Sociology of Science
Dr. Anindya Jayanta Mishra
Department of Humanities & Social Sciences
Indian Institute of Technology, Roorkee

Lecture – 08
Science and Technology of 17th Century England R.K Merton

Dear students, we have been discussing about Sociology of Science last few lectures. In the last few lectures, I talked about Sociology of Science as a subject which was developed by Robert Merton, renowned sociologist from United States of America.

Now we are continuing the that same discussion, will look at some of the other contribution of Robert Merton in sociology of science. I started with for instance Sociology of Science of Robert Merton in the context of Ethos of Science. What the Ethos of science that he has developed, which are the guiding principle for the scientific community.

Then we spoke about the counter norms; the norms of science, the norms which guide, regulate the scientific community as well as the counter norms which were developed by (Refer Time: 01:24) based on his study of Apollo moon scientists at NASA in 1974. So, that is just to put things in a perspective regarding the norms and counter norms in science which are the guiding principles for the scientific community.

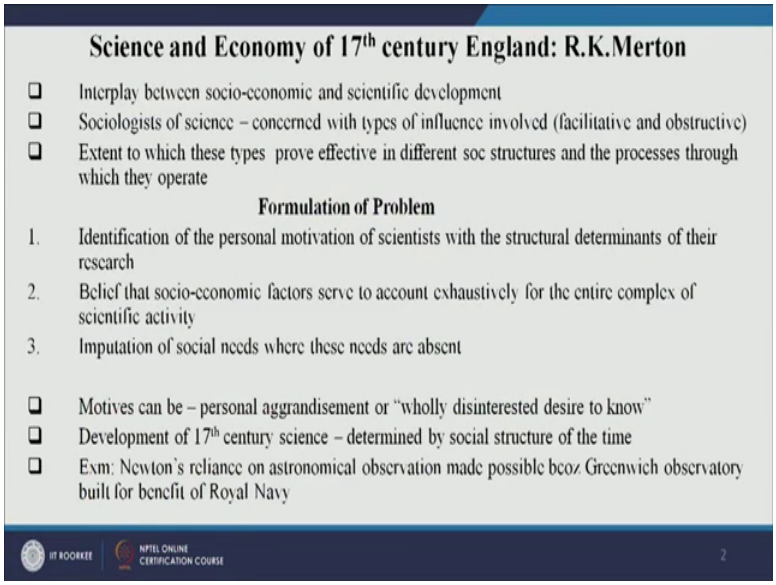
Now, we look at another issue within Sociology of Science and that is Robert Merton's discussion on the relationship between, the linkage between the social needs and scientific and technological advancement. In other words, how the social needs of a distinct time period can lead to scientific and technological innovations, scientific and technological developments.

To discuss that I will look at one of the chapters of Robert Merton, in his book Social Theory and Social Structure; where, he is talking about the relationship between science technology and society in 17th century England. So, the title of the chapter is Science and Technology of 17th century England. Now the question is why 17th century England? Why he choose 17th century England? We know very well that 17th century England, it was the nursery of industrial revolution.

The industrial revolution took off in England in 16th and 17th century; that was the high time where scientific and technological innovations were taking place or coming into being. That was a time of industrial revolution; that was a time of scientific, technological inventions; that was a time of new things. That was a time of entrepreneurship; that was the time of mercantile development; that was a time of voyages been taken. That was a time of England slowly emerging as the most politically and militarily powerful country all over the world through its voyages, through its conquering of various countries all over the world in various continents.

And that was possible England could become a military might not only in Europe, but all over the world England could become a political early stronger force; it could conquer most parts of the world because of it is scientific and technological advancement and that was possible because of the need of English people to develop, to innovate, to bring about changes in the lifestyle. Now Robert Merton paid attention to the social needs of seventeenth century England, how it drove, how it shaped the scientific and technological advancement.

(Refer Slide Time: 04:56)



Now in order to explain that first point that he makes is that Socialists of Science are concerned with types of influences involved either facilitative or obstructive; extent to which this forces. These types of influences prove effective in different social structure and the processes through which it operates or they operate. The point is what are those social forces that act as a facilitator or act as an obstruction to scientific and technological advancement?

In order to understand that he formulates his thesis in the following way. The first formulation of the problem is the identification of personal motivation of scientists with the structural determinants of their research that is whether it is a personal motivation of the scientist, personal interest that drove the scientist to look for new things to innovate to bring about changes in their immediate social world or the second formulation the belief that socio-economic factors soft to account exclusively for the entire complex of scientific activity that is in other words, it means the socio-economic factors play a very important role in the formulation development advancement of scientific activities.

And the third one is imputation of social needs where these needs are absent; that is you act impute social needs to people actually to the society, but these needs are absent. In other words it means that we make an argument, we claim that there are certain social needs which lead to scientific activity, but that may not be so. The scientific activity may have happen because of serendipity, because may have happen because of personal interest, may have happen because of changes in time.

So, which of this argument should hold? We will look at it at the end of this discussion. He says that this 3 ways we can formulate the problem regarding the relationship between social needs and scientific activity.

The first it is a personal motivation of scientist which has a bearing on development of scientific research; the advancement in science and technology. Second is the social needs, which lead scientist to look for practical solutions, to look for utilitarian solutions to practical problems or the social needs are actually on ground reality they are absent, but we have a tendency to claim that these are social needs which are connected to the development of science and technology.

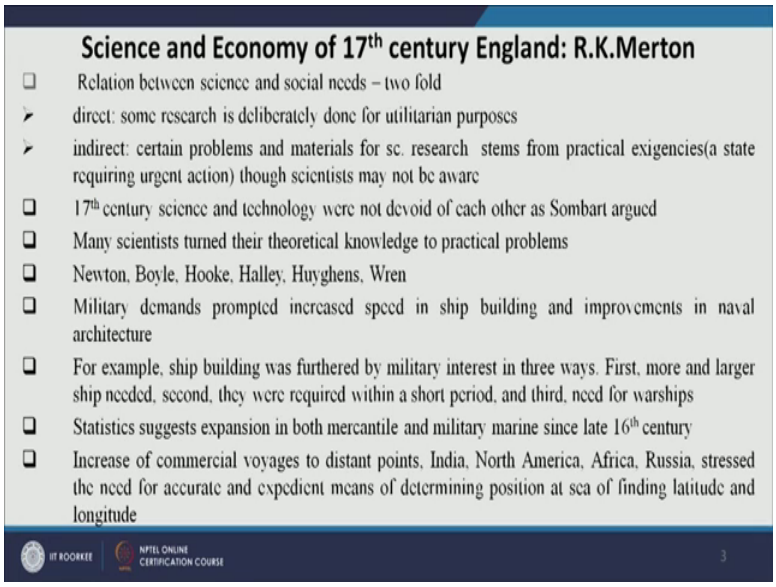
Now if we look at the personal motives what can be personal motives personal motives can be personal aggrandisement or "wholly disinterested desire to know" that is you curious, you have a passion, you have not know the world, you want to explore the world, you have no personal stake; it can be personal motive.

The development of 17th century, science was determined essentially by the social structure of time. Now for example, if you look at we know that Newton made some astronomical observations, but his reliance on the astronomical observations was made possible because Greenwich observatory built for the benefit of Royal Navy; Royal Navy the British Navy.

For the benefit of the British Navy, the Greenwich observatory was made and thanks to the Greenwich observatory, Newton could make all these astronomical calculations. He had his personal interest to have more knowledge of the natural world over the solar system, but he took help from the Greenwich observatory which was essentially built for to provide support to the British Navy.

So, it is a personal motive, but this personal motive was actually structured by the indirectly, but the social needs. So, in that context Robert Merton says the relationship between science and.

(Refer Slide Time: 09:52)



Social needs are twofold; one is direct, one is indirect. The in direct is some research is deliberately done for utilitarian purposes, practical purposes; you take up a research in order to solve a practical problem. For instance, we want better bigger ships to be built, we need to make some research in the field of hydrodynamics. There is a direct thing we want to stop the depletion of forest reserve; we make some botanical research that is direct need.

We want to understand the, we want to understand grasp the problem of latitude and longitude at sea so that the voyages can be safe. So, we make some scientific research that is a direct need, in order to help those mariners at sea; we were studying the longitude and latitude. There is a direct need; direct social need and this is a direct relation between the social need as well as the scientific research.

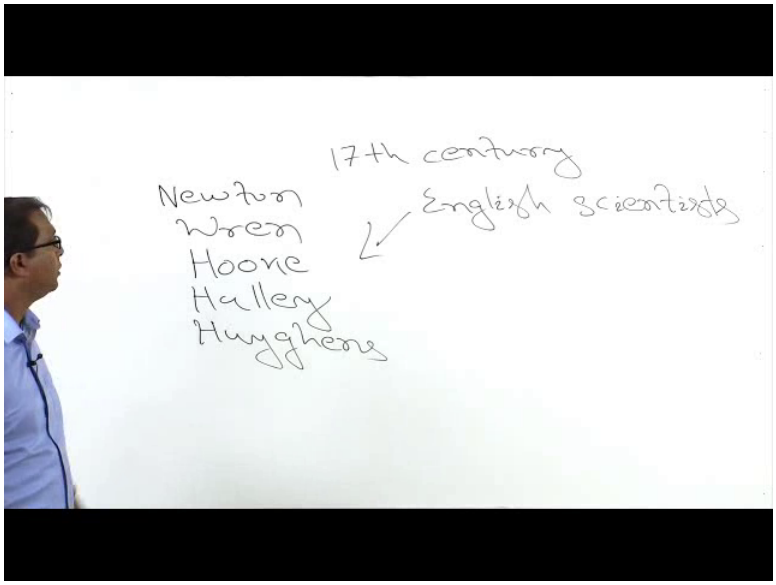
Indirect certain problems and materials for scientific research stems from practical exigencies that is a state requiring urgent action through those scientists may not be aware of it; that is the scientists is working on something and comes up with something, but he or she may not be aware that he or she is making use of materials and resources which has been built or developed to cater to certain social needs. I gave you example of Newton; Newton was making his astronomical observations was making study of astronomy, but unknowingly, he was making use of Greenwich observatory which was built for the help of the Royal Navy.

So, that is in direct need, but 17th century science and technology were not devoid of each other as Sombart argued. Robert Merton says and he quotes Sombart who says that 17th century science and technology were devoid of each other that is there is no relations between basic pure science and application of the science; in terms of solving the practical problems. He says that is not the case as Sombart was arguing that 17th century England.

In 17th century England the science and technology were divorced from each other they were not connected the pure science and practice and application of that science to solve practical problems, social problems it was not there, but that is not true.

Sombart say, what Sombart says is not true that is what Robert Merton argues. Many scientists turn their theoretical knowledge to practical problems. For instance, Newton, Boyle, Hooke, Halley, Huyghens, Wren all the scientists they turned their theoretical knowledge to solve practical problems. I will just write down some of the names of the scientists, Newton.

(Refer Slide Time: 19:33)



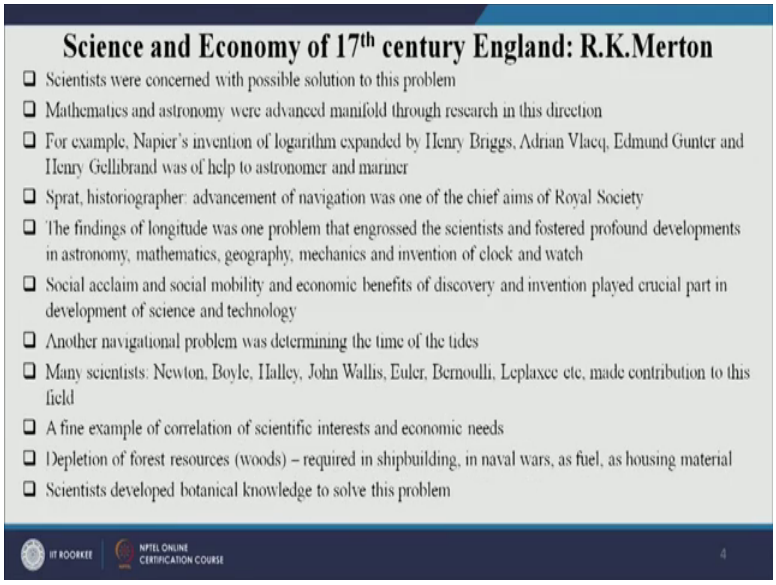
So, these are some of the 17th century English scientist who turned their attention to solve practical problems; they had basic knowledge of the pure sciences. They had theoretical knowledge in their field, but they did not stay there. They did not confine their theoretical knowledge to universities to research institutes. They rather they wanted to apply those theoretical knowledge to solve practical problems; one of the practical problems of that time was military demands; military demands prompted increased speed in say building and improvements in naval architecture.

So, why did they want to have a faster ships and why did they want an advancement in naval architecture? Because sea transport was the most common mode of transport in 17th century world and the British wanted to have better ships, faster ships, bigger ships. So, that they can take voyages they can go to other countries, make trading links, establish businesses there and if possible have political control over those countries and so, that they can use the raw materials of those countries and which can be manufactured in back in England.

So, they wanted to have, they had political interests, they had economic interests. And hence, they wanted improvement in naval architecture and for the improvement in naval architecture, they turned to the scientists; to bring about those improvements, advancements. So, the scientist in order to solve this practical problems of building better ships, larger ships, sails which could be built in quick time, in double quick time that was their attention; they wanted to build warships.

Now, statistics suggest that expansion in both mercantile and military marine happened since late 16th century. So, businesses as well as the British Navy developed it's sea building; developed it's ships from 16th century onwards for business purposes as well as for military purposes; started and the increase of commercial voyages to distant ports points such as India and North America, Africa. It stressed the need for accurate and expedient means of determining position at sea of finding longitude and latitude. The scientists were concerned with possible solutions to this problem.

(Refer Slide Time: 17:41)



How do we solve the problem of longitude and latitude at sea, because if we can solve that problem, we can reach distant points on earth. We can develop through that we can develop our business perspective; we can expand our political control. So, the Mathematics and astronomy, they were advanced manifold through research in this direction. In the direction of studying of longitude and latitude, trying to find out the position at sea.

For example, Napier's invention of logarithm was expanded by which was expanded by Henry Briggs and Henry Gellibrand was of help to astronomers and mariners.

This is a Napier's invention of logarithm is a theoretical contribution, but that was used by the astronomers and mariners for practical purposes, to understand the problem of longer, to understand the problem of longitude and latitude; to understand the position at sea. They made use of Napier's invention of logarithm sprat a history graphic of that era, he said advancement of navigation was one of the chief aims of Royal Society that is Royal Society of England, what was their intention? Advancement of navigation; why?

So, that they can be a powerful economic and political force in the world through their advancement in novel, a novel architecture and navigation system and prop findings of longitude was one problem that engrossed the scientist and fostered profound developments in astronomy, mathematics, geography, mechanics and it led to finally, the invention of clock and watch.

So, in order to find a solution to the problem of longitude; the astronomers, the mathematicians, the geographers, the mechanical engineers all turn their attention to it. And it finally, also lead to the invention of clock and watch. Now one of the important reasons where science and technology developed multi fold in 17th century England is because of the social status attached to the scientists.

The scientist who could invent who could come up with new technology, new gadgets they also got more social acclaim, got more social prestige, the social mobility became more fluid for them; they could go from lower class or lower middle class to upper class in no time. Because of their reputation as a scientist and that also acted as a strong social forces, strong driving force for the scientist to look for new inventions, to work on new gadgets, new machines which could ensure social acclaim, social prestige to this scientists

So, that is one of the social needs which lead to advancement in science and technology that the promise of social mobility more social prestige, more social a claim, more economic benefits that definitely triggered interest in the scientist and that lead to scientific and technological advancement in 17th century England.

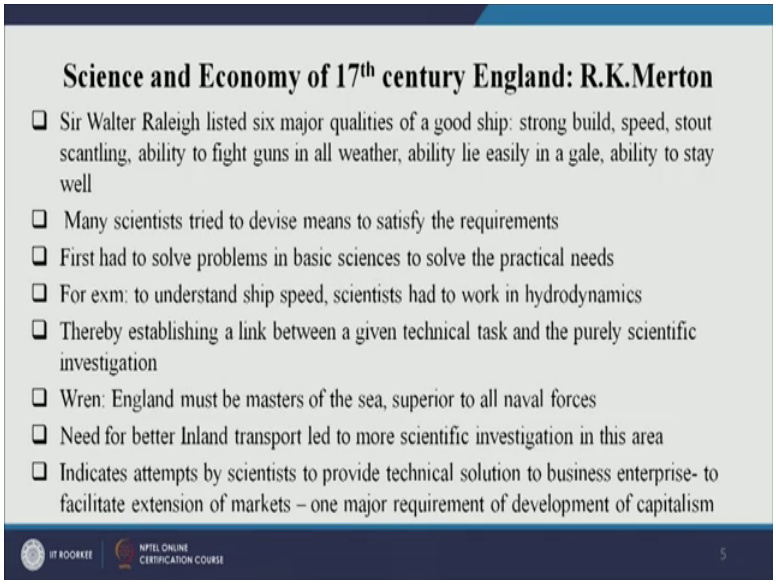
And there are also this issue of developing and advancing the novel architecture because they wanted to be a dominant novel force in the world. So, that they can be a stronger political force; they can develop that business, the business perspectives could improve. Hence they wanted to build better ships, bigger ships, stronger ships; ships which has which can carry artillery the warships and the ships could has to be built in double quick time.

So, they turned their attention to that apart from that then, they tried to solve the problem of longitude and latitude they try to solve the problem of navigation. They wanted to solve the problem of deciding the time of the tides; they wanted to have exact understanding of the timing of the tides that came on the sea. So, that would help them in controlling the sea many scientists like Newton, Boyle, Halley, John Wallis, Euler, Bernoulli, Laplaxce etcetera. They made contribution to this field, to the problem of navigation, to the problem of finding land longitude and latitude to determine the time of the tide.

Now, another fine example of correlation between scientific needs and interests and economic needs and social needs is that of the issue of depletion of forest resources or woods. Now this for woods were required and not only in ship building, but also it was required as a fuel, as housing material and it was fast depleting the forest reserve was first declining because of it's extensive use.

So, that triggered interest in botany in trying to understand the scientist wanted to develop botanical knowledge to solve the problem of timber and wood which was off which was essentially used in almost every industry in 17th century England.

(Refer Slide Time: 24:32)



Now, Sir Walt, Walter Raleigh, he listed 6 major qualities of good ship. What are these qualities? Strong build, speed; the ship should have strong build, it should have speed, it should have stout scantling; it must have ability to fight guns in all weather. It must have ability to lie easily in the face of a sea storm and must have ability to stay well; it should have better balance. Many scientists turned their attention to satisfy these requirements.

So, they made use of their theoretical knowledge to understand and explain and solve this problem which were needed to make a good ship with all these qualities. First, they had to solve the problem in basic sciences in order to solve the practical needs for example, to understand the ships paid they had to work on hydrodynamics. Hence it was a direct correlation between science and technology of relationship and correlation linkage between pure science and technology application of that practicals, practicality of the basic science.

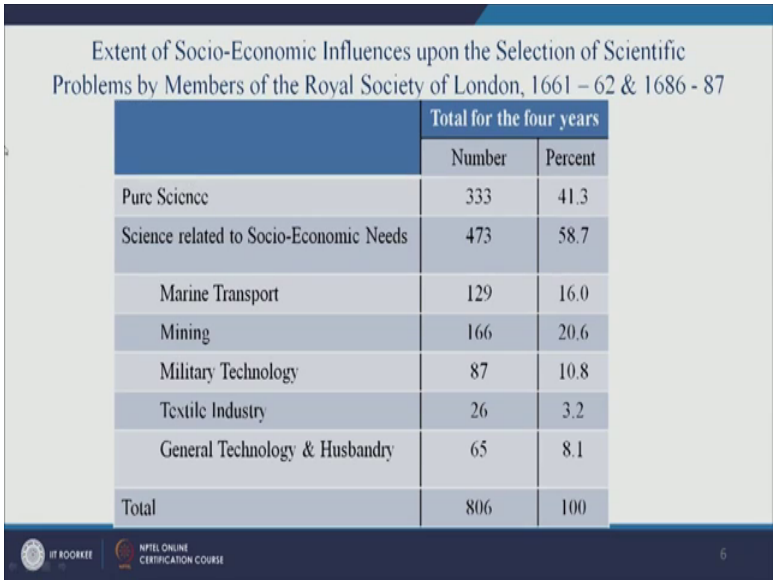
And which establishes a strong link between a given technical task and purely scientific investigation as I told you earlier that they wanted to be the British, they wanted to be the master of the sea. They wanted to be superior to all the others in Europe, in terms of their strength of naval forces.

And hence, that was a economic need, that was a political need, that was a military need and the scientist of that country in that period, they started research in order to solve the problem of navigation; in order to solve the problem of longitude; in order to solve the problem of latitude; in order to solve the problem of time of the tide. They wanted to solve the problem of depletion of forest resources, depletion of timber and wood.

Hence botanical knowledge developed because of their interest to solve navigational problems. They wanted to be the superior naval forces through that their astronomy developed manifold, their mathematics developed manifold, their mechanics developed manifold. They also tried to solve the problem of, they also tried to solve the problem of In-land transport; they wanted to have faster In-land transport; not only they were looking to improve their sea transport means, but also they are trying to improve their n-land transport and that lead to more scientific investigation.

And because of this capitalism directly or indirectly developed; capitalism as a economic system developed because of this linkage between social needs and scientific and technological advancement that lead to a newer kind of economic system which we now know as the capitalism.

(Refer Slide Time: 28:02)

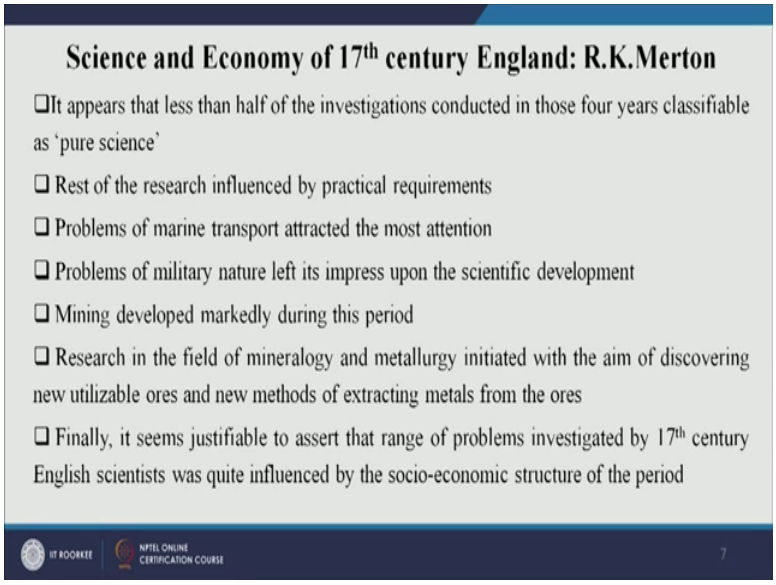


Now, if you look at this table; this is a table which has been shown by Robert Merton to show the extent of socio-economic influences upon the selection of scientific problems by members of the Royal Society of London. The period mentioned here is 1661- 62 and 1686 to 87; why he has chosen this 2 particular years, data after 1661 and 62 and 1686 to 87 period is because of data is easily available for him.

Hence, he made use of this data and this data reveals that if you look at the number of research activities that were undertaken by the members of the Royal Society of London which is the scientific society of la England, if you look at the total number 333 that is 41.3 percent research was done in Pure Science.

Whereas, Science related to Socio-Economic Needs; Socio-Economic needs such as Marine Transport, Mining, Military Technology, Textile Industry, General Technology Husbandry, research on those aspects on such social needs, it accounted for 58.7 percent in terms of number it is 473.

(Refer Slide Time: 29:27)



So, this is an indicator that in the 17th century England, it is a social needs which predominated. And thus, because of social needs scientific research was directly or indirectly guided by that it appears that half of the investigations are conducted in those 4 years, I am referring to the table now is can be classified as Pure science less than half.

The rest of the research whether influenced by practical requirements, problem of marine transport; it attracted the most attention as we have just discussed. Problems of military nature left its in press upon the scientific development. They wanted to be a military militarily strong force. So, the lot of research who went into that.

Mining developed markedly during that period because they want the factories were coming up and the factories required huge amount of coal, factories also required minerals, ores, iron ores. So, they had to develop methods of extracting iron from the iron ores. So, research in the field of mineralogy, metallurgy; it was all initiated with the aim of discovering new utilizable ores and new methods of extracting metals from the ores.

Finally, based on this discussion we can always assert that the range of problems investigated by 17th century English scientist was quite influenced by socio-economic structure of the period. Now if we just go back to the first slide, where we proposed 3 problems; we formulated 3 problems.

Now if you again look at these problems, we know that that the belief that socio-economic factors accounted for scientific activity in 17th century England. It holds true, based on all this evidences furnished by Robert Merton. Now we stop here.

We will take up a new topic in the next class.