, industry total estimate -- that some 30 per cent of the total depended on structural adjustment in the allocation of resources between sectors, resources being shifted from the low-performing to the high-performing sectors. Taking one further step down to the plant level, in one industry sector we again found that 30 per cent of the sector's total factor productivity change depended on resource re-allocation between plants in that sector (see Figure II:1).

Similarly, when attempting to measure labour productivity change in new investment vintages ("best practice plants") we found that the average annual change over the 1955-75 period was around 2.5 per cent, compared to a corresponding aggregate industry figure of some 6 per cent. This was also the figure generated by the IUI micro-to-macro model (Carlsson 1980; Eliasson, 1979, 1980, p. 230 ff, 1981).

Hence, by these independent estimates, more than 50 per cent of productivity change as measured at the aggregate level appears to have been generated through a re-allocation of resources between <u>firms</u> and <u>plants</u> at the micro level. Simulation experiments also suggest (Eliasson and Lindberg, 1981, p. 381 ff.) that investment misallocations <u>per se</u> may not matter that much, as long as mistaken (non-profitable) investments are properly and

Figure II:1

COMPOSITION OF THE RESIDUAL TOTAL FACTOR PRODUCTIVITY
GROWTH AT VARIOUS LEVELS OF AGGREGATION IN SWEDISH MANUFACTURING



Source: Carlsson, "The Content or Productivity Growth in Swedish Manufacturing", p. 37 in The Firm in the Market Economy - IUI 40 Years, Stockholm, 1980.

rapidly scrapped. What matters is that you otherwise tie up labour in low-productivity plants, depriving high-productivity activities of labour input and raising the real wage level in industry above where it would otherwise be, especially in marginal expansion phases, thus holding back expansion in the high-performance firms. In fact, it has been possible to demonstrate in the micro-(firm)-based simulation model that, holding technology in new investment vintages constant, differences in long-term output growth rates as large as those observed between countries over the last 100 years (see Figure II:2) can be generated by simply varying types of market regime, that is, the parameters that set entry and exit frequencies and the speeds of new resource applications in response to prices and profit opportunities: in other words, the speeds at which old resources disappear and new resources come in.

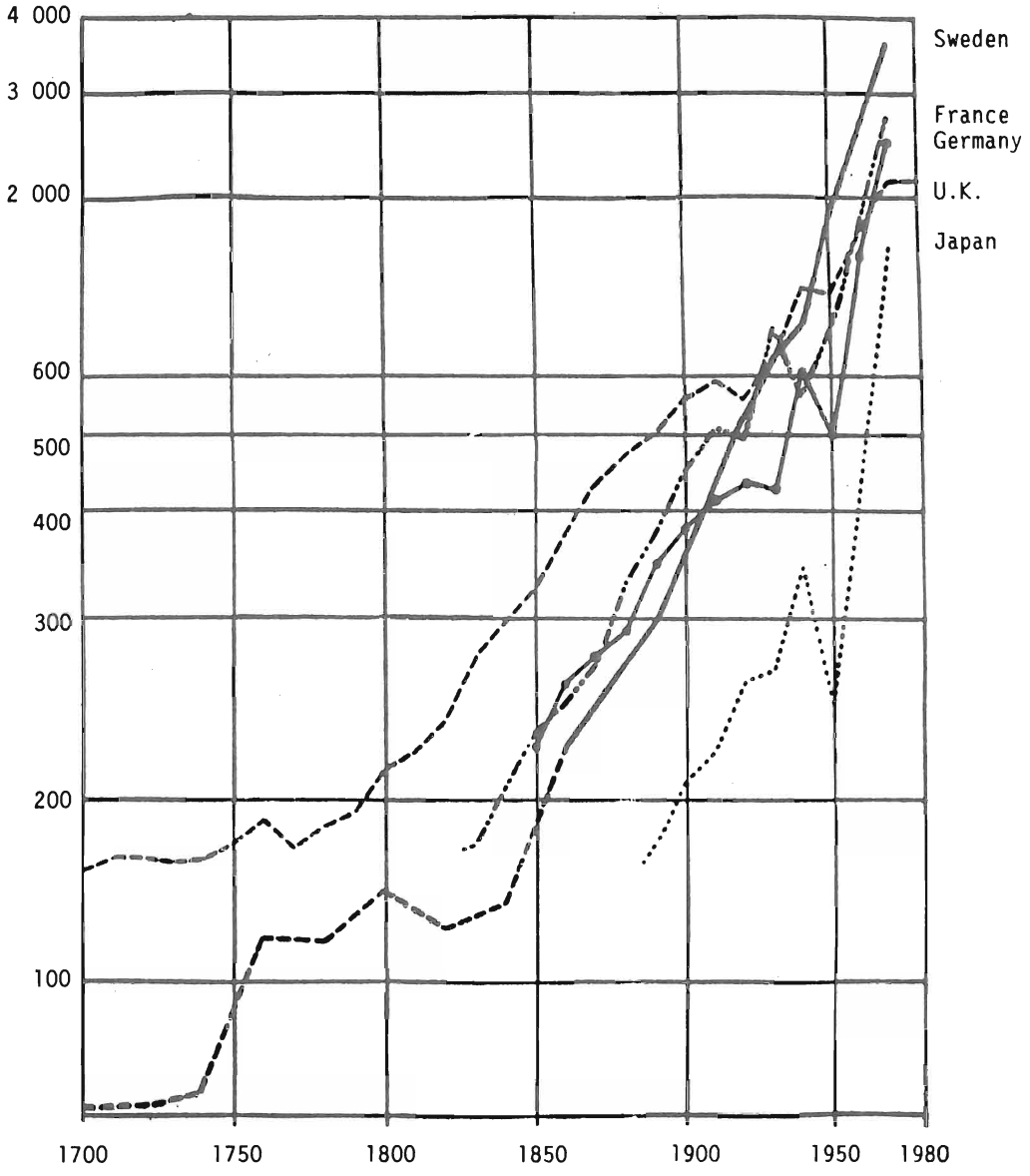
A survey of the literature of economic growth suggests that existing theories and thoughts can more or less be fitted into four categories (Eliasson, 1980b). We take Ashton (1948) and Solow (1957) as the representatives of the first (classical) macro-production function proposal. Ashton argues that new innovations in the credit market made capital cheaper. Thus, new and more productive capital was invested and the growth process, called the industrial revolution, started up in England. The main feature of this growth story is that improved productivity is embodied in the new hardware. What is needed to speed up growth is more saving to finance more and better hardware investments. It is an understatement to say that much policy making during the post-war period has been based on this notion of the economic growth process. This study will also raise and answer the question of to what extent an analogous theory of massive investments in human capital through more schooling can be successful.

The second type of explanation, the socio-economic, covers a variety of approaches, all placing major emphasis on the social, non-economic or semi-economic sides to economic growth. Weber, Schumpeter, Marshall and recently Olson (1982) belong here. In a stimulating but daring article, Wax and Wax (1955) place the cradle of capitalist thought and action in the Scandinavian Viking culture, well before the year 1 000. Recent archeological research is also proving the point that the Vikings, though armed and brutal, were more often traders and industrialists than robbers, and very much exhibited the individualist and democratic spirit that many researchers, among them Schumpeter, want to associate with a capitalistically organised market economy. Parker (1984) tells a similar story, but his begins with the Renaissance. The socio-economic explanation of economic growth emphasizes the economic-cultural-political environment as a factor in the growth process. One particular aspect of this is how the cultural climate influences attitudes towards "change" and "economic experimentation".

The third explanation we call the bureaucracy or (in modern terms) the industrial policy model. Here also the roots can be traced in history, European mercantilism being an example. It emphasizes the role of a central non-market body, like the Government or the King when it comes to organising an optimal growth process. It was commonplace in 17th-century Europe for the "dictator kings" of small and large empires to regulate the competitive entry process of the economy. Normally the ruler regarded the national economy as part of his private economy, a role adopted by some governments of today. The modern theory of economic planning, dating all the way back to the discussions of Taylor (1929), Lange (1936-37) and von Hayek (1940, 1945), is the core body

Figure II:2

GNP PER CAPITA IN DIFFERENT COUNTRIES, 1700-1980
(IN U.S.$ 1967, FIVE-YEAR AVERAGES)



Sources: Rostow (1980) and OECD statistics.

of thought that emphasizes, or rejects, the potential of a central overview of the allocation of resources, beautifully worked out within a static Walrasian framework. The traditional versions of this theory all presume that full information is feasible, at least at a cost, and hence directly contradicts the socio-economic explanation (1). The paradox that has to be recognised is that central economic doctrine (Keynesian and Walrasian general equilibrium theories) as taught throughout Western universities, lacks a theory of the dynamic market economy. Its assumption of a given number of agents or a given organisational structure confers upon it a strong "implicit bias" in favour of a centralistic planning solution, a fact that was not recognised in the Taylor-Lange-von Hayek discussion (see Pelikan, 1985).

A case for a market solution cannot be made within the framework of these theories without allowing competitive entry and exit and changing some fundamental assumptions about the availability of, and the costs of, gathering and using information. There are, of course, numerous soft versions of the bureaucracy model, all of them being manifested in the current ambitions of many Governments to develop a rational modus vivendi for a centrally-run industrial policy.

The fourth explanation we have attempted ourselves. We bring in a little from all three propositions, together with some elements of evolutionary economic theorising about technological regimes associated with Nelson-Winter (1982). We emphasize the initiative, and competence, of individual actors in the market, in this context notably the firms, and we set them up against each other (market competition), individuals and the political institutions. The notion of dynamic market allocation is that developed in modern micro-macro market theory (2). We talk about "market regimes" signifying their different efficiency features when it comes to handling resource allocation through factor markets. The individuals, through the latter, set a limit on the efficiency of the allocation process, forcing it to operate continually somewhere below its potential.

This explanation recognises the importance of know-how, but emphasizes both technical know-how and commercial know-how in a broader sense, thus removing the rigid connection between hardware capital and productivity improvements associated with the production function of the first hypothesis. It also emphasizes the importance of free trade and free competitive entry. We note that dynamic micro-macro market theory tallies nicely with the above decomposition of productivity (Figure II:1). It makes human knowledge, rather than machines and plants, the moving factor behind productivity change. When the requisite knowledge is missing, it does not help output, however much finance and hardware are supplied. With this approach the nature of the accumulation of human capital, and the allocation of labour become natural ingredients of the growth model; we need a micro-macro market theory. If special "elements" of human capital are important -- as we will find later -- we have also incorporated some of the socio-economic explanations.

In what follows, we will go through a number of issues related to the creation and dissemination of new techniques in an economy from a historical perspective with the fourth micro-to-macro growth explanation in mind. One purpose is to identify the institutions that carry the growth process, and to describe the roles of other institutional players. We will view the organisation of the market process and the use of information as two related, complementary technologies.

3. Why Industrialisation and Fast Economic Growth Started Earlier in Some Countries than in Others

A number of academic studies have been devoted to the question of why industrialisation started earlier in some countries than in others; and there are some historical indications as to an answer.

A commonly advocated theory has been that the sudden provision of physical (capital) resources in developing countries causes their economies to shift into higher growth gear and to take off. This theory has not worked well in practice. Resources have been wasted, the "bureaucratic" explanation of which would be lack of planning and coordination. The socio-economic explanation would be lack of proper infrastructure, or the wrong cultural environment.

With the exception of small, thinly populated countries that derive their wealth from an abundant, long-lasting raw material resource, one can observe that all wealthy industrial nations have been through a period of free capitalist organisation of their economies, prior to and during the industrialisation process. This can also be said to be true of countries currently experiencing very rapid growth in output.

If this is the nature of a successful capitalist, macroeconomic growth process, the outcome in terms of wealth creation between countries and between individuals will be highly varied. The important question, however, is to what extent prospective wealth creation moves the capitalist growth engine. On the basis of pure statistical records, it would be hazardous to bet on theories that propose that inequity in incomes and wealth creation do not matter as key factors behind fast industrial performance. It is obvious that supergrowth in the new industrial nations is closely correlated with very high rates of return, and profits reinvested in industry (see Chen, 1979). But it is also obvious that both high rates of return and fast growth depend on the ability of firms and nations to compete efficiently in world markets. This is all a matter of the created human capital endowment.

From all this, the explanation of the fourth market theory would be the commonsense one: if the requisite profit incentives and the necessary competence to use resources profitably do not exist, resources that flow in too easily or at a subsidised cost will be wasted. The answer, then, lies in the nature of industrial knowledge and how it is accumulated. On that problem economic theory has close on nothing to tell. What we know from historical studies is that if knowledge is to be accumulated from scratch at home, it is an extremely long-winded process. Strongly felt needs of survival may have forced (induced) new technological solutions. To speed up the process by "economic policies", however, operational knowledge has somehow to be imported, and in some countries military ambitions may have been the moving force behind fast technological progress. The following evidence would seem to support this explanation.

Raw material resources that can be profitably exploited have undoubtedly been a help in the growth process when a matching industrial knowledge has been present to make profitable reinvestment of the resource flow possible -- as in Sweden for the last 150 years, up to the early 70s. If the industrial knowledge is not present, or the resource flow cannot be channelled back to new investments, much or most of it winds up as public and

private consumption. This is a typical problem of the oil-rich countries including Norway, and to some extent Holland.

It is still a debated issue among economic historians whether the liberalisation of trade and production (the market argument) or technical innovations (the Schumpeterian view) or foreign demand (the Keynesian view) propelled industrialisation. A composite proposition is that when trade and production were formally and legally liberalised, the thrust of technological change had already in practice broken down the regulatory framework erected in the past. In that interpretation trade liberalisation was an endogenous outcome of economic development.

Those nations that deliberately or by chance have begun to accumulate the necessary human capital infrastructures and organised themselves on a capitalistic mode, have also, eventually experienced industrialisation and economic growth. A study of industrial policy making should look back into the economic history of today's industrial economies to see how early the groundwork for infrastructure and knowledge accumulation really began.

Heckscher (1953) is very categorical in arguing that the existence of an efficient central, administrative control system, dating back to Richelieu's days, prevented early industrialisation from taking off spontaneously in France. In England it was much less elaborate controls (and in particular the absence of an efficient monitoring and control system) that made early industrialisation possible. It is interesting to observe from Figure II:2 that the Swedish industrialisation phase took off later, at about the time domestic trade and new competitive entry in industry were liberated around the mid-19th Century. It is also interesting to note that a foundation of industrial knowledge for industrial take-off had been deliberately encouraged by the Swedish kings since the mid-17th century, through imports and immigration of industrial know-how (Heckscher, 1935, 1941).

Much, or perhaps most, of human capital accumulation is part of a learning process engaging the entire labour force. It has been very time-consuming. Above all, human capital cannot easily be brought in readymade from abroad and injected into the local population through a crash schooling programme.

From the Printed Word to the Computer

One reason for this study has been the concern that industrial technologies of the Western world may be suddenly and rapidly reaching a higher stage of sophistication that will compete laggard economies into stagnation and cause severe adjustment problems in the labour market. The emotive words have been "electronics", "computers" and the "information economy". This is not the first time in history that worries of this kind have been voiced. National authorities have been worried about the international competitiveness of domestic industries. Labour has been worried about jobs. A first and very similar round of debates on computers had already occurred in the 60s.

It is illustrative in this context to look at a technological innovation of 500 years ago: printing. Studies of historic, long-run growth processes have generally neglected the factor of production knowledge and

concentrated on the diffusion of technological innovations. The diffusion of information for hundreds of years through the printed word allows us to discriminate between these two factors. Printing technique was a pathbreaking production technology. It made it possible to pass on large volumes of knowledge in the abstract form of written information, which is a technology in itself. The use of that information required, however, a knowledge base in the receiver. He had to be literate. Eisenstein (1979, Chapter I) calls printing "the unacknowledged revolution". She goes on to point out that the contribution of the printed word to the development of an industrial society has been a matter of many centuries and it may never be possible to realise the full extent of society's debt to this information technique.

Parker (1984), on the other hand, passes over "printing" in the traditional way: the importance of communications techniques before 1850 has to do with physical transport of people and goods. In the second half of his section on communication, the economic "effects of the telegraph and the telephone" are discussed. Economic growth is typically propelled by physical innovations. He fails to observe, however, that none of the innovations he mentions would have been discovered or applied with success were it not for the ability to pass on information through the printed word. In fact, a money-based market economy cannot be conceived of without a complementary, extensive use of information techniques based upon this fundamental discovery.

Braudel (1972, p. 764) emphasizes that "one of the great borrowings of Mediterranean civilisation was undoubtedly the printing press which German master-printers introduced to Italy, Spain, Portugal and as far away as Goa". Later (1981, p. 3197) he refers to its contribution to the development of more efficient techniques of warfare ("artillery") and ocean navigation -- the printed word as a vehicle for transforming and transmitting the mathematical revolution of the 17th Century into practical applications. These two techniques helped Europe to achieve military and commercial dominance in the world for a long time.

But the capitalist market economies that began to develop in stages used information techniques -- and since the 16th Century the printed word -- as an integral part of innovative, productive and distributive activities. Eisenstein (1979, p. 8) also notes how the abundance of written records "affected" ways of learning, thinking and perceiving among literate élites. It affected the ways tradition was passed on from generation to generation. Barriers to the spread of information and knowledge were efficiently broken down and the way was paved for the age of enlightenment. Eisenstein also underlines that "standardization was a consequence of printing". Standardization and improved taxonomies are requisites for improved measurement techniques and, hence, an integrated part of scientific and industrial development. It is a first stage in the development of theory, measurement and quantification techniques. The development of mathematics certainly depended on the technique of printing, as is still the case for the diffusion and transfer of sophisticated skills of industrial society.

On the other side of the coin, the potential importance (indeed danger) of this was officially recognised as long ago as the early 1600s when the Vatican attempted to suppress all printed references to the unwelcome conclusions of Copernicus and Galileo (de Santillana, 1958).

Generalised and efficient taxonomies, standardization and mathematical thinking are key notions in the new, digitally-based information and communication technologies with which this study is concerned. For purposes of our further analysis of the commercial implications of information techniques, we will reformulate a distinction that Eisenstin carefully makes. The spread of printing first profoundly affected and altered the nature of communications within the already literate élite. Second, however, the advent of printing also encouraged the spread of literacy, although the latter, as can be seen from Table II:1, has been a fairly drawn-out process. In both cases the reason was that printing lowered the costs of communication, including teaching, and increased opportunities. If we generalise this observation to information technology in general, and modern computer technology in particular, we can say that the change in the nature of communication among those already "literate" corresponds to improvements in productivity experienced in already existing firms while the spread of literacy corresponds to the widening of the base of such improvements.

The latter is probably what matters in the longer run. It explains why nations and individuals have experienced a tremendous variation in success, and why the economic effects can be profoundly negative if a "nation is unobservant" and negligent.

The Knowledge Endowment of a Nation

This example also indicates the enormous size of the human skill endowment of an advanced industrial society -- something that its inhabitants normally take for granted, or may not even realise. Not even the devastation of the Second World War destroyed the industrial human capital endowment of Germany, only physical capital. But in a historic perspective the human capital of a country, by degrees and through political and institutional arrangements, can be made both to deteriorate and improve in quality and quantity.

It is difficult to be more explicit about the ways in which information is applied to generate economic growth. Almost all economic historians have concentrated their attention on the invention and use of physical means of production. These are of course important, and we will sift through the evidence in what follows. Our argument, however, is that the means of upgrading and co-ordinating the physical resources is really what matters, and that information and communiation techniques then become supreme techniques of industry. The capitalistic market system, the planning system or any administrative or management system are different "technologies" of using information to co-ordinate production. A few remarks are appropriate on the question of which of these is the most efficent mode of organising resources.

How to Release the Technological Potential of an Economy

Some authors (among them Boserup, 1965 and 1981) have emphasized social pressures as driving forces that have induced technical innovations. Throughout observed economic history and, notably, in the industrial age, they observe the occurrence of combinations of positive factors, like closeness to mass markets (Europe), immigration of a skilled work force (notably the United States), etc. Cohen (1977) argues that overpopulation in prehistoric times

forced a hunting and food-gathering population to leave a pleasant living style for a better organised food production (i.e. agriculture), harder and longer working hours and "civilisation". Ashton (already mentioned) suggested that credit market innovations released the tremendous industrial technology potential that already existed, and started the industrial revolution in England. Heckscher (1953), on the other hand, emphasizes the productive forces released when barriers to trade and new competitive entry were removed.

Major exogenous technological advances can pull the natural innovative process along by making it easier to solve pressing social problems. While some believe that the technological advances within the defense establishment have fuelled industrial growth, others point out that freely available technologies have been no blessing to the underdeveloped world. Some, like Vogel (1979), argue even that the large fraction of US economic resources devoted to defence and space-oriented R&D has significantly lowered its efficiency, compared to R&D investment in Japan, where practically all industrial R&D spending has passed the market test.

However, policies or more resources will do nothing to promote economic growth if the requisite knowledge base is not present. On this we know that ambitious and imperially minded kings of 17th-Century Sweden needed an upgraded manufacturing base to boost military might (Heckscher, 1941). The only way of doing that with some success in recent times was to import the knowledge. The kings of 17th-Century Sweden encouraged immigration of entrepreneurs and industrialists. It is interesting to note that the corresponding way today of introducing industrial knowledge fast and to obtain a skilled labour force is to encourage multinational firms to establish subsidiaries. The links between states and organisations like firms are, however, much looser than was the case as regards the immigrants who invested both their knowledge and their money on the basis of a "privilege", or a monopoly contract. They eventually became Swedes. However, manufacturing was slow to get started (3), but the knowledge base was there when demand for manufacturing products began to increase and resources started to flow from Swedish basic industry exports.

The steady improvement in heavy transport efficiency since the 18th Century "suddenly" moved producers and markets very close to one another. Competition intensified, old producers were forced out of business, and international specialisation to a degree not seen before became possible.

Governments could support this process or slow it down. Railroads were perhaps the most significant early infrastructure improvement. There was an economic rationale behind having the Government as a partner and even initiator in railroad building. Countries with an early start in this transport business today belong to the most advanced industrialised countries in the world.

Before Europe leapt ahead industrially during the second half of the second millenium, China probably had the most advanced economy in the world (Needham, 1961). The vast territory in China (and in India) was connected through a system of canals, built at enormous cost. The very existence of this canal system seems to have worked as a deterrent to modernisation of land transport through railroads, and hence, perhaps also took the steam out of industrialisation (Boserup, 1981, p. 160 ff.). Japan, on the other hand,

already at this time had a Government that positively interacted with the private sector to help and push industrialisation along.

It has been argued (Eliasson, 1980c) that the very steady, fast and long industrialisation phase of the Swedish economy was essentially due to the right, delicate interaction between private industry and Government. Until the late 60s, Government in Sweden predominantly meant local government, and it was here that most resources were devoted to the upgrading of an industrial labour force (health, education, insurance and, in the post-war period, moving labour to the jobs). The remaining resources were largely spent on building a transport infrastructure. Decisions on how to run businesses were completely separated from the political system.

Until the late 60s, public aspirations to take a part in the division of the output pie increased. By the late 60s, ambitions to regulate the decision process were growing. While the Swedish economic success story began just before the mid-19th Century when the economy was deregulated (see Figure II:2), it began to pale when the opposite happened in the early 1970s.

All countries that have successfully industrialised have relied on some domestic resource, the most important being a minimal amount of social discipline and economic abstinence. This has made it possible to abstain from consuming a significant part of the extra amount of consumption released by the industrialisation process, or abstaining from consuming an abundant raw material resource too fast (Eliasson, 1983, especially for the current Norwegian problem). A crude way of saying the same thing is that the social and political organisation is efficient in keeping the poor people from consuming the resources generated by the economy. Sweden is perhaps an outstanding example in this respect, where the rents of a fair amount of abundance of raw material resources were effectively shielded off from the consuming general public, and the public sector, until they had reproduced themselves through wage formation in industries built on the profits from raw material exploitation. The Government also restricted its ambitions, at least until the late 60s, to funneling resources into transport, health care and educational infrastructures and by degrees also into building a retirement insurance system. Altogether, the Government's main function appears to have been to provide a growing industry with disciplined, educated, healthy and insured workers and an efficient transport system. This was the tacit idea of the old Swedish policy model.

The historian has, however, for good reasons a professional inclination against overly simple explanations like the above for complex phenomena like the industrialisation process of a nation. The economist cultivates the opposite approach. It certainly is not difficult to compile long lists of pros and cons (from existing literature) in an attempt to explain the economics of the past one hundred years. There is always a strong wish to come up with something simple, a key notion or a variable that explains "it". A tempting such variable is "knowledge" or "education". Education by definition is the crucial investment element behind human capital. But this is simply passing over the issue by a verbal trick. What exactly is human capital? How do we measure it?

Literacy is a minimum, simple output of the educational process. And we have already observed from Table II:1 that you cannot run an advanced industrial economy with more than an insignificant fraction of illiterate

people in the labour force. What is the nature of the "minimum literacy" needed to run the advanced industrial society of today and tomorrow? In an effort to reach a "simplistic" explanation, quite a few studies have focused on the extent of technical and engineering education.

4. The Possible Importance of Technical Training and Engineering Education

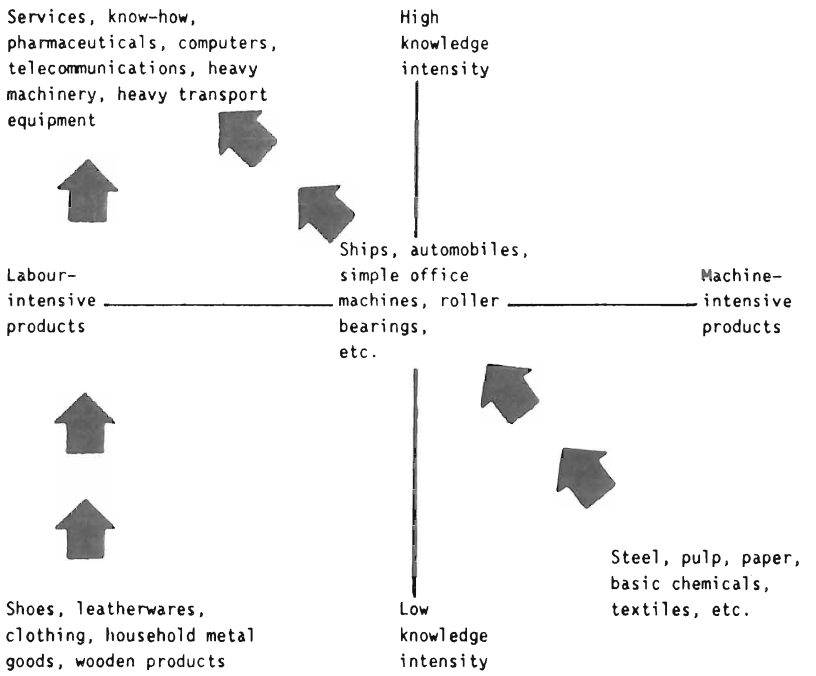
The competitive structures of manufacturing industries in advanced industrial nations have shifted considerably during the last couple of decades. Figure II:3 gives a summary overview of the Swedish situation based on a series of studies at the Industrial Institute for Economic and Social Research (IUI) in Sweden (see Eliasson, 1984a). It can probably be generalised to the other advanced industrial economies. The question is what forces have pushed this development, or made it possible. It is clear that the transformation of industrial knowledge and skills shown in Figure II:3 has been instrumental for Swedish industry in maintaining its technological lead position in European industry. This Figure well illustrates, too, the main theme of this book, namely, the nature and importance of human knowledge for economic performance and the nature of the investment process that generates human knowledge.

Immediately after the Second World War, Sweden was one of the few countries in Europe with a reasonably intact production system. Simple hardware capacity to produce and to deliver was enough to achieve high export growth rates in international markets. Hardware capital alone, however, soon ceased to be an indicator of competitiveness and rapid sales growth in international markets. By the middle of the 50s, it became increasingly important for export success to have a high hardware capital intensity of production combined with a high intensity of skilled workers. This signified the emergence of a fast-growing engineering industry in Sweden, and it is to be observed that a necessary condition for this to happen was the existence of a sufficient supply of not overpaid (in foreign currencies), skilled workers. Ever since the mid-50s, hardware-intensive basic industries that were low on human skills have been on a declining trend, drawing (at least in Sweden) a constant share of total capital and manpower resources, but generating a declining share of total profits and output.

By the mid-60s, a high fraction of skilled workers in the blue-collar labour force was no longer sufficient for success in export trade. Also, a higher fraction of engineers in the total labour force was needed, and hardware capital was becoming less and less of an indicator of competitiveness (Ohlson, 1980). By the early 70s, a high-skilled worker content of production was no longer necessary for export success. This could mean two things: either skilled workers had become overpriced in relation to their productivity and wages in other countries, or other factors had taken over. Evidence in favour of the former hypothesis is provided from an IUI study on foreign direct investments in Sweden (Samuelson, 1977) which indicates that US firms that had successfully invested in skilled worker-intensive production in Sweden for exports in the 60s, were curtailing such investments in the early 70s, or closing their plants. Wage overshooting (the "cost crisis") in the mid-70s meant a further competitive squeeze for process-based industries. Evidence in favour of the latter hypothesis has become increasingly obvious during recent years, notably in the ongoing shift from a process towards a product-based industrial technology (Eliasson, 1984b).

Figure II:3

FROM MACHINE CAPITAL TO KNOWLEDGE CAPITAL



Source: Translated from Figure in Ohlson, L., "Att utmönstra industrier med goda framtidsutsikter", supplement till Vägar till ökad välfärd, DsJn 1979:2.

Throughout the 70s, engineering-intensive production gained in importance as an export success signal and by the early 80s, the "three leg" nature of competitive Swedish firms was well established; high (1) R&D and (2) international marketing-intensive production carrying the competitiveness of (3) domestic hardware production for exports. Key competitive factors were clearly to be found now in product technologies rather than process technologies (Eliasson, Bergholm, Horwitc and Jagrén, 1984). There is even some evidence (Swedenborg, 1979) that the more R&D-intensive domestic production is, everything else being the same, the more inclined firms are to produce for export in Sweden rather than to supply foreign markets from factories outside Sweden.

Most of R&D spending in Sweden takes place in the large firms, that also account for the bulk of foreign investment. The bulk of R&D spending is devoted to new product development and the bulk of foreign activities (about half of the labour force in the 30 largest exporters, about 35 per cent of the total manufacturing labour force) concerns various forms of marketing or market-oriented production (Eliasson, 1984a). It is obvious that educational, or high-skill-intensive kinds of production, dominate successful production for exports in the large Swedish firms. The transition to this new industrial structure occurred during the 70s, pushing the traditional raw material, rent-dependent basic industries into the background. Since the mid-50s at least, skill-intensive production has dominated Swedish industry to a rapidly increasing extent. It is even more important to know what exactly -- in the form of industrial competence -- was required to engineer the highly successful transition from a crisis-loaded industrial structure in 1975 to a very competitive and advanced industrial base in 1986 -- a transition many other industrial countries have yet to achieve (4).

Before we come back to this difficult question, we must attend to a number of other items, beginning with the extent and importance of engineering education in economic growth in a historic perspective. There has been much speculation on this matter built on poorly systematised evidence. Gerschenkron (1966), for instance, believes that a fast economic payoff from systematic instruction in engineering schools after the middle of the 19th Century was critical for industrialisation. Landes (1969, p. 150) is much more sceptical about the short-term effects of such engineering instruction, but emphasizes the long-term effects as something self-evident.

Bergh, Hanisch, Lange and Pharo (1981) suggest that one of the factors behind the faster industrialisation of Sweden than of Norway was a much earlier (fifty-year) start of systematic engineering instruction. Petersson (1983) finds that machinery capital and engineers have been complementary factors in production. As is implicit in the title of Ahlström's (1982) book on German, French and Swedish engineering education, and fairly explicit in his summary of results, engineering has meant something, and probably a lot, for industrial growth. However, this does not mean that we can plot quantitative measures on the extent of engineering education over time in various countries on one axis and expect to see strong correlation patterns between the relative rates of growth in output.

A comparison of Figures II:2 and II:4 demonstrates that the relationship is much more complex -- even if it exists. The number of "comparable" engineers per unit of "comparable" GNP volume shows no relationship with GNP growth for the period 1870 to 1914. The stock of

engineers is growing roughly parallel in Sweden and in France, while the rate of growth is considerably higher in Germany. The engineering intensity (in Figure II:4), however, remains constant in Sweden because of a faster growth rate in the denominator than in both France and Germany, both of which entered the 1870s with a higher and more rapidly growing engineer intensity for production.

Systematic engineering education started early, and grew fast -- like railroad building -- in those countries that later became advanced industrial nations. There is, however, the puzzling exception of Great Britain. The industrial revolution began in Great Britain and, obviously, without any prior systematic engineering instruction. Even more interesting is that no, or very little, institutionalised engineering instruction developed later to support the industrial revolution during the 18th and 19th centuries. Industrial growth continued anyhow and "British engineers, entrepreneurs, managers and scientists emerged from a striking variety of educational backgrounds" (Weiss, 1982, p. 9). The "unlettered, pre-scientific tinkerer" (Mussum and Robinson, 1969) appears as the image of the British entrepreneur and industrialist. Since then, higher engineering education has been absent, or on a small scale, in Great Britain. In a couple of hundred years, it did not seem to matter, then all of a sudden it seemed to do.

Was systematic engineering knowledge less important in the first phases of an industrialisation process, only to become significant later? Is the situation different nowadays, for instance, in the underdeveloped world? Is it rather that only recently a science-based industrial technology has begun to demand systematically trained academic engineers to achieve competitiveness in international markets from a high wage production base?

What does the quality, comprehensiveness and orientation of engineering instruction mean for growth performance of the macro economy?

French technical education started very early (late 18th Century), in fact before the industrial revolution in England, and it obviously did not initiate an industrial revolution of any consequence in France. When the Ecole Polytechnique was founded in 1794, the reason was not to cure French economic retardation and make France catch up with British industrialisation. The British were seen as "a traditional enemy" and the reason for starting the school was the need for military engineers to confront them (Weiss, 1982, p. 13).

Another aspect of engineering education is its relative emphasis on science and vocational training and, in addition, its degree of vocational comprehensiveness. German engineers compared to British engineers are said to have a larger vocational element in their training and also a broader educational experience, including, as a rule, business administration and economics.

Having accounted for these factors to the extent possible, the density of engineers graduated in recent years does not appear all that different among countries (see Table II:3) except in Germany and (especially) Japan with numbers much above the average. One is rather wondering about the low density of engineers reported for Sweden and the United States, two advanced industrial economies supposedly manning the technological frontiers together with Germany and Japan (see Pavitt and Soete, 1981).

Hutton and Lawrence (1981, Chapter 3) emphasizes the "quality" of engineering education from the point of view of the later application of that education as engineers. They find again that German, Scandinavian and French engineering education has an edge in that respect over British engineering education. The latter has a distinctly more scientific, theoretical orientation of instruction, closer to the natural sciences. The importance of practical training as part of engineering education is also illustrated by the fact that while engineers from the highly theoretical departments of graduate engineering schools in Sweden went to industry, graduates in similar fields from the natural science departments at universities stayed in academia or became teachers or bureaucrats.

However, before drawing fast inferences from this observation, one should note the differences in orientation of the two lines of seemingly similar education, and the different recruiting sources when it comes to teachers. Engineering schools place a high premium on practical industrial experience compared to academic writing in recruiting professors or teachers, and they are concerned with solving industry problems rather than theoretical ones. Interaction with firms is strong. Quite the opposite holds for physics departments at universities. More similar conditions may prevail in laboratory-oriented sciences like chemistry and microbiology and one also finds stronger ties with industry here. The point is that the content of teaching may not matter so much, but the orientation of students and teachers does.

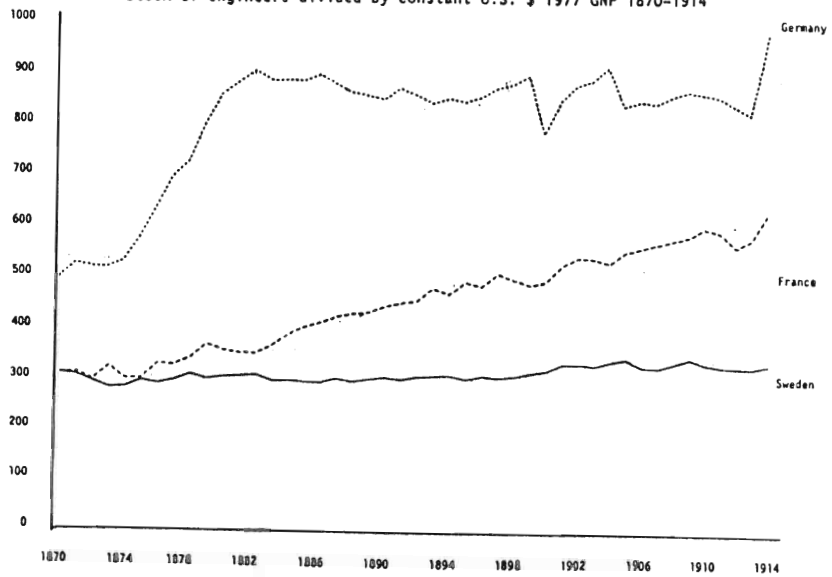
There is also the question of whether the practical qualities said to be observed in graduate engineers are a consequence of instruction per se, or are due to the filter provided by the admission rules to engineering schools.

In a study by Bartenverfer and Giesen, reported in Hutton and Lawrence (1981, Chapter 3), on German students intending to enroll in various graduate programmes, the would-be engineers were found to be very good students and interested in everything relevant to engineering, while they were not so proficient in languages, verbal fluency, and humanities in general. Their spheres of interest, furthermore, were narrowly practical. Other studies (see same reference) corroborate these findings and also label engineers as "convergers" rapidly focusing on practical solutions, while arts students tended more to act intellectually and critically as "divergers". Hence, again, the question remains unanswered, whether the engineering schools endow their students with a certain repertoire of useful vocational talent, or whether they filter out students with these other qualities through admission tests and other selection mechanisms.

A reliable answer to this question is certainly important for the formulation of good educational policies aimed at improving the industrial knowledge base of a society. And we still have not asked the question if industrial knowledge is taught at all at school. Perhaps what really matters is on-the-job learning, and the important task for schools is only to give a good pre-programming for self-instruction on the job. There is also the question of the kind of qualities that will be needed in the future compared with today. The human qualities desired for higher level non-production labour are vastly different from the skills demanded in factory workshops. As one climbs further up the career ladder, the ability to cope with complexity and variety to deal with people and, now and then, to reorganise your methods of work and business orientation gain in importance as elements in the

Figure II:4a

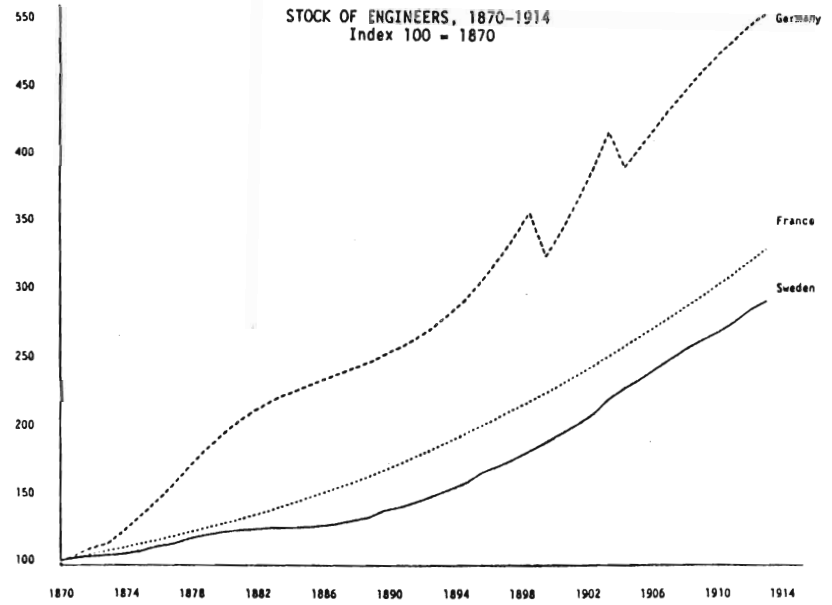
HIGHER ENGINEERING EDUCATION IN ENGLAND, FRANCE, GERMANY AND SWEDEN
Stock of engineers divided by constant U.S. $ 1977 GNP 1870-1914



Sources: Ahlström (1982), Kutznets (1971), Rostow (1980) and Maddison (1961, 1977).

Figure II:4b

STOCK OF ENGINEERS, 1870-1914
Index 100 = 1870



Sources: Same as Figure II:4a.

Table II:3

ENGINEERING GRADUATION AS A PROPORTION OF RELEVANT AGE GROUP

Country	Date	Proportion
United Kingdom	1978	1.7
Sweden	1977	1.6
France	1977	1.3
United States	1978	1.6
Germany	1977	2.3
Japan	1978	4.2

Source: Hutton-Lawrence (1981), p. 103.

knowledge base. Such talent is not taught at all at school; it is rather harnessed there, and as a rule in conflict with the assimilation of work skills.

As we will observe in the next chapter, the firm of the future will certainly present the individual with a much more "abstract" work environment than it does today. This is a continuation of a long trend out of the past, but the "information revolution" may mean that it will be speeded up. The rapidly increasing use of information technologies in industry, in any case, diminishes the relative importance of direct manual labour. To this we will return when we have introduced more facts about the nature of work in industry, and in particular about the nature of work in the emerging modern firms.

5. Cultural and Political Inclinations Matter

The "country squire" attitude combined with bad management and irresponsible unions have frequently been diagnosed as important sources of the British industrial disease of the post-war period: stagnation in the economy and the failure of one industry after another in export trade. Wiener (1981) gives a very different picture, however, of the British entrepreneurial class of the 18th and 19th centuries, as red-haired, uneducated, vulgar but shrewd industrialists and traders that saw profits as their main objective in life.

One factor in the cultural and political value formation that is particularly important on the innovative side of an industrial society is the status accorded to the bearers of technological change. In comparing German

with British engineers, Hutton and Lawrence (1981, chapters 9 and 10) note that the Germans undoubtedly have a higher status in society. They are relatively much better paid and they tend to work in industry rather than in the bureaucracy. The German engineers have, in addition, a less theoretical education which includes a range of subjects of vocational significance, such as economics, business administration and law (see also Crockett and Elias, 1984). Once we allow socio-economic and non-economic factors to enter the economic analysis, we are in an entirely new methodological arena. Above all, the causal lags explaining the formation of values in society work over centuries rather than decades and take us outside the current technology of measurement. Where should we look for the beginning of the Western capitalistic culture? Who began it? Phoenician travellers and traders, Italian Renaissance cities or the British pre-industrial countryman? Parker (1984) tends to favour the Renaissance. Wax and Wax (1955) want to place the cradle of capitalist thought and action in the Scandinavian Viking culture, more than a thousand years back in time. The written documents exhibit a production-oriented society with a no-nonsense attitude, strict quality standards on cultural attributes (bad performing poets were simply thrown out) and an extremely profit-minded, individualistic value system. Recent archaeological excavations have unveiled large-scale production sites for weapons and jewellery, organised for export, just north of Stockholm, dated around 400 AD (Holmqvist, 1980).

Schumpeter (1943) very eloquently hammers home the strong relationship between individualism, democracy and capitalism and sketches a dismal future where economies of scale in production will breed industrial concentration to the extent that the industrial and political establishments will merge and destroy both democracy and individualism.

Olson (1982) follows up on this idea, telling the story that success breeds its own downfall through the creation of a sclerotic institutionalisation of an economy. The welfare economies of Europe, obviously based on past economic successes, have been taken by many to illustrate this economic decline.

The story from these writers appears to be that a capitalistically organised, efficient economy has to be supported by an individualistic, profit and market-oriented culture.

The Swedish economist Åkerman (1950) once remarked that the four fundamentals of economics, "interdependency, welfare, process and institutions" all had to be studied in one context if one was to understand economics. Institutions are the carriers not only of information but also of the appropriate cultural orientation. Indoctrination and reinforcement of a "useful" value system then become an integral part of the information and educational system of society. The family, the church, the school and media are producers of such indoctrination.

It is obvious that attitudes and values play a role in explaining economic performance of a country. It is possible, indeed, that economics cannot take us beyond the notion of an exogenous generating mechanism for technological innovations; a deus ex machina, as seen by the young Schumpeter (1912). However, if most of what we call technological advance really consists of the ways existing resources are allocated -- as we will argue later -- and if the intensity of the generation of new technological

innovation really depends on cultural attributes like the commercial orientation of the value system -- as argued by Dahmén and Eliasson (1981) -- then we have at least an embryo for a socio-economic growth model.

Cultural, religious and political factors are extremely difficult not only to define and to measure but also to incorporate explicitly in economic thinking. There simply is no plae for them except as exogenous parameters entering the utility functions of individuals.

But in a context where human resources for economic growth are analysed, such factors have to be considered to understand the nature of the economic growth process as it evolves over long stretches of time. Do certain cultures have a value orientation that is favourable to industrialisation and commercial life in general? Does this mean that it is impossible to industrialise a primitive economy without ripping open its cultural system and established values? The interaction hypothesis also means that efficient economic performance creates new values and new preferences that may, in Olson's (1982) view, sometimes be counter-productive to the process that generated them in the first round.

The conclusion of Dahmén and Eliasson (1981) was that the culture of a successful industrial society had to be favourably inclined towards active economic experimentation among all its members, agents and institutions. The acceptance of free competitive entry in all markets and activities is one requirement. The willingness to accept change in various economic, cultural and political dimensions as a natural, pleasurabale and continuous part of a life experience, is another critical, competitive factor for a successful industrial society. This conclusion (or working hypothesis) carries far-reaching implications for the educational institutions of a country.

6. Free Competitive Entry Enlarges the Economic Growth Engine

The young Schumpeter emphasized the importance of creativity and innovative change for the capitalist engine to work, and for macroeconomic growth. The entrepreneur saw new combinations of techniques, talent and institutions that could be realised at a temporary, monopoly profit.

The Joseph Schumpeter of 1943, viewing the economic development around him, had changed his mind considerably. The efficiency of large-scale production techniques would generate enormous concentration and a threat to individualism, democracy and the capitalist market economy.

A series of simulation experiments on a dynamic "Schumpeterian" micro-to-macro model at the Industrial Institute for Economic and Social Research in Stockholm also suggest that without a steady inflow of varied, innovative technical change, strong tendencies toward concentration are exhibited -- the vision of the old Schumpeter. Perhaps even more challenging are the results that concentration breeds macroeconomic instability. Diversity in various forms -- structure, profitability, wages, etc. -- has to be maintained for stable macroeconomic growth (Eliasson, 1984b). The innovative entrepreneur is the main provider of diversity through the entry of new establishments that compete monopoly profits of established, large-scale producers away. More research has to be carried out to establish this property of a dynamic macro economy, but if the propositions are valid, they

suggest that we should reason in terms of the old and the young Schumpeter simultaneously. And there is a message for the kind of educational inputs, the attitudes and the properties of the labour market process that are needed for long-term stable macroeconomic growth.

The organisation of the economy, and its institutions in particular, become central for understanding the dynamics of markets and the growth process. And, above all, the preservation of a viable entry function becomes central for a viable capitalist economy. Controlling entry reduces both vitality and competition. One wonders why the regulation of new competitive entry (new establishments) is a key policy in all planned nations and that it is typical of the regulated sectors of the mixed economies of the OECD world where political influences carry weight. Taxes, domestic banking, schooling and hospital care are cases in point.

If the creation of new institutions or new activities that enter into competition with existing ones is central to a viable economic process, the first question to ask is what is meant by new entrants and, second, why their numbers vary so much within countries and between countries. What are the motives that move new competitive entrants?

We will restrict our inquiry in this respect to the private business sector, notably the firms. But this restriction probably precludes the most interesting illustrations. The labour market and the public sector are the most regulated parts of the mixed welfare economies when it comes to new entry.

New and more educated entrants into the labour market, of course, constitute a competitive force for the established group, and since time immemorial established workers have tried to squeeze out such competition through craft union requirements, restricted work practices, closed shops, etc. Many of these restrictions have been motivated by elaborate moral reasoning.

Second, the public sector is the largest single economic sector in most countries that practices restrictive competitive practices regulated by law. In most continental European countries, elementary and secondary schools are a public production monopoly. The main motive for the monopoly is to provide equal schooling opportunities for everybody. From this does not follow, however, the widespread practice that the actual production of schooling services has to be run by public agencies. As a rule the public production monopoly is supported by the teachers' unions. Competitive pressure on school performance in some countries, Sweden being an example, is additionally prevented by allowing little choice for the children or their parents as to schools.

If competition in the private sector, notably manufacturing industries, can be demonstrated to bring in new superior technologies, compete inferior productive units away or to force them to improve, thus fuelling the growth process, it should be a reasonable conjecture that this result could be extended to other sectors of the economy. (On this score we will note in chapters III and IV that the public monopoly of schooling is endogenously being eroded by technological change, making qualified education on the job and through careers more important, and through technological change in the sense that firms take on the schooling function themselves, perhaps because the quality of the public school system is unsatisfactory.)

This is the first critical proposition of this section. If competitive entry is more generally allowed or stimulated, removing public and private monopolies, economic growth will be speeded up. Under such a market regime, the supply side of the entire economy, not only the private industrial sector, will constitute the engine of the growth process (a Schumpeterian term). Barriers to trade are as harmful in public as they are in private production.

7. Government Infrastructures

The role of government in the economic process has been subject to much discussion in recent years. One could even talk about an awakening after the illusion of an all-informed, benevolent Government disintegrated in the 70s.

A study of the optimal size and organisation of public activity for efficient and fast economic growth would certainly warrant a special study. We do not have enough information to say very much, except that some welfare economies in Europe seem to have reached a stage of public involvement in the production machinery of their economies that does not contribute to economic welfare. Much of this negative involvement seems related to egalitarian ambitions that separate the value of inputs from its compensation to the extent that the intricate signalling machinery of a market economy gets disorderly (see, for instance, King and Fullerton, 1984, on capital income taxation).

In a historic perspective, we can describe public sectors as military machines that gradually took on the task of infrastructure builders to provide educated and healthy people for a growing industry that (to begin with at least) was mainly organised as a supplier of the military machine. The monarchs of the past long pursued what today are called industrial policies to promote manufacturing growth. Skilled craftsmen, entrepreneurs and industrialists were encouraged to immigrate and set up shop, not least in 17th-Century Sweden. Sometimes forecasts were wrong. Worrying about the long-term supply of high-quality oak for the naval shipyards, King Gustavus Adolphus had a large forest planted in the early 1600s. Now, some three hundred years later, the wood is ready to use. The development of orderly legal and enforcement systems, a monetary system, education and transport also meant building infrastructures that paved the way for an information and co-ordination technique to accommodate all the diverse transactions of growing market economies. The governments, so to speak, carried on positive, market-oriented industrial policies, stimulating and pushing activities that the markets were late in initiating. Education is one such infrastructure activity often pushed by "enlightened" kings. We should observe here that while the effects of human capital upgrading through education or health care showed up in the form of increased productivity in industry, the costs were incurred in the public sector (Eliasson, 1985b).

8. Education, Human Capital and Productivity

Where Does Education Take Place?

Human capital accumulation takes place in the educational system. Education takes place:

i) Within the family -- upbringing;

ii) At school -- formal education;

iii) On the job -- experience.

Even though a growing part of the resources devoted to education are used up in the public schooling system, the longest educational periods occur before and after school, at home and on the job. It is difficult to single out and estimate the resources devoted to education, since it is mixed with other activities. The resources devoted to schooling in industry may be much larger than we have previously thought (see Chapter V, 3), or quite small, indicating efficiency. It is necessary in this study to ask the question where the important, performance-enhancing qualities are acquired, and where efficiency in education is attained.

The School as a Filter or an Investment?

The educational process, as traditionally viewed by economists, was long seen as a human capital-enhancing investment, improving, so to speak, the quality of labour input in the production function. Educators normally took a broader view, seeing education as part of the social indoctrination system that was also part of the current cultural and political value system. In an inspiring article, Arrow (1973a) introduced the notion of education as a filter or a screening device, whereby the talented were distilled upwards in society and awarded a quality label (the diploma).

The filter theory is difficult indeed to test, and Arrow does not believe it to be more than part of the educational story. But if the filter plays any role, and in particular if it plays a dominant role, the implications for educational policies are far-reaching. And Arrow demonstrates mathematically that if the educational system is only a filter, society may be better off with no formal education at all. In fact, under certain simplifying assumptions as to the production process, "everybody would gain by prohibiting college". There will be no efficiency gains for society, because people are assumed to be as productive in one place as in another. The filter will draw resources, and inequalities in ex post incomes will be created by the filter. (Hirschleifer, 1971, produces a similar argument against "too much" research.)

A standard worry on the part of administrators of schools and universities are low levels of "graduation" on the part of admitted students. A typical feature of universities with tough entrance screening is that a larger fraction of enrolled students graduate with diplomas than in educational institutions with no, or low entrance filtering.

If school is predominantly a filter, worries about low graduation rates are justified, because many students will enter the labour market without the badge -- the quality label -- of many years of schooling. However, if schooling is a pure skill-enhancing investment, and if skills can be generally applied with the same output effects, there should be no reason to worry, at least not from the point of view of returns to society. The education achieved should have a productive effect on work where it is applied. However, where the quality label (the diploma) is missing, the individual may

command a lower value on the labour market, at least until a potential employer has learned about his qualities by other means. So, it seems, the diploma commands a monopoly premium. On the other hand, if the allocation of people with a widely varying endowment of human capital matters significantly in a modern industrial society, then the absence of a reliable quality labelling will mean a loss to society, since this information has to be reprocessed over again through labour market search.

Arrow's filter hypothesis should be seen as an attempt to rectify general equilibrium economics under a situation of limited information. In fact, education at school, or in general, may be considered as part of the job market search process.

One critical assumption of Arrow's theory is homogeneity of labour quality, irrespective of where it is applied. While qualities differ and are labelled by the educational filter, each labelled quality has a given productivity effect wherever it is applied. Without that assumption, Arrow could not reach the conclusion he does about college (see Ysander, 1978). In fact, the assumption is probably wrong: the school can be only one part of the quality-labelling procedure that persists in the labour market and the job career structure. It is only natural then to expect some educational programme, or labour market experiences, to give negative labels, like the stigma that may follow from participation in public labour market or retraining programs (Burtless, 1984).

Communication of Knowledge or Consumption?

One should also distinguish between education as a way of improving the intellectual capabilities of students (reasoning, etc.) and education as the communication of experience and skills from an existing knowledge base. If the two aspects can be viewed separately, it may appear that lower level training and apprentice work is of the second kind, while university education would include more of the first kind. This is probably not correct. Much in the high-level executive jobs in society that are reached only after a long career (a combination of apprentice work and selection) has to do with acquiring a complex base of both general and specific knowledge and experience. This is a form of on-the-job training that creates an extremely complex fabric of knowledge. We will discuss it in the next chapter in the context of high-level management of the modern firm.

There are also two other dimensions of education, and especially the public schooling programmes in the modern welfare economies with heavily subsidised education. Education has a sizeable consumption content. Schooling for many is utility-generating in itself, and the more subsidised, the less differentiated as to remuneration the job market, the larger the incentives to regard education as partly, or wholly, an act of consumption. This appears to be especially appropriate for some graduate university training. In some countries students are even paid salaries that are not much below the market pay they will later fetch.

Political Indoctrination vs. Efficiency

Public formal education has been deliberately used, in many welfare states, as a vehicle for egalitarian policies. Liberal educational policies of the 19th Century were based on the investment notion. Everybody should be given the same opportunity to acquire human capital. What happened after education was up to the individual. The more far-reaching egalitarian ambitions of some welfare countries are based on particular propositions of the economic effects of schooling. If, for example, important parts of the educational process take place at home, then the school should be organised to compensate for the effects of a low-quality home environment. Hence, schooling should be standardized, so that nobody acquires more human capital than anybody else. Kids should spend more time at school. The monopolies associated with particular educational categories should be broken down by expanding education in these fields, and so on. This conception of education is especially intriguing in combination with the filter hypothesis. If education is really to a large extent a filter, and if egalitarian policies that run throughout the system lower the job market quality of the educational output, then the low talented end of the student input may come off worse as a result of more such egalitarian schooling based on an erroneous assumption of what kind of service the school gave to its students.

A particular aspect of education practiced everywhere, although more in some countries than in others, is indoctrination. The educational system has always been allotted the task of instilling the value codes of the country in its pupils. These may include nationalistic attitudes, certain morals, discipline or particular political ideologies. All these aspects mix. Part of the overall result is a set of attitudes to various dimensions of life. A particularly important one is how the individual sees himself as a participant in the labour market process: as a passive waiting agent or as an active searcher for new opportunities.

Curiously, the willingness to take risks and the ability to take initiatives appear to be factors that contribute to a positive labour experience. If employers want to avoid people who are passive and unwilling to put in an extra effort when things have to get done fast, then they should pay special attention to records of past experience or behaviour so as to filter out the wrong people. This indeed seems to be current labour market practice. If acquired attitudes to work are such an important influence on actual performance, how much more should attitudes developed during 15-20 years of public schooling be a prime concern in educational policy making.

Let us summarise the various dimensions of education.

The Efficiency of the General Schooling Process

Educational efficiency has already been the subject of considerable research. The quality of schooling has been assessed through its effect on grades, and attempts have been made to relate grades to productive performance on the job, usually measured by income. In attempting to compensate for the filter effect, IQ tests are inserted to obtain a "mental" quality grading of the individual. However, experience and research for the most part confirm that school grades and IQ scores reflect the ability of students to pass

Table II:4

EDUCATIONAL PURPOSES

1. Investment - upgrading of human capital
2. Filter - labelling
3. Search - signalling, information gathering
4. Consumption
5. Egalitarian device
6. Indoctrination

through school, rather than their potential as candidates for the job market. There is even evidence of negative correlations, or for other factors mattering more (see Murnane and Nelson, 1984).

In fact, it has been extremely difficult to explain more than a small fraction of the variations in income by observed socio-economic characteristics. Jencks (1972) lists a number of reasons for this, among them "unobserved endowments of native ability" and differences in luck. Varian (1980) even makes the "randomness of income" his main point.

The Returns to Mobility

What literature tends to neglect altogether is the enormous diversity of job opportunities that exists in an advanced industrial economy, and that an almost equal diversity of talent or human capital must be a characteristic of the labour force. Arrow's filter theory, as well as the idea of using IQ tests to control the filter assume the existence of universal quality gradings. Hence the possibility that one quality grading (label) has more than one unique on-the-job productivity is disregarded by prior assumption. Hence, most of the allocation functions of the labour market are assumed away: a set of tests and exams are all that is needed. Job-oriented talents of various sorts may be correlated, but multi-talented individuals nevertheless face a broad menu of productive and gainful job opportunities, so much so that it is not always easy to make a final decision. Nevertheless, an individual's particular talent mix is always likely to have some productive applications somewhere at some relative remuneration.

If, in addition, the talent and acquired skills are not immediately apparent, one would expect the outcome of the "matching process" in the labour market to exhibit a significant variation even for equally graded or labelled students. Hence, the design of the educational system at school or in the job market increases in importance -- whether as a filter or as a mechanism for

identifying talent. The argument is very similar to that of comparative advantages and the growth effects of international trade.

A school can "filter out" people, but it can also "filter people in" to their right places in professional life, away from the wrong places. The job market and on-the-job training both have a filtering function. It must be as economical for society and the individual to have significant resources spent on a schooling or re-schooling process, mainly oriented towards helping individuals find the right jobs, as it is for manufacturing firms (as we shall see in the next chapter) to spend a significant part of their total costs on finding the right customer for their specialised products.

Holmlund (1984) demonstrates that it pays the individual to move and that mobility between jobs is the major vehicle for workers to improve their economic position. This also means that the value of their work effort and of their human capital increases. The fraction of workers that moves (in Sweden) is fairly low, however, and mobility has been constantly decreasing over the post-war period, an observation that underscores the importance of the design of the labour market search process. This is in marked contrast to the United States, where every tenth person changes job every year, and every sixth person moves house every year.

The Development of Internal Labour Markets

Holmlund (1984) shows that in Sweden job mobility initiated by the workers dominates. Layoffs account for only a minor fraction of all job separations. Labour market performance, however, depends on its institutional characteristics. The growth of large-scale business has meant that the labour market within the firm increases in importance.

At the same time, the human capital vested in individuals appears to have become more firm-specific (Holmlund, 1984). This observation emphasizes two policy conclusions. General education, currently offered in the public schooling system, is becoming more important, if general education increases the ability to acquire and retool specific human skills. Second, the shorter the life of specific skill investments, the more important internal firm retraining programmes become.

If school is mostly a filter, and if transaction costs in the labour market are high, then being careless in choosing your job, and especially the first job, will be costly. On-the-job search for new jobs seems to peak at an early age, when transaction costs are probably relatively low. For workers, search activities peak at 20-24. At that age about 20 per cent report some on-the-job search during the year, a figure that comes down to 5 per cent for 50-year-old workers (see Albrecht, Holmlund and Lang, 1985).

Not only employers are uninformed about the productivity of workers as in Arrow's (1973a) filter analysis. As Holmlund (1984) emphasizes, workers also have to learn about the job through actually trying, which may require a sequence of moves. If the situation is that a wide spectrum of differently combined talent meets an equally wide spectrum of talent requirements, the first trial step in the labour market is unlikely to lead to an optimal, or even a good, combination. In a simulation model, Nichols (1980) has demonstrated how more efficient search improves both the position of the

workers, their productivity and their pay. In such a (labour) market setting, the value of an individual's human capital, irrespective of how it has been created, is maximised when he has found the "right job". Hence, the optimal design of the overall search process in the labour market is crucial for individual welfare.

Welfare can be reduced if laws enacted to protect workers on the job simultaneously sharpen the employer's screening procedures and reduce the payoff from worker-initiated search activities. The same can be said of progressive taxes designed to equalise after-tax incomes that reduce incentives to search. This also makes search, and the whole labour market allocation process, socially costly, by making inflation a necessary condition for the creation of sufficient incentives to move. Indications are that the total Swedish labour market programme, currently using up resources exceeding 3 per cent of GNP for a given inflationary target, may even have increased unemployment (Schager, 1985a, 1985b).

Search for new job positions is associated with various forms of uncertainty both for the employer and the worker. Hence, if successful search is to be easily initiated, it probably requires both previous practice and obvious pecuniary benefit. Increasing uncertainty and reducing compensation for search is probably debilitating for the individual, since it reduces the control the individual exercises over his own situation in the labour market (Magnusson, 1981; Seligman, 1975).

Two critical questions have so far been distilled out of this discussion:

-- To what extent does individual productive performance depend on skills and to what extent on job allocation?

-- To what extent does education in a broad sense contribute to an increased skill endowment and to what extent does it label or filter people?

The two distinctions run between the effects of investment, on the one hand, and market allocation on the other. And without some empirical control of the relative importance of these two factors, educational and labour market policies will be mainly groping in the dark.

Empirical testing -- or rather the formulation of empirical hypotheses to test -- requires that one takes both alternatives into account simultaneously, rather than exclude one through prior assumption. The latter has been current academic practice. The former, the only acceptable way in a serious policy context, requires a close look at the production process, which we will do in the next chapter. Before that, however, we will look at the traditional agenda of discourse in this area, and try to firm up a bit on a few provisional hypotheses to guide us through our area of application, the work environment in a modern industrial firm.

General or Specific Skills?

Becker (1964) introduced the notion of general and specific skills. General skills (by definition) could be transferred from one job to another.

Specific skills were developed on the job location ("on-the-job training"), and lost in value when the worker moved.

General skills were thought to be acquired at school, specific skills on the job. This gave a nice division of labour between the public schooling system and the firm as an educational institution.

For the sake of a theoretical argument, this may be a convincing distinction. It is still, however, an open question to what extent the same distinction carries any empirical meaning in a highly specialised industrial society. Work life is full of specialised skills that can be transferred to many jobs (welding, computer programming, etc.). Many of them are not taught at school. On the other hand, the public education system teaches a variety of skills with extremely limited applications -- graduate university training in some fields being an example.

At the same time, it appears to be a widespread experience that the more there has been of general education, the more flexible workers are when it comes to intellectual retooling, labour market mobility and transferability between jobs.

The empirical content of such experience, reported ad hoc, should certainly be investigated further before being used for far-reaching policy decisions. However, they are convincing enough to be brought in as assumptions in a theoretical argument. Does more general education give a higher "skill" to relearn and readjust; does more education filter out those who have these skills from the beginning, or is more education in itself a form of practice in changing environment, communicating with new people, etc.?

Becker's (1964) distinction between general and special skills is not consistent with another, frequently reported, experience from the labour market. Employers are often said to refrain from investing in their employees' skills, because once the employee has been trained he or she will be in the market for higher wage or salary offers elsewhere (see, for example, Ryan, 1984).

Incentives for In-House Training

"Slave contracts", or a Japanese-style labour market, are said to be remedies for employers not investing in their workers' skills. However, a more market-compatible solution for the financing of individual investments in skills through on-the-job training would be not to pay the young person more than he contributes to the company on the margin, or less. The only reason then for the employer to hold back the opportunity for employees to learn more on the job would be the risk of dissipation of unique skills through labour mobility. At the same time, if young employees are paid more than they are worth to the employer on the margin, because of union contracts or tight labour market conditions, the incentive for the employer will naturally be to get the employee on a productive job as quickly as possible. Such a situation will discourage both employers and young employees to aim long term for a more qualified job through job-related training.

Similar arguments are often heard in favour of patent legislations. If temporary protection to cash in on an invention is not granted legally,

investments in innovations will be discouraged (see von Weizsäcker, 1984). Such arguments may be quite inapplicable when taken out of the narrow context in which they are often presented (Hirschleifer, 1971). If the innovator knows more about the innovation than others, Hirschleifer argues, he should also be the one best suited to exploit, most rapidly, the innovation commercially. This conclusion, in favour of the innovator, is probably wrong, for the talents to innovate and those to run a business are not the same, and a large part of both the innovation and the costs incurred are directly related to its commercialisation (see Eliasson, 1985c).

A similar information bias is, however, present in the labour market. And on corporate education and training programmes Hirschleifer's argument may yet hold water. The employer who trained the employee and who has monitored his progress will normally be the one who is best informed about his performance. If it is native talent that matters for productivity rather than acquired skills, the actual employer should always be willing to pay more for the best workers than for potential outside employees, and he should be very selective, and invest the marginal training needed primarily in his best workers.

The Importance of Information, and of Individual Search Initiatives

From the above it follows that a badly functioning labour market with passive workers who do not actively signal their competence to outside employers will lead to the creation of internal administrative labour markets within firms. If the employer has an information monopoly, his willingness to train his workers should be high, but he will allocate training selectively to the best. Lack of information on the part of potential outside employers will breed "implicit slave contracts" or lifelong employment relationships. There is only one efficient way of getting out of this implicit monopoly contract, namely, a more active, searching labour force. However, if labour is active enough to advertise its productivity features and to search intently for new job opportunities, it should also be aware of both the importance and the nature of good education and training. The young or the prospective members of the labour force should, therefore, be willing to invest in it him- or herself.

From an economic efficiency point of view, then, the whole question of employers being unwilling to fund corporate training programmes becomes academic in an informed and active labour market.

However, both in the monopolised and in the active and informed labour markets, useful education and training will go to the talented workers. The whole discussion about insufficient corporate training, or insufficient incentives for individuals to educate themselves, should probably be seen in that perspective. It is not economical for the employer to invest in not-so-talented individuals and it is not economical for the not-so-talented individuals to invest in themselves. The issue is one of welfare and distribution, and the most efficient way to achieve a "fair" outcome may not be to use the education system or to require firms to take on educational programmes which they do not find economical.

A well-functioning labour market requires efficient transmission of information. The most efficient information agent is an active worker

signalling his competence and looking for new opportunities. But information cannot be effectively transmitted from one workplace to another if demonstration periods cannot be arranged for entrepreneurial activities on the part of individuals.

The more protected from competitive entry the labour market is because of job security laws or union practices, the less informed employers will be about the capability of individuals. However, the more informed and the more mobile the labour market, the less inclined to invest in talented workers will the employer be and the more of the financing and the risk associated with educational investment will fall on the individual or the state.

One should, however, be careful not to pay excessive attention to the formal side of schooling and training. What is learned on the job itself may be as important for the job career as what is achieved through a formal programme. This is certainly so for high-level jobs. This is the reason why the firm as an educational institution deserves a special section in the next chapter.

To perform a simple task, or a complex task that repeats itself over and over again can, as a rule, be learned effectively through a brief introductory course and a "break-in schooling programme". The ability to perform well in this respect and then to produce efficiently is often well paid in the labour market. And many people appear quite satisfied with a repetitive work experience. Complexity may, however, increase because the technical nature of the production process changes and forces adjustment on the part of workers. It should be noted that repetitive work is not restricted to manual labour. Much office work and many academic jobs are extremely simple and repetitive or tend to become so, if the holder of the job opts for such a work experience.

However, at some level the exercise of judgement or choice between vaguely defined alternatives begins to be a critical job performance characteristic. Again, this is as common with manual as with other jobs. Complex machine service or repair jobs are good examples. An argument of the next chapter is that these kinds of jobs will become much more frequent as the industrial economy advances. The talent or skill required on such jobs is mostly acquired on the job and in particular through a varied work experience. Hence, active job market search or active career plans with companies or institutions may be what really matters for human capital accumulation. To what extent does formal education prior to, or parallel with, the job career contribute to such a learning process, and to what extent do restrictive work practices and labour market legislation prevent people from doing something with themselves in the labour market?

9. A Working Hypothesis for Policy Makers

It is not possible at this stage to reach clear and simple conclusions about the nature of human resources that generate economic wealth and what policy makers can do about it. But a rough working hypothesis for policy makers can be formulated.

To begin with, productivity growth (when measurable) is always associated with significant structural, institutional and organisational

change that also significantly affects everyday life of individuals. This process of change brings in new ideas, technologies and organisational combinations that make it possible to produce new things and/or more of old things with less input of resources. Hence, the better organised society is for such change, the more economic growth will be observed.

Also, the larger the fraction of the economy that is involved in the change process, the larger, proportionately, will be the engine of growth at work in the economy and the faster economic growth. It is wrong from a principal point of view to see the public sector as an alien part of the economic growth process, a burden that has to be carried by private industry. What we know is that the public sectors were quite small during the early phases of the industrial revolution, but at that time they often contributed to the growth process through introducing important infrastructural activities that did not spontaneously come about as part of the market process. However, today the public sector together with some domestic sectors that are typically protected from competition are the most conservative ones when it comes to structural and institutional change. Hence, it has become commonplace to look at private industry, and manufacturing in particular, as the engine of the economic growth process. But this is reasonable only under the special assumption that the typical market processes of competitive entry and exit are barred from the public sector, and other protected sectors as well (Eliasson, 1985c).

We have also concluded that the inclination of society to accept structural change or to allow it to expand into protected areas is part of the political and cultural heritage of a nation, that can be modified slowly through the educational process.

Again, the human capital resulting from the educational process at large is becoming increasingly more important for the production process, part of this input being an improved skill in moving, adjusting and relearning. This is probably a major explanation for the fact that a relatively shrinking private, and notably manufacturing, sector has been able to function as the central growth engine for a larger and larger load of public and protected activities.

The most radical solution to the perceived growth problem of the old industrial world that opened Chapter I would be to open up the entire economy, including the public sector, to free competitive entry and exit of institutions. Such a solution would most probably worsen the unemployment situation temporarily and in itself it is beyond the ambition of this study even to discuss this broader political issue. We note in passing that different countries have different borderlines between the private and public parts of the economy that often cut right across the classifications for institutions or economic functions. Thus, Harvard University is in the US private sector while the State University of New York is engaged in public activities. Government-operated business agencies are classified as private industry in Sweden and are part of the public sector in the United States. Hence, for practial purposes we take the politically imposed sectorial structures of the old industrial world as given and continue to look at the private sector as the growth engine that has to be reorganised over and over again to stay competitive in international markets. What kind of human capital inputs do the agents of the private sector demand, and will they demand in the future?

We conclude here that an endowment of continually updated industrial knowledge is what keeps production growth in industry going. Most of this knowledge accumulation takes place in the form of on-the-job training and selection in schools, in the labour market and through varied careers.

It will transpire in the next chapter that the emerging growth industries will require a different educational and training background to existing industries. Labour with the ability to handle abstract thinking and an ability to approach problems in multiple ways will command a premium in the labour market. Manual repetitive labour will be less in demand.

Here, we have already seen that ability and the willingness to move and adjust in the labour market depended positively on a good formal education and a varied work experience. The new entrants into the labour market from school undoubtedly have a competitive edge in this respect, and it looks as though the youth unemployment problem should be explained for the most part in terms of the market process, rigid wages and restrictive labour market practices (Björklund, 1985b).

Looked at this way, the labour market problem narrows down to two conclusions:

i) Economic growth depends positively on the availability of human talent. Availability is partly a question of proper schooling for the future job market. What it may demand in the form of education we will discuss in the next chapter. But availability of talent is as much, and perhaps mostly, a question of allocation of existing human resources through the educational system and the labour market. Our conclusion is that the more successful the macroeconomic growth process, the more dominant in this process the market allocation function will become.

ii) Individual welfare is directly linked to the adjustment process. As a rule, most people seem to benefit from this process, and the problem in the labour market can be narrowed down to one particular group, namely, those who have worked for a long time on simple, repetitive tasks in firms that happen to be competed out of business. This group appears to be difficult to retrain for tasks in the growing and more intellectually demanding industries.

We take up this problem in Chapter IV and conclude that, to be at all efficient, labour market policies should focus on the smaller groups that really have serious adjustment problems. For this smaller group more generous service can be afforded. Since these people have been in the labour market for extended periods of time, the service provided could, indeed, be regarded as the payoff from labour market insurance premiums they have paid in the form of unemployment fees and taxes.

In identifying and narrowing down the labour market problem to proportions that can be coped with, one could also loosen up restrictive practices elsewhere in the labour market and allow the competitive entry and exit process a freer play, with the likelihood that macroeconomic growth and new job openings will increase as a result.

NOTES

1. A technical note is required here. The feasibility of full information is closely linked to the notion of an equilibrium (model) economy (see Eliasson, 1985a, Chapter VII). In static, general equilibrium models in which information about the equilibrium can be gathered at no cost (the assumed "auctioneer" or central planner, present in all Walras-Arrow-Debreu-Hahn general equilibrium models) equilibrium and full information coincide. When information gathering becomes the dominant cost item, which is the case in manufacturing (see Chapter II), neither equilibrium nor full information are feasible states. The equilibrium becomes dependent on the technology of using information, which is a knowledge in itself, and so on. A whole array of solutions dependent on the state of knowledge are equally good. The nature of market search as a technique of gathering and using information becomes decisive for economic performance. Hence, socio-economic factors from hypothesis 2 come into play, and the optimal use of freely available information in the industrial policy model 3 is pushed into the background.

2. As in the micro-to-macro (M-M) model developed at the IUI (see Eliasson, 1976, 1985). Also see Day and Eliasson (1986). It is important to note that this is not the standard, general equilibrium Walras-Arrow-Debreu-Hahn etc. notion of a free market. General equilibrium theory includes no theory of the dynamic market process.

3. The military orientation of the Swedish state was probably not the right organisation for an innovative commercial activity. When military ambitions subsided, other industries than manufacturing were the first to experience a strong export demand pull.

4. It has to be noted that a significant share of the manufacturing labour force (some 5-8 per cent, down from about 15 per cent in 1975) is still employed in restructured crisis industries, and we doubt that these firms -- despite enormous subsidy grants -- will weather the next recession well.

Chapter III

THE MODERN INDUSTRIAL FIRM

1. What is a Firm?

The popular and (economic) theoretical notion of a firm has long been that of a goods-producing factory. It draws manpower from the labour market, savings from the capital market, and sends goods to the product markets for final consumption; and it takes prices in all markets as given, as long as it cannot exercise some degree of monopoly power. Veblen brought the notion home nicely in 1921 with the title of his book: "The Engineer and the Price System".

Received micro theory views the firm as a production function in the price system. This concept also has a strong hold on the minds of current commentators concerned with the economic effects of technological change. Technical change enters the standard production function as more or less unexplained shifts in materials processing performance. (It is difficult to tell to what extent this notion of the firm was adequate some one hundred years ago. We doubt if it was. Today it is grossly misleading, if valid at all.)

Apart from having a certain production function, the firm is first of all an administrative financial system that competes with the market for funds, people and customers. Second, the major advances in productivity performance, as we measure them, have to do with reorganisation of the internal life of the firm, or institutional change. Third, new forms of "soft" capital that are difficult to measure are beginning to dominate the "true" balance sheets of the modern manufacturing firms. The argument we will present here is that the bulk of activities going on in a modern economy, in the private sector of an advanced industrial economy, in the manufacturing sector, and within the firms consists of various forms of information gathering, interpreting and use. This in itself makes human resources the central capital item to consider in attempting to understand the workings of an advanced industrial economy. Modern information technology is making this focus even more relevant, a circumstance that places the educational process of a society at centre position in the capital accumulation process.

The transformation of input factors in the production process (e.g. labour, capital, energy) into some output measure is, of course, most generally embraced in the term "production function". This term has been repeatedly misused during the post-war period in the narrow context of a

simple relationship between aggregate inputs and aggregate output or to represent a firm or a production establishment, to the extent that we agree with Murnane and Nelson (1984) who argue that a new term is needed to convey what is going on -- especially if we want to capture the subtleties of human capital inputs in production. For instance, the specification and quantification of the "production function" are generally not known at the micro level or, for that reason, at higher levels of aggregation. Business management only vaguely knows the outer limits of installed production capacity and the properties of potential production technologies available. Hence the notions of a fully informed, optimal choice of production and of the firm always operating on its production function are simply wrong, and of questionable educational value (Eliasson, 1976, 1984d, 1985a).

Some of the knowledge applied in the production process enters as quality improvements in labour inputs that are difficult or impossible to measure; some affect the quality of capital service inputs. Much, perhaps most, is acquired though trial and error and experimentation (or learning by doing, to use Arrow's 1962 term). The most important knowledge inputs affect the ways capital and labour and other inputs are combined and are part of a decentralised organisation of knowledge (Eliasson, 1984d). It is "tacit" (using Polanyi's 1967 term). Hence, no database will ever be able to reveal the true, potential production frontier of a production line, a workshop, a factory, a firm or an industry.

The resources used up within a modern manufacturing corporation for physical materials processing, for instance, are less, or much less, than half of total resource use, and the fraction is diminishing (Lindberg and Pousette, 1985). Service production of many sorts (R&D, product development, marketing, etc.) dominates. Most of it consists of some form of information processing activity that is also a dominant activity in the market surrounding the firm. To capture these one has to redefine the concept of the firm for use in analysing the effects of technological change. The following three criteria have to be satisfied. We need: i) A reasonably autonomous decision unit; ii) Delimited by variables that relate to the objectives of the managers of the decision unit; and iii) An (elementary) unit that exhibits reasonable definitional stability. The most obvious candidate is a financial definition of the firm, delimiting an intersection of the institution and the markets for money. This definition of a firm comes fairly close to the firm, or the group, presented as a decision unit in its annual report.

Generalising our discussion to the entire private sector makes our notions of production and of the firm even more appropriate. The non-manufacturing part of the private sector is currently the rapidly expanding sector. It is expanding for two reasons: a rapidly growing demand for services of all kinds in an expanding economy; a trend towards a larger service content of goods production. Both these tendencies have been exercising a strong influence on the "institutional composition" of the entire economy for a long time. So far, this has mostly been noted in economic debate as a rapidly growing and/or oversized public sector. Excessive political concern with crisis, manufacturing bulk producers, means that little seems to be available in terms of empirical knowledge and statistical data on the institutional dynamics outside manufacturing. For instance, technological change, shifting the industrial base from large-scale factory processing (such as in steel or pulp production) toward a product technology foundation, is blurring the statistical borderlines between manufacturing and the rest of the

private sector. Even though most of our data will be on manufacturing, we are concerned with the firm of the private sector, when analysing the nature of the economic growth engine.

The growing service content of goods production and of consumption signifies a continued and perhaps faster transformation of advanced industrial economies into "information economies". As a consequence, the reader will soon observe that this essay is more focused on the nature, creation and application of industrial competence that makes the firms competitive, than on the skill content of factory production.

Nevertheless, the increasing accumulation and use of sophisticated knowledge to run an advanced industrial society is certainly affecting the markets for labour. A discussion of this and suggestions as to coping with our embarrassing lack of knowledge conclude this essay.

2. What Does a Modern Firm Do?

A financial definition becomes natural when we take a closer look at what goes on within a private firm. We can list at least ten activities in Table III:1.

Table III:1

MAIN FUNCTIONS WITHIN A LARGE FIRM

1. Innovation, entrepreneurial activities
2. Institutional reorganisation (owners, board)
3. Product development
4. Investment company
5. Commercial bank
6. Insurance company
7. Materials processing (the factory)
8. Marketing organisation
9. Educational institution
10. Welfare institution

Item 7 corresponds to the standard production function concept of the firm. The other items denote various forms of information gathering, analysing, and using activities at the interior of the firm or its exterior environment, product development and marketing being perhaps the most resource-demanding of these activities. Remove Item 7 and the service firm is defined.

Standard economic theory, notably general equilibrium theory, does not as a rule recognise costs associated with collecting, analysing and using information to guide a firm in its market environment. The presence of a so-called auctioneer is assumed. He does all this work free of charge. Modern search theory is a crude way of dealing with this problem.

Modern empirical research tells a very different story on how information is gathered and put to use within a firm (Eliasson, 1976, 1984d) or in a market process. Clower and Friedman (1985) are very careful in modelling the importance of traders as information carriers that co-ordinate and perhaps equilibrate a market economy. In fact, information costs seem to dominate total costs of production. The bulk of resource-using activities going on in markets is concerned with the intermediation of information and is carried out by traders called firms that act as intermediaries between firms -- seen as goods-producing factories -- and end users of goods. (Even this is a narrow perspective to take. Much of the intermediation of information takes place in the non-market part of the economy, the public sector, etc.)

The dominant part of interior firm resource use has to do with the collecting, analysing and application of information to get the right design of the product and the product itself to the right customer. If marketing and product development are defined as an information activity, probably more than 50 per cent of total resource use in a modern firm on the average is devoted to information processing in a broad sense, and most of it is applied to move the producer closer to the customer, thereby fundamentally changing the nature of the market process.

There is a large substitutability between the various forms of organisation of information processing. Some goes on within the goods-producing institutions, some in separate market traders. Whenever prices and technologies change, so do institutional structures.

Recent empirical research tells us (see Eliasson, 1984d) that organisational change between firms, between plants, and within plants is the major vehicle for productivity change. This process is an integrated part of information processing and production and, hence, spells out some important characteristics of technical change in the business sector that we have to recognise when we proceed to study the knowledge and skill requirements in industries. This is especially challenging in the context of the development of modern information technology, so we will discuss the various items in Table III:1 in turn.

a) Innovative Activities

A high proportion of information activities measured by resource use appears to be a characteristic of the successful firm, while a heavy concentration of resources to hardware production signals the opposite

performance. For large, international Swedish firms it is possible to talk about three commercial legs -- product development, production and marketing -- where successful product development and superior marketing techniques have become decisive for the profitability of productivity growth (Eliasson, 1984a). Both product development and marketing are a typical, human capital-intensive service production. It is also significant to note that a great variety of institutional and organisational solutions to handle the combination of product development, production and marketing and distribution are coming to the surface. Some internalise all activities within one firm. Some decentralise the various activities over many firms. Sometimes the critical manufacturing technology may reside in a service organisation that statistically does not belong to the manufacturing sector.

Innovative activities go on at all levels within firms. In the economic discussion it is often associated with the individual inventor who comes up with the unique idea. However, entrepreneurship at large, in the form of innovative entry, and (to use a modern term) intrapreneurship in the large business corporations both belong here. We have also observed that the large Swedish engineering corporations were very innovative indeed during the 70s.

b) Institutional Reorganisation

The most important innovative activity, however, has to do wih the structural adjustment process of the entire firm. Part of it relates to the pure technical innovations already mentioned; much of it has to do with improved techniques in all other areas of Table III:1, not least in marketing. Much of it also has to do with bringing in new ideas from the outside. Some would even argue that the bulk of R&D activities within firms in fact has to do with "imitating" competitors.

From the point of view of the firm as a whole, the most important innovative activity is to co-ordinate all ideas with the existing production process to engineer institutional change of the entire business entity. The initiation and realisation of this institutional, innovative surgery is located at the very top of the firm hierarchy where major decisions as to competitive reorganisations of the firm are taken, that is, at Board level and among the major owners of the firm.

A major reorganisation of a firm normally meets with strong and effective resistance from within. To break such resistance and to carry it through, the discretionary power vested in the owners is often needed -- together with a visionary talent that is not always present at these levels. The reorganisations we are talking about include mergers of various sorts, and the whole process of integrating new technologies, production processes and marketing arrangements of the acquired company with the old company, disinvestment of alien activities, the scrapping of commercially obsolete activities, and so on.

c) Product Development

The resources devoted to high-level innovative activities are almost impossible to measure. Primarily, it is a question of finding the right team

to manage the firm. R&D spending can, however, be measured and most of it appears to go into product development. What is more, it seems to be mostly "imitative" in the sense that novelties from competitors' workshops are taken up and improved upon. Table III:2a gives data from one large Swedish firm on a cost-share basis. Table III:3a gives a breakdown of both total costs and total investment spending among the largest industrial groups in Sweden on R&D spending, process investments and investments in marketing and distribution.

The larger the firm, the fewer resources used in processing and the more in R&D.

d) Investment Company

Innovative activities of various kinds determine the technical and commercial frontiers of the firm. As a rule, they enter through new investments. Frontier and best-practice activities mix within firms and between firms. They all compete for resources and the worst performing activities, or firms, are eventually forced out. Investment resource allocation within a firm is normally accompanied by a continuous reorganisation of the firm. Together, this pair constitute the major vehicle for implementing long-term changes on the production structure of a firm, changes that in turn are decisive for productivity change. The two functions (items 2 and 4 in Table III:1) are top executive activities in a large firm. They include the decisions to invest, to decide on which existing units to expand, the decision to contract or to scrap, and part of the decision to enter new activities. The totality of this decision affects the entire business organisation top down and it relates directly to the in- and outflows of the organisation's funds. The management of funds is a major production activity of the large, modern firm, and efficiency in earning a profit, long-term and short-term, is the limiting factor of firm size and fundamental to the profitability of the firm (Eliasson, 1976). It is important enough to warrant consideration on its own.

3. Institutional Fragmentation

a) Changing Institutional Structures and Productivity

A stable unit of measurement helps to stablise the analysis of a firm's behaviour. Institutions like firms, or families, have conventionally been regarded as having structural configurations in economic analysis. We have here introduced a similar assumption by defining the firm as a financial decision unit. However, we have to recognise the enormous variety of activities that go on within that unit (see Table III:1). We also have to observe that some of them may either be carried out within the administrative and planned system called a firm, or externally in separate trading units, also called firms, in the market (see Eliasson, 1984d, on database designs), a circumstance that blurs the limits of the firm and the concept of a market. A market process is the combined action of its institutions (see below).

Finally, a realistic analysis has to recognise institutional transformation and recombination as an endogenous element of economic progress. In fact, institutional change appears to be the major vehicle for

Table III:2a

TOTAL COSTS[a] OF AN ENGINEERING FIRM BY FUNCTIONS AND DOMESTIC ACTIVITIES[b], 1981
(Per cent of total)

	Per cent
R&D, engineering design and documentation	17
Work scheduling	15
Production	44
Marketing and distribution	9
Financing and administration	5
Other	10
TOTAL	100

a Excluding depreciation and interest expenses.

b Excluding foreign subsidiaries, that are predominantly concerned with marketing.

Source: MOSES database. See Fries (1983).

Table III:2b

LABOUR INPUT BY TYPE OF WORK IN A FACTORY, 1974-79
(Per cent of total manhours)

Work scheduling	51
of which	
administration, planning	38
technical preparation	13
Production	10
of which	
supervision, service, quality control, etc.	33
direction production	33
transports, inventories	6
TOTAL	100

Note that data cover only factory production and item 6 in Table III:1.

Source: Eliasson (1981).

Table III:3a

INVESTMENTS BY THE 5 AND THE 37 LARGEST MANUFACTURING GROUPS IN SWEDEN, 1978

(The groups have been ranked by number of people employed abroad.)
(%)

	The 5 largest		The 37 largest	
	All group	Foreign operations	All group	Foreign operations
R&D	25	10	21	6
Machinery and construction	45	41	52	42
Marketing	30	49	27	52
TOTAL	100	100	100	100

Table III:3b

TOTAL WAGE AND SALARY COSTS IN DIFFERENT ACTIVITIES IN THE 5 AND THE 20 LARGEST SWEDISH MANUFACTURING GROUPS, 1978 (PER CENT)
(%)

	The 5 largest		The 20 largest	
	All group	Foreign operations	All group	Foreign operations
R&D	7	3	7	2
Process and	63	52	70	50
Marketing and distribution	30	45	23	40
TOTAL	100	100	100	100

Source: Eliasson (1984d).

performance improvements at the firm level. This also defines the distinction we want to make between dynamic efficiency and static efficiency. Static efficiency means doing the same thing better. This concept has to be defined at a fairly low level of aggregation within the firm, say, a production line or, possibly, at the product group level. Dynamic efficiency (what we also call flexibility) on the other hand is achieved through entry of new activities, and exit or recombination of established ones. Introducing institutional or organisational change at the micro level means pushing formal, mathematical analysis at the current state of mathematical economics out of reach.

We have observed that the conceptual designs (the taxonomies) of our databases become more or less arbitrary when we allow for institutional change. Both the "firm" and the "family" happen to be useful analytical groups because they define rather monolithic decision systems. Both are also linked up to a joint financial purpose that in modern societies corresponds to fairly well defined statistical systems. But neither the firm nor the family are stable institutional forms. The forms of interaction between firms, between firms and individuals, between individuals and households, and within both firms and families as "administrative processes" change under the influence of outside forces, like the competitive market processes.

The interior content of a successful business entity is anything but stable. If seen over a longer time span, surviving firms change the composition of their activities tremendously. In addition, both their products and their production processes change their technical specifications. At the same time, competition between firms and new innovative entrants force out outmoded and less efficient activities.

b) Producers and Customers Grow Together in Customer Markets

Furthermore, "industrial technology" is all the time making new institutional combinations superior to their predecessors. Thus, for instance, the more complex and specialised product designs are, the more efficient it has become to incorporate sales agents and separate traders and marketing organisations as part of the large production organisations. A growing part of the traditional market process has, so to speak, become part of the administrative system of large firms. Producers and customers form a symbiosis. Okun (1981) has coined the term "customer markets" to cover that phenomenon.

At the same time, the development of new complex products or production processes, including their maintenance, requires a large spectrum of specialised knowledge and talent. Even for large firms, it is costly and sometimes impossible to maintain such a knowledge base internally. The last few years have witnessed the development of a veritable jungle of small specialised service firms around the large production and market organisations. This is especially typical for the electronics and computer industry where small-scale human talent plays a critical role and where small-scale establishments become relatively efficient economically.

While economies of scale mean that administrative solutions are taking over market processes in customer markets, increased specialisation of

products means that competitive entry of small service producers is breaking up administrative solutions on the factor side.

On the one hand, we have observed that economies of scale prevail in the financing, banking and risk-reducing functions. This is making industrial firms incorporate such activities into their normal business.

On the other hand, technological change is currently eroding the earlier advantages associated with large-scale factory organisation. The really strong technological push for small-scale production is most vividly exhibited in the new intelligence industries, that of electronics and computer industry and in practically all the entire surrounding software industry. Here individual talent and specialised knowledge are what matter and the consequence is a surrounding swarm of humming and profitable software firms. However, similar tendencies can be observed also in engineering industries. Even basic industries like steel -- especially high-grade, multi-quality special steel -- are seeing all kinds of small-scale production technology entering the market.

c) Institutional Fragmentation and Work Compensation

Since non-process activities are growing in relative importance, and since product development, marketing, etc., do not necessarily have to be an integrated part of the production organisation, we expect to see more of such institutional fragmentation in the future. It appears that the emerging service economy that is integrated with industrial production may be breaking the old factory-based industrial organisation apart, producing new and more rapidly changing institutional structures. If these tendencies continue, they will increase and personal initiative and adjustment abilities will command a premium.

There is one challenging economic aspect of our observations on institutional change in the private sector. All large-scale factory or business organisations have developed a certain internal compensation structure. This is partly the result of difficulties of measuring the productivity of individuals in an integrated production process (see Alchian and Demsetz, 1972) and partly an effect of social convention, legislation and union agreements. The output value of talented, skilled or hard-working labour is partly redistributed to the low-performing end of the labour force of the same production establishment. In an integrated factory, or at a long production line, it is difficult to identify individual contributions even though firm managmement as a rule does its utmost to identify and form small and separate "profit centres".

However, modern technology in modern information-based industries is changing the situation. With a growing number of specialised talent inputs becoming critical for the large business organisations, the potential for forming small separate profit centres within the organisation, or hiring the services externally is increasing. Furthermore, it is often the case that such talent is only a valuable input for specific, brief periods. Individuals or groups of individuals who want to keep the value of their labour for themselves can break loose from the large organisation. This arrangement is beneficial for them and often in the interest of the employer organisation. Recruitment practices and employment security laws also make separation of

certain functions attractive to employers, who want to pay well when they need the service but who do not want to take on a life-long employment responsibility.

The servicing of products or installations, advertising, the organisation of marketing campaigns, educational activities, parts production, specialised engineering, etc., may even be more efficiently handled by separate, small firms. This is becoming desirable also for purely technical reasons. The modern welfare economies provide strong incentives for individuals to exploit such technical opportunities; labour market laws often make the employment decision a life-long relationship between employer and employee, if the employee so wishes; tax laws make it virtually impossible for the individual to collect the market value of his or her talent or competence for himself, if it is unique and large.

Leaving the team organisation of the large factory or firm and "going individual", or to a small firm, the high-performing individual no longer has to share the value of his output with the team. Secondly, running your own firm makes it possible to time your income flow personally over your life cycle and also to cash in on an income definition that minimises your taxes. The best examples of what is going on are offered by the rapidly expanding electronics, communications and information sectors with typically small-scale and sophisticated service production in combination with extremely large income opportunities.

This development, which is being encouraged by the extensive welfare and social security systems of the industrial nations, is probably already seriously threatening the position of the traditional large firm as a welfare institution and a vehicle for income equalisation. This does not seem to have been noticed yet, either by politicians or by economists. We will return to it later because the firms -- and for that reason, the family -- may (unknown to most) have been a much more effective egalitarian device than the public sector has ever been.

As a consequence, the not-so-talented, low-skilled worker may no longer be as protected as before from competition within a large, administrative and unionised factory organisation. In particular, in the future the low productivity workers may have to be satisfied with a compensation more in line with their productivity on the job. This particular aspect of technological change will probably be a concern of labour market analysts in the near future.

There is little statistical or empirical evidence to demonstrate the institutional fragmentation that has been going on for some time. The recent employment crisis in OECD countries, however, created a partial awareness and, in a sense, the demand for more public sector growth to solve the unemployment problem has been overtaken by the question as to whether private services take care of the people laid off from obsolete manufacturing industries.

It is probably true that part of the enormous expansion of employment in the private service sector in the United States is due to a widening income distribution and -- as a consequence -- the opening of more menial service jobs. However, much of the new employment is directly linked to hardware manufacturing production. Some of it consists of new types of jobs associated with new technologies being developed. Some of it was previously run as an internal firm activity. In the advanced industrial countries -- the United

States and Sweden -- business services have been the most rapidly expanding sector when it comes to employment (see Figure III:1). Expansion is not only rapid: the business service sector in both countries employs today a significant number of people.

4. The Definition, Limits and Increasing Structural Instability of a Firm's Organisation

There is a vertical and a horizontal dimension to the business activities of a firm. As it grows in size, measured as a financial unit, its horizontal size increases and "coordination" becomes a major information-demanding concern of top corporate management. The vertical dimension is what we usually associate with production flows. A small firm often has only one vertical dimension, one production line. Within a large firm, the business unit, the profit centre or the division are vertically organised. Technological change within the division means increasing the vertical flow speed to reduce factor use coefficients in all dimensions. There are heads of division that run and co-ordinate divisional activities, but they are always subordinated a higher executive level within the firm, before the firm reaches contact with the external markets (the Corporate Headquarters function reporting directly to the owners).

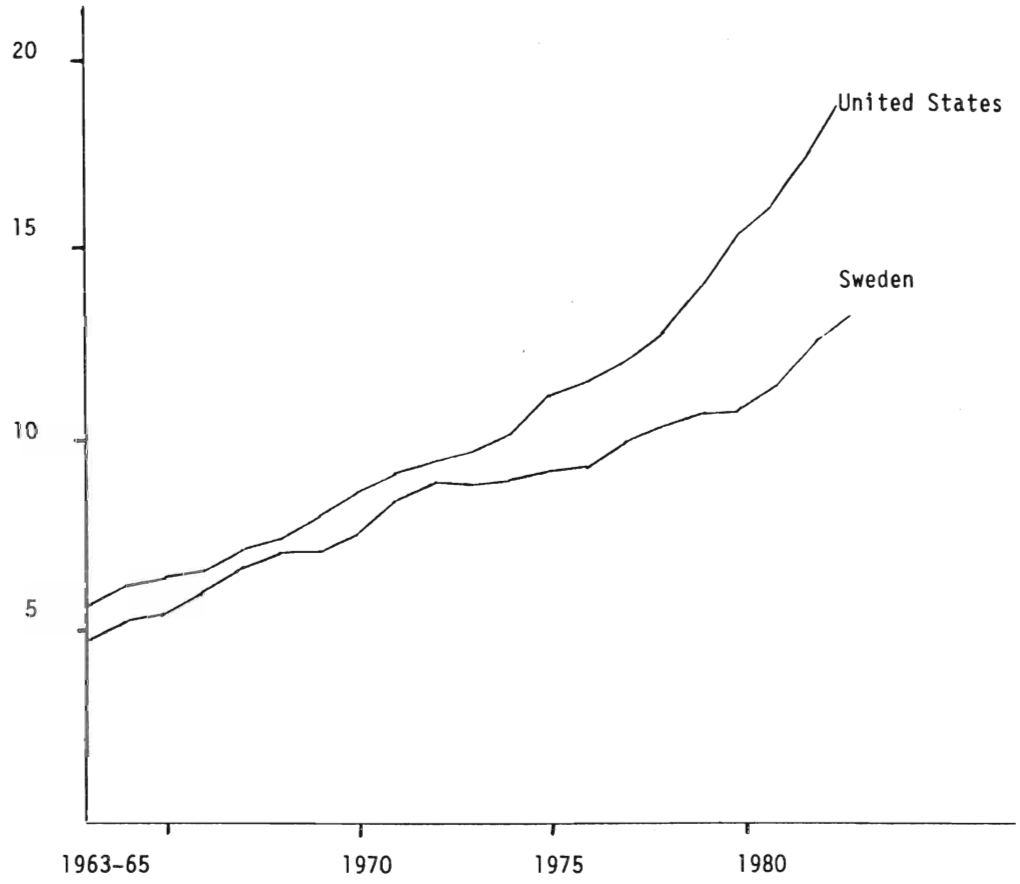
There are more or less decentralised organisational structures that control the interior life of a firm while the firm itself is a monolithically controlled financial system. The interior units are allowed more or less autonomous external, financial market contacts. But the normal situation is that financial management, practically always long-term finance and always equity finance, is centralised at Corporate Headquarters and linked up with ownership. It either isolates the interior coordination process from external market influence or transforms it into an administrative procedure (or a team) that in theory is more efficient than the market. This is at least the rationale for the existence of the firm as an administrative decision system (Coase, 1937; Arrow, 1974; Williamson, 1975), or rather as a financial decision system.

We will demonstrate that internal coordination between major investment blocks, divisions and reorganisation is the major vehicle for enhancing corporate performance. Hence, the financial definition of the firm as a monolithically controlled institution, or a financial intersection between administrative and capital market performance (Eliasson, 1976, pp. 255 ff.).

The firm of the economics textbook is still, however, that of a goods-producing factory. Economy of scale in factory production has been the basis for much theorising about the optimal size of the firm, productivity growth and market concentration. As industrial technology is gradually shifting from a base in cost-efficient production toward a product-based technology, economies of scale also begin to shift from factory production towards marketing, internalised financial intermediation and risk reduction (insurance).

Figure III:1

EMPLOYMENT IN BUSINESS SERVICES IN THE UNITED STATES AND SWEDEN IN PER CENT OF MANUFACTURING EMPLOYMENT



Note: Business service is defined as SNI codes 832100-833000.

The insurance function of a firm (item 6 in Table III:1) is closely linked to the finance function. We are thinking not only of the traditional property insurance activities that, to an increasing extent, are being internalised in large business organisations, but rather of the ways general risk reduction is managed (see Eliasson, 1984d). Sheer financial size makes it possible for a firm to absorb large risks. With a growing part of total investment allocated on product development (item 3) prior to production, with the length of product gestation periods growing and -- once in the market, because of more intensive product technology competition -- with shorter product life spans, the larger the total risk burden associated with each business activity. Hence, while the traditional risks associated with the factory investment diminish in importance, the total risk of the business as a whole increases. Thus, "one product" firms live a more precarious life than hitherto. This alone is enough to stimulate the growth of conglomerate businesses that can internalise both the investment banking and the insurance functions.

The interesting question is what such institutional reorganisation means for industrial efficiency at large. Could this explain Pratten's (1976) observation that while the Swedish firms operated larger production establishments, and were generally more productive and expansive than a matched set of British firms, the British firms defined as financial units were significantly larger than the Swedish firms and somewhat more profitable?

Technological change, including new materials, new tools, automation and robotics, combined with a growing demand for sophisticated and highly specialised products associated with advanced industrialisation, is placing traditional, large-scale factory production under competitive pressure. This tendency is reinforced by the growing service content of both products and production (Lindberg and Pousette, 1985). Production efficiency is no longer as dependent as before on efficient flow arrangements of teams of people and machines.

5. What Do We Mean by Industrial Competence?

Productivity of a firm has to be identified as the art of managing the entire firm and adjusting its organisation to changing market circumstances. Part of the competence to run a firm is to choose the right markets and the right products, and to leave commercially impossible activities in time. Hence, the result of industrial competence is always measured by the rate of return to capital.

Human capital is always the basis for superior industrial competence, whether at the higher management level or on the shop floor. To estimate human capital or competence from data on income -- which is the approach taken in human capital theory -- we have to know to what extent human capital has been awarded its "rightly" or "justly" derived monetary value in the market. This requires strong assumptions about market equilibrium that are never satisfied. To say anything on the matter of human capital, we have to back away from the notion of equilibrium economics and attempt to understand, and preferably to quantify, the disequilibrium adjustment process and the content of the skill endowment of a business when it comes to upgrading and co-ordinating its activities in a dynamic and not very predictable economic environment.

We should consider four levels of competence.

Table III:4

LEVELS OF COMPETENCE

1. Process (production line)
2. Product (market)
3. Management (firm)
4. Economic policy (national)

The first (and "lowest") level refers to the making of products (factory production), the second to their development, marketing and distribution. The third level takes in everything else at the level of a controlled business decision unit operating in product, labour and capital markets, and in our view delimits the concept of a firm. The fourth level has to do wth the interaction of "firms" in this sense with markets, the administrative action in the non-market part of the economy, and government policies in general, or, in short, the nature of the market regime.

Evidence has already been presented that the modern industrial firm -- and probably any successful industrial firm -- bases its competence on three legs: product development; factory production; and marketing. The profitability of the factory process in a modern manufacturing firm appears to depend significantly on the earlier product development phase and the later marketing stage. This means that item 2 in Table III:4 is very important at the firm level. However, both product design and marketing depend on a prior selection or choice mechanism that is traditionally called management.

For reasons of clarity of discussion, we want to relate Table III:4 as closely as possible to our previous Table III:1. It is obvious that levels 2, 3 and 4 in Table III:4 all deal with various forms of information and choice activities. Product development clearly belongs to this group of activities. It links one-to-one to the corresponding item in Table III:1. We (arbitrarily) assign part of materials processing (item 7 in Table III:1) and all other activities to <u>management</u>. It is they alone who deal with the use of information; most of it being concerned with <u>co-ordination</u>, some of it with innovative activities. It is typical of these activities that they all interact with one another. Few can be isolated and treated as a variable factor in a production function.

Thus, competence at policy and management levels depends on overview, co-ordination, and control of <u>the whole</u>, whether it be the whole economy, the whole firm or the whole of some activity going on within the firm. At this level we are not talking about "skills" or "experts" as representing competence, even though the management level may be populated by large numbers of experts, such as accountants, tax specialists or computer people. The top

managers in firms command a very special competence. As a rule, they have some kind of academic background, but this is not sufficient, maybe not even necessary, for their special (top) managerial competence. We will attempt a more precise description of this competence presently.

Book or classroom learning of job tasks is not a typical feature at the management level. The nature of knowledge depends, however, on where exactly we draw the line between management and process levels. This will have to be somewhat arbitrary. The sweeping of floors of the executive offices is not a management activity even though it is often allocated as such in the cost accounts. Computer support (hard- and software) of management activities on the other hand is often classified as operating expenses. If we use the cost accounts of a business organisation to measure the volume of various kinds of inputs, which we have to do, a fair amount of not so sophisticaed and not particularly human capital-intensive production will be defined as management.

To complicate things further, looking at the process level (inside the factory), we find that even there management activities are important (see Table III:2b). A much finer statistical detail is needed to take us down to the level of pure hardware production, with blue-collar workers manning machines. To get a grasp of the extent of the vast array of non-hardware processing activities within a modern firm, we have added a tabular breakdown (still a very aggregated one) of the cost account taxonomy of a typical manufacturing firm (see Table III:2a).

A fairly large number of people in the factory are occupied with co-ordination of larger activity blocks, requiring overview rather than specialised expertise. The nature of competence needed at various "levels" in a business organisation is perhaps best illustrated by Figure III:2. The figure also leads directly into the next chapter on how competence is being created.

Rationalisation at the process level (item 1 in Table III:4) takes place at the third bottom level of the pyramid. Productivity improvements depend on skills in organising and updating the factory process. In the debate on productivity and employment, most attention has been paid to activities at this level. The results have often been uncritically generalised to the firm and the industrial levels.

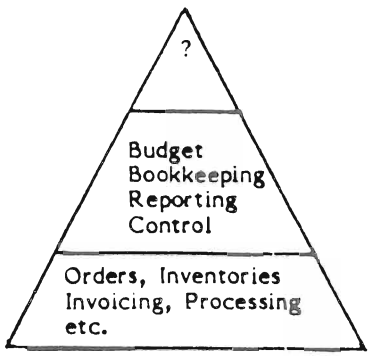
Co-ordination occurs at levels 2 and 3 in Table III:4 and consists in improving the low efficiency of a combination of given processes and products.

Large improvements in total factor productivity are achieved at this level. Modern information techniques have also been improving overview, transparency and control at this level, partly replacing certain middle management functions (see Eliasson, 1976, 1984d). Actual and potential productivity effects on the whole of the firm organisation at this middle level are much larger than the sum of productivity effects occurring at the rationalisation level.

By far the largest productivity effects, however, have occurred and will occur as a result of decisions taken at the top level of the pyramid in Figure III:2. They have to do with adjusting the organisation of the business entity to changing environmental circumstances, including the decisions "what to do" or "to close down". The nature of the knowledge capital residing at

Figure III:2

DECISION AND COMPETENCE LEVELS IN A BUSINESS ORGANISATION



	Type of decisions	Education
1	Strategic (Structural change)	Career Academic
2	Tactical (coordination)	College/ Special courses
3	Operations (rationalization)	Vocational

this level is difficult to identify and to measure. Its importance, however, is witnessed by the growing number of publications on engineering and management education. This concern in such literature, however, is mostly focused on the notion of industrial competence as technical (bottom level in Figure III:2) or controlling and co-ordinating (middle level).

To illustrate the need for a knowledge base to bring about structural change, let us take the large number of diversification ventures into high technology markets undertaken by large, mature firms with a view to creating a new product base, when the existing mature product range ceases to be profitable. Many, perhaps most, of these ventures have not been successful. As a result, successful firms tend to grow, eventually become large and then to start contracting, often destroying large resources in futile attempts to get back on a new technology and a new growth path. Exxon for many years tried to develop an "office systems" industry group, financing it from the enormous cash flow in oil activities. This was clearly a top-level activity, but the knowledge capital needed to run the oil business did not mix well with the knowledge base needed to develop such new activities and a significant part of "Exxon Enterprises" was shut down in the early 80s.

The development of Swedish industry during the last one hundred years offers a similar macro illustration that can be compared with the "transformation process" the Norwegian economy wants, and can afford because of its enormous oil wealth. In fact, the Norwegian "management problem" facing industrial policy makers is quite similar in scope and character to that of Exxon.

6. From a Process to a Product-based Industrial Technology

When looking at the firm of today and the typical firm of the past, some clear tendencies can be summarised:

1. Diversification of activities, products and skill requirements have increased. This is partly a reflection of the growing importance of engineering industries relative to basic industries, or producers of rather crude materials and simple products that dominated industry earlier. Increased domestic and international specialisation is another term for the same phenomenon.

2. This development also places product innovation rather than processing at the centre of the competitive economic process.

3. Longer gestation periods combined with rapidly growing investments in development costs appear as a significant characteristic of new product development.

4. At the same time, once in the market, product life spans have tended to shorten. This is also a reflection of the more intense, competitive market process associated with increased specialisation among more producers and traders.

5. Service content of the whole production sequence up to the final product is rapidly becoming a competitive edge. We have already mentioned the service contribution of R&D in new product development and the large addition to final sales value in the marketing process. However, maintenance contracts or guarantees and various insurance packages, the existence of large dealers, reserve parts and service networks are important product value-enhancing factors.

6. Unstable market environments and lowered predictability have become the typical business experience since the mid-70s.

7. More diversity and less market predictability (more uncertainty) have generally increased the environmental complexity associated with running a business firm. Information processing and use in a multitude of forms have become a major cost item.

8. One way of coping with increased environmental uncertainty is to absord it internally through expansion in size as a financial unit. The broader the array of products or activities, the easier to absorb local mistakes, and the easier to take bold, strategic moves in one area, by concentrating resources from many activities. While longer gestation periods, shorter product life cycles, less predictability and a more uncertain external environment in general have led to larger firms as financial units, the administrative system also increases in size.

9. The internal complexity of the modern firm. Top decision makers become removed from the actual production process, and more and more elaborate information, co-ordination and control systems are needed to run the entire enterprise. Very often these co-ordination systems clash with flexibility requirements. Remote guidance and

control of diversified, non-transparent business bodies over rough and unpredictable commercial waters have become a major element of business competence.

10. At the same time production technologies seem to be heading in the direction of small-scale processing of sophisticated products away from large production scale and simple products.

11. A break-up of traditional factor combinations at the earlier stages of production is creating a much more varied institutional structure around the traditional engineering firm. This development is encouraged because of the combinations of taxes, regulation and legislation that are typical of the modern welfare states. Such arrangements stimulate individuals to organise themselves in separate business entities, to keep the compensation from individual talents and specialised knowledge for themselves, through appropriate institutional arrangements.

12. One should, hence, expect self-employment to increase relative to "wage employment".

13. The same process is obviously also taking place abroad, intensifying international competition for domestic firms that are not leaders in their field in adopting the new technological opportunities.

14. On the whole, materials processing and large-scale factory production of a simple kind and of simple products appear to be suffering economically in the advanced industrial countries. This competitive pressure comes from two directions: internally in the form of competition for factors of production from the more sophisticated and profitable domestic producers who can pay higher wages, and from abroad through producers in less advanced countries who are learning the established and less advanced production techniques.

15. The limiting factor in this economic race is the availability of human knowledge and skills.

The new business environments thus characterised are clearly demanding a new breed of workers, managers and leaders. We have also emphasized that availability of human knowledge is more a matter of quality than of volume. A key question is to what extent the educational system at large is producing and deploying those skills adequately. We have already concluded that both generalised education and specific skills matter, and especially in combination. The specific skills are closest to the production process and offer development facilities "on the job". To this we will turn in the following chapter.

Chapter IV

THE CREATION OF INDUSTRIAL KNOWLEDGE AND SKILLS: WHERE AND HOW?

1. The Policy Problem

A worrying conflict of concerns about the adjustment process in the old industrial world is creating policies that may block sound, long-term solutions of the structural problems.

On the one hand, new technologies being adopted faster in some firms and in some countries than in others, places increasing competitive pressure on the old industrial world. Some countries are concerned about their apparent lack of industrial and technological knowledge for adapting fast enough to counter such competition.

On the other hand, this adaptation of new industrial technologies or structures, whether forced or carried out through domestic initiatives, places many individuals under pressure to adjust. They are either forced into unemployment or initiate their own search for new knowledge and new jobs. The adjustment problem notably affects those who happen to be holding low-skilled jobs in the wrong firms.

Both sides of the adjustment problem have been dealt with in this essay, albeit emphasis has been placed on the first of them -- the "positive" one. The key questions have been: what constitutes industrial competence and -- in this chapter -- how it is created. The other side, the labour market problem, has already been discussed from the point of view of how to deal with the consequences of good or bad business performance.

Chapter III concluded with two observations: first that the availability of industrial knowledge, know-how and skills was a restriction on the competitive performance of industries; second, availability was partly (perhaps largely) a matter of labour market allocation.

As a consequence of these observations, this chapter has two purposes: the first is to identify the investment, or educational process, that generates the industrial knowledge presented in the foregoing chapter; the second is to identify and delimit the social side of the adjustment problem introduced there. We will find that the number of people actually or potentially affected is relatively small, that the problem to a large extent

has to do with generational change, and that the social factor coincides with the educational process that enhances the economic growth potential. If the labour market problem could be focused properly, it shoud be manageable through a well-designed educational and labour market programme.

Both standard economic theory and official statistics display a strong bias toward the manufacturing and consumption of goods and the hours of the industrial worker as a factor input. This neglect of the service side, and the quality of economic activities dates all the way back to Adam Smith, who wrote condescendingly about the value of services, a view reinforced by Karl Marx that is still ingrained in the measurement taxonomies of all national accounts systems.

The neglect of service production as a quality-enhancing part of goods production, or in the use of goods, has created in turn a secondary neglect of the knowledge necessary to co-ordinate machinery and labour hours efficiently in production.

Bad theory and bad measurement in combination foster misunderstanding. Misunderstanding means something when the distorted knowledge is put to use for policy making. To produce a better (national accounts) measurement base and a useful theory for dynamic economic reasoning should be a prime long-term concern of politicians, who cause the worst damage to national economies when they act on misconceptions on how economies work. They act from a central level with the excessive leverage made possible by the resources controlled by a modern welfare economy.

2. Where Does Education Occur?

Human capital is (by definition) created through an investment process called education. We concluded in Chapter III that much of what we call education is not investment in the sense of building human competence for gainful occupation in the production system. Some of it is pure private consumption, some of it is part of an egalitarian process that may produce negative values for others, some of it is national indoctrination, and so on.

Human capital investments that are useful capital inputs in the production system take place at three levels:

-- At home (through upbringing);

-- At school (through education);

-- On the job (as career experience).

The first stage, upbringing, may be the most important one, especially in laying a foundation for effective education at school and on the job. Lack of knowledge of the input-output characteristics of the educational process prevents us from being more positive, except to say that in most countries educators and politicians have attempted to compensate individuals through the schooling system for an inferior family background. Experience is that such attempts have not been successful (Murnane and Nelson, 1984).

When we focus on the last two levels of human capital investment, discussion is made easier if we first restrict ourselves to competence creation for private industry (previous chapter) and simply assume that "high level industrial knowledge and competence" is created solely through a varied career experience in the labour market. The foundation for such a career is laid in the formal schooling system (middle level).

This means over-emhasizing the white-collar part of the labour force. In one sense this emphasis indicates where the industrial structure is moving on the margin. However, it also highlights the nature of the labour market problem, which involves directing the new entrants away from simple manual labour and retraining laid-off labour for different tasks in the growing service-oriented industries.

Hence, we will be very brief on the matter of hardware production and menial skills for factory and routine office work. This is the area where most of the negative experiences from new technologies -- notably through competition from other firms acquiring the new technologies faster -- have been felt, and also where most empirical research has been carried out (for more on this, see Part II).

In over-emphasizing the white-collar part of the labour force, we can also place the "filter" property of the educational system and of the labour market up front. As a consequence, it will be natural to begin with the firm as an educational institution, and then proceed to discuss what the formal schooling system can do to improve its educational output to the benefit of on-the-job schooling. Finally, we return briefly to the firm, the family and society as welfare institutions.

3. The Firm as an Educational Institution

The firm as an educational institution is the core issue in this chapter. Specific skills at all levels are developed in direct conjunction with the ongoing production process. The more sophisticated, specialised and complex, the less of the skill content can be abstracted from the ongoing production process and transferred in documented form through an external schooling system. Furthermore, schools and universities, by their very organisation and recruitment practices, will always teach an old generation of skills. Frontier technologies are developed in the firms. This is witnessed from many countries, where dominant, technology-based firms have employed all high-quality, specialised research talent in their field, while technical institutes and universities employ the cream of the nation's technical research personnel in secondary fields. These are the reasons why high-level industrial competence in technical fields can only be acquired through a job career.

In order to make the importance of this topic clear, we will quote from Eurich (1985) that in the United States the combined classroom teaching, college level and up, carried out by the private sector -- excluding similar teaching in the public sector and excluding direct worker on-the-job training and apprentice programmes -- amounted to an activity of the same magnitude as the combined total of United States college and university education, 8 million people being constantly in "corporate classrooms". If only 20 per

cent of this was true, it woud be a remarkable observation and something the educational officials of a country could not be expected to neglect.

The extent of corporate educational activities makes them very important. The capital associated with product development, management, process innovation and marketing never shows in the accounts of firms. This human capital is, however, what matters in the modern firm. Some authors even want to define competitiveness as the unique knowledge base that makes the firm profitable. The ability to operate successfully the large, private, complex industrial organisations that dominate growth in the Western economies constitutes a major technological base, a human capital that has been developed on the job on the basis of a good formal educational system. Having said this, it is odd to observe how neglected the firm's role as an educational institution has been among those who talk and write and express such confident opinions on what is good and bad in business. Peters and Waterman (1982) do not even make education or training one of the criteria for "best" companies, despite the fact that all companies they have marked as "excellent" operate extensive educational programmes.

The productivity of high-level human capital in industry is both organisation-specific and related to the team of people and installed capital. It is, however, more mobile than hardware capital and very mobile as a team. Hence, the turnover of critical human talent becomes an issue in the investment, salary and employment policies of an advanced business firm.

It would, of course, be desirable to quantify the accumulation of unique human capital or business competence in a firm in the same way as we do with machinery capital, but this is close to impossible. Firms have no good statistical systems to keep track of such investments. Part of the competence built up is directly linked to selection procedures when hiring people at all levels, and much of further accumulation of skills relates directly to current work and individual career experiences and capabilities. One might even ask whether the fact that we measure hardware capital the way we do really does not mean that we are caught in a statistical illusion. Perhaps the concept of hardware capital is as impossible to capture in statistical terms as human capital.

To organise our thoughts under this ambitious heading, we have to introduce a few prior assumptions that will remain to be tested even after this paper has been printed. We will start by distinguishing between three layers of human capital in the business organisation that correspond to the listing of functions in Table III:1 and to the decision hierarchy of Figure III:2.

Table IV:1 is a somewhat broad statement; nevertheless it distinguishes clearly enough between the different knowledge bases and correspondingly different backgrounds, educational processes.

a) Executive Competence

First, the decisions that really matter for the long-run success of a business organisation are taken at the very top, by owners, the Board members and the most senior executive people. The kind of knowledge they apply to their decisions is rarely taught in schools or universities. It consists of a

combination of a variety of talent, experience and skill and the ability to co-ordinate. In addition, it is normally of the tacit kind: a combination of intuition and explicit awareness. Decisions cannot always be communicated in operational terms to outsiders, or even explained to others than those participating in the decision process (Eliasson, 1976; Pelikan, 1969; Polanyi, 1967).

Table IV:1

LEVELS OF MANAGERIAL COMPETENCE

Nature of knowledge	Level	Tasks to:	Education
1. Strategic knowledge	top executive	engineer structural change	Career, academic
2. Communication	middle management	inform, co-ordinate and enforce	College, special course
3. Operations	workers	produce	Vocational

Some 20 years ago, the "schools" of scientific management were seeking for generalised information, control and guidance systems that would remove the dependence of the firm on a particular group of people. The idea was that, though people would come and go, "the system" would remain and, indeed, itself take critical high-level decisions. Nothing of the kind, of course, has occurred: the disorderly 70s of the world economy have rather reinforced the old, person-dependent management style. A new management in a troubled firm as a rule removes the remains of the old management and introduces its own system. The system informs and co-ordinates the people. It is differently designed in different companies. For all practical purposes it cannot be explained in operational terms to outsiders. It is too complex. It operates as a special language for that particular firm. To learn the system, one has to participate (work) in it.

An important function of the new management system is to teach newcomers who will make their career in it. This educational function is an extremely important part of Western advanced, industrial technology. No business school can take on the task because much of the knowledge, and all the critical knowledge, is tacit. The ambition of all firms is, of course, to develop such a management system that keeps repeating success. More precision in presenting the human competence vested in it is currently beyond our reach; we can, however, conclude that the value of "downstream" human and hardware capital depends on skills demonstrated at this level.

b) Middle Management

The co-ordinators of existing complex management processes in large companies are a relatively large group of people below top executive level charged with changing existing process structures. Middle management forms the largest part of this group. Its task is to communicate targets down the organisation, monitor their realisation, and respond by communicating deviant behaviour and suggestions upwards.

c) Skilled Workers

The further down the scale, the more locally well defined the tasks, and the more specific the skills applied -- hence the easier they can be communicated. Variety diminishes in importance, repetitiveness and ability to perform a few tasks efficiently come into the foreground.

However, even at very local workstations in the factories, what might be termed "operational blueprints" or explicit instructions for work processes scarcely, if ever, exist. A typical workshop in engineering industries consists of a group of skilled and specialised workers organised in a product flow system. All important knowledge of how to do things resides in individual workers. There is no central production head or foreman who possesses it all. It is both special and difficult to communicate except through learning-by-doing.

In fact, this difficulty in communicating specialised skills appears to be the major obstacle to process automation, especially in engineering industries (Eliasson, 1980a). The reason is that no one, even at local levels, has a central process knowledge of what goes on and with the detail and precision needed to code the process for automated computer control. And the reason for this is that even specialised manual jobs are very complex and normally -- in advanced industries -- require a significant input of judgement. Nevertheless, at very low and simple levels, an exact computer representation (explicit logical presentation) of the work process can be obtained, and automation may be both feasible and economically motivated.

As one reaches higher levels of complexity, specialised knowledge has to be combined with flexible organisational forms. The explicit logical representation is beyond both economical and practical reach. However, even if each individual at a workstation may possess intuitive control of his/her work, a growing number of high-level people charged with co-ordinating all local tasks will have to rely on the incentive structure and the organisational forms to get the whole of the work accomplished.

d) The Development of Skills and Knowledge

To define the educational process at work at the three levels, a distinction should be made first between the acquisition of manual skills in factory production, on the one hand, and more abstract, theoretical skills on the other for the surrounding software production or non-process activities.

Craft or manual skills were earlier taught on the production site through various forms of apprentice arrangements. Later on, with the

emergence of large-scale production sites, "vocational schools" associated and integrated with the firms developed on the initiative of firms themselves. This was the normal organisation of vocational training well into the post-war period. By degrees, however, ambitions to integrate vocational training with the regular public schooling system grew. In Sweden, for instance, a government educational policy was to take over the responsibilities of these firm-related schools. With the growth of labour market policies in the 60s in particular, the authorities began to establish and run retraining programmes that by degrees have become established courses, rather than the flexible programmes originally envisioned to take care of specific labour market demands.

This retraining activity to move people on to new and better jobs was one important element in what has come to be called the (old) Swedish policy model. The recent experience of these activities is that they have become alienated from the production process, that they teach obsolete skills, or practices and that they have taken on social ambitions and considerations that make their pupils less well adapted to the tough labour market life than they would otherwise have been (Björklund, 1985a). It is even the case that Swedish labour market education or retraining is no longer effective on the margin. Here, increased inputs tend to lower output. Rather than increasing such activities on the margin as they are currently organised, they should be reduced (Björklund and Moffitt, 1983).

Table IV:2 illustrates that introductory training programmes for the newly employed vary between industries but they clearly have significant scope.

A particular consequence of the ongoing, technological upgrading of industries is that information and service production, as opposed to actual materials processing, is becoming increasingly important. The work tasks are becoming more and more abstract and remote. New concepts and theoretical schooling are needed to understand not only one's own task but the whole process of which it is a part. This broader understanding is often quite essential for good performance on high-level jobs.

In the old days, skills were passed on directly by older colleagues who had already acquired them. Today, instruction on how to do things is increasingly presented in documentary form, sometimes directly from the computer and often in more than one language. This requires a corresponding education and training in receiving, understanding and applying abstract information.

The nature of jobs is constantly changing, requiring continuous relearning of skills, even for performing the same job function. Doubts are being expressed about how long the labour force can go on coping with this change, either because of lack of talent and basic schooling or because the change in itself is too demanding, socially and mentally.

Toffler (1970) made the pressure of faster environmental change his main argument in Future Shock. There is no clear and simple answer, except that well-educated people seem to be better at changing, relearning and adapting than people without a good general education, and especially people who have stayed long on the same type of job. It is also observed (Magnusson, 1981; Seligman, 1975) that people feel bad about their inability to improve their job situations. This can be due to risk aversion or absence of practice

in changing jobs; but it may also be the result of an overregulated labour market, or a tax system that reduces the payoff from moving, thus tying people to their original jobs. We note (Bosworth, 1981; Deiaco, 1985) that for a particular professional task there is considerable substitutability between subjects of background education, but that once a job experience or a job classification has been established, substitutability of job background for a given professional task seems to disappear.

Table IV:2

AVERAGE INTRODUCTORY TRAINING PROGRAMMES FOR THE NEWLY EMPLOYED: SWEDEN, 1984

Sector	Months	
	Blue-Collar Workers	White-Collar Workers
1. Basic industry	3.3	3.9
of which		
- Iron and steel	4.0	4.2
- Pulp	3.1	4.1
2. Intermediate goods	1.6	3.7
of which		
- Chemical	1.3	4.3
- Metal	1.8	5.0
- Paper	1.6	2.1
3. Investment goods	3.2	8.1
of which		
- Machinery	2.4	5.0
- Electrotechnical	4.3	12.7
4. Consumer goods	3.7	2.0
5. Construction materials	1.1	3.5
Total	2.9	4.8

Sources: IUI MOSES database, and Deiaco (1985).

A varied job career requires a constant relearning of skills: this is part of the human capital or experience that people who have reached the higher professional levels often possess. It is interesting to note Holmlund's suggestion (1984) that the decreased mobility in the Swedish labour market, observed as less labour turnover between firms, may be due to an increased turnover of labour on job types and locations within the larger business organisations. One of the reasons quoted is the improved career and on-the-job learning opportunities presented by "internal job markets". One should also remember that individual adjustment forced by environmental change is nothing new. It is not even clear that change in work environment is faster now than it was 20 years ago.

If structural change associated with economic progress means that new jobs are opened up in service-oriented and more educationally demanding industries, while jobs are disappearing in industries dominated by low-skilled, manual labour, we can conclude that the new entrants in the labour market should be as well prepared educationally as they can be. The adjustment burden will fall on the unfortunate few who are laid off from low-skill industries. They will have to retool from a routine repetitive job based on rote training, to an intellectually more demanding work environment that requires abstract thinking. Evidence suggests that such human retooling is difficult or impossible. As a consequence, rather than retraining labour, firms in distress and in need of fundamental reorganisation opt for replacing both management and work force. The case for reorganising businesses from within, to avoid forcing people to move, does not appear to be strong.

It is easy to forget that a major part of most work activities, and a part that has increased over time and that increases with the qualification level of the job, consists of communication between humans. This is the essence of an information society, even though the hardware side of communication called IT (for information technology) tends to attract most attention. In retrospect, man-machine interaction will probably be regarded as more typical of the worker environment of the past than it will be of future industries.

Communication has both an efficiency side, a human side and an educational side. It is important to "talk the same language"; it is important to organise and use information efficiently and it is important that humans understand each other without too much explanation, and communicate what they know with ease. The latter, and the combination of the three critical, strategic, communicative and operations functions of Figure III:2, is largely a matter of adequate organisation of people and of practice. It is extremely difficult to teach human interaction in the abstract, theoretical setting of a classroom with teacher and pupils. Whatever abilities and experience there were to begin with, a human being who has spent a long time on an isolated job, easily loses the competence he may once have had to communicate socially with a variety of his fellows. People who are not at ease in communicating with new acquaintances or in settling down in new job locations obviously will find change of job extremely demanding, even though they are capable of learning to perform the new tasks with ease.

We must recall here that the modern industrial firm has expanded dramatically during the last decades in activities that are almost purely concerned with human communication, with taking initiatives, with making judgemental decisions and with risking making personal mistakes.

Marketing is the most typical such activity. Research and development work is of the same kind although the nature of communication is different. People from different knowledge backgrounds using different specialised languages have to combine efforts. It is interesting to note that this works reasonably well under market pressure in large firms, while academic institutions have not succeeded at all.

For instance, modern, generalised electronics-based business information systems, currently being "attempted" by several large electronics firms, require that at least 12 "disciplines" represented and departmentalised at Technical Universities have to be merged.

Further breakdown and specification of production thus require more communication between humans (co-ordination, targeting, control) compared to longer work sequences of individuals in craft jobs. (Perhaps the problems associated with repetitive routine tasks on the production line do not really stem from a lack of variation in the performance of menial tasks, but rather from a lack of job-related human instruction.)

It is a common observation that state schools have practically no tradition in teaching social communication, or how to take initiatives and risks -- United States schools have some of this on the teaching agenda, but European schools practically nothing. Rather is there discussion about public schools and colleges destroying creativity, making students shy away from initiatives and risks and fostering passivity (see e.g. Illich et al., 1971). As a consequence, new competing educational institutions are being established within the business community to provide an educational product that the public schooling system has been unable or unwilling to supply.

4. The Firm as a Welfare Institution

The limits of a firm as a financial organisation are set where administrative efficiency on the margin falls below the alternative returns offered in the market. Hence, changing market conditions and administrative techniques force institutional reorganisation.

a) The Economic Rationale for Institutional Separation

An aspect of the internal team solution of a business organisation is that efforts and compensation cannot always be related one-to-one. This is as typical of the joint action of six men lifting a heavy burden as it is of large-scale factory work. The bureaucratic or administrative solutions of teams always mean interior redistributions of efforts and income. If the team cannot be reorganised continuously to fit particular jobs, some people will always benefit from the work of others. This is a well-known labour market experience, and it is interesting to speculate on how such interior, unintended redistributional arrangements within business organisations compare in importance with the welfare programmes of the public sector. Even though we cannot yet quantify, the implication is that the unintended income redistributions of large organisations contribute much more to the ex post equalisation of incomes than the total of public welfare programmes. The effects of the former, by its very nature of being unintended, cannot be evaded. A corollary of this is that the market-induced institutional

fragmentation made possible by technical and organisational change observed in the previous chapter will have far-reaching consequences on the final distribution of income.

Some efficiently managed large firms make deliberate and often successful efforts to squeeze "parasites" out of their operations (Eliasson, 1976). The "construction worker team" that negotiates a piece-work settlement with the construction company is a good example of an efficient team solution. Shirking is minimised within such teams because team members have usually been self-selected to be of equal quality, and supervise one another. Structural readjustments after major crisis periods often force reorganisation of firms (or teams) to achieve improved cost efficiency through forcing out overpaid, low performers.

b) Taxes and Economies Stimulate Self-Employment

The ongoing technical change in advanced countries, away from an industrial structure based on cost-efficient production toward a product-based industrial technology dominated at both ends by sophisticated, often small-scale, service production, is posing a growing market threat to elaborate internal (but unintended) redistributional arrangements associated with large-scale factory production There are three reasons for this development. Two are new, the third -- large tax wedges that separate disposable income from factor compensation -- has been at work all the time in high-tax welfare states.

First, the growing importance of specialised service inputs in final output of modern industries is making institutional separation easy. Second, the modern firm is, to a growing extent, becoming dependent on easy availability of a wide range of such specialised service inputs at different points in time to achieve overall profitability. The value of these specialised inputs when needed is high -- often five, ten or even more times what the firm can pay an employee doing the same service job. The economic rationale for separation of specialised service activities into small, high-performing teams is compelling. Forming small consultant firms or becoming self-employed, furthermore, makes it possible both to distribute and define one's income over one's life cycle in accordance with one's own preferences. Hence, taxes place a leverage on the economic incentives for institutional separation already at work.

c) Blue-Collar, Non-Skilled Workers are Placed under Market Pressure

Human capital-intensive service production linked to manufacturing goods production is typical of the emerging, profitable firms. The mirror image of this is that the manufacturing of simple products with a minimum of human capital inputs is coming under growing pressure from more efficient competitors abroad, with competing alternative organisational arrangements that compensate workers more in line with their work contributions. It is only natural that many of these competitors are in the newly-industrialised countries, since their comparative advantages are in the manufacturing of not-so-human capital-intensive products.

The impact of the relative change in cost efficiency of factory production associated with foreign competition and technology is reinforced in some countries, not only by progressive tax legislation, but also cumbersome labour market legislation and union practices. For all these reasons large-scale factory production which employs the bulk of the unskilled and semi-trained blue-collar labour force is diminishing in economic importance as the competitive engine behind industrial growth in Western economies. Protected and not sufficiently skilled people are laid off in contracting industries and new hirings of untrained people are slow. The labour market is rather looking for, and handsomely paying for, well-educated technical staff suited for the educationally more demanding work environment of the future.

d) Modern Information Technologies Will Also Affect Routine Middle Management

A similar problem is also emerging at the middle management level because of the combined effect of a growing bureaucratisation of large business organisations and rapid advances in information technology in business information systems (Eliasson, 1984d). A large middle management cadre is typical of large business organisations. Their main task is to relay information (communicate) upwards and downwards in the organisation. Top-down communication mainly consists in imposing business targets. Bottom-up communication mainly consists in modifying targets to become reasonable and to control and enforce targets. Top-down transparency to allow top executive people to see through their organisation is the ambition of all information systems. Communication through human beings is always subject to distortions. Modern computer and electronics-based information techniques that have developed rapidly in recent years are improving the potential for less biased information and commmunication systems within firms. The new, electronics-based database, communication and presentation systems largely bypass routine management personnel with a significantly reduced middle management involvement as a consequence.

One often hears about the need for a thinner management structure, or fewer hierarchical levels between those who do the job and those who run the organisation The organisation of communication links between the top and the bottom constitutes the technology to operate large business organisations. At some size, in every organisation, diminishing returns for larger size sets in. There are three ways to deal with this. One is to introduce market principles into the business bureaucracy and reorganise the firm into divisions or subsidiaries, a reorganisation that allows delegation of authority. Another way is to use the market to 100 per cent and allow separation of certain activities that are easy to manage. The third way is to use more efficient information technologies that allow a thinner bureaucracy for a given size of the organisation. All three approaches are being used. They all affect routine middle management in a fashion similar to local labour consequences from process automation.

5. Conclusions about Policy -- Education Through a Varied Job Career or at School?

A number of fairly distinct policy conclusions can be drawn from this overview of the applications of human capital to the industrial process.

First, the key to macroeconomic, firm economic as well as individual (economic) success is the right skill and human capital endowment. These endowments are distributed unevenly among nations and individuals, but they can be improved by investments in education. A significantly improved knowledge of the nature of these endowments is necessary for success of any form of deliberate policy action to improve the education system of an economy. Among the few concrete results of the inventory of what we know about education presented here, the most important one is that the economically important educational experience comes after school and is intimately tied to a varied job career.

Second, attempts at major reorganisations and reforms of the public schooling system on the basis of what we currently know about job requirements is not likely to do much good. Reforms, to result in improvements, should be incremental and gradually improve on the existing design. Under such circumstances the efficient way of improving the public schooling system is to stimulate local experimentation and to learn from the experience of local initiatives. To make the public educational system more experimental means making it more similar to the commercial activities of business firms. A business firm has to reorganise itself radically all the time to meet competition, without sufficient knowledge about how to do it. Firms try, and frequently fail. Large centralised systems, on the other hand, like the political system or the education system of a nation, should never be exposed to risks of fundamental failure and hence should remain conservative at central levels. However, if one is willing to accept a wide variety of educational outcomes at local levels, and a useful learning experience about how to improve upon the education system's design, local experimentation should be encouraged. This means giving up on some of the egalitarian ambitions associated with public education. As in any case, public education is not adequately attending to its other task of providing useful human capital for the production system, there seems no alternative to such restriction of ambitions unless it be reduced into insignificance by competition from outside the domain of public schooling. Then, of course, the egalitarian objective will still have failed. Hence, in effect there is no choice.

Third, the problems associated with forced structural adjustment on the private part of the economy become manifest in the form of business failures and new business opportunities as well as individual failures and new individual opportunities. There appears to be no need to care for business failures. The human, individual failures constitute the only policy problem. This is where labour market policies enter. A successful labour market experience means a continuous educational investment process in the form of a varied career, exposure to trouble and experience in solving human, technical and commercial problems.

New entrants in the labour market are, in principle, better equipped and prepared for the new jobs than people who have been in the market on the same job for a long time. A priority task of labour market policies must be

to encourage people to get a varied labour market experience. If we look at those who have actually been pursuing a career, the group is relatively small, although growing. If we look at those who would have potentially benefited from attempting to pursue a career, the group may be very large. Whatever factors at work are holding back people from learning through a varied career, we can safely conclude that the labour market performs a much too important educational function to allow itself to be regulated by any vested interest group.

Fourth, those who carry the costs of adjustments in the labour market will not, as a rule, be the same as those who benefit. With a current upgrading of skills and educational requirements attached to new job opportunities in growth industries, failures will most frequently hit people who have not attended to the updating of their human capital, and who happen to have been working on the same repetitive job for a long time in a firm that is also subject to failure. "Intellectual retooling" appears to be the main labour market problem in a growth economy. If attitudes are biased in favour of accommodation to changes in job market requirements, adjustment problems will be natural, and smaller than if external change is opposed. To build attitudes favourable to change ought to be a priority task of the public schooling system if national objectives are to achieve fast macroeconomic growth. This is, however, seldom part of public school policies, and most schools are badly prepared for such tasks: recruitment practices for teachers tend to create the wrong type of teachers -- people who have rarely ventured outside the public educational system to obtain, for instance, a varied work experience.

It is fortunate that on-the-job schooling can compensate for some of the deficiencies developed at school. It is fortunate, too, that some modern firms have learned that offering a multitude of internal career and educational programmes is in their own interest. But this reorganisation of comprehensive education will be unegalitarian in final outcomes. Those who take initiatives and those who realise that lifelong, useful education consists in selection and investment, (not only investment) will succeed. It would be far more efficient from a welfare point of view if the public schooling system also organised itself accordingly.

Viewing the labour market process as part of the educational system implies a distinct change of policy. The old model of Swedish labour market policy had the express ambition to retool people for new jobs and new locations through retraining programmes. It was, however, based on a misconception by industries that consisted of factories with skilled blue-collar workers. Labour demand under this policy hypothesis shifted from one skill to another and the policy prescription was, first, to predict the demanded future skill composition and, second, to arrange training and retraining programmes in manual skills accordingly. Such manpower training programmes gradually became less efficient through the 60s and the 70s. Nobody in central planning positions predicted the emerging new industrial structures of the late 70s, the emergence of the modern manufacturing firm and -- in particular -- the nature of the so-called electronics revolution.

The advanced industrial firm is to a diminishing extent based on manual skills. Growing firms want people capable of abstract thinking and used to an environment with little manual work and few similarities with "the factory". The ability to make judgmental decisions and take initiatives commands a

premium. Under such circumstances, a long and singular work experience becomes a negative factor both for labour market performance and for the ability to take on new jobs. The continuous, work-related educational experience associated with a varied job career becomes a critical positive factor for labour market success. Also for the firms it becomes important to have people continually on "the career move". It is the only way to get really competent labour. It is also the only way to observe and select the right people for high-level jobs. In fact, the further up the scale one gets in a modern firm, the more of an integrated part of production learning and competence enhancement are seen to become. The advanced industrial firm, and the large firm in particular, offers an increasingly larger relative share of such career jobs. There are many ways of organising work at all levels so that accumulation of career experience is facilitated. A key notion in all these arrangements is that education is integrated with work, and not imparted separately in alienated schools.

This listing of results allows three summary conclusions as regards the labour market problem facing the old industrial nations. First, some personal failures in the adjustment process are unavoidable. A labour market failure is normally defined in terms of failure to achieve previous, or higher job performance and compensation. This is natural, since changing job tasks always means switching human capital inputs, the old inputs losing in value. If the new job pays better, it means that you had earlier been under-using your human resources -- or, in short, holding the wrong job. On the other hand, the world is replete with job opportunities for those who take initiatives and those who accept a down-grading of work compensation. There is no way of getting around the conclusion that rigid work compensation rules cause unemployment. The current policy solutions tend to be bureaucratic and personally humiliating. An insurance arrangement that offers a whole spectrum of intermediate solutions between a full-time job and "phase out" should be feasible -- for instance, an insurance system that fills in the difference (or a significant part of the difference) in pay to an extent that increases with the length of the job career. Private professional insurance schemes already offer similar arrangements in a number of Western countries.

Secondly, however, the majority of people who change jobs do so on their own initiative and, as a rule, experience an improvement in their situation (Holmlund, 1984).

Thirdly, and finally, the ability to take initiatives in the labour market and to retool professionally hinge on education in a broad sense, while industrial policies enacted in the OECD world have been oriented toward avoiding the need for individual adaptation (Eliasson, 1984c) by conserving existing structures and worsening the long-term competitive situation of industries.

On this score, this essay points very strongly in one direction. If industrial policies are at all needed, they should consist of improved labour market policies, and better educational policies. However, no body or institution has the knowledge to prescribe how to improve policies apart from being aware that experimentation and initiatives at local and individual levels will help improve both labour market and educational performance. Improved policies are therefore synonymous with bringing competition into the labour market and the public educational system. And the main form of competition currently lacking in most countries is not job market competition

between individuals (already intense at all levels) but innovative entry of new ideas, solutions and initiatives related to the institutional organisation and the administration of the public schooling system and the network of rules that make much of the labour market in the industrial world, in fact, an administered system. Competition is normally prohibited to protect monopolised educational and labour market institutions, except when education and the labour market are internalised in firms.

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