

Discussion with Dr. Roland Part – 2
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Professor R. Santhosh: Welcome come back to the session, we have Dr. Roland Wittje with us to discuss about the scientific revolution which subsequently led to the industrial revolution in Europe. Roland, we were talking about the emergence of scientific revolution and important scientists and their impact over Europe especially in terms of providing an alternative, explanatory paradigm.

Now, can you briefly start with the transformation from this natural philosophy into specific sciences that led to the emergence of technology and its impact on industry? It is a large transformation, but could you summarize.

Dr. Roland Wittje: First, if you do not mind, I would actually argue against that.

Professor R. Santhosh: You would say that there is no linear connection?

Dr. Roland Wittje: yes, there is no linear connection. Obviously, in hindsight, we can always create linear connections.

Professor R. Santhosh: But usually that is how we understand isn't it? And then technology ...

Dr. Roland Wittje: Yes, But if you look really at least in the, as I said in the last class science or the scientist as a person and as a profession, that has really arisen only in the nineteenth century. Obviously, we can talk about philosophy, natural philosophy, about experimental philosophy. Yes, if you go back to somebody like Francis Bacon, you would then not only talk about science as empirical science, but also sciences, useful science.

You would also have throughout the enlightenment of the eighteenth century, scientific societies who would kind of reiterate that. So in the last class, I talked about natural philosophers traveling around and collecting data, quantitative data and trying to have an influence on agriculture for example. A kind of modernizing what we would call today modernizing agriculture, there is this idea of progress, a scientific progress and using kind of science to improve the world, like of improve technology as well. But if you look at the Industrial Revolution, I mean, historians of

technology have and very much agree on that it was actually not driven by scientific discovery, even though you had that ideology of useful science and science should be used more technological progress, you can you can say, but that was actually not the case.

If you look in the history of science, and this is surprising to a lot of people. If you look in the into the history of science as natural philosophy and the history of technology, we will actually find out that technology used to be, which is very paradoxical at a place like IIT, I asked my students and they always say, technology is applied science; full stop. But in its original, it is actually not at all.

If you would look at Aristotle and Greek philosophy, you would say, first, experimental method is not part of science, you are forcing the world to do something. Mechanics is not part of science, but is part of the arts.

Professor R. Santhosh: It is quite interesting.

Dr. Roland Wittje: Mechanics is artificial, we are forcing nature to do something, and it is actually technology, that would be one of the definitions of technology. So, technology and we see that if you look at the protagonist all over the world, for example, the Indian caste system, you would see the separation between the kinds of sections of society like the Brahmin caste.

The artisans which in the Indian system as much lower in in the caste system. Who actually responsible for technology? So, there was actually in this debate between science and technology, also in I mean, who expresses this probably best in Europe is really Leonardo Da Vinci, as an example because we look at Leonardo Da Vinci as obviously a very gifted engineer, if he would say that with modern words.

And at the same time, a very gifted artist.

Professor R. Santhosh: That is true.

Dr. Roland Wittje: Like and a lot of people describe Leonardo Da Vinci as a scientist, he was not a scientist and this is really the kind of mechanistic design most of the kind, of anatomical drawing, he has an all that. So, we really see the kind of link between the Arts and Technology and we also have this an English language if you talk about artisans, and arts and craft.

So, you can say historically, technology has been much closer to the arts than

Professor R. Santhosh: Surprising.

Dr. Roland Wittje: to the science. the Industrial Revolution also, if you look at the protagonists of the Industrial Revolution, it was much more of this traditional trial and error, technical tinkering, gentle warming, theory kind of thing.

Professor R. Santhosh: Not coming from the high theory thing.

Dr. Roland Wittje: No, not coming from the high theory thing. It is also very interesting. We have one of the very interesting people to read here would be, Edgar Schisler, who has been writing a very interesting book already in the 1930s, where he puts up the hypothesis that the scientific revolution actually did not emerge from abstract thinking but much more from technological practitioners, and they actually gave inspiration to scientific abstracts.

Scientific extraction actually, empties and also brings up and this is again a very sociological theory that actually modern science as we know it today is a thesis that did not arise earlier because earliest societies were slave societies and basically manual labor was given to the slaves and the ruling classes would never engage in manual labor. Specifically, you could make an argument, if you look at Holland, for example, there were a lot of these people you have like the craft skills, actually, their status. I mean, specifically, if you look at arts and crafts in Germany, and the status of class skills in city societies, we were seen as free societies, if you think the idea of the citizen.

That they were very much kind of giving inspiration for, for like, creating or transforming a useful or like using technology as an inspiration for scientific abstraction. So, if you look at the Industrial Revolution specifically in Britain to the end of the nineteenth century, there was a big distance between engineering and the practice of engineering and science, it was not really coming together in the same way as in other countries.

So, in Britain actually a James Watt who invented the steam engine, but even like earlier versions, the new common engine which has been around before ,if you look at the driving forces for the Industrial Revolution and we can make out several of them, but science was actually not one of them.

We have this saying by historians of technology that science owes more to the steam engine than the steam engine owes to science because, the steam engine came up, but that motivated really research in thermodynamics, you can say there is a lot of research in thermodynamics that was inspired by the steam engine and you can see the complex relationship between science and technology.

Technology is a driving force for science, as much as science is a driving force for technology. So, you can say this also happened really, during the time of the, of the enlightenment and the French Revolution. What we have in here is the Industrial Revolution starting in Britain, where this kind of ideology of bringing science and technology together was not really that strong.

Whereas in France, you have this very much with the kind of way how we can say Newtonian is then moving from, from Britain to France, and developing a very different kind of understanding and also the states playing very different kind of role. So in France you have,

Professor. R Santhosh: During Napoleon period or after that?

Dr. Roland Wittje: Even before with, with absolutism and France where you have a very central estate. The very central estate takes a very strong role in the organization of science and actually also the organization on science and technology. So we get a very, very new model of relationship between science and technology, which I would say at the beginning is not grounded in empirical evidence, then there is a relationship, but rather as an ideology, how technical technological shift ought to be made.

We have specifically the foundation of these grand Ecols in France, and specifically the Ecole Poly technique. We have a number of French military engineers. So a lot of these people, kind of French mathematical physicists, lot of these people were actually military engineer. So, we have for example, Coulomb, the Coulomb which is one of the fundamental law of electricity. If you look at the rise of electricity or electricity and magnetism, where you have the inverse square law modeled after the gravitational law. The forces between electrical charges and essential forces and the structure is essentially the same as in gravitation. Coulomb was a military engineer, and he was concerned with the problems of saving, powder storage against lightning.

So, how do you build a lightning rod? The idea was, if you really want to understand this, you have to do research of its fundamental scientific principles. I would say the Coulomb law was

very successful, but it was not necessarily to begin with very successful to build a lightning rod. So to begin with, you can say this was more of a kind of ideological model but throughout the nineteenth century obviously the situation or the relationship change, yeah.

So, there is a certain historical development in the relationship between science and technology. You can see that very well in the nineteenth century specifically as I said, there was no strong connection between science and technology in Britain. What you have is latest from the mid nineteenth century, the start of a British declined debate.

Part of that is related to so you have the first phase of the Industrial Revolution, which lasts like until the 1850s, like and then you have a second phase where other countries then Britain are much more successful specifically Germany, like and the rise of the chemical industry and electrical industry.

But then obviously, railways and other things machine making these things and but what was very specific both about you can say the chemical industry and the electrical industry that there were very much science driven.

Professor R. Santhosh: From bottom up.

Dr. Roland Wittje: You can say what would be the scientific disciplines metallurgy, for example, that actually came much later. Yeah, like in chemistry that metallurgy came much later. So, it was much more trial and error to bring up new melting processes, new steel producing processes, the steel engine, also the spinning jenny and the mechanization of, of spinning and then weaving, scientists were not that much involved in it.

But then specifically, if you look at the electrical technology of electrical industry, there was no traditional arts and crafts and precedents, like was entirely based on new scientific discoveries. People taking these scientific discoveries not necessarily understanding, that there is still not a very linear relationship between scientific discovery and industrial, industrial production.

But obviously all these are based specifically on Faraday's experiments, electromagnetic induction, Volta's discovery of the electric pile and electric battery, Galvani's experiments. So, there was a lot of scientific experimentation and also scientific theory going along with that

experimentation. That was very important for the rise of electro of the electrical industry, which was very different.

Chemical industry we can say obviously, there is predecessors to chemical industries, I mean, people have been making soaps, making chemicals all the time. But the kind of rise of analytic chemistry specifically in Germany, and using this kind of analytic chemistry, which came up after Lavoisier and this kind of chemical revolution in order to synthesize new chemical compounds and on that base kind of industrial development, I mean specifically if you think about the tar, coal industry chemical dyes, which again had a huge impact on India like think about indigo and the decline of natural, natural dyes and the rise of chemical dyes.

Professor R. Santhosh: Now, coming back to the social implications of the Industrial Revolution, we know that as a student of sociology, we are trying to understand how this larger transformation, but the very economic fundamentals of society from a feudal agrarian to a capitalist industrial society. That is something very significant. So what would be your observations on the social implications of especially people who migrated landscape to the cities and the rise of urbanism, the slums the kind of chaos that followed?

Dr. Roland Wittje: First, I would say, obviously, industrialization has been a very long process. It started in the 1750s. We would say in places like India still ongoing. We can still say, certain sections of society or certain sections of our productive sector if you think about agriculture. I would say for example, even a Germany, industrialization and increasing industrialization of agriculture is still ongoing.

I can also make of criticism of industrialization, if you think about meat production, for example, in in Europe. So, industrialization is still and we talked about the first, second and the third and most. We talk even about the fourth phase of industrial revolution. Obviously, we have many social, social transformations and the rise of new of new classes like obviously the rise of the bourgeoisie on one side and the rise of the proletariat of the workers.

The rise of urbanization of cities, which came along with a very new mode of production. And obviously also with a very new way of describing economies with capitalism as we know it today and this has been very much linked also, if we come back to science in the nineteenth century, if we think about the scientist as a kind of professional idea like both the scientists as or

the scientific community part or as kind of new rising bourgeoisie and the idea of the scientist as a profession.

In technology, we should not be understanding that the impact of this of the steam engine, for example, which was invented already in the mid eighteenth century and became much stronger in the nineteenth century. It took some time before it will really take on. Also if you see the rise of cities and city populations, if you go to British cities, it would take on very early on in cities like London, Manchester, then the spread of this was rather slow or not very even through Europe as well.

Belgium would be one of the first up in cities but then also France, Germany where in Britain industrialization would take on right like and then, as I said, would also go over from into new types of industrialization. I mean one of the biggest impacts if we look for example, on transport, like, but also on communication.

So, if you think about transport we would then also look at the second phase of the Industrial Revolution. For example, the railroads and this steamboat as well. If you think of increasing global trade, for example, a contraction of space. And here I am not talking about Einstein's theory of relativity, but much rather like how space in a social way got very much contracted and also time really changed.

I mean, if you think about the Telegraph, for example, as a means of communication, suddenly, you could actually communicate instantaneously more or less with all parts of the world, like which then had a big impact on markets, for example, which, which really changed perceptions, but even reality sometimes and space.

Professor R. Santhosh: That brings us to the very important question about the connection between industrial revolution and colonialism. Do you think Industrial Revolution would have taken place in Europe without colonialism?

Dr. Roland Wittje: Certainly not in the same way, because basically the kind of trade, the way how trade was organized and specifically how the British organized trade in their empire was a central element of the Industrial Revolution. But if we really understand this as a system, you cannot remove one component and think that that would not impact other systems.

So, if you think about one of the main driving forces of one of the main sectors that really got mechanized was the textile industry and that was very much depending on colonial trade, on also slave labor, obviously, in the colonies on cotton production, and also on colonial markets as markets.

Professor. R. Santhosh: Because colonies provided both the raw materials as well as the markets for the finished products.

Dr. Roland Wittje: If we specifically know India, where the main exporters of textiles. This has been known since I mean, you can go back into antiquity, like the market. So, you really have this kind of very new mode of production here coming in would be very difficult to say. But then obviously, colonialism has a longer history than the British colonial empire, obviously.

We in India, we usually understand colonialism as kind of the British colonial empire. But obviously there is a longer history to that. They have been different modes of operation, on how to run your empire. Obviously, there has been this kind of coming together. I would even say this kind of relationship between science and technology. As I said, it is not really that easy.

Like if you go back to a Kuhnian ideas, you already have this idea that scientific knowledge would be useful knowledge and the kind of idea of scientific societies in the nineteenth century. As I said, the kind of French model of, of bringing science and technology together, which happened at the same time as the Industrial Revolution unfolded. We should not imagine, obviously, the French Revolution is a different type of revolution than the Industrial Revolution.

I mean, the Industrial Revolution, like the scientific revolution, if you even want to use these terms, and a lot of historians have criticized these terms have not been proclaimed revolutions. Like by actors, having said we topple over the old regime like, and they are rolled out. What is also typical for these revolutions is that they are rolled out over a much longer time period. Especially the French Revolution did not really succeed in that sense. So only in hindsight, we would call for example, the Industrial Revolution, a Revolution. Like where I still very much, even though a lot of people have questioned the notion of the Industrial Revolution, but I think the industrial revolution is much more obvious and stronger argument.

I call that a revolution than the scientific revolution. The scientific revolution, you really see has kind of unfolded over a period of several 100 years. Where is the kind of effects? I mean,

specifically, if you look right now, one of the biggest indicators of industrial industrialization has been for the longest time and many ways to live and as part of our problems of battling climate change, and the paradoxes of what we would call sustainable development.

We talk about growth on one side, and this kind of idea, and this comes really with this kind of idea of progress. If we really see, when we really start having larger amounts of carbon dioxide in the industry, we can really point out at the point of the Industrial Revolution, this is really the starting point where things really change.

Also our kind of impact on environmental factors were very much stark, right like, and when we look at this kind of increase of a energy production, like that has, for the longest time really been kind of a direct indicator off of industrial development, and we are struggling to get away from that like, specifically in India country where we still have large percentages of population not connected to electricity.

So these kind of transformations and revolutions come together. It is really kind of this idea of which again, today has been much criticized the idea of modernity. And also, this idea of instead of having a more static understanding of your, to have an idea of some kind of progress, like whether that is linear or in any other shape, like, but this idea of progress that is taking shape.

Professor. R. Santhosh: We identify all these revolutions as coming together producing something called as modernity, it actually promised you better control over the natural resources, nature and it promised you that human condition would be better it would emancipate. But now, when you look back those promises, we realized that many of these promises were quite problematic and we are finding ourselves now in a very difficult situation.

Dr. Roland Wittje: Obviously, we can say yes or no. I mean, one of the things you would really have after the Industrial Revolution is a very strong population. Obviously we have improved living conditions, we are able to kind of place many more humans on earth. Also we can say in many ways conditions have improved if you think about mortality.

Professor R. Santhosh: But quite a lot of the argument is that a lot of unintended consequences, consequences that we did not really anticipate that they have emerged as major things that we are learned to deal with them.

Dr. Roland Wittje: Obviously, we have talked about colonialism as well, like the whole colonial experience, where a lot of additional populations have been extinct. If you look at the Americas, and also Africa, genocides that has happened through colonialism and also specifically I mean, we also talked about the ideas of Darwinism like that the rise of humanism was something that race.

If you look at the French Revolution, the ideals of fraternity, equality, liberty, that were not in any way extended to the colonial world. So with the kind of humanization, specifically, if you look at natural philosophy in throughout the nineteenth century, I mean, and that has been for a very long time. I mean, if you look at natural history museums until rather recently at the Smithsonian, in the US, for example, where indigenous populations were placed as part of the natural history, rather than as part of humanity.

There were lot of exclusion or the kind of the expansion how much was that kind of promise of equal opportunities for people really extended, we could not only have to look at that we can look at gender equality, for example. That has obviously been a rather recent phenomenon, like that women actually were even considered to be eligible to have equal rights as men.

So, there were strong limits to that. If you look at specifically the 20th century, there are two large blows actually to the whole promise of modernity which are called the First World War and the Second World War, right? Like where we can say, all our scientific and technological advantage, the only thing we are using it to is to kill each other more efficiently.

So, obviously these have been rising concerns and yeah, obviously and also criticism of this kind of ideas of progress and modernity also through industrialization. Like specifically if you look at Science and Technology obviously, they have made a huge impact on warfare to make wars more deadly and lethal?

Professor R. Santhosh: So, thank you very much. We are winding up the session. Thank you Roland for providing very useful insights, especially on this connection between science and technology because usually it is taken for granted that science led to the emergence of technology that led to the emergence of industrial revolution and as a historian, you really problematized and made it more complicated. Thank you.

Dr. Roland Wittje: The relationship between science and technology is a very complex one and we also have to historicize it. We really have to understand the kind of changing relationship and specifically if you look at modern times if you take our time again, you can say the relationship between science and technology has taken a different term which is usually expressed in the term techno-science.

Like where we say that science and technology have kind of come together, at least to certain types of science and technology have come together to kind of seamless web that is very important for the historiographical debate, a very important book by David Edgerton, 'The shock of the old', on what we should really be thinking about the relationship between science and technology.

Old modes of production have never really disappeared. We still have craft, craft technology and a lot of technologies that are with us since the beginning of humanity, for example, we still use hammer is technology. We have been using hammers as humans and using hammers since Stone Age and other kinds of technologies. So baskets, for example, like we have been using baskets since, since Stone Age. Like even though hammers are easier to remains off. That does not mean hammer we are using today is the same hammer as we were using to Stone Age. But our problem that we have a lot of times looking at technology, we only understand technology as the kind of newest technology.

Whereas obviously technology and the interaction of technology with society is rather complex. We should not only be looking at the kind of high tech, kind of newest technology which can be very much described by the term techno science. So, technology is a much broader concepts really and still there is a lot of artisans in the world, a lot of crafts people in the world and we still have the kind of craft mode of production in the world together with industrialization.

Professor. R. Santhosh: So thank you. Thank you very much. Thank you.

Dr. Roland Wittje: You are welcome.

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