Course: Science, Technology and Society

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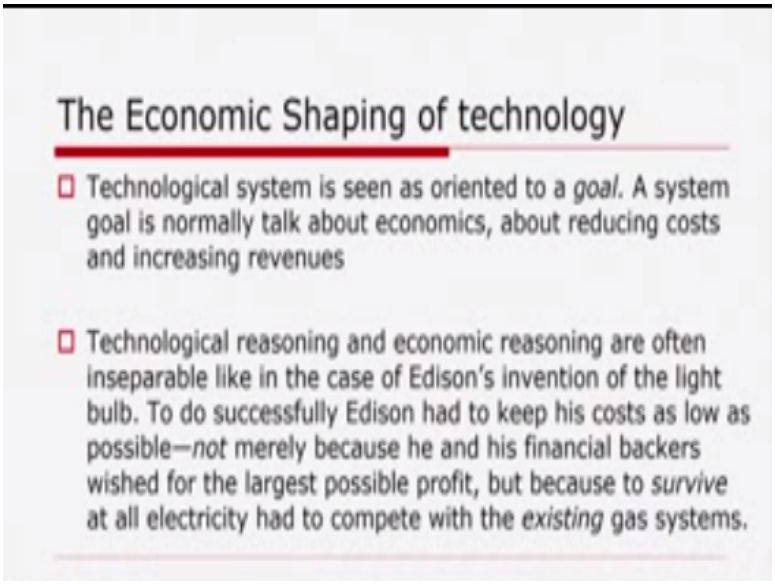
Week: 09 (Social Shaping of Technology II)

Lecture: 26 (Donald MacKenzie and Judy Wajcman II)

When we discuss the technological shaping of technology, we have discussed the critics on the inspirational notion of invention in the form of Ogburn and Hughes. From the technological shaping of technology, we will come to economic shaping of technology. The very concept of river salient makes only if a technological system is seen as oriented to a goal.



See, in economy, in the evolution of technology, economics is deeply embedded, economic goals are deeply embedded. As Hughes pointed out that the technological system is seen as oriented to a goal, to an objective, to an aim. It must aim towards certain social needs or economic needs or by keeping the market in mind.

Otherwise, any metaphor of advancing or of backward parts become meaningless. Language of this kind is dangerous if it is allowed to slip towards vague talk of the cultural need for a technology. But the notion of a goal can be given a direct and down to earth meaning.

Most importantly, most importantly a system goal is normally talk about economics, but reducing costs and increasing revenues. talk of a system goal is normally talk about economics, about reducing costs and increasing revenues. , electricity supply systems, for example, have been private or public enterprises and those who have run them have inevitably been concerned above all about costs, profits and or revenues or losses and so on.

The river salient is an inefficient or uneconomical component , for Thomas Hughes and for many practical purposes inefficient means uneconomical. so far as practicality is concerned, practical considerations are concerned. What is efficiency? efficiency means economical, inefficiency means uneconomical.

For the time being we can also argue that efficiency may be uneconomical, inefficiency may be economical. We will see that in the lectures to follow. technological reasoning and economic reasoning are often inseparable like in the case of Edison's invention of the light electric bulb.

Like our extract from Hughes work demonstrate this in the case of Edison's invention of light bulb. Edison was quite consciously the designer of a system. He intended to generate electricity, transmit it to consumers and to sell them the apparatus they needed to make use of it.

To do so successfully Edison had to keep his costs as low as possible not merely because he and his financial backers wished for the largest possible profit, but because to survive at all electricity had to compete with the existing gas systems. Crucially Edison believed he had to supply electric light at a cost at least as low as that at which gas light was supplied. These economic calculations enter directly into his work on the light bulb.

A crucial system cost reverse salient was the copper for the wires that conducted electricity. Less copper could be used if these wires had to carry less current simply, but crucial science was available to Edison as a resource. What are those? Ohms and Joules laws from which he inferred that what was needed to keep the current low and the light supplied high was a light bulb filament with a high electrical resistance and therefore, with a relatively high voltage as compared to current.

Having thus determined economically as well as or rather economically as much as technologically its necessary characteristics finding the correct filament then became a matter of hunt and drive. The precise characteristics of the Edison case are perhaps untypical. Even in his time Edison was unusual in his conscious individual grasp of the nature of technological systems there in perhaps lay his successes and since his time the inventor entrepreneur has in many areas been overshadowed by the giant corporation with research and development facilities.

Menlo Park that was Edison's R& D institution, research and development institution was only an aspect of the beginning of the great transformation brought about by the large scale systematic harnessing of science and technology to corporate objectives, but the essential point remains that typically technological decisions are also economic decisions. if we produce a technology, if we design a technology which is not marketable, which consumers are not interested in then perhaps it will expire very soon.

if technological systems are economic enterprises and if they are involved directly or indirectly in market competition then t technical change is forced on them.

If they are to survive at all, much less to prosper they cannot forever stand still. Paradoxically the compelling nature of much technological change is best explained by seeing technology not as outside of society. In the context of hierarchical or linear model as well as

interactionist model we have seen. how science technology and society are, separate entities, but in the case of embedded model we have witnessed how science and technology are very much a part of social institution.

That is why the compelling nature of much technological change is best explained by seeing technology not as outside of society, as some versions of technological determinism would have it, but as inextricably part of society. That is why I repeat if technological systems are economic enterprises and if they are involved directly or indirectly in market competition then technical change is forced on them. Technical change is made inevitable and if such technological systems are to survive at all, much less to prosper, leave them whether they prosper or not, but if they have to survive they cannot forever stand still.

That is why economic shaping of technology is also important, is assuming greater significance in this context. Technical change is made inevitable and it is nature and direction profoundly conditioned by this and when national economies are linked by a competitive world market as they have been at least since the mid 19th century technical change outside a particular country can exert massive pressure for technical change inside. the dominant way of thinking about the connection between economics and technology is the neo-classical approach, which is based upon the assumption that firms will choose the technique of production that offers the maximum possible rate of profit.

if you look at basic economics textbooks up to Arthur Cecil Pigou by 1920s we consider it is a neo-classical age from John Maynard Keynes, the general theory of employment interest and money we come to know that it is the modern economics, but this is not a part of the course I am just giving you some example whoever may be interested in economics.

That is why the dominant way of thinking about the connection between economics and technology, that is the neoclassical approach, which is based upon the assumption that firms will select the technique of production that offers the maximum possible rate of profit. Despite its apparent plausibility this assumption has been the subject of much criticism within economics.

The issues involved are complex there is a useful review of them later on for example, by Elster in 1983, but they hinge upon whether human decision making does or indeed could confirm to the strict requirements of the neo-classical model. For example, how can a firm possibly know it has found the technique of production that produces maximum profits? Is it not near reasonable to assume that a firm will consider only a very limited range, a few range from the set of possible options? And will be happy with a satisfactory profit rate? or not necessarily, only satisfactory not maximum. In the new approaches that have developed within economics, inspiration has been found in the work of Joseph Subbete with it is emphasis on the aspects of innovation that goes beyond and cannot be explained by rational calculations.

That is why we at times theoretically speaking one may say that an entrepreneur and or an investor must look at the maximum profit, how can an individual, how can an entrepreneur, how can an innovator, how can an investor, how can a firm, how can an industry possibly know when it has found the technique of production that produces maximum profits. We do not know. This is just an assumption. Rather, instead of making such rational calculation we are trying to look at some kind of satisfactory profit rate instead of maximum profit. It is found in the works of even Subbete who was perhaps one of the first ones to offer the theory of innovation in economics and which transcends economics, which goes beyond the purview of economics we sociologists also study a Subbete in the context of social innovation. Therefore, when innovation transcends the field of economics it goes to the level of culture, society, polity and so on. Therefore, we say economic shaping is social shaping.

What are the sociological explanations for this? The alternative neoclassical economics of technology thus offers a direct bridge to more sociological explanations. What are those sociological explanations? costs and profits matter enormously, but in situations of technical innovation key factors are future costs and future profits. Since there is an element of uncertainty in these, they cannot be taken as simple given facts.

Estimating costs and profits is part of what law calls “heterogeneous engineering.” What is that heterogeneous engineering? What are these sociological explanations for this? When we say heterogeneous engineering engineering social as well as technical phenomena. That is why whenever we say technology is always sociotechnical in nature and social and technical are inseparable.

Constructing that that that heterogeneous technology, that is engineering which is social as well as technical or technology which consists of both social as well as technical phenomena constructing an environment in which favoured projects can be seen as viable. In this context market processes punish those who get this wrong and reward those who get this right, but which outcome will prevail cannot be known with certainty in advance nor can it be assumed that market processes will eventually lead to optimal behavior as successful strategies are rewarded by the differential growth of forms that pursue them. That standard neoclassical argument may have validity for static environments in which selection has a long time to exercise its effects, but not for situations of technological change.

A strategy that succeeds at one point in time may fail shortly thereafter. A strategy that succeeds at one point in time I repeat the may fail may fail shortly thereafter and the market's "invisible hand" may simply have insufficient time for the neo-classical economists' optimization to take place. Furthermore, even if sure calculation of costs and benefits or profits and even optimization were possible the economic shaping of technology would still be its social settlement.

Economic calculation and economic laws after all specific to particular forms of society not universal. Suppose, I will discuss this, whenever we talk about economic calculation or economic laws they are very much context specific to a particular form of society. n when people were engaged in economic calculation and economic laws in feudalism do we apply the same process of economic calculation and economic laws in capitalism? Are we going to do the same in the context of a socialist state? even if in all societies people have to try to recon the costs and benefits of particular design decisions and technical choices, the form taken by that recording importantly variable.

it is economic calculations, economic laws they are not universal phenomena they are context specific, they are they are specific to particular forms of society or they are specific to particular modes of production. For example, technical innovation in the erstwhile USSR (Soviet Union), people in the erstwhile Soviet Union (USSR). They certainly made calculations as to what served their economic interests and plant managers had greater autonomy to make decisions than is often assumed, but the framework of that calculation was different prices were set by central planners of the state price committee rather than being subject to the vagaries of the market as in the west or even in Indian context.

Today Indian state does not determine, we do not have price stabilizing mechanism rather we leave it to the vagaries of weather or the vagaries of the corporate sector in the context of medicine in the context of agriculture and so on. A price we might say was thus a different social relation in the Soviet Union. In its classical form the system of rewards to Soviet managers hinged upon quantity of production in the short term fulfilling the norms of the plan in the current quarter. since 1989 or 90.

the focus on quantity implied that while small technological innovations might be welcomed larger changes. For example, changes that made meant elaborate retooling were a threat

developing a new product meant coating risks with little promise of commensurate reward if successful. The reforms that erstwhile Soviet leaders introduced to alleviate this situation often made it worse.

Thus economic reforms in 1965 tied the rewards to managers more closely to the profitability of their enterprises, but because the price system was not fundamentally changed the greatest profits could be earned by concentrating on existing products whose costs of production had fallen well below their bureaucratically set prices. Innovation instead of speeding up actually slowed and the consequences contributed to the eventually dramatic collapse of the Soviet Union as parrot in Mackenzie and Wajcman's book argues. Furthermore, even if we restrict our attention to societies in which prices reflect market competition we find that economic calculation remains a mechanism of social shaping.

Why? Now, because it is specific to particular forms of society, to particular modes of production. Economic calculation presupposes a structure of costs that is used as its basis, as its foundation. But a cost is not an isolated arbitrary number of pounds or dollars. It can be affected by and itself affect the entire way our society is organized. This point emerges most sharply when we consider the cost of labor, a vital issue in technical change because much innovation is sponsored ,contract driven and justified on the grounds that it saves labor costs.

To take a classic example- because of the different circumstances of 19th century British and American societies such as the presence of the USA of a frontier of agricultural land whose ownership by indigenous peoples was largely disregarded, labor costs more in America than in Britain. Hence, Habakkuk in 1962 argued that there was a much greater stimulus in America than in Britain to search for labor saving inventions. And thus, a different pattern of technological change that we find in two societies in British and American society.

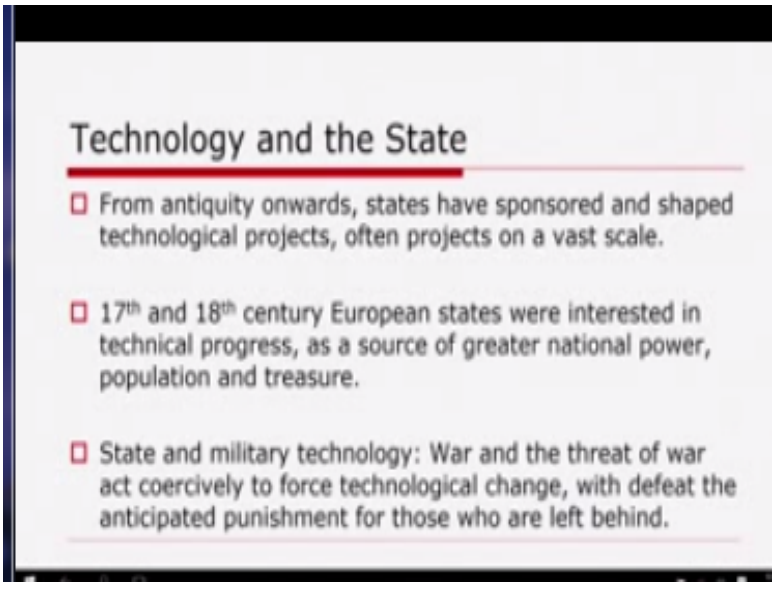
Habakkuk's claim has in fact proven to be controversial, but the general point remains- the way a society is organized, the way a society is instituted and its overall circumstances, its overall conditions affect its typical pattern of costs and thus the nature of technological change within it. That individuals are typically paid. you will also find historically and even today you will find it that men are typically paid more than women. For example, it is clearly not an arbitrary matter, but one that reflects deep seated social assumptions and an entrenched division of labor including unequal domestic and child rearing responsibility.

Do not think that it is arbitrary. men are paid, typically paid more than women. It is not arbitrary.

It is it reflects deep seated social assumptions, deep rooted social assumptions and an entrenched division of labor including unequal domestic and child rearing responsibilities. The different costs of men's and of women's labor translate into different economic thresholds for machines that have to justify their costs or by elimination of men's or of women's tasks or mechanism of the gender shaping of technology that deserves systematic study. we must discuss this when we come to technology and gender within social shaping of technology.

Nowwhen we say that technical innovation includes economic calculations, economic laws which are after all specific to particular forms of society or modes of production. They are not universal technical for example, technical innovation in the erstwhile Soviet Union USSR. Then what is the nature of the state so far as technology is concerned? that is how we come to a point of technology and the state.

social relations then affect technological change through the way that they shape the framework of market calculations, but the market is far from the only social institution that shapes technological change.



From antiquity onwards states have sponsored and shaped technological projects often projects on a vast scale. That is why we can look at any projects on dam, projects on electricity, projects on water, projects on a large scale technological projects.

if you can slightly recall what we discussed in the political construal of technological systems, the work of Louis Mumford authoritarian technology and democratic technologies. Authoritarian technologies are very often proposed by or funded by, shaped by, sponsored by the state. Mumford provided a classic account of this.

Let me quote him, he said that "authoritarian techniques it begins around the fourth millennium BC in a new configuration of technical invention, scientific observation and centralized political control." There are three things here, technical invention one scientific observation and centralized political control by the state. The new authoritarian technology was not limited by village custom or human settlement sentiment.

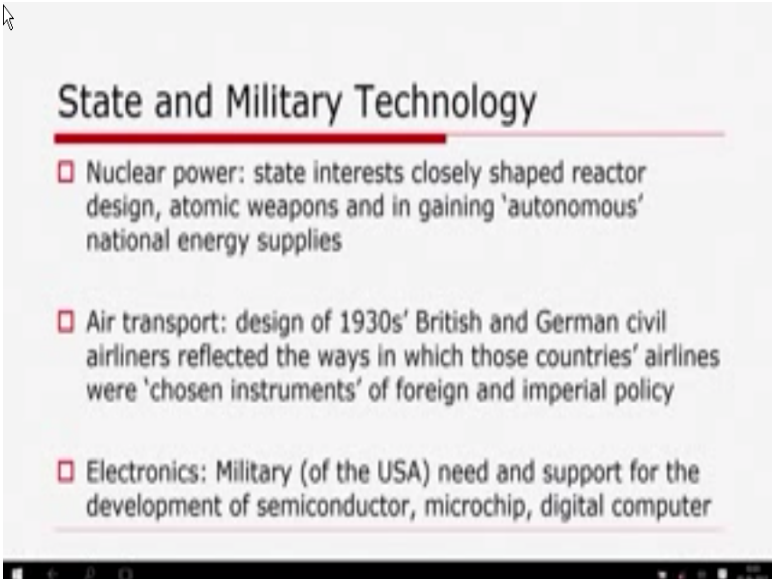
Its herculean feats of mechanical organization rested on ruthless physical coercion, state coercion, forced labor and slavery which brought into existence human powered machines that were capable of exerting thousands of horsepower. 17th and 18th century European states were interested in technical progress as a source of greater national power, population and treasure. this mercantilist framework , what is that mercantilist framework? The state and military technology greater national power, population and treasure.

This this mercantilist framework carried different implications for the shaping of technology. state and military technology when we talk about it is the war or and or the threat of war, they act coercively to force technological change which defeat the anticipated punishment for those who are left behind. when I say such mercantilist framework of having greater national power, population and treasure carried different implications for the shaping of technology than did straight forwardly capitalist judgments.

While in England there was strong commitment to labor saving devices in France, the mercantilist notion that work must be found for the largest number of hands prevailed. As late as 1784 the brocade loom was praised in France because it employed twice as many workers as the plain cloth loom. It being argued that it was the benefit of labor which remains in the towns when the products have left that is the real product of the manufacturers.

The single most important way that the state has set technology has been through its sponsoring of military technology. That is how we come to state and military. War and its threat of or the war of or the threat of war or war and its preparation have probably been on a power with economic considerations as factors in the history of technology.

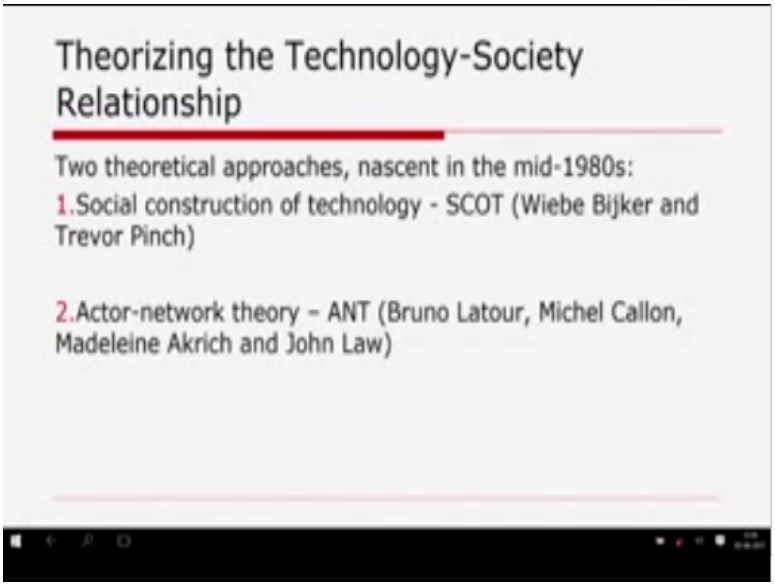
Like you will find that like international economic competition, war and the threat of war act coercively to force technological change which defeat the anticipated punishment for those who are left behind. Military technology is the subject. That the military technology when we talk about it is the extent to which military concerns have shaped civilian technology. Military interest in new technology has often been crucial in overcoming what might otherwise have been insuperable economic barriers to its development and adoption and military concerns have often shaped the development pattern and design details of new technologies.



we can keep on giving such examples. in the case of nuclear power state interest closely shaped reactor design, atomic weapons and in gaining autonomous national and energy supply. We can give case studies like air transport where we will find design of 1930s British and German civil airliners reflected the ways in which those countries' airlines were chosen instruments of foreign and imperial policy.

That is how colonialism operated for a for a long time and through military technology colonialism ruled India for almost a couple of centuries. In the context of electronics you

will find military of the US need and support for the development of semiconductor, microchip, digital computer and so on. these are these are certain ways to look at the nature of path dependence of technological change.



When we look at theorizing the relationship between technology and society, a major development in the social studies of technology since the first since the first edition of the of such work that science technology and society studies reader came up in 1985 is the flowering of the theoretical work on the relationship between technology and society. Two theoretical approaches which were quite nascent in the mid 1980s have particularly close bearing upon the social setting of technology. what were those two in the mid 1980s? That was first is the social construction of technology perspective developed by Wiebe E. Bijker and Trevor Pinch and represented here in a succinct extract from the work of Pinch and his colleague Ronald Klein.

Its focus is on the very phenomenon that has been underestimated in the debate over path dependence. What is that path dependence in the context of social construction of technological systems is concerned? That is the interpretative flexibility of technology, interpretative flexibility of technology. Then what is that interpretative flexibility? Bijker and Pinch they discussed the construction of a bicycle.

we can look at anything, we can look at a refrigerator, we can look at a television set, we can look at a computer, we can look at a power loop, we can social construction of

technological system. what what is that interpretative flexibility? Interpretative flexibility refers to the way in which different groups of people involved with a technology can have different understandings of that technology including different understandings of its technical characteristics. This is important.

Suppose when you look at a particular project on dam. This Subansiri dam in north east. that particular dam elicits different responses from different stakeholders. It includes different understandings from different stakeholders, different social groups, economic groups, political groups, cultural groups, pressure groups and so on.

Bijker and Pinch focus is not just on the symbolic meaning of technologies, but includes also variation in criteria for judging whether a technology works or not, . The Bijker- Pinch Social Construction of Technology Approach, this SCOT approach draws heavily upon earlier work applying the sociological perspective to scientific knowledge. Those developing the sociology of scientific knowledge such as David Bloor in 1976 sought symmetry of explanation.

We have already discussed Bloor. when we discussed the externalist characterization of the relationship between science, technology and society. Earlier notion was that all knowledge except scientific knowledge is socially and culturally conditioned.

Whereas Bloor in 1976 pointed out that no it is not correct. All knowledge including scientific knowledge is socially caused. Bloor what did he argue? Bloor argued that argued against the then prevalent notion that true scientific knowledge was the result simply of unaided human rationality and causal input from the material world.

Instead of invoking social processes only when the credibility of false belief had to be explained. Bloor argued that proper explanation of all knowledge true or false, true and false both typically would involve recourse to material input, psychological processes and social processes as well. There are few more difficult and more contentious topics than what sociology of knowledge symmetry would be taken to mean.

Certainly not all subsequent authors employed the term in the way Bloor did. For Bijker and Pinch, in the context of SCOT, symmetry means avoiding explaining the success or failure of

technologies by whether or not they work. For them machines work because they have been accepted by relevant social groups.

Who are those relevant social groups is also a matter of political choice, political selection. To our minds this formulation underplays the extent to which for Wajcman and MacKenzie such such formulation whether they work or not. For them for Bijker and Pinch machines work because they have been accepted by relevant social groups.

Machines do not work because they have not been accepted or they have been rejected by relevant social groups. for MacKenzie and Wajcman such formulation under plays the extent to which technology always involves interaction between human beings and the material world, but they wholeheartedly agree that historians and sociologists of technology should consider the fact that machines work as something to be explained rather than take it for granted , in their explanations. In particular explanations of success and failure in terms of the intrinsic superiority or inferiority of technologies are suspect because of the path dependence of the history of technology. That one type of machine works better than the alternatives may reflect their histories of adoption and improvement rather than any intrinsic unalterable features of the technologies involved.

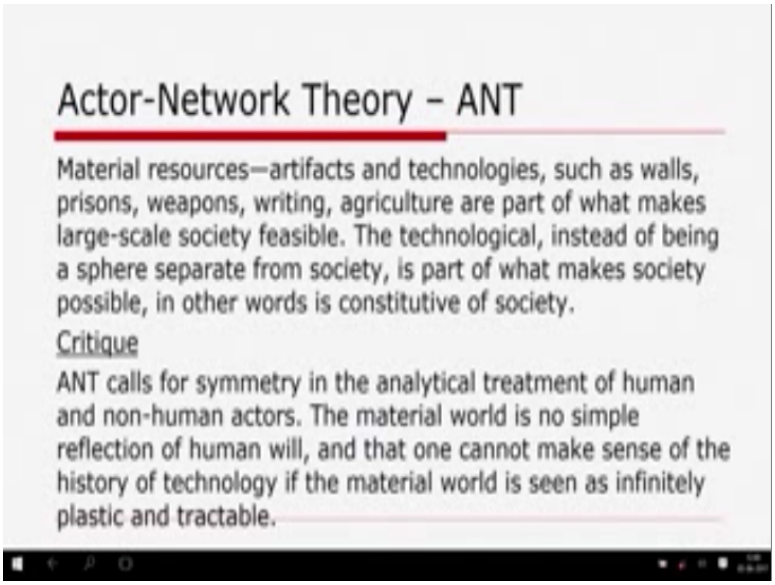
it is important, the first is the issue of structural exclusion.Who are the relevant social groups or not is a matter of political choice political selection as we discussed. it is the issue of structural exclusion in the SCOT approach what we find that the social groups relevant from the point of view of a particular technology are typically identified empirically in historical research. For example, we can identify what social groups are relevant with respect to a particular artifact by noting all social groups mentioned in relation to that artefact in historical documents.

Suppose, when powerloom was introduced, when handloom was in full flow, when power loom was introduced who were those relevant social groups who accepted that no, power loom should work, no more hand loom that relevant social group the very construal of such relevant social groups is a matter of political choice or is statised in nature. it is also historically conditioned. The trouble of course, is that the exclusion of some social groups from the processes of technological development may be such that they have no empirically discernible influence on it and are not for example, mentioned in documents concerning it

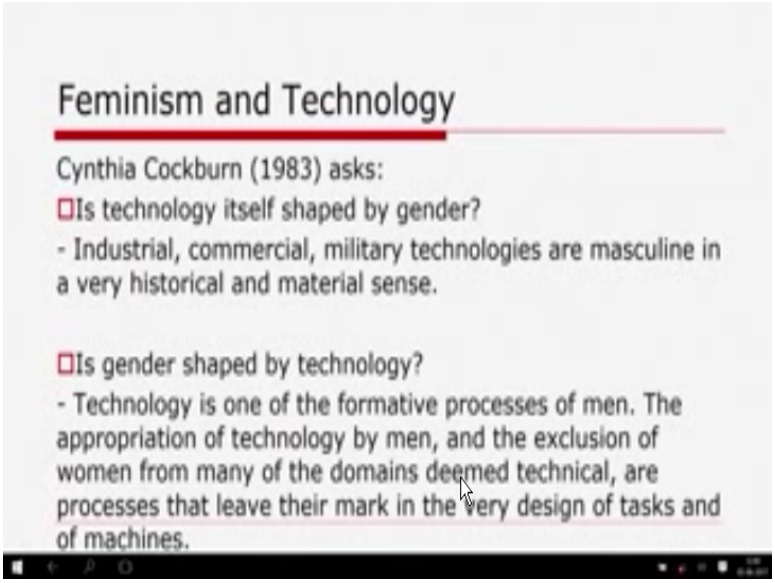
this for instance will often be the case with women ethnic minorities and manual workers. When I say manual I meanhand loom or power loom, there is hand loom is done manually, power loom is done by machines and those manual workers who are not skillful, who are not familiar with or who are not being made familiar with the sophisticated power loom, they will be left out, they will be socially, politically, economically excluded, culturally excluded.

In this case, it would be most foolish to assume that gender is irrelevant to the development of a technology just because no women were directly involved and the masculinity of the men involved was never mentioned explicitly in discussion of it and analogous points hold for class and especially ethnicity. The point is a difficult one. We would not claim to have formula for how to analyze the effects on technological development of structural exclusion, but it needs always to be kept in mind. The influence of politics upon weapons technology is for example, by no means always the direct one of technologists compliance with explicit political demands. And then it can also take the indirect form of the efforts of technologists to keep their technologies as black boxes opaque to scrutiny from the political system. The developers of the US submarine launched ballistic missile systems for instance carefully avoided design options that might lead to political controversy and congressional involvement. However, attractive these options seem to others this is what McKenzie wrote in 1990. The other problem with the original formulation of this SCOT approach is one that also manifested itself in the first edition of that book, “Handbook of the STS Reader”, that is the reciprocal relationship between artifacts and social groups. The theoretical perspective that has done most to sensitize the field to this issue is what is often called the “second theory theoretical approach” that we witnessed these days. in the mid 1980s. It is the Actor Network Theory propounded by Bruno Latour, Michel Callon, Akrich, John Law and so on.what we are trying to do here that we will be looking at mostly Latour's work on Actor Network Theory, Laboratory Life and others even Callon's work Law's Work and so on. The key point can be conveyed in the way, let me put it this way, that in the 1985 first edition of that Reader Handbook on Science Technology and Society Studies was thought largely of the social shaping of technology in terms of the influence of social relations upon artifacts. The problem with this formulation is its neglect of the valid aspect of technological determinism the influence of technology upon social relations. To put it in other more accurate words, it is mistaken to think of technology and society as separate spheres influencing each other, technology and society are mutually constituting.

The reason why from the varied and influential writings of Latour why we are trying to look at Actor Network Theory, both SCOT as well as ANT are important theoretical approaches to study the relationship between technology and society. to sum up the thing quickly about SCOT and ANT that SCOT approaches SCOT focuses interpretative flexibility of technology which refers to the ways in which different relevant social groups involved with a technology can have very different understandings of that particular technology including different understandings of its technical character. The critique to such SCOT approach is the exclusion of some social groups from the processes of technological development and the reciprocal relationship between artifacts and social groups we have already discussed.



Then what is this ANT, Actor Network Theory? Actor Network Theory it dwells upon material resources artifacts and technologies such as walls, prisons, weapons, writing, agriculture are part of what makes large scale society feasible. The technological instead of being a sphere separate from society or social is part of what makes society possible, in other words a constitutive of society. What is the critique to ANT approach? That the ANT approach calls for symmetry in the analytical treatment of human and non- human actors.



The material world is no simple reflection of human will and that one cannot make sense of the history of technology if the material world is seen as infinitely plastic and tractable. Coming to constructing gender, we can we can look at many many things that how do we construct gender, how do how does feminism examine technology, how can or how technology is constructed through gender, is shaped by gender. We will discuss this in the lectures to follow.