Organization Theory/Structure and Design
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Lecture - 16
Technology - I

Welcome to this course on Organization Theory, Structure and Design. Now we will talk about module 16. So, module 16 and 17 are dedicated to this term ‘Technology’. So, let us start with the module 16, that is, technology.

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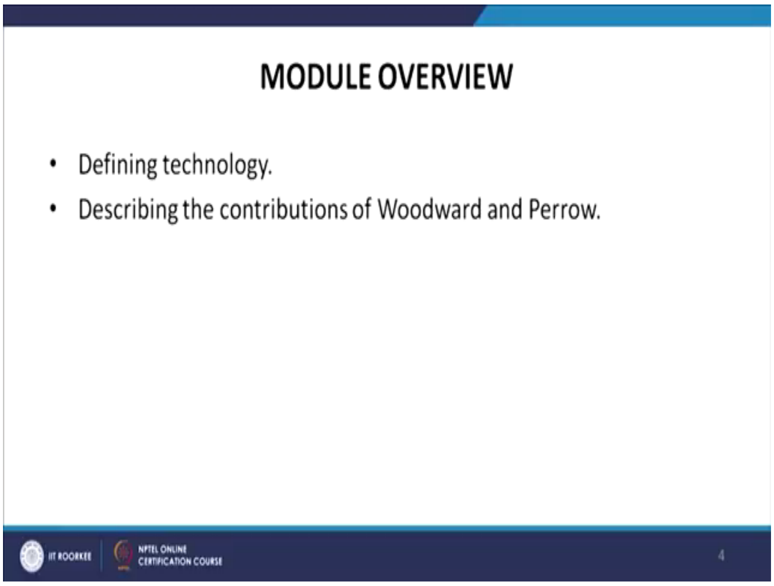

And these are the two things that we will talk about in this module; defining technology and then describe the contribution of Woodward and Perrow. To start with we will talk about Ford versus Avanti.

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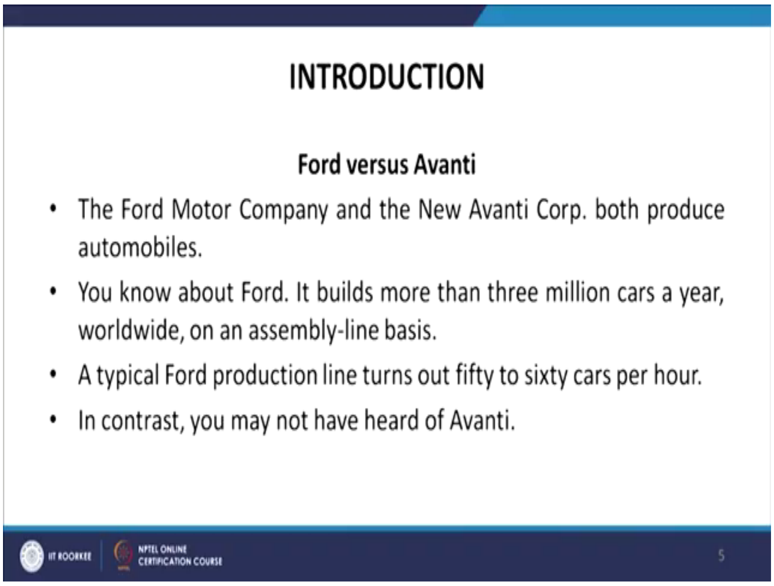

The Ford Motor Company and the New Avanti Corp both produce automobiles. You know about Ford, it builds more than three million cars a year worldwide, on the assembly line basis. A typical Ford production line turns out fifty to sixty cars per hour. In contrast you may not have heard of Avanti.

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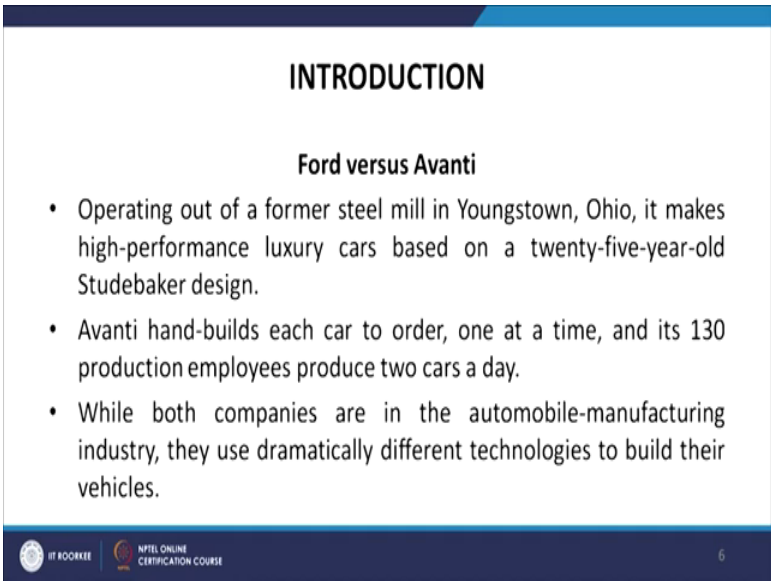

Operating out of a former steel mill in Youngstown, Ohio, in the US, it makes high performance luxury cars based on a twenty-five-year-old Studebaker design. Avanti hand-builds each car to order one at a time and its 130 production employees produce two cars a day. While both companies are in the automobile manufacturing industry, they use dramatically different technologies to build their vehicles.

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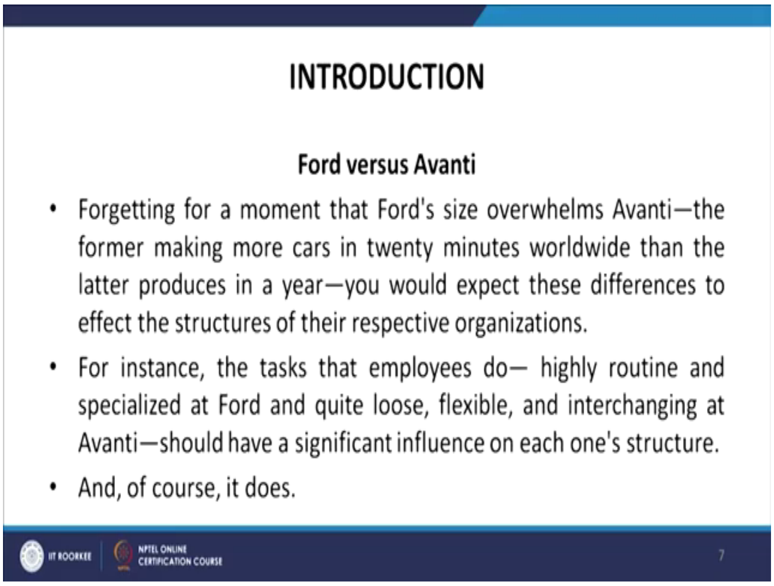

Forgetting for a moment that Ford size overwhelms Avanti, the former making more cars in twenty minutes worldwide than the later producers in a year, you would expect these differences to affect the structure of their respective organizations. For instance, the tasks that employees do highly routine and specialized at Ford and quite loose, flexible and interchanging at Avanti should have a significant impact on each one’s structure and of course, it does.

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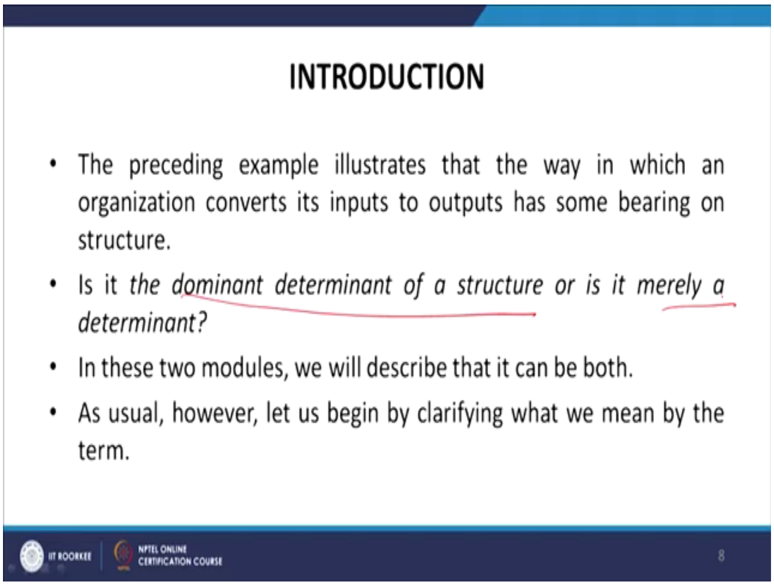

The preceding example illustrates that the way in which an organization converts its input to output has some bearing on structure. Is it the dominant determinant of a structure or is it merely a determinant? So, now, the question is, is it the dominant determinant of the structure or just one of the other determinants? In these two modules we will describe that it can be both. As usual; however, let us begin by clarifying what we mean by the term.

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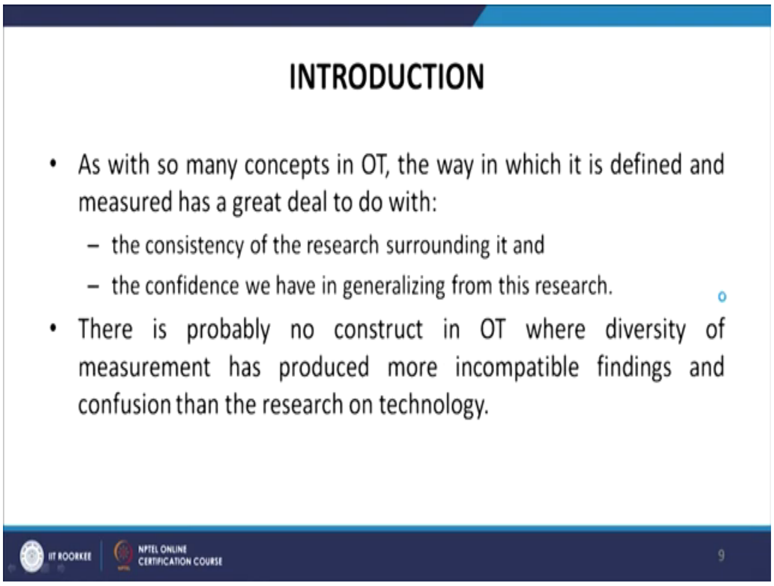

As with so many concepts in OT, the way in which it is defined and measured has a great deal to do with: the consistency of research surrounding it and the confidence we have in generalizing from this research. This is probably no construct in OT. There is probably no construct in OT where diversity of measurement has produced more incompatible findings and confusions than the research on technology.

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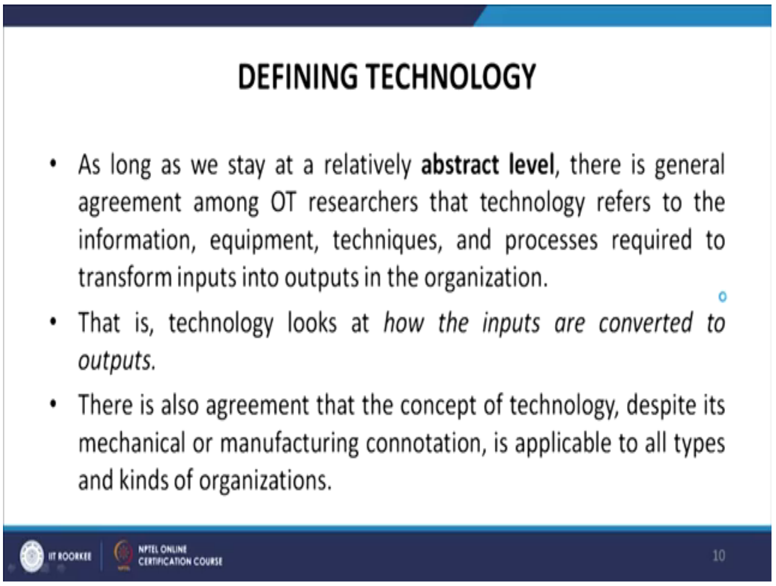

As long as we stay at a relatively abstract level, there is a general agreement among OT researchers that technology refers to the information, equipment, techniques and processes required to transform inputs into outputs in the organization. That is, technology looks at how the inputs are converted to output.

There is also agreement that the concept of technology, despite its mechanical or manufacturing connotations, is applicable to all types and kinds of organizations.

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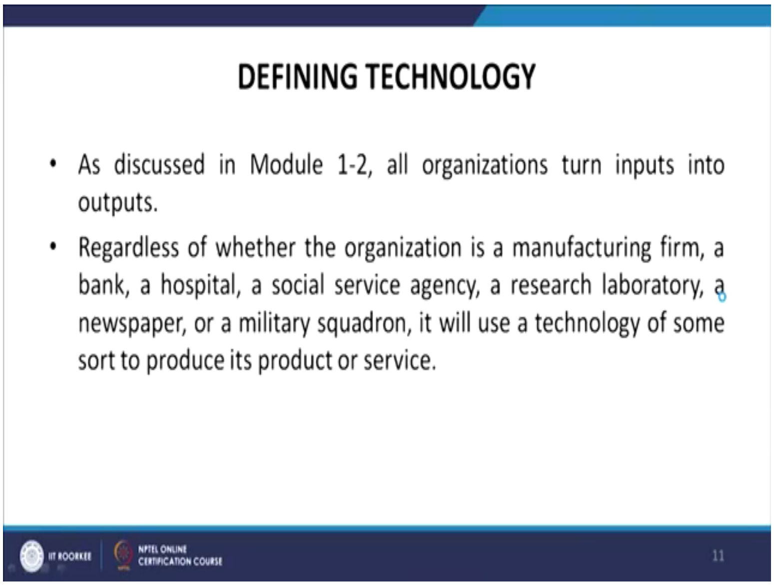

As discussed in module 1 and 2, all organizations turn input into output. Regardless of whether the organization is a manufacturing firm, a bank, a hospital, a social service, agency or research laboratory, a newspaper or a military squadron, it will use technology of some sort to produce its products or services.

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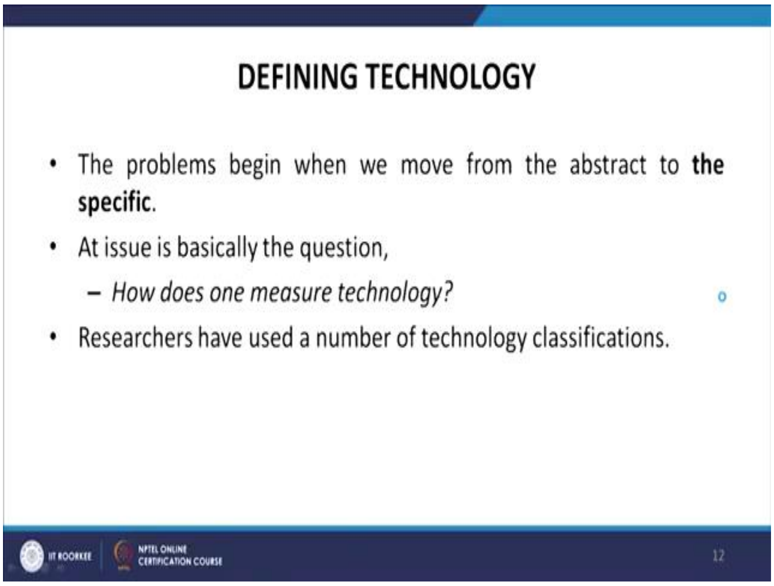

The problems begin when we move from the abstract to the specific. The issue is basically the question, how does one measure technology? Researchers have used a number of technology classifications.

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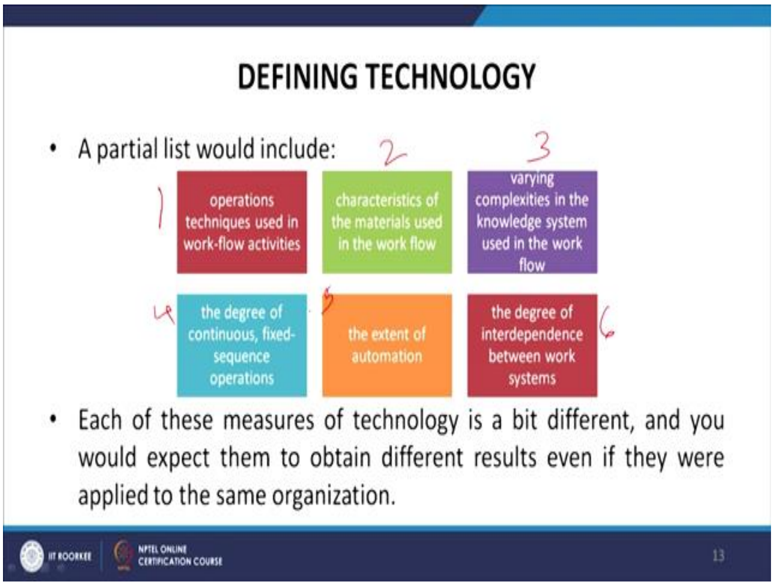

The partial list would include, the first is operations techniques used in work-flow activities. The second is characteristics of the material used in the workflow, the third is varying complexities in the knowledge system used in the workflow. The fourth is the degree of continuous, fixed sequence operations, the fifth is extent of automation and the sixth is the degree of interdependence between work systems.

Each of these measures of technology is a bit different and you would expect them to obtain different results even if they were applied to the same organization. But this introduces several additional problems: varying types and sizes of organizations and different levels of analysis.

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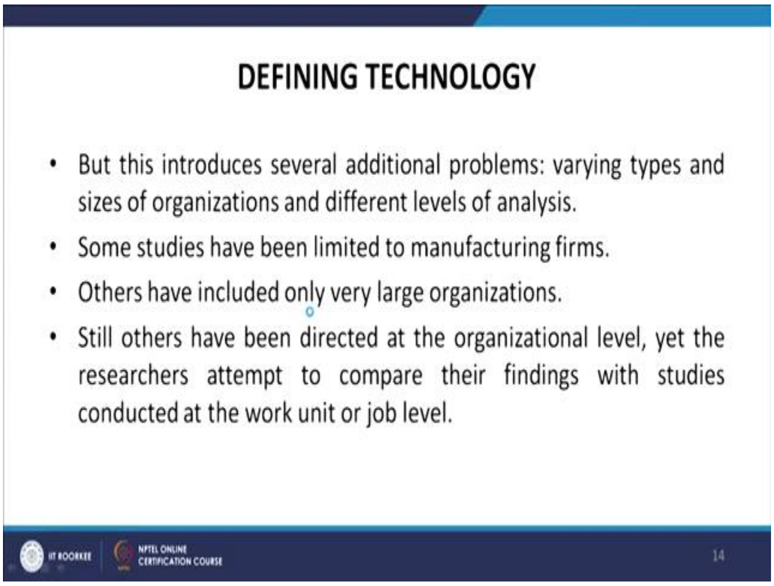

Some studies have been limited to manufacturing firms. Others have included only very large organizations. Still others have been directed at the organization level, yet the researchers attempt to compare their findings with studies conducted at the work unit or job level.

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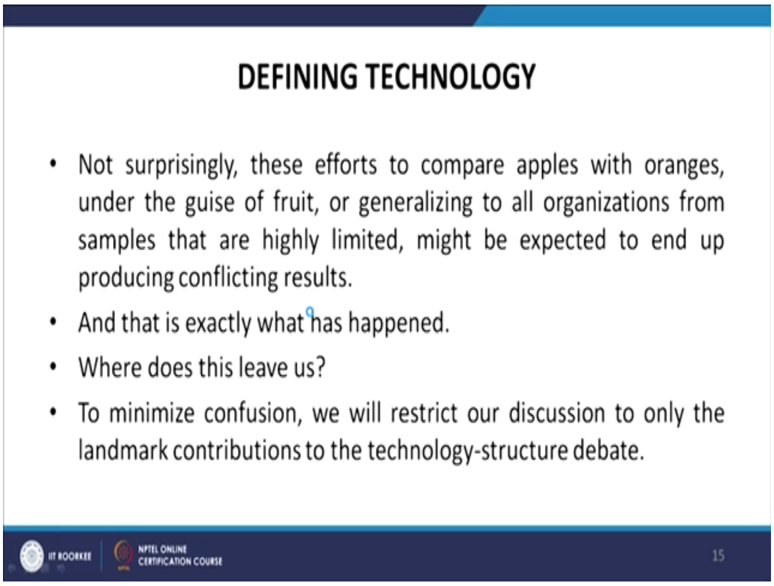

Not surprisingly, these efforts to compare apples with oranges under the guise of fruit or generalizing to all organizations from samples that are highly limited, might be expected to end up producing conflicting results. And that is exactly what has happened. Where does this leave us? To minimize confusion, we will restrict our discussion to only the landmark contribution to the technology structure debate.

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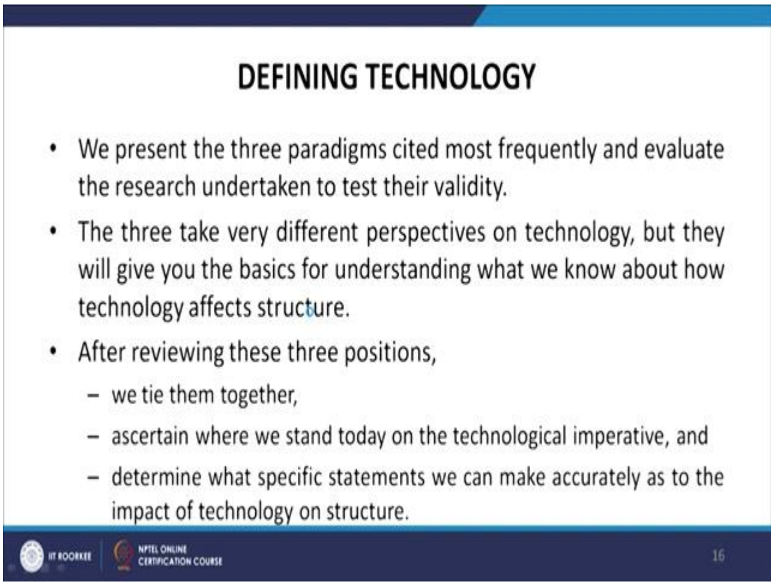

We present the three paradigms cited most frequently and evaluate the research undertaken to test their validity. The three take very different perspectives on technology, but they will give you the basics of understanding what we know about how technology affects structure.

After reviewing these three positions, we tie them together ascertain where we stand today on the technological imperative and determine what specific statements we can make accurately as to the impact of technology on structure. So, let us look at the initial thrust that is Woodward’s research. The initial interest in technology as a determinant of structure can be traced to the mid 1960s and the work of Joan Woodward.

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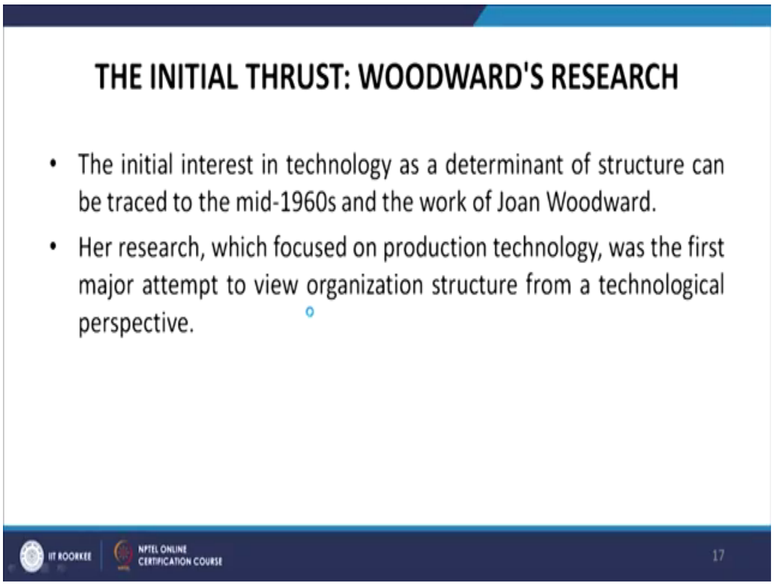

Her research, which focused on production technology, was the first major attempt to view organizational structure from a technological perspective.

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Woodward chose approximately one hundred manufacturing firms in the south of England. These firms ranged in size from fewer than two hundred and fifty employees to more than one thousand. She gathered data that allowed her to compute various measures of structure.

The number of hierarchy levels, second is the administrative component, the third is a span of control and the fourth is the extent of formalization and the like. Now, let us talk about the background of this research. She also gathered financial data on each firm's profitability, sales, market share and so on, which allowed her to classify the companies as above average or below average in terms of success or organizational effectiveness.

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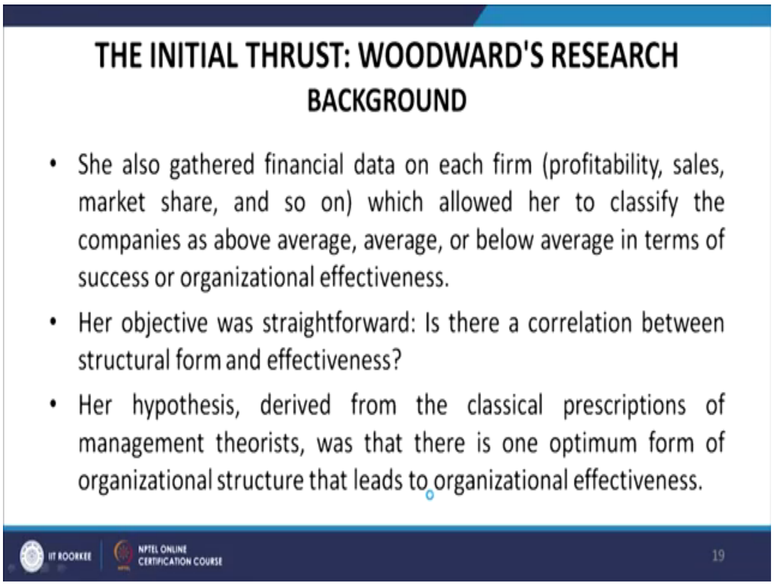

Her objective was straightforward: Is there a correlation between a structural form and effectiveness? Her hypothesis derived from the classical prescription of management theorist was that there is one optimum form of organizational structure that leads to organizational effectiveness.

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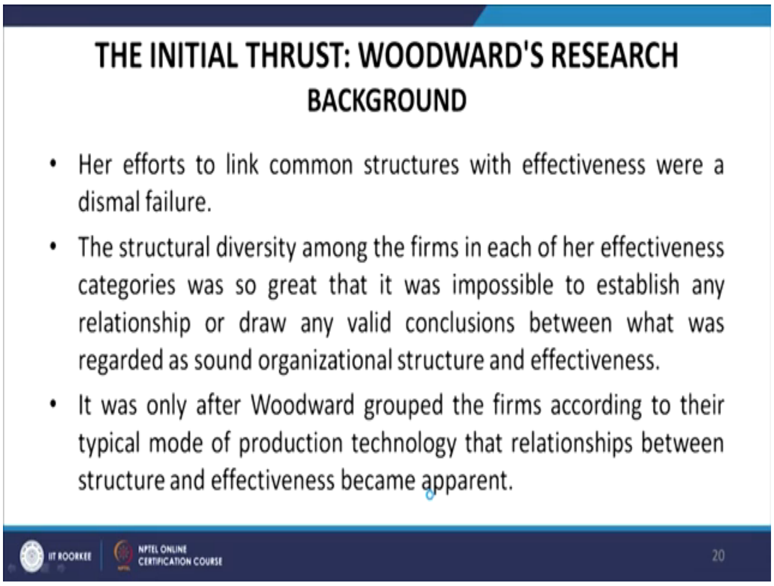

Her efforts to link common structures with effectiveness were a dismal failure. The structural diversity among the firms in each of our effectiveness category was so great that it was impossible to establish any relationship or draw any valid conclusion between what was regarded as sound organizational structure and effectiveness.

It was only after Woodward grouped the firms according to their typical mode of production technology, that relationship between structure and effectiveness became apparent. Woodward categorized the firms into one of the three types of technologies: unit production, mass production or process production. She treated these categories as a scale with increasing degree of technological complexity with unit being the least complex and process the most complex.

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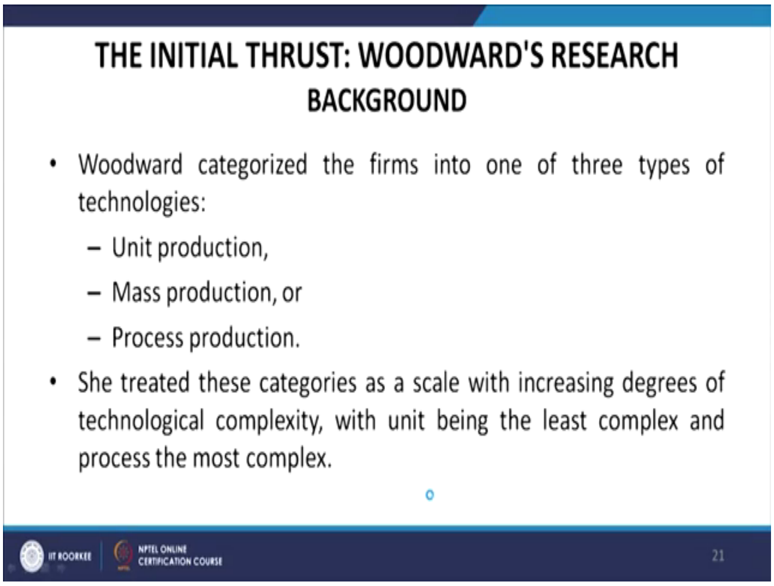

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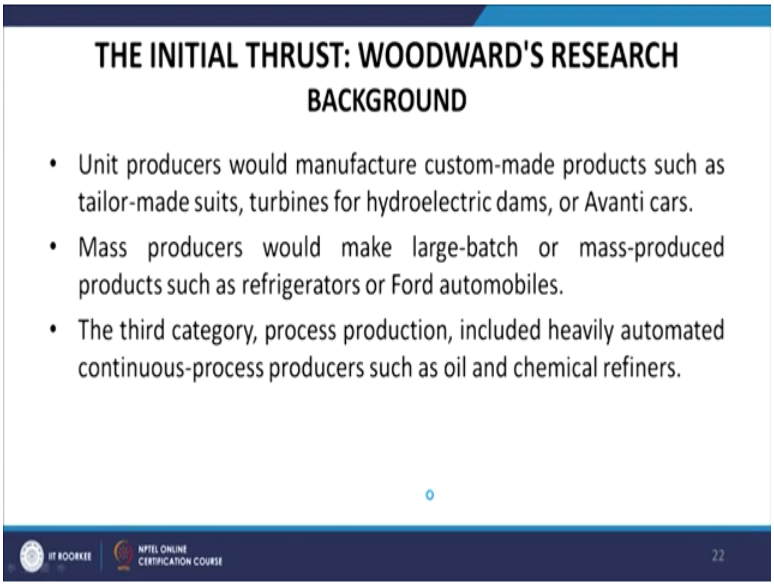

Unit producers would manufacture custom made products such as tailor-made suits, turbines for hydroelectric dams or Avanti cars. Mass producers would make large-batch or mass-produced products such as refrigerators or Ford automobiles. The third category, process production, included heavily automated continuous-process producers such as oil and chemical refineries.

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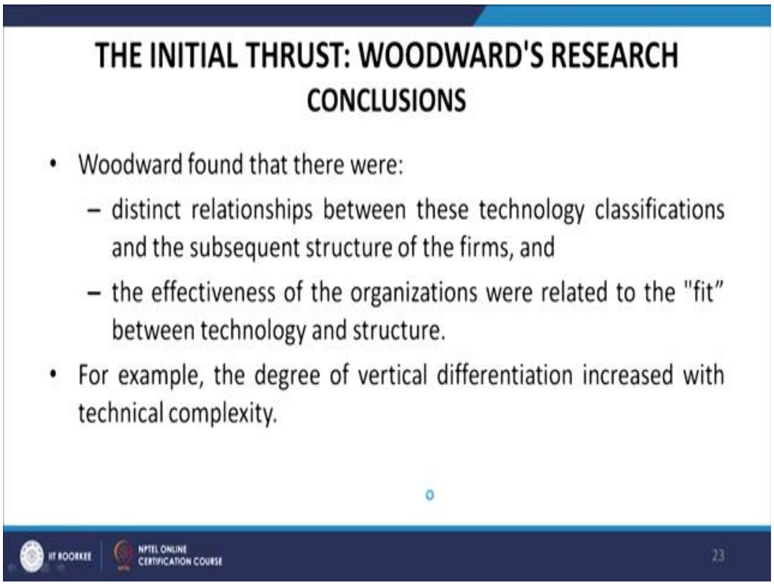

Woodward found that there were: distinct relationship between these technological classifications and the subsequent structure of the firms and the effectiveness of organizations were related to the fit between technology and structure. For example, the degree of vertical differentiation increased with technical complexity.

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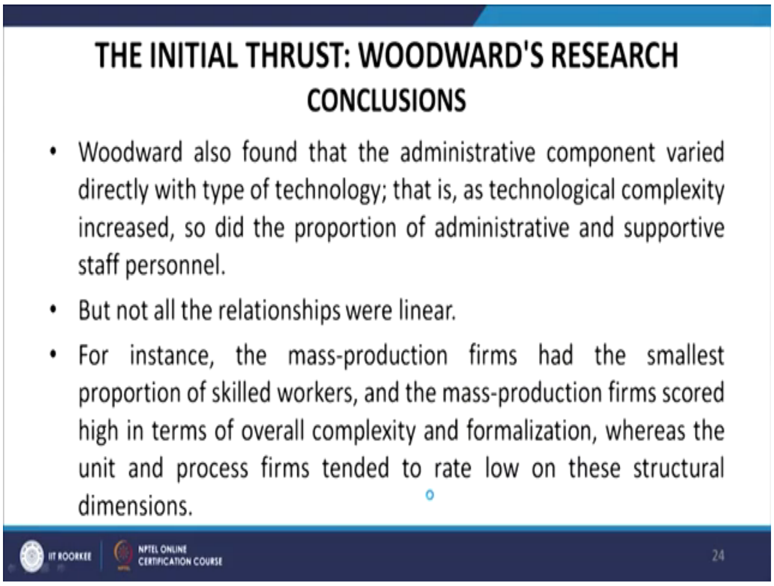

Woodward also found that the administrative component varied directly with the type of technology, that is, as technological complexity increased, so did the proportion of administrative and supporting staff personnel. But not all the relationships were linear.

For instance, the mass production firms had the smallest proportion of skilled workers, and the mass-production firms scored high in terms of overall complexity and formalization, whereas the unit and process firms tended to rate low on these structural dimensions.

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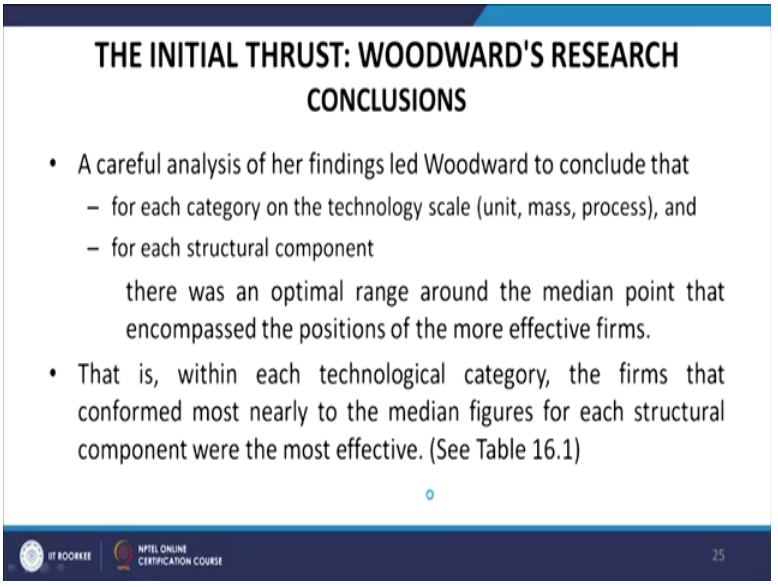

A careful analysis of her findings led Woodward to conclude that, for each category on the technology scale that is unit, mass or process and for each structural component, there was an optimal range around the median point that encompassed the positions of the more effective firms. That is, within each technological category, the firms that conformed most nearly to the median figures for each structural component were the most effective.

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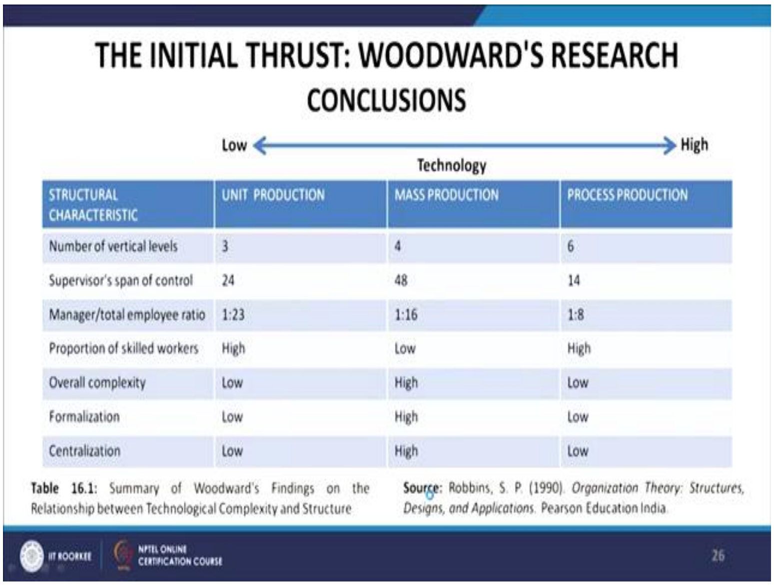

Let us see this table 16.1. Now in this table the technology moves from low to high that is unit production to process production. So, the structural characteristics the first is the number of vertical levels so, for unit production it is 3, for mass production it is 4 and for post process production it is 6. Similarly, the supervisors span of control was 24 in unit production, 48 in mass production and just 14 in process production.

Similarly, you will find that the manager versus total employee ratio is the lowest in process production while proportion of skilled workers in unit production are a high, mass production they are low and then again in process production they are high. Overall complexity varies from low to high and then again to low across the different levels of technology. The centralization is low for unit production, high for mass production and again low for process production.

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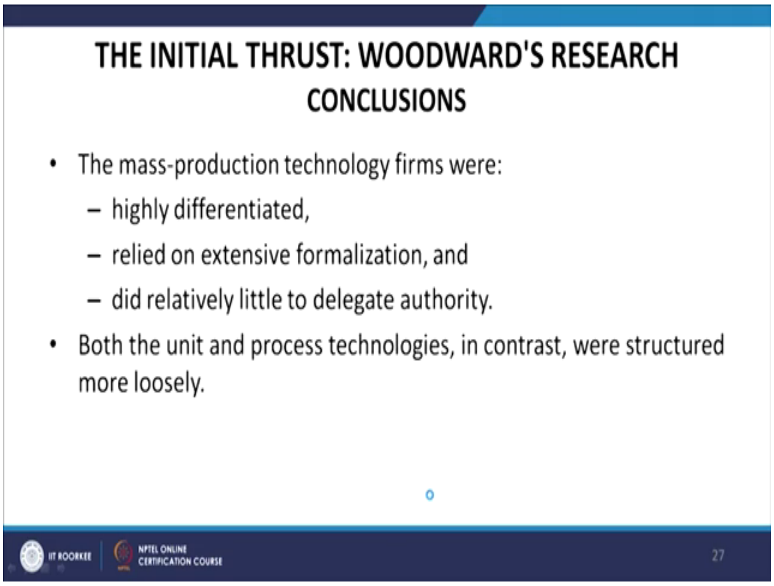

So, the mass production technology firms were highly differentiated relied on extensive formalization and did relatively little to delegate authority. Both the units and process technologies in contrast were structured more loosely.

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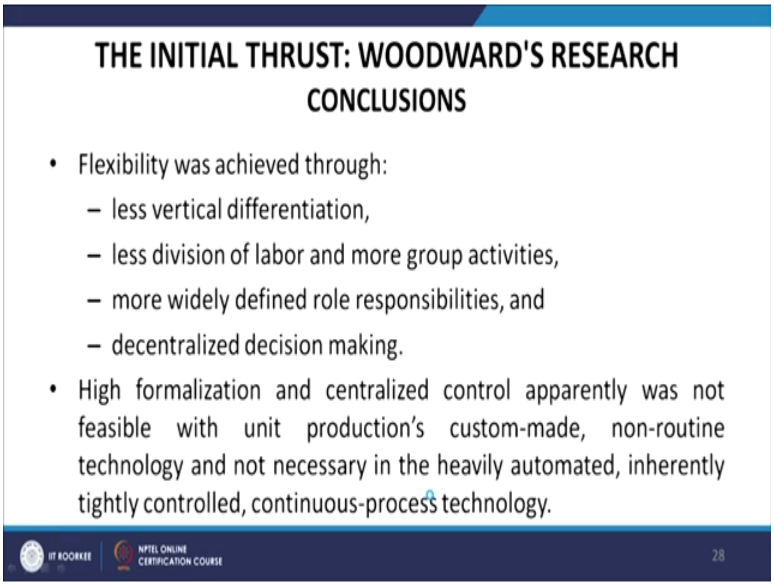

Flexibility was achieved through: less vertical differentiation, less division of labour or more group activities, more widely defined role responsibilities and decentralized decision making. High formalization and centralized control apparently was not feasible with the unit production's custom made non routine technology and not necessary in the heavily automated inherently tightly controlled continuous process technology.

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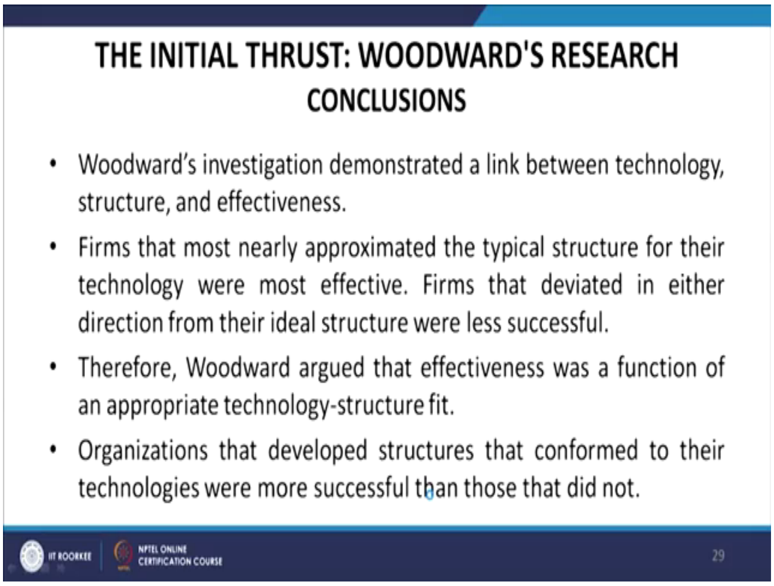

Woodward's investigation demonstrated a link between technology, structure and effectiveness. Firms that most nearly approximated the typical structure of the technology were most effective. Firms that deviated in either direction from their ideal structure were less successful.

Therefore, Woodward argued that the effectiveness was a function of an approximate technology-structure fit. Organizations that developed a structure that conformed to their technologies were more successful than those that did not.

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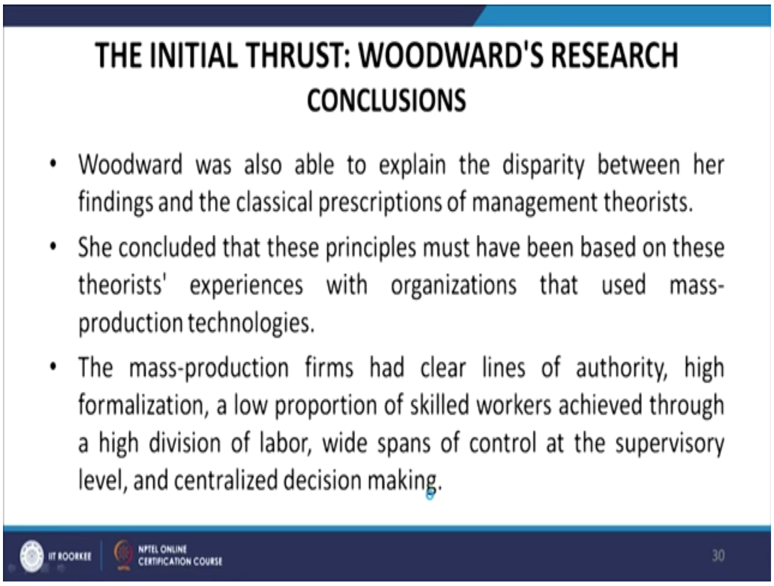

Woodward was also able to explain the disparity between her findings and the classical prescription of management theorist. She concluded that these principles must have been based on these theorists' experience with organizations that used mass-production technologies.

The mass-production firms had clear lines of authority, higher formalization, or low proportion of skilled workers achieved through a high division of labour, wide span of control at the supervisory level, and centralized decision making.

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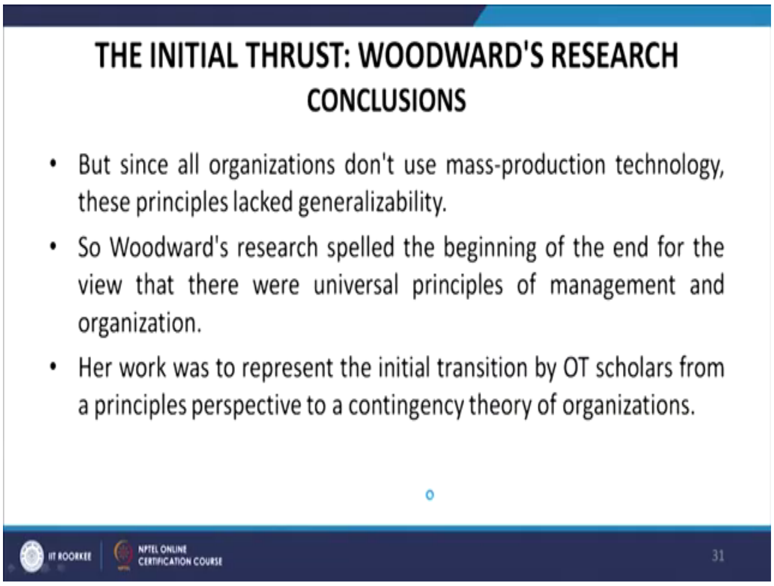

But since all organizations don’t use mass production technology, these principles lagged generalizability. So, Woodward’s research is spelled the beginning of the end for the view that there were universal principles of management and organization. Her work was to represent the initial transition by OT scholars from a principles perspective to a contingency theory of organizations.

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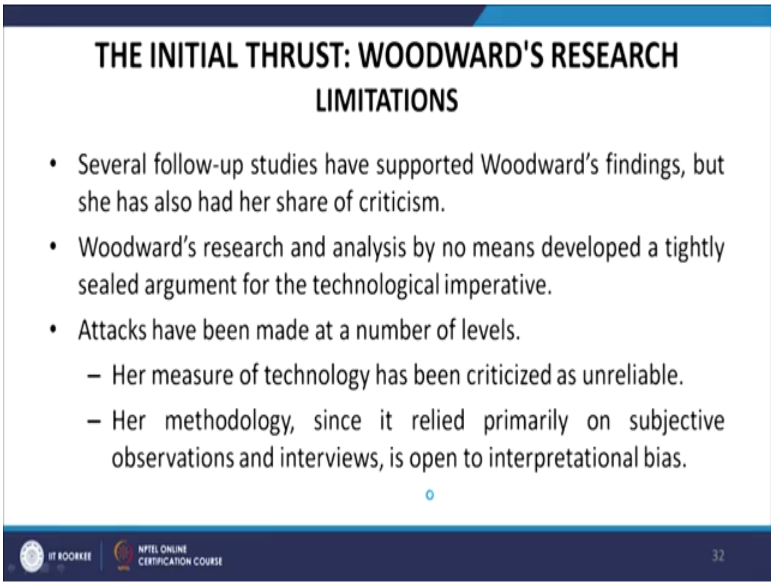

Now, let us look at the limitations of her work. Several follow up studies has supported Woodward’s finding, but she has also had her share of criticism. Woodward’s research and analysis by no means developed a tightly sealed argument for the technological imperative.

Attacks have been made at a number of levels; the first is her measure of technology has been criticized as unreliable, second is her methodology since it relied primarily on subjective observations and interview is open to interpretational bias.

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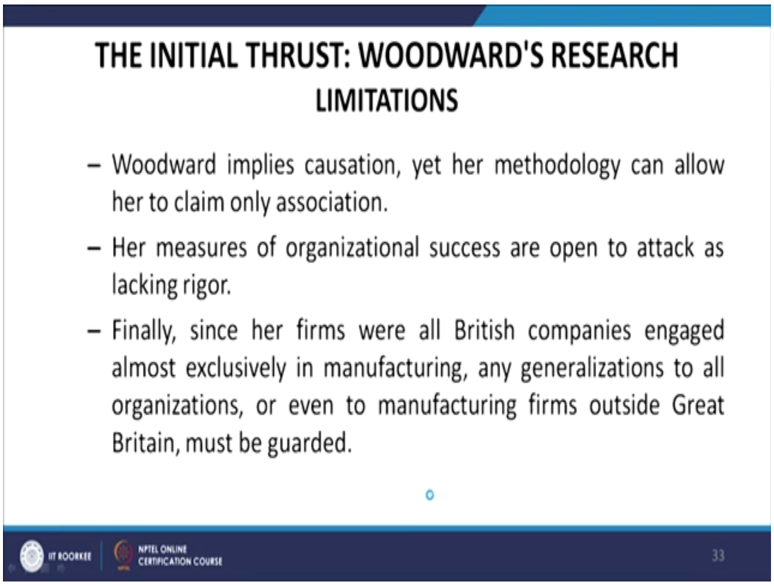

Woodward implies causation, yet her methodology can allow her to claim only association. Her measures of organization success are open to attack as lacking rigor. Finally, since her firms were all British companies engaged almost exclusively in manufacturing and generalization to all organizations, or even to manufacturing firms outside of Great Britain must be guarded.

Now, let us look at this knowledge base technology and we are talking of Perrow's contribution. One of the major limitations of Woodward's perspective on technology was its manufacturing base. Since manufacturing firms represent less than half of all organizations, technology needs to be operationalized in a more general way.

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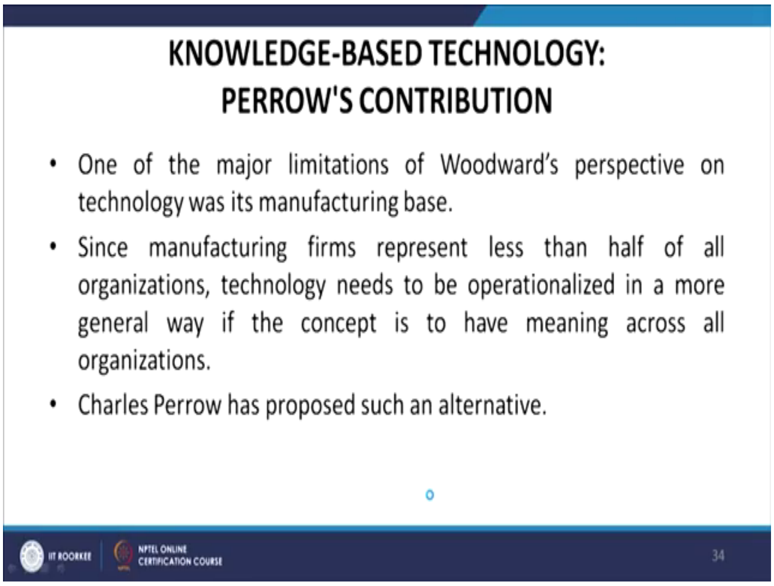

If the concept is to have meaning across all organizations, Charles Perrow has proposed such an alternative.

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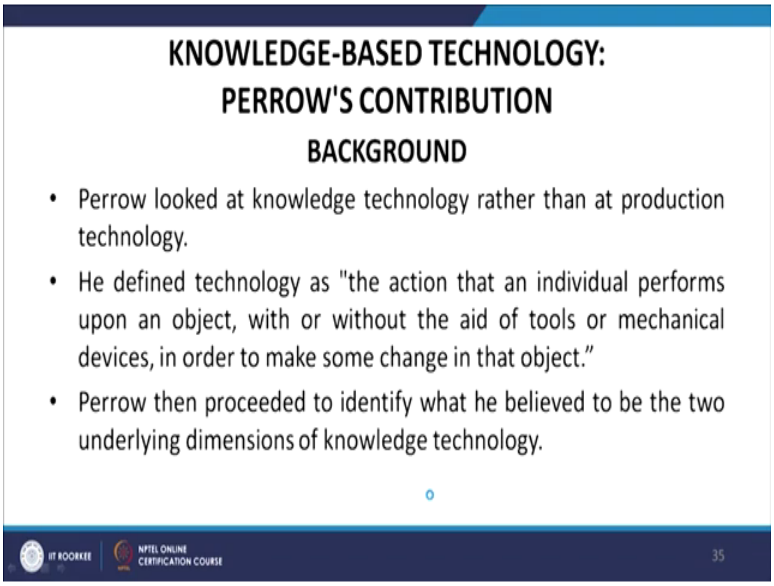

Let us look at the Perrow's contribution background; Perrow looked at knowledge technology rather than production technology. He defined technology as the action that an individual performs upon an object with or without the aid of tool or mechanical devices in order to make some changes in that object. Perrow then proceeded to identify what he believed to be the two underlying dimensions of knowledge technology.

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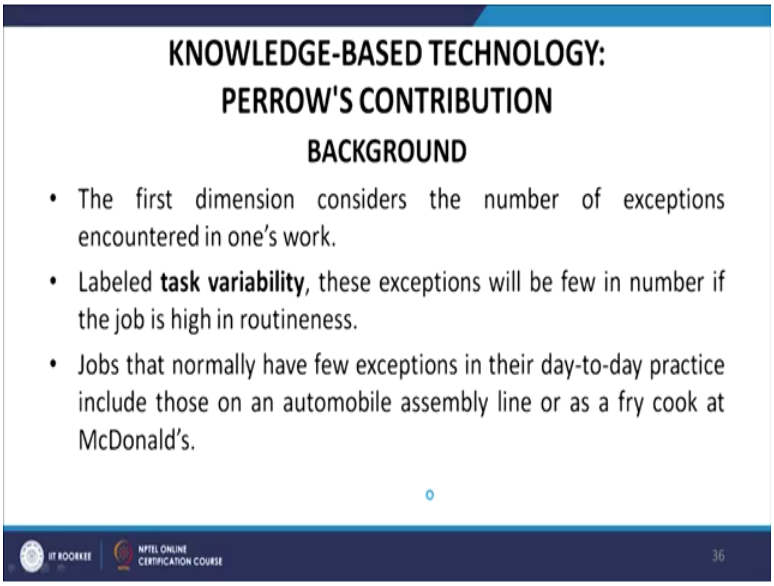

The first dimension considers the number of exceptions encountered in one's work. Labeled as task variability; these exceptions will be few in numbers if the job is high in routineness. Jobs that normally have few exceptions in their day-to-day practice include those on an automobile assembly line or as the fry cook at McDonald's.

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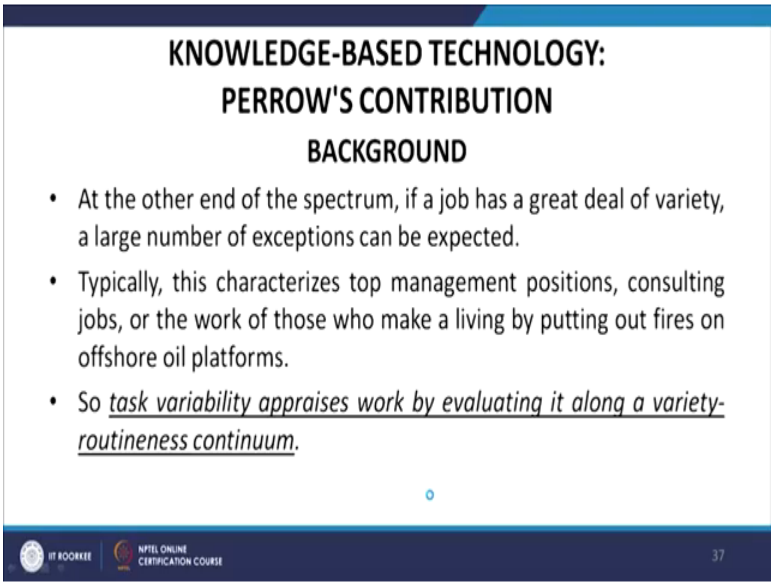

At the other end of the spectrum, if a job has a great deal of variety a large number of exceptions can be expected. Typically, this categorizes top management positions consulting jobs or the work of those who make a living by putting out fires on offshore oil platforms. So, task variability appraises work by evaluating it along a variety-routineness continuum.

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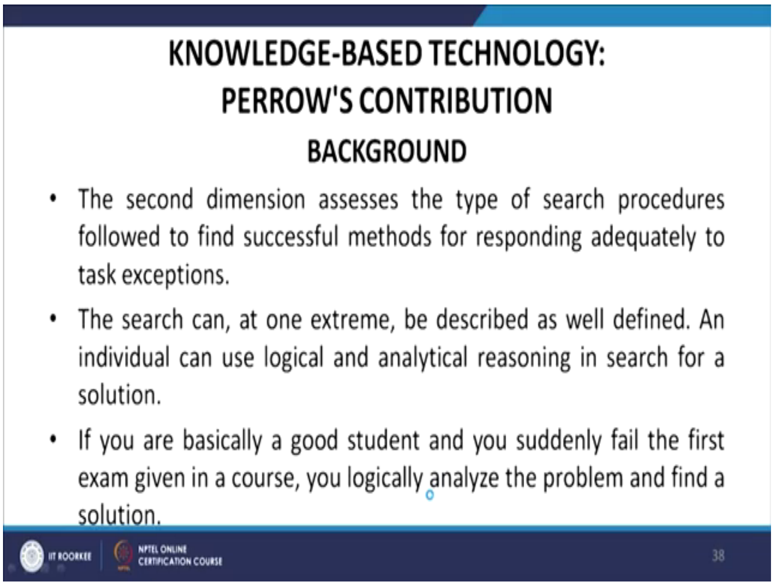

The second dimension assesses the type of search procedures followed to find successful methods for responding adequately to task exemptions. The search can at one extreme be described as well-defined and individual can use logical and analytical reasoning in search for a solution. If you are basically a good student and you suddenly fail the first exam given in a course, you logically analyze the problem and find a solution.

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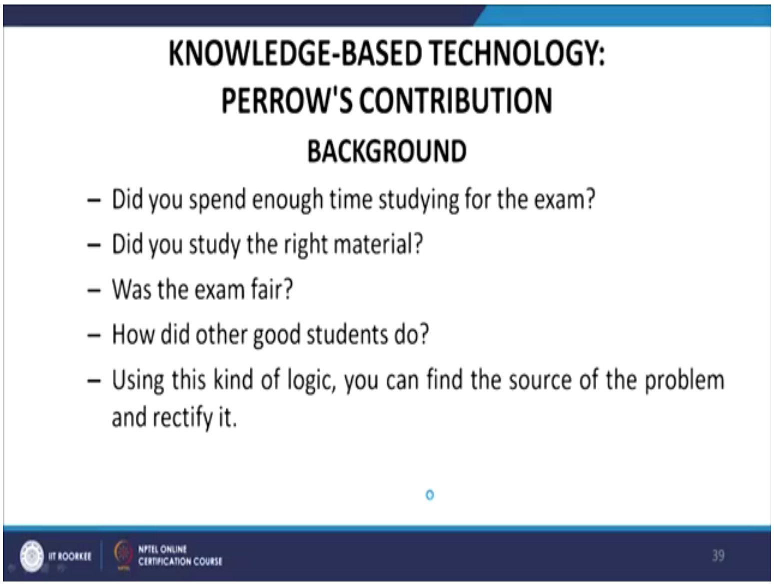

Did you spend enough time in studying for the exam? Did you study the right material? Was the exam fair? How did other students do? Using this kind of logic, you can find the source of problem and rectify it.

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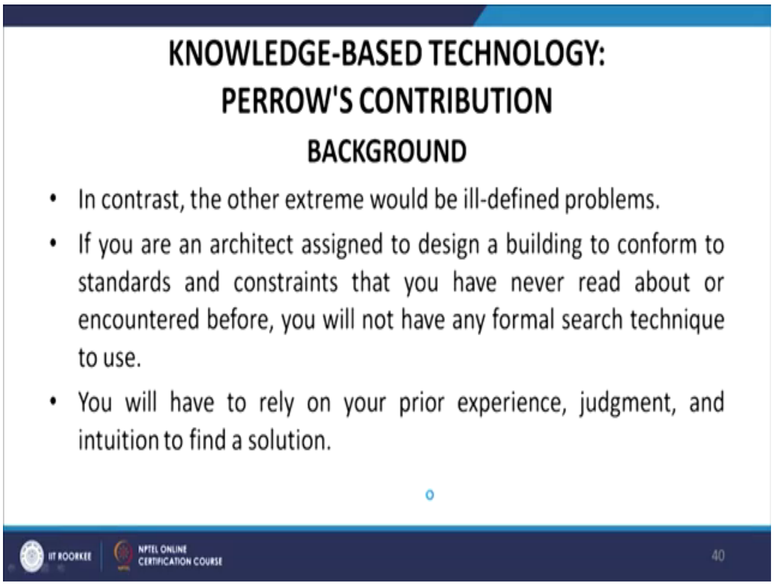

In contrast, the other extreme would be, ill-defined problems. If you are an architect assigned to design a building to conform to standards and constraints that you have never read about or encountered before, you will not have any formal search technique to use.

You will have to rely on your prior experience, judgment and intuition to find a solution. Through guesswork and trial and error you might find an acceptable choice. Perrow called the second dimension as problem analysability, ranging from well-defined to ill-defined. Table 16.2 represents a ten-item questionnaire that measures these two dimensions. Task variability and problem analysability can be measured in an organization unit by having employees answer the following ten questions.

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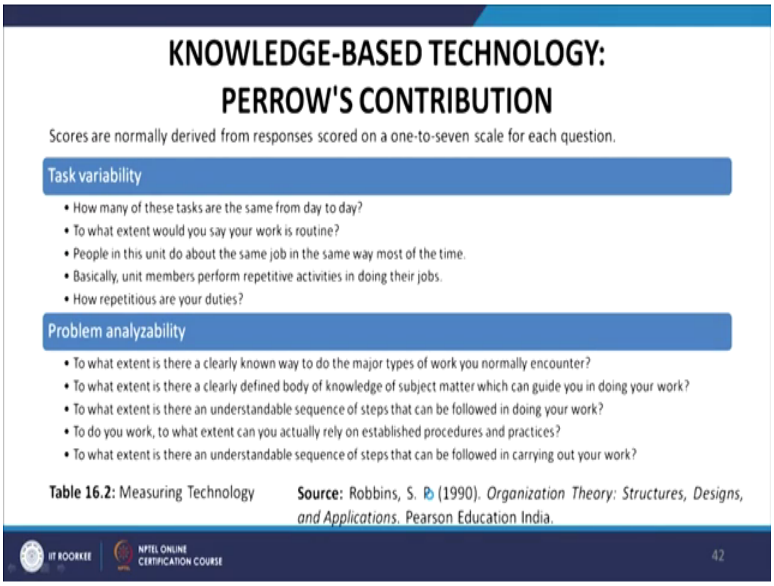

So, scores are normally derived from responses scored on a one-to-seven scale for each question. For task variability there are these five questions, how many of these tasks are the same from day to day? To what extent would you say your work is routine? The third is people in this unit do about the same job in the same way most of the time, the fourth is basically unit members perform repetitive activities in doing their jobs and the fifth is how repetitious are your duties?

The next construct is problem analyzability and again there are these five questions to what extent is there a clearly known way to do the major types of work you normally encounter? To what extent is there a clearly defined body of knowledge of subject matter which can guide you in doing your work?

To what extent is there an understandable sequence of steps that can be followed in doing your work? To do your work to what extent can you actually rely on established procedures and practices? And the fifth is to what extent is there an understandable sequence of steps that can be followed in carrying out your work? These two dimensions, task variability and problem analysability can be used to construct a two by two matrix.

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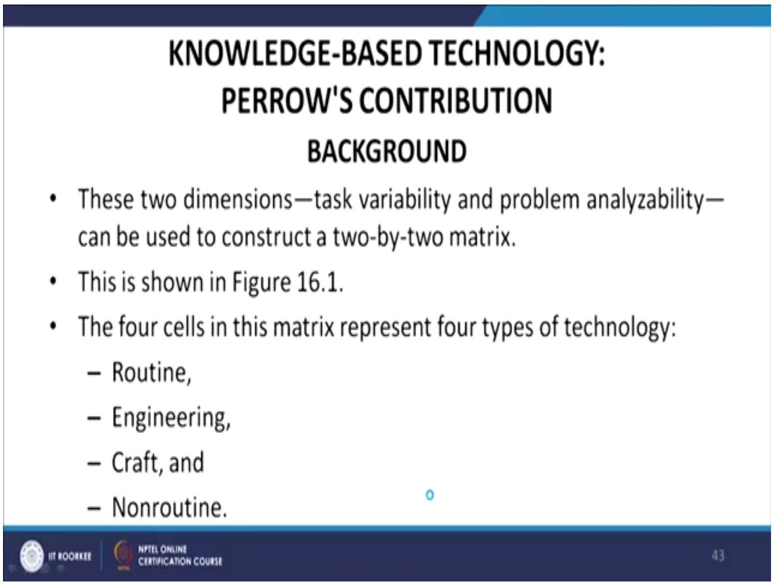

This is shown in figure 16.1. The four cells in this matrix represent four types of technology; routine, engineering craft and non-routine.

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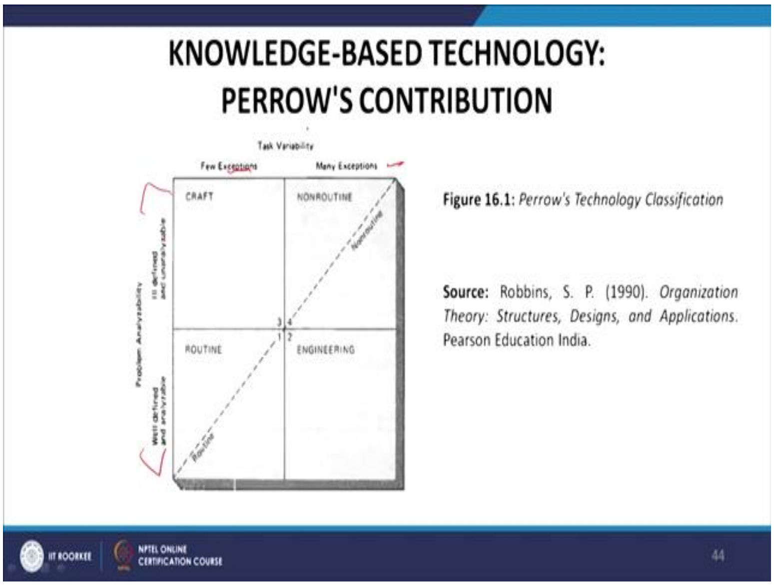

So, these are the four type of technology; task variability varies from few exceptions to many exceptions; problem analyzability varies from well-defined and analyzable to ill-defined and unanalyzable. So, when there are few exceptions in task variability and the problem analyzability is ill-defined and unanalyzable then it is craft that is three.

When the problems are well defined and analyzable and there are few exceptions. So, that is routine. While, when the problem is well defined and there are many exceptions it is engineering while when there are many exceptions and the problems are ill-defined. So, it becomes non routine. So, in the middle we have this line that moves from routine to non-routine.

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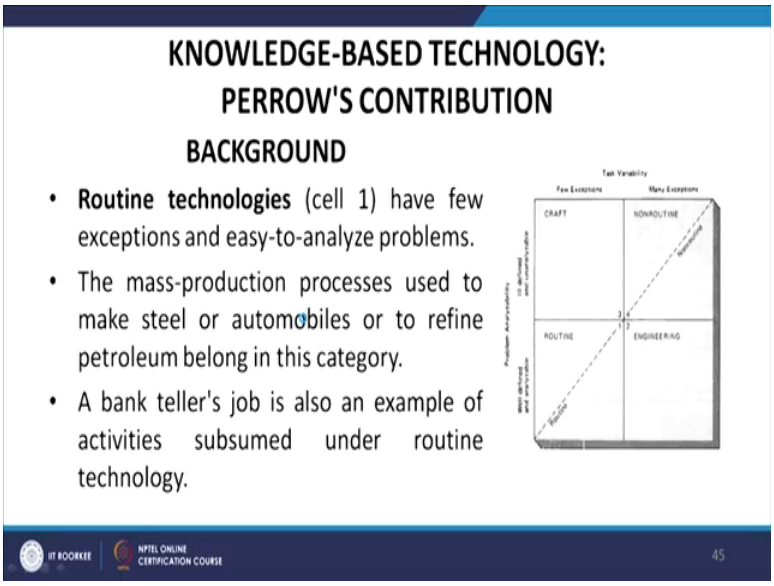

Now, let us look at cell 1 this is what we are talking about. Routine technologies that is cell 1 have few exceptions and easy to analyze problems. The mass production processes used to make steel or automobiles or to refine petroleum belongs in this category. The bank teller’s job is also an example of activities subsumed under routine technology.

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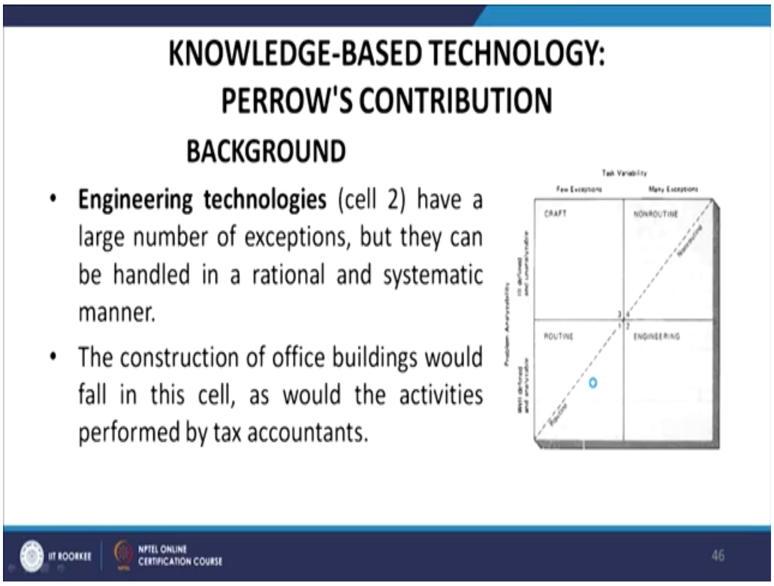

Cell 2 that is engineering technologies have a large number of exceptions, but they can be handled in a rational and systematic manner. The construction of office buildings would fall in the cell as would the activities performed by tax accountants.

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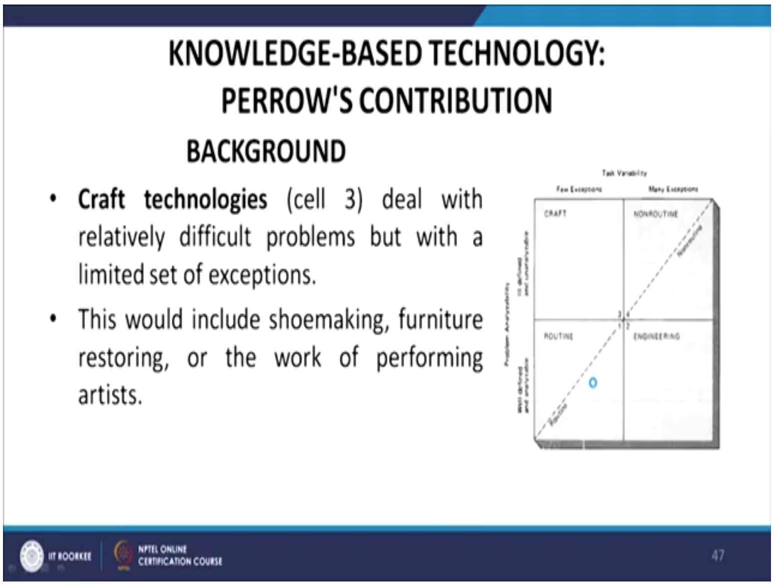

The third cell that is craft technology deal with relatively difficult problems, but with a limited set of exceptions, this would include shoe making, furniture restoring or the work of a performing artist.

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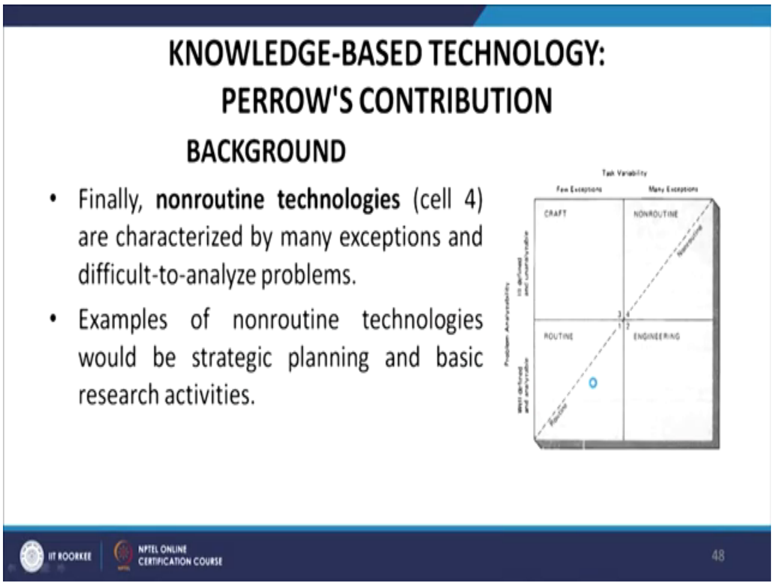

And finally, that is, non routine technology, cell four, are categorized by many exceptions and difficult to analyze problems. Examples of non-routine technologies would be strategic planning and basic research activities.

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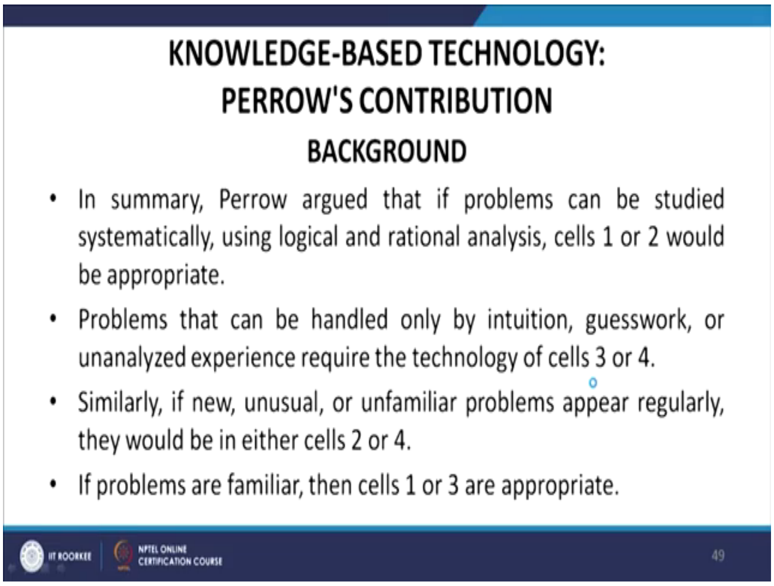

In summary, Perrow argued that if problems can be studied systematically, using logical and rational analysis cell 1 or 2 would be appropriate. Problems that can be handled only by intuition, guess work or unanalyzed experience requires the technology of cell 3 and

4. Similarly, if new unusual or unfair problems appear regularly they would be in either cell 2 or 4. If problems are familiar, then cell 1 or 3 are appropriate.

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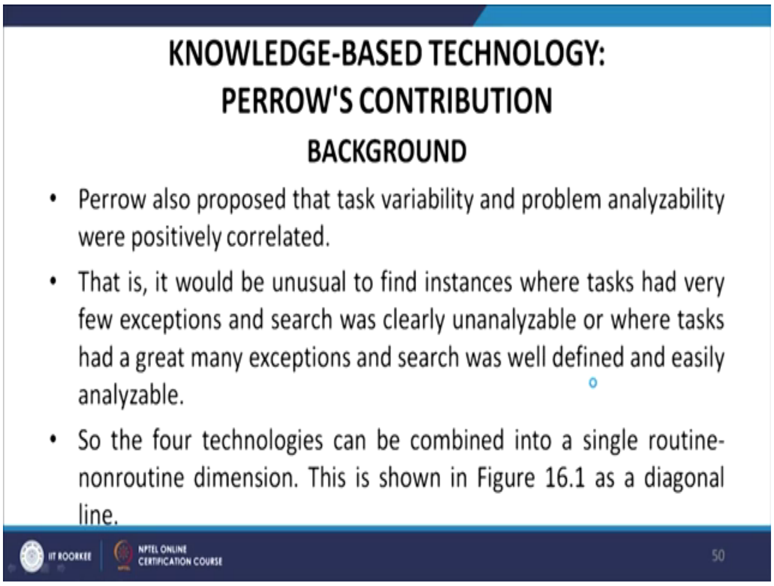

Perrow also proposed that task variability and problem analyzability were positively correlated. That is, it would be unusual to find instances where task had very few exceptions and search was clearly unanalyzable or where tasks had a great many exceptions and search was well defined and easily analyzable. So, the four technologies can be combined into a single routine-non routine dimension that is shown in figure 16.1 as a diagonal line.

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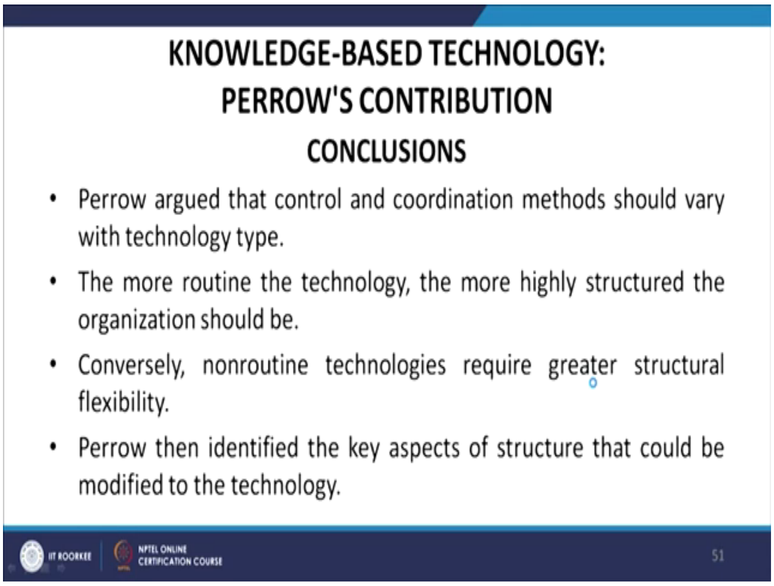

So, the Perrow's contribution conclusion includes the following: Perrrow argued that control and coordination methods should vary with technology type. The more routine the technology, the more highly structured the organization should be. Conversely, non routine technologies require greater structural flexibility. Perrow then identified the key aspect of a structure that could be modified to the technology.

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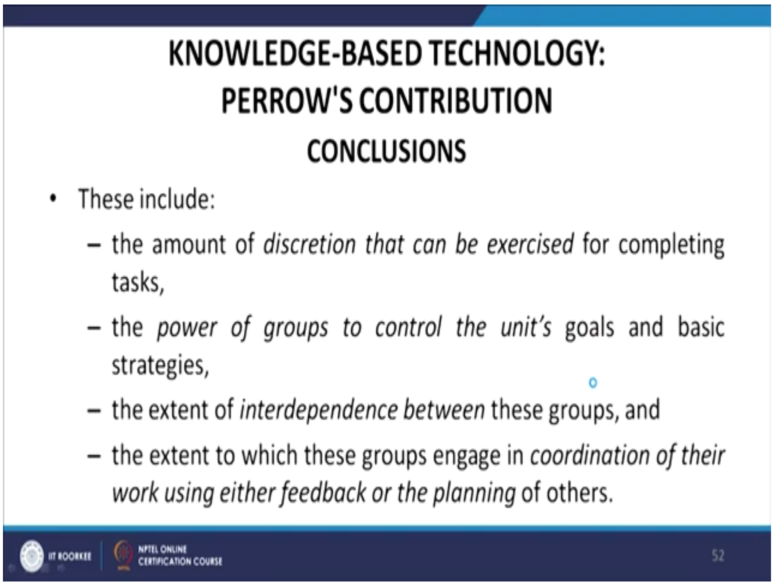

These includes the amount of discretion that can be exercised by completing tasks. The power of groups to control the unit's goals and basic strategies, the extent of interdependence between these groups and the extent to which these groups engage in coordination of their work using either feedback or the planning of others.

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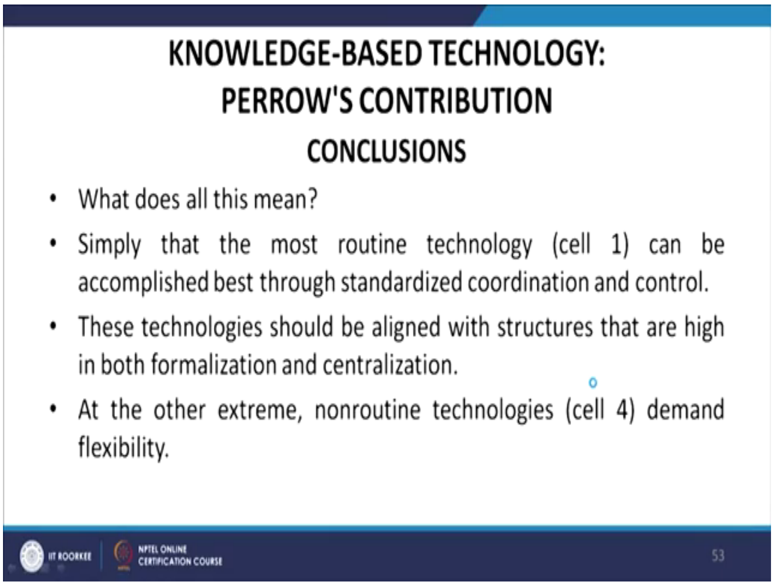

What does all this mean? Simply that the most routine technology that is cell 1 can be accomplished best through standardized coordination and control. These technologies could be aligned with structure that are high in both formalization and centralization. At the other extreme non routine technologies that is cell 4 demand flexibility. Basically, they would be decentralized, have high interaction among all members and be categorized as having a minimum degree of formalization.

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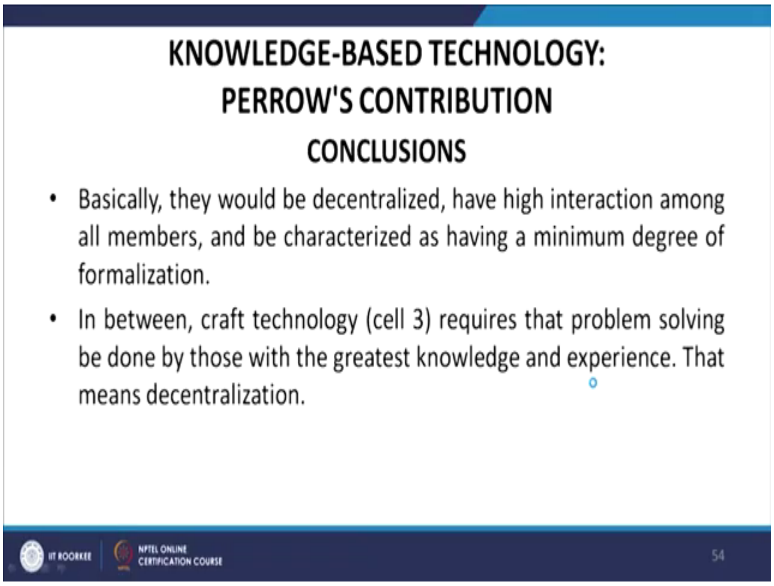

In between craft technologies, that is cell 3, requires that problem solving is done by those with the greatest knowledge and experience; that means, decentralization.

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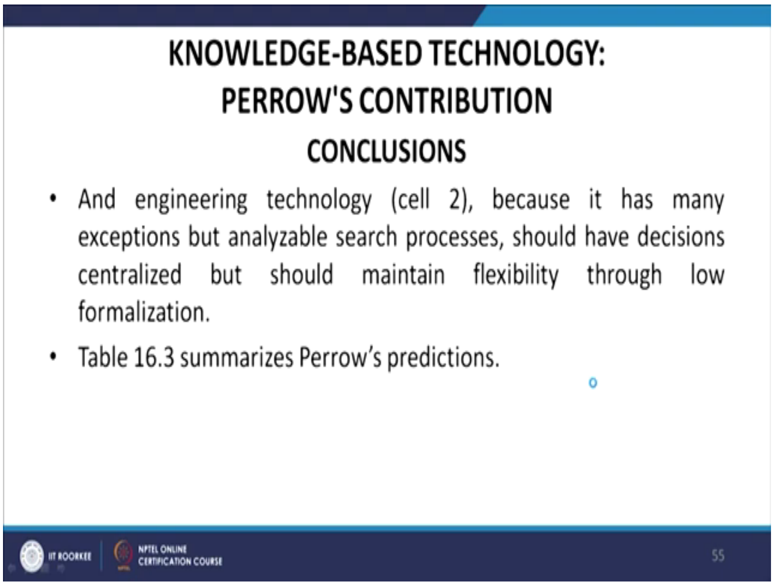

And engineering technology, that is, cell 2 because it has many exceptions. Analyzable search processes should have decisions centralized, but should maintain flexibility through low formalization. So, table 16.3` summarizes Perrow's predictions. This is the table 16.3.

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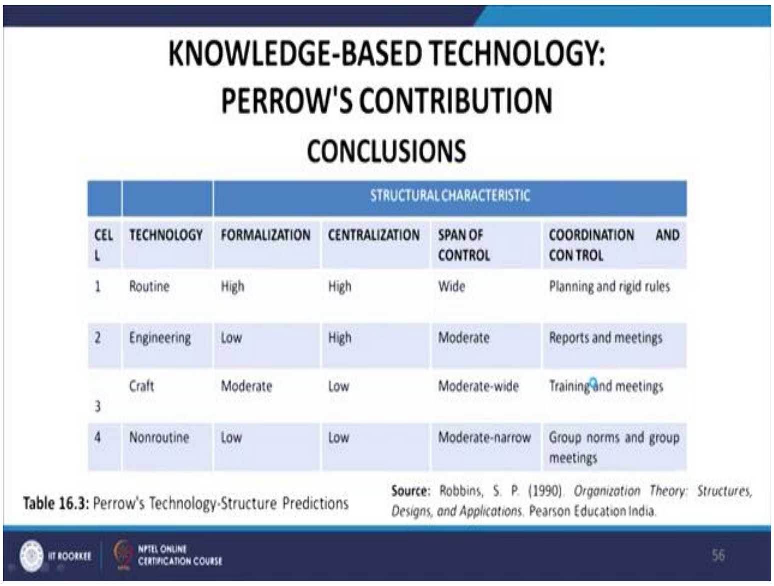

		STRUCTURAL CHARACTERISTIC			
CELL	TECHNOLOGY	FORMALIZATION	CENTRALIZATION	SPAN OF CONTROL	COORDINATION AND CONTROL
1	Routine	High	High	Wide	Planning and rigid rules
2	Engineering	Low	High	Moderate	Reports and meetings
3	Craft	Moderate	Low	Moderate-wide	Training and meetings
4	Nonroutine	Low	Low	Moderate-narrow	Group norms and group meetings

Table 16.3: Perrow's Technology-Structure Predictions

Source: Robbins, S. P. (1990). *Organization Theory: Structures, Designs, and Applications*. Pearson Education India.

So, there are these four cells on the left and then we have technology, formalization, centralization, span of control, coordination and control as structural characteristics. So, you can see that technology can be routine, formalization can be high, centralization is again high, span of control may be wide and the coordination control is planning and rigid rules.

Similarly, for non-routine formalization is low, centralization is low, span of control is moderate to high and then coordination and control group norms and group meetings and similarly for engineering the coordination and control means reports and meetings and for craft it may means training and meetings.

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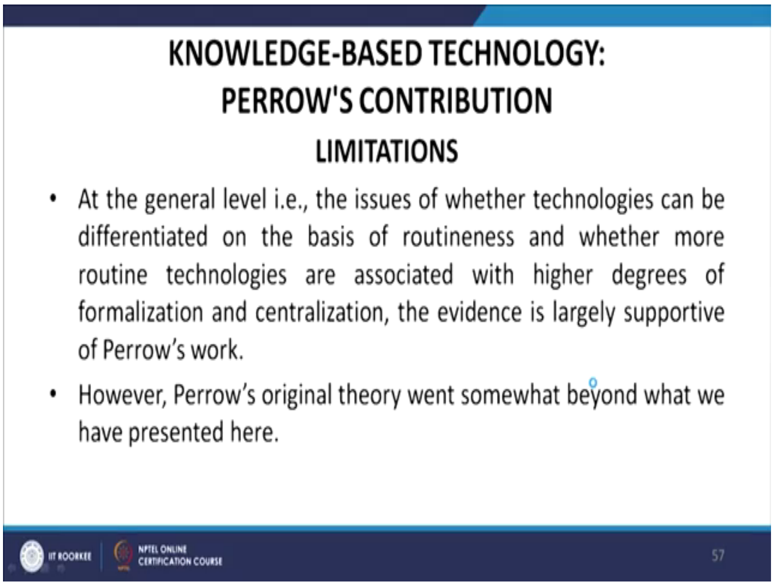

Now, limitation of this contribution at the general level, that is, the issues of whether technologies can be differentiated on the basis of routineness and whether more routine technologies are associated with higher degrees of formalization and centralization, the evidence is largely supportive of Perrow's work. However, Perrow's original theory went somewhat beyond what we have presented here.

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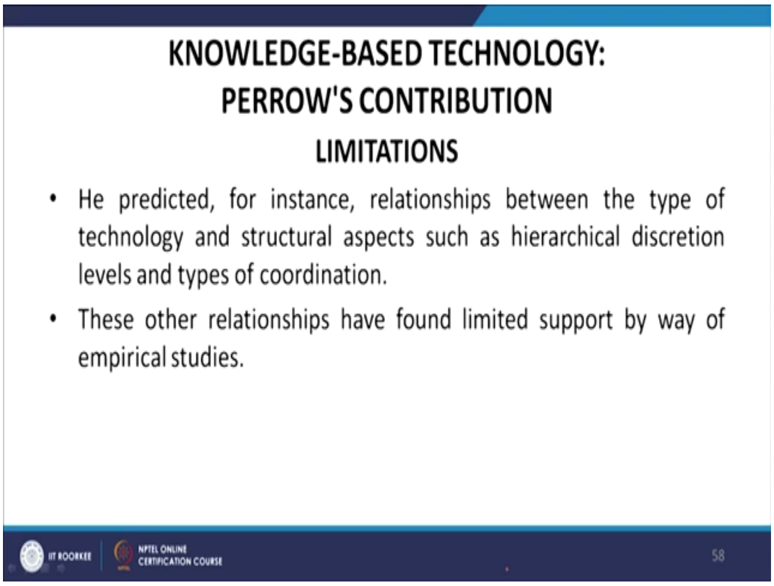

He predicted for instance relationships between the type of technology and structural aspect such as hierarchical distribution levels and types of coordination. These other relationships have found limited support by way of empirical studies.

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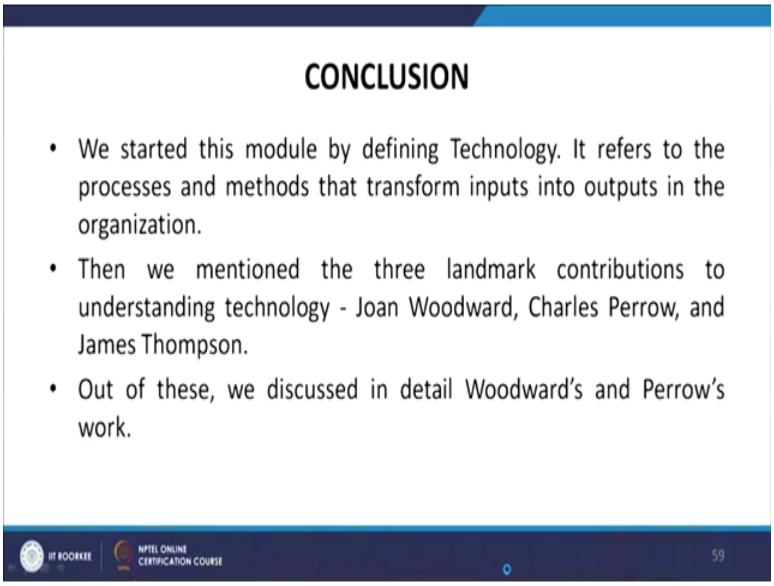

So, to conclude, we started this module by defining technology. It refers to the processes and methods that transform inputs into outputs in the organization. Then we mentioned the three landmark contributions to understanding technology; Joan Woodward's, Charles Perrow's and James Thompson's. Out of these, we discussed in detail Woodward's and Perrow's work.

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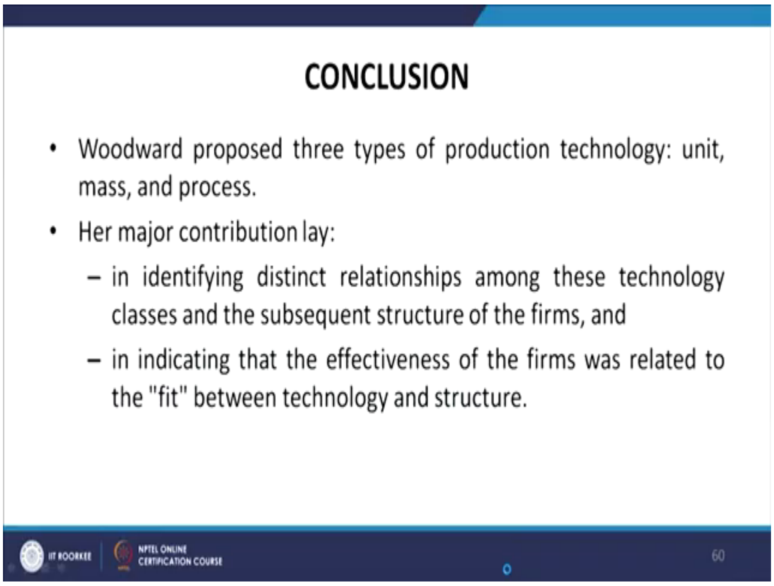

Woodward proposed three types of production technology; unit, mass and process. Her major contribution lay in identifying distinct relationships among these technology classes and the subsequent structure of the firm and in indicating that the effectiveness of the firm was related to the fit between technology and structure.

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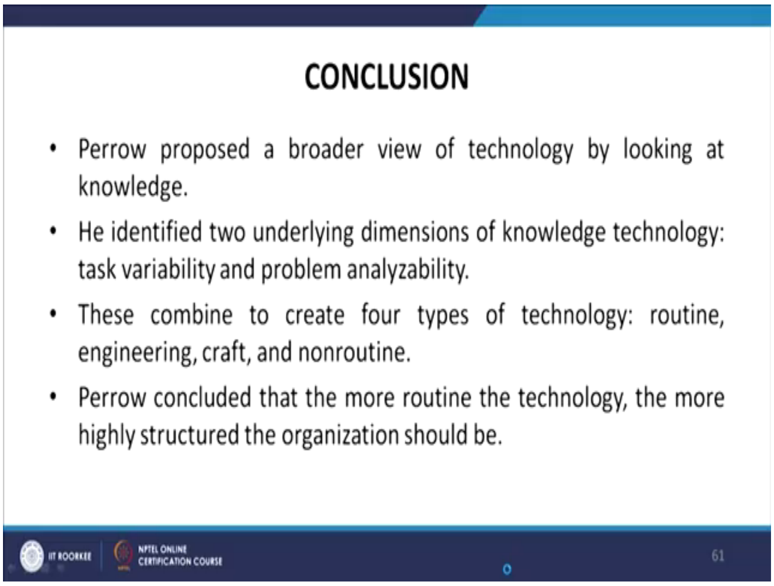

Perrow proposed a broader view of technology by looking at knowledge; he identified two underlying dimensions of knowledge technology: task variability and problem analyzability. These combine to create four types of technology: routine engineering, craft and non-routine. Perrow concluded that the more routine the technology, the more highly structured the organization should be.

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And these are the four books from which the material for this module was taken.

Thank you.