ABOUT THE CONCEPT OF INDUSTRIAL REVOLUTION

Among historians, the industrial revolution has a particular meaning and it refers to a change in the history of human development based on industrial change and social change, first of all in Britain and later on accepted in other countries in Europe and in North-america and elsewhere. I think it consist in of two parts and one has to look at it as consisting of two aspects: one is a technical aspect. Industrial revolution really meant that cotton goods, iron goods, etc, were made in a new way by machinery, by mass-production techniques, in factories , etc. But it also had a social aspect: in that it created greater income, greater mobility, new social relations between workers and employers and for the time being of course gave Great Britain a great advantage in international trade by being able to sell to other countries and in term of other countries then imitated this and got the same advantages. So we mean something very specific: one change, once and for all, transformation form a traditional society to modern industrial society.

POLLARD

ABOUT THE ROOTS OF INDUSTRIAL REVOLUTION IN THE PAST

Of course it didn't happen suddenly overnight without preparation There are several roots. One is a tradition of craftmanship which goes back to the middle ages in Italy and in the Netherlands and then spread to the rest of Europe. A craftmanship: craftmen being trained by the guilds so that you have a minimum standard of efficiency, a minimum standard o honesty and so on. A second root is what we now call proto-industry, that is the domestic industry in the countryside but collected by putting out merchants and then possibly sold on a large scale and that created capital, a form of commercial capitalism, international trade and so on. And I think the third root is a technology aspect, the arise of science, the idea that you could innovate, that you didn't have to take the technology of the past but that you could think of new things. To some extent, the industrial revolution is a technical innovation process where people were deliberately going out to find new ways, cheaper ways, more efficient ways of doing things which enturns and goes back to a the new science, european scientific change, scientific revolution of the 17th century. There are more, but these are the three most important roots of the industrial revolution.

POLLARD

ABOUT THE RELATIONSHIP BETWEEN THE INDUSTRIAL REVOLUTION AND THE SCIENTIFIC REVOLUTION

It is not very clear. Certainly the technology gave many ideas to the scientists. That is to say: because of surprises people found in chemical works, in iron works, etc. the scientists were stimulated to find new answers. What is more significant, what

more people are interested in, is the way in which the scientist helped the industrialists to change their methods.This is clear in chemistry. The chemists developed bleaching, modern methods of bleaching, of dyeing, of putting colours in textiles. The matalagists, so that iron making and the melting of other metals was developed, the mathematicians because some of the calculations of James Watt for his steam engine were based on notions of physics and mathematics. There is some influence, but it's not clear how strong it was. In some case like Watt and the steam engine it's very much there, in other cases there is less direct influence and in fact many of the innovators and of the inventors had scientifically quiet the wrong ideas as what they were doing. Science was sometimes catching up with technology and not helping it but in some cases it helped directly. One of the things that are important is the scientific attitude, that is the attitude that you don't accept what tradition has told you, but you test for yourself. This testing and questioning habit of mind, I think that is the most important contribution from science to technology.

POLLARD

THE RELATIONSHIP BETWEEN THE TWO: SCIENCE TO TECHNOLOGY OR TECHNOLOGY TO SCIENCE

It's certainly both. The second is obvious: from technology to science. In the works, in the coal-mines people come up against problems and they don't understand them and they report the problems back to the scientists. They develop means of measurement so they helped the scientists. That is clear, but perhaps not very important. The other one is much more difficult. Weather science actually helps technology. In some cases yes and in others no. In many cases a new technology developed on its own and only much later did science explain how it worked but in some cases, as I say, chemistry, glassmaking, ironmaking, yes, science directly helped to establish, to improve, to explain industrial methods.

POLLARD

WHY AN INDUSTRIAL REVOLUTION IN ENGLAND AND EUROPE

I think science was largely international. France was much the biggest country in western Europe and they had more scientists than anybody else. But it was international: people met and read each others books and papers, but the acceptance of science, at least, turning the scientific spirit into industry depended on the market, depended on having entrepreneurs and on having the resources. And there England was favored. England had a free market, a bigger market, internal market, it had market freedom and it had the resources. It had coal and it had iron. And so happened that that is where the first inventions were made. Also England had certain bottlenecks. Some people think that the industrial revolution is a response to bottlenecks. You needed more wood and England had a delimited number of forests so it had

to replace wood with something else: coal and iron. to some extent, the advantage of England was that is was short of certain thing and had to find replacements. If you then ask why Europe and not Asia, I think this has to do with freedom and with a free market and with the ability to think up new answers against the notions of religion . A certain amount of competition, different countries were competing against each other so that governments were supporting industrial efforts in a way that one huge nation like the chinese didn't have to. or India, didn't have to. But in Europe, with many competing countries, in the age of mercantilism, which is the age just before industrial revolution governments were inclined to support their own industrialists against other countries and that helped the process along. Science alone, science was international, but the application, technology, there where certain advantages in England and in Europe.

POLLARD

ABOUT THE DIFFERENCES AND DIVERSITIES BETWEEN ENGLAND AND THE UNITED STATES

The british started with shortages of material, they were short of wood, short of certain metals, but they had plenty of skilled labour. So the british answer to many technical problems was to use the skill of their artisans, of their labour, as well as that, of course, of their managers. Also the british had a large overseas market and they worked to the overseas market, for example, the cotton industry, the leading industry absorbed more than half of its products abroad. So that the market was split up between many different countries, each with different fashions, with different colours, with different patterns. The United States had plenty of resources but were short of labour, of skilled labour, so the tendency was for the americans to go for much more machinery and much more capital, and more resources. So american technology tended to be wasteful of resources, used lots of wood and lots of coal, but saving labour and of course making labour-saving-inventions. And the market was also different. Basically the americans produced for their home market. Their market was mainly democratic, but for this one level of demand, they tended to go for mass-production were as the british went for splitting up the market according to what people wanted, which was not easy in mass-production.

POLLARD

WAS THE MACHINE/TOOL INDUSTRY VERY IMPORTANT IN THE DEVELOPMENT OF TECHNOLOGY

Yes, Marx of course, thought that it really made a difference between the old and the new, the machine tool industry. Yes, I think in some key phases in England - between 1800 and 1850 and in America and Germany after 1850 - these were the industries that helped everybody else along, there were some mayor inventions made including the chance to mass-produce screwthread,

to make very leveled plains surfaces, to mass-produce things that are turned on the lathe, to standardize screwthreads, all this came from machine-tool-industry. course that enabled other industries to get their machines cheaper. The (1w) and most successful british machine-tool-industry in Great Britain finished about 1850 and it then became rather conservative and that held back perhaps british advance after 1850. At that point the americans took over, and later the germans, and developed better and better lathes, (1w) lathes for example, a complicated turning machine for metals, etc. Yes I think it's rather central in certain phases, the very first machines of the british industrial revolution in the 18 century were largely made of wood, but the next stage, metal machines, they had to make their machine tools and that was rather critical.

POLLARD

ABOUT THE RELATIONSHIP BETWEEN WAR AND TECHNOLOGY

This is a disputed subject.
Some people certainly think that war helped along certain key industries, obviously metals, armaments. One, one well known example is a fact that when James Watt invented his steam engine he needed a very good fitting cylinder and piston. And in those days one couldn't drill a very straight cylinder so the piston should fit in without leaving gaps or without getting stuck. And the invention for making a straight-through cylinder was made by another man called Wilkinson when he was building cannons. So here is a direct effect of making arms on making machinery, in this case a steam engine. So that is how steel and iron products were helped along. The idea of mass production occurred first in the war. For example in America they started making guns with interchangeable parts which is perhaps a basic notion of mass-production, so that any part would fit any gun about 1805. In England they made blocks which is wooden parts used in fitting up sailing ships. A sailing ship has several hundreds of these, and block-making was mass-produced in the Napoleonic wars. So we can find technical examples of an overspill as it were from a war production into civilian production.

Other people say the opposite. Other people say that war diverted resources from what would have been industrial progress to making arms and uniforms and there is now a fairly convincing statistical argument about this, that's British technical, economic and social progress was held back for about twenty years during the French- Napoleonic wars and that is one reason why poverty was such a marked feature in the British industrial revolution. The money all went on the war and only after 1850, after 1820 perhaps, did they have social progress arising from the peaceful development, in other words, the war withdrew capital and technology from progress and in that extent was harmful. It's, it's a difficult question but the answer is certainly not all on one side.

POLLARD

ABOUT THE DIFFUSION OF THE TECHNOLOGICAL KNOWLEDGE

There are several methods. It is very soon known that british firms could produce cheaper or had new machines, new processes. As far as a scientific basis was concerned, people did write scientific papers an the difference between science and technology was not very clear. For example a text book of chemistry written in England in the seventies, eighties, mostly contains descriptions of how to make iron , and how to smelt copper. In other words, chemistry was very much applied chemistry. A second method was industrial espionage. People sent their agents or went themselves to factories and tried to find out what happened. A third method was to hire workers and managers from a successful firm, either to other british firms or abroad - hundreds of them went abroad - to set up new firms with modern methods. The forth method was to buy the equipment. People bought, f.e., steam-engines from Watt and textile machinery, etc,. For a long time, it was prohibited in Britain to export certain machinery, but people went around it, they broke the machine into parts and the costs could not all be guarded. It was also, for a time, forbidden to skilled workers to immigrate, (3w) either. And in the next phase when Germany, Belgium and France were advanced countries, they did much the same thing. They tried to prevent their latest methods from being learned abroad but it always did go abroad. The knowledge was relatively easy, how actually to do it very often was difficult and they had to get skilled people to show them how to do it, for blueprints, and books and models sometimes were not enough. I think this is true today. And this happened then. Some went to England to learn, but hundreds of british workmen were recruited abroad and later on Belgium workmen and this is how it spread.

POLLARD

ABOUT UNITY AND DIVERSITY

Economic historians think the industrial revolution is something special and unique, that is we ought to be able to define it in such a way that is different from other technical changes. There were technical changes in the middle ages, and in the early modern periods and yet we have to, in some ways say, that the industrial revolution is unique and different, and we ought to be able to show this in some way to measure it. And yet if we try and provide a measurement which will fit the industrial revolution in many countries but be different from anything else, this is very difficult. One could say the industrial revolution meant a certain level of achievement being boosted by greater achievements and we take national income as a level of achievement and if we do that there is a certain level that every country that reaches industrial revolution has reached before, but it doesn't fit terribly well for other countries. For example, the level of income which set Britain off on industrialization has long since been reached by latinoamerican countries and they haven't industrialized. An other method might be to take the rate of change and we say: if an economy grows fast, that's industrialization . And this also doesn't work very well. Or we might say it has been proposed to say that the proportion of national income devoted to capital investments is critical because capitalization means a lot of capital and that also doesn't give very good results. And I could go on , One has tried

to compare, f.e., the proportion of consumer-goods industries and capital-goods industries and say capital- industries beyond a certain proportion, that is industrialization. And it also doesn't fit. And we have tried to look at structure: industrialization means fewer people work in agriculture, more work in industry and in the services and that also doesn't fit very well. So whatever we try is a reasonable approximation but in the end it doesn't give perfect results. And the question is why, and in the end, i think the main reason, there are two reasons: that countries have different resources and so their process has different waiting, for ex. the US industrialized while the country was still largely agrarian and exporting agrarian goods like grain and row cotton. Other countries like Belgium and Britain were largely industrial. So the structure depends to some extent on resources. But the most important reason is that countries industrialize in different times , at different phases of world development. So when they get there, they get to the (1w), the world is a different world and they have to do different thing. F.e. Great Britain being pioneer country, had no competitor, development was slow, but from the beginning it was largely geared to exporting manufactures and importing agricultural row materials. So the british industrial revolution was slow and very early leading to decline in agriculture. The second group of countries that industrialized after Great Britain , which is Germany, Belgium, Switzerland and France already had an advanced country next to them, from which they could take industrial technology , so they industrialized more quickly. At the same time they had neighbours on the other side who were less developed to whom they could sell their not very good industrial products. So they had a kind of intermediary position and as industrialization proceeded, this boarder line between those already industrialized and the others moved east and south away from the core of Europe and then covered Austria, northern Italy and so on, leaving out perhaps some parts of Europe which didn't industrialize until very recently. That means that the actual development of industrial revolutions in each country was different in the sense that it faced a different structure of world development and it was based on different resources. In one sense they were doing the same things, they all industrialized, they are all changing from a traditional society to a more modern society with factories and with capital and with proletarian labour and large cities, urbanization, etc. They were getting there by slightly routes, that is your diversity. In the sense it was the same thing that was happening but when you measure it and you look at it the similarity is not all that great and one is struck by the differences.

POLLARD

THE EXAMPLE OF THE RAILROAD BUILDING

The railroads are an interesting example of this because the acceptance of railroad technology was almost instantaneous in Europe, but in 20 years virtually every country had at least some railroads, and then in another 20 they had quiet developed networks. But the interesting thing is that while they were simultaneous in the railroad development, they were not at the same stage in other respects. Consequently you can say that the

british railroad system was developed at the end of the british industrial revolution and it had to be so because it needed the capacity to build locomotives and thousands of miles of rails. In other countries like Germany and Belgium and the US,it is well known that the industrial revolution was at the same time as the building of the railway building. That in a sense kept the industrial revolution going. It created engineering capacity and ironmaking capacity. Were as in other countries The railroads came before the industrial revolution. They had to have them but they hadn't the capacity to build by foreigners, foreign capital usually, foreign engineers using foreign iron, rails, etc. Ahead of demand often they had to have railroads because of prestige and in some cases because of military means, perhaps to attract tourism, to bring out their own row material which in sense tended to fix them in a preindustrial stage. Some countries began to specialize in agriculture, Hungary f.ex. was specialized in agricultural exports with the help of railways and in that way never got round to industrializing. So the same railways have very different role to play and looking at it the other way round, looking at the industrial revolution in each country the railroads play a different part, happened at different time, had different causes and different consequences and at the end, looking at them superficially they are the same railroads.

POLLARD

ABOUT THE THREE INDUSTRIAL REVOLUTIONS

We have been basically speaking about the first industrial revolution, the industrial revolution which transformed the traditional world into an active moving industrialized technically changing world and this is what happened in Great Britain late 18th century and in Germany, France, etc, in early 19th, in Italy late 19th century. It was based on iron and coal and steam technology and on textiles basically. A second industrial revolution is often thought to be the development in the late nineteenth century early twentieth century based on electricity but also based on mass-production machinery and almost automatic machinery like sewing machines and automatic setting of prints, etc, but very largely it's an electrical and internal combustion engine, that is motorcar based transformation. Like in other ages, technical progress goes on all the time, but this was particularly marked, it was strongly interconnected through this electricity lead to a number of other changes, new forms of motors and works, lighting, communications, telegraph later radio and information services and so on so that one can say not that it is merely progress beginning in the 18th century but a cluster of new things, new inventions, new processes, that amount to a second change or a second revolution. And then we say that the third revolution is happening, a third industrial revolution is happening now and that of course, is based on electronics and on chemical achievements, on bio-chemical achievements and so on. The change here, I think, is much greater than the 2nd and it's much more like the 3rd, that is to say: not only is the technology better, different, new things are being produced and new processes, but it also reacts on the social system. This one for example, the present 3rd industrial revolution has taken a lot of people out of factories, of building solid things to make

them work in offices and in planning offices, etc., so now in most advanced countries the blue collar worker is a minority. That caused great political consequences, labour parties don't have labour to support them, had social and educational consequences. It also means that because of new communication and transportation methods people can live further out, the cities take different structures, the motorcar dominates traffic, holyday practices, the way people live, it really does transform society, not just industries, but societies, I should imagine like the 1st one. It really is a revolution of a mayor kind as far as we can tell now.

POLLARD

HOW DID PEOPLE BECOME MECHANICAL MINDED

We go back to the 18th century. Some people refer to the british (categoria di artigiano), that is you hammer about, try and file a little off here, a little off there. To some extent people are born into a world which already has some machines. The industrial revolution in England was strongly original. Some regions made cotton goods and some regions made iron woods. In the regions making iron goods the boys took this up, they learned to play so far they are doing it, and they began to have a feeling for metal and the feeling for what a machine can do and if it didn't do what they wanted they had a kind of idea of how to improve it, mainly by (1w). There is really no basic knowledge of engineering or science or mechanics behind it but (1w) and engineerity, that is the way, the attempt to find new ways. Even old fashion things like water reels, that were hundreds o f years old, in that time and only in that time were very greatly improved : from the same quantity of water you got many more horse-powers out. By contrast, even today in third world countries you introduce machines and the local population can't keep them going and what seems to be lacking is the feel of what metal can do and what it can't do. So I think, to some extent it's a slow accretion of traditional experience highly localized, industrial revolutions highly localized: it didn't spread at all over the whole country, it was always regional, local and it was a kind of experience which I think people have to get to when they are very young and then they seem to be masters of the equipment and I would say they think about it, they play around with it and sometimes they make improvements.

POLLARD

ABOUT THE SOCIAL CONSEQUENCES OF THE INDUSTRIAL REVOLUTION

It had very many social consequences. First, it seemed to lead or didn't think to prevent a very large population increase. Industrialization is everywhere associated to strongly rising population . Why this is so, is not very clear but it may have something to do with jobs and so families married earlier and had lest restraint in having many children, it may be that children survived better, but anyhow it allowed or encouraged more people.

It created very strong urban centers, urbanization is a very strong feature of industrialization . People have to live in large settlements in order to (mam?) the factories. It's very strong the change of the relationship between employer and worker, it made it more and more impersonal, discipline was a different sort of discipline, most workers lost whatever equipment and property of their own they had (the preindustrial worker would have tools or a little workshop of his own) now they owned nothing so they were peerage workers, it meant the family as a work-unit was destroyed: in many pre-industrial occupations and of course in agriculture, the whole family tends to work together, now they didn't. The educational system, the attitude to the states, to church, to politics, people are drown to a changing society so that the traditional acceptance of authority was changed. So here are a number of very important social changes directly arising from industrial revolution.