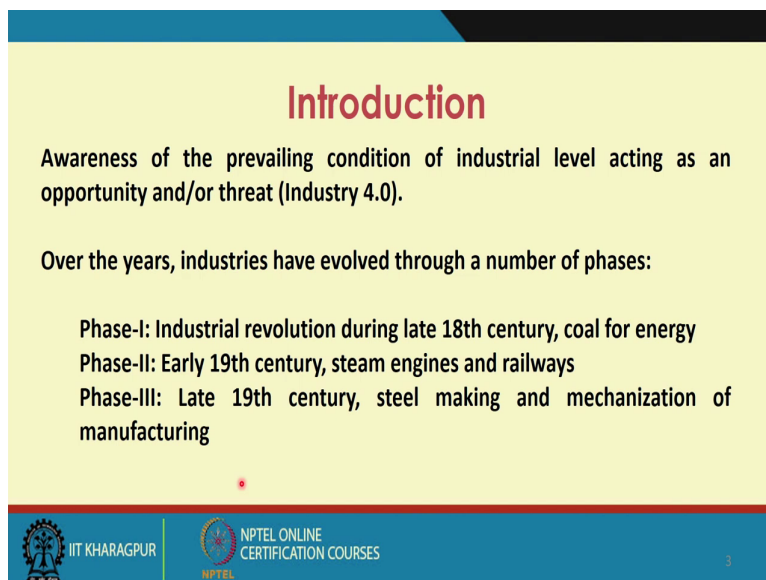


Automation in Production Systems and Management
Prof. Pradip Kumar Ray
Vinod Gupta School of Management
Indian Institute of Technology, Kharagpur

Lecture - 08
Industry 4.0

During this lecture sessions, we will be discussing an important topic called the Industry 4.0. If you want to adopt industry 4.0 norms, you have to adopt and create certain conditions in your manufacturing system. When we refer to this industry 4.0 norms or standards, we have to create an automated system and a database management system. It will definitely promote the industry 4.0.

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Introduction

Awareness of the prevailing condition of industrial level acting as an opportunity and/or threat (Industry 4.0).

Over the years, industries have evolved through a number of phases:

- Phase-I: Industrial revolution during late 18th century, coal for energy
- Phase-II: Early 19th century, steam engines and railways
- Phase-III: Late 19th century, steel making and mechanization of manufacturing

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When we refer to the manufacturing systems, many a time we refer to the factory system and there are different kinds of factory systems which you find these days. It was stated that factory system started during the time of industrial revolution by 1780 and the new kinds of factory system was introduced. We are at industry 4.0 and you have to set the conditions in your manufacturing or production system in such a way that it complies with the requirements under industry 4.0. Those requirements you have to fulfil and if you want to your company a competitive one and if you want to improve or increase your profitability,

there are certain conditions imposed and under industry 4.0 those conditions are to be maintained and fulfilled.

Awareness of the prevailing condition of industrial level acting as an opportunity and or threat; that means, you must know that the details about this industry 4.0, the requirements, and then you assess your manufacturing system, and you check that whether there is a need and it becomes essential to adopt industry 4.0 levels or the norms.

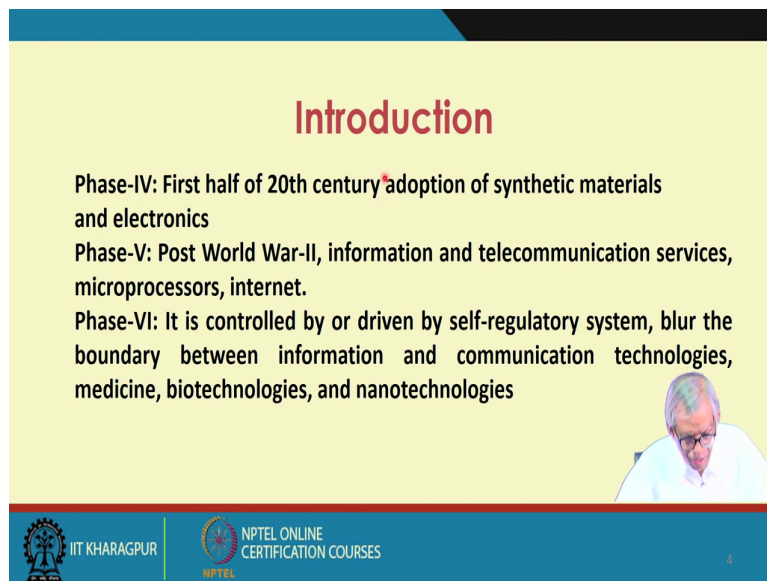
Over the years, industries have evolved through a number of phases. I have already mentioned that it started this factory system, started in the working during industrial revolution during late 18th century, 1780 A.D, that is called the phase-I .

Coal for energy for the first time we started using. The second phase began in early 19th century – steam engines and the railways were introduced. Then you move to phase-III late 19th century, steel making and mechanization of manufacturing. Human labour, then mechanization, and then the computer based systems, and then we started talking about automation.

Suppose your manufacturing system is almost 100% labour intensive and you want to adopt automated system, then you have to go through certain phases. You just cannot jump on from 100% human labour to 100% automated system.

In the phase-III, we started talking about the mechanizations of manufacturing.

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Introduction

Phase-IV: First half of 20th century adoption of synthetic materials and electronics

Phase-V: Post World War-II, information and telecommunication services, microprocessors, internet.

Phase-VI: It is controlled by or driven by self-regulatory system, blur the boundary between information and communication technologies, medicine, biotechnologies, and nanotechnologies

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Then we move to phase-IV. At this stage, first half of 20th century, i.e. 1910, 1920, 1930, adoption of synthetic materials and electronics and with this introduction, the entire the scenario is changed.

Like the kinds of the materials you need to handle or you need to process, the kinds of the machine tools you have to use, the kinds of the raw materials you need to use, the entire scenario has change significantly.

Then we move to phase-V, post World War-II, information and telecommunication services, microprocessors, internet. Then in phase-VI, it is controlled by or driven by self-regulatory system.

In a self-regulatory system, the boundary is diminished between information and communication technologies and lot of improvements has been made on medicine and biotechnology and we started using nano technologies.

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Present Industrial Scenario

- Marketing Knowledge
- Product development process
- Uncertain Environment
- How to sustain business performance?
- Absence of entrepreneurship skills and aptitude in adverse environment
- Non-compliance with the standards/regulations related to work environment and safety
- Essentially controlled by globalization phenomenon – focusing on selling of products and services and surviving in a single market

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Now, before you start adopting industry 4.0 norms, you must be aware of the present industrial scenario, like marketing knowledge, etc.

With respect to a particular manufacturing systems or the production systems where automated system is to be introduced, you just check that on all these factors where do you stand.

Then you have one particular function called marketing and market research. You have to either create a market for the existing product or you have to create a market for the new product and you have to carry out the marketing research all the times.

Level of knowledge in marketing must be known and this knowledge is to be quantified, like kinds of information, kinds of the data you get, etc. are to be appropriately preserved

What is your product development process? Usually the product development process involves three kinds of activities – one is product design, followed by process design, followed by the manufacturing. There are two principal types of product development process. One is the serial engineering approach and the other is the concurrent engineering approach.

If you can convert the product development process into concurrent engineering approach, if you follow concurrent engineering approach for product development, then it becomes easier for you to adopt an automated system.

Uncertain environment – it means that three kinds of the problems you may come across, problem under certainty, problem under risk, problem under uncertainty. Many companies they face problem under uncertainty or, in other words, the demand pattern has become for your product has become totally erratic- sometimes you have underutilization of your resources or the capacity underutilization.

How to create a technology in such a way manufacturing technology in such a way that even if you go for underutilization or overutilization, the cost increment is minimum?

How to sustain a business performance? Is your production system a sustainable one? There are three kinds of sustainability. The first one is the financial or the economic sustainability, followed by the environmental sustainability, followed by social sustainability. You should be aware of that whether your level of social sustainability is high or low. Similarly, for environmental sustainability, whether it is high or low.

Absence of entrepreneurship skills and aptitude in advance environment is a serious deficiency in many manufacturing or production systems. Non-compliance with the standards, regulations related to work environment and safety.

Essentially controlled by globalization phenomenon – focusing on selling of products and services and surviving in a single market-this is refer to as the globalization phenomenon-this is the present industrial scenario.

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Present Industrial Scenario

- Without having ability to adopt to an absolutely new and demanding social and economic systems, mainly controlled by 'globalization', a company or an organization in any sector of a national economy may not survive even for few years.
- Two important aspects any company must look into in this context:
 - i. Be continually innovative
 - ii. Adoption to Industry 4.0 trend
- Considering uniqueness, social and mass livelihood relevance of MSME in our country, adoption to Industry 4.0 trend may be considered a must.

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Without having ability to adopt when absolutely new and demanding social and economic systems, mainly controlled by globalization, a company or an organization in any sector of a national economy may not survive even for few years.

Two important aspects any company must look into in this context. One is be continually innovative and adoption to industry 4.0 trend.

You need to adopt the technologies or processes in such a way in your manufacturing system that the your manufacturing system or production system becomes an automated one and it becomes easier for you to be continually innovative and you have to adopt industry 4.0 trend.

Considering uniqueness social and mass livelihood relevance of MSME in our country, adoption to industry 4.0 trend may be considered is a must.

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Innovation

“Innovation is defined as the successful application of new ideas resulting from organizational processes in which different resources are combined. This combination of various resources is a multi-stage process leading to improved or new products, services, or processes with which firms seek to differentiate themselves on the market”. (Mark Dodgson, David M. Gann, and Nelson Phillips, The Oxford Handbook of Innovation Management, Oxford: Oxford University Press, 2014)

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What is innovation? “Innovation is defined as the successful application of new ideas resulting from organizational processes in which different resources are combined. This combination of various resources is a multi-stage process leading to improved or new products, services, or processes with which firms seek to differentiate themselves on the market”. (Mark Dodgson, David M. Gann, and Nelson Phillips, The Oxford Handbook of Innovation Management, Oxford: Oxford University Press, 2014) That means, you are focusing on new product development, or new process development, or the new kinds of services you need to design with which firms or the companies seeks to differentiate the themselves on the market this is the definition of the innovation. There could be other definitions, but this definition is acceptable and it is the most comprehensive one.

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Innovation

- Innovative tools, techniques and approaches have been instrumental throughout the ages for quantum or radical change in the patterns and performance of products, processes and systems.
- Innovation is considered one of the key dimensions of performance (others being efficiency, effectiveness, productivity, quality, quality of work-life and profitability).

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Innovative tools, techniques and approaches have been instrumental throughout the ages for quantum or radical change in the patterns and performance of products, processes and systems. When you try to make your production system an automated one, in all likelihood that system is a new or unique one. There are many kinds of special he tools and techniques; the custom built tools and techniques you need to use.

We have highlighted certain new products, new technologies, new processes in each phase which actually radically change the industrial environment – particularly the manufacturing system, the quality, or the manufacturing system characteristics.

Innovation is considered one of the key dimensions of performance others being efficiency, effectiveness, productivity, quality, quality of work-life, and profitability.

There are seven criteria performance, One is the innovation that already we have defined.

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Innovation

- Organizations in order to be sustainable in the long-run must be able to adopt innovative means and procedures in their tasks, operations and resources.
- In today's highly competitive industrial environment, dictated by conditions set by globalization (survival in a single market) companies must adopt appropriate strategies for innovation.



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Simultaneously you have to get or you have to achieve the best performance, or the best level of performance with respect to each and every criterion of performance.

Organizations in order to be sustainable in the long-run must be able to adopt innovative means and procedures in their tasks, operations and resources in a today's highly competitive industrial environment, companies must adopt appropriate strategies for innovation.


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Phases of Innovation

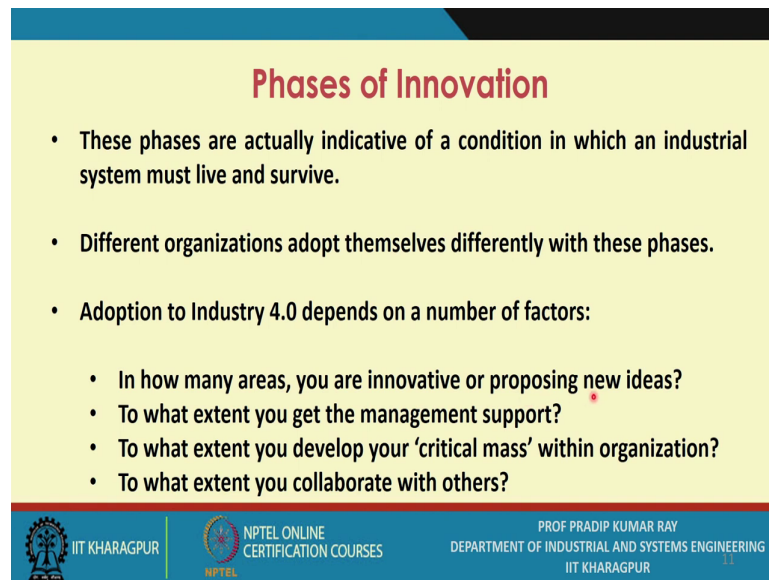
- At each of these industrial phases, there could be four sub-phases:
 - Prosperity
 - Recession
 - Depression
 - Recovery



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There are four phases of innovation like prosperity where everything goes fine. Then recession, then there could be depression, and then again there will be recovery.

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Phases of Innovation

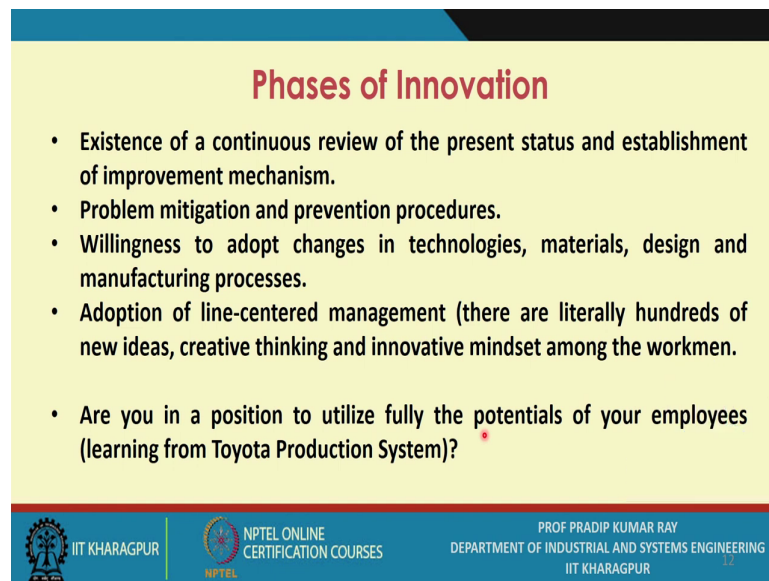
- These phases are actually indicative of a condition in which an industrial system must live and survive.
- Different organizations adopt themselves differently with these phases.
- Adoption to Industry 4.0 depends on a number of factors:
 - In how many areas, you are innovative or proposing new ideas?
 - To what extent you get the management support?
 - To what extent you develop your 'critical mass' within organization?
 - To what extent you collaborate with others?

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The adoption to industry 4.0 depends on a number of factors. In how many areas, you are innovative or proposing new ideas? To what extent you get the management support? That is a management issue. To what extent you develop your critical mass within organizations?

You need to develop the inherent competency of certain individuals who are having the knowledge and expertise. They are referred to as the critical mass. To what extent you collaborate with others?

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Phases of Innovation

- Existence of a continuous review of the present status and establishment of improvement mechanism.
- Problem mitigation and prevention procedures.
- Willingness to adopt changes in technologies, materials, design and manufacturing processes.
- Adoption of line-centered management (there are literally hundreds of new ideas, creative thinking and innovative mindset among the workmen.
- Are you in a position to utilize fully the potentials of your employees (learning from Toyota Production System)?

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Existence of continuous review of the present status and establishment of improvement mechanisms. There must be willingness to adopt changes in technologies, materials, design and manufacturing processes. And then only you will be able to install or design, and develop an automated system.

Adoption of line-centered management (there are literally hundreds of new ideas, creative thinking and innovative mindset among the workmen. There are literally hundreds of new ideas, creative thinking and innovative mindset among the workmen.

Are you in a position to utilize fully the potentials of your employees? This is to be explored. A group of persons to be engaged, and their potential to be fully utilized? You must know against each and every individual what is his or her the potential like when we refer to TPS or the Toyota Production System, this aspect is emphasized.

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Levels of Innovation

- Innovative measures can be adopted at all levels of an organization, strategic, tactical and operation levels.
- At operation level:
 - i. Physical resource/asset
 - ii. Machine tool, operations control, maintenance and service
 - iii. Automation
 - iv. Yo-i-don
 - v. Holding devices including jigs and fixtures
 - vi. Energy savings, utilization
 - vii. Work environment
 - viii. Recycling and reuse of waste products
 - ix. Shift schedules

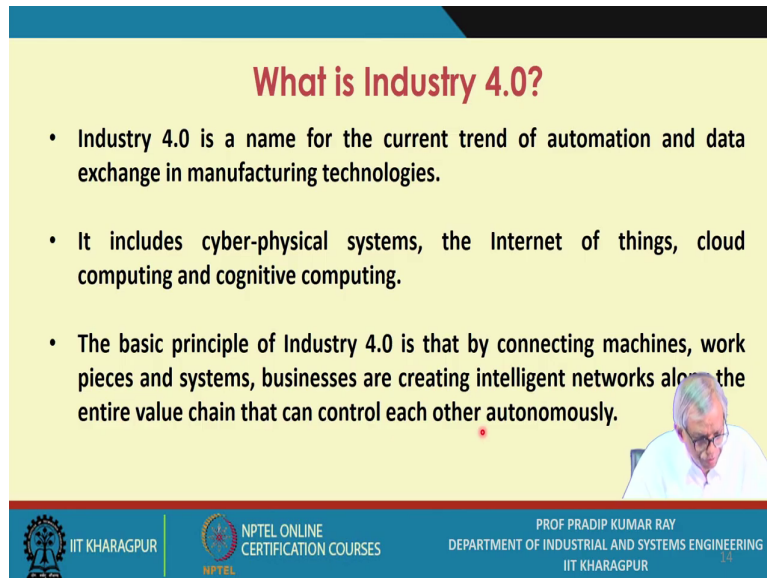
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Innovative measures can be adopted at all levels of an organization, strategic, tactical and operation levels. At the operation level, these innovative measures are related to physical resource asset, machine tool level, automation.

Automatic stoppage of the machines when it produces defective item, that is termed as automation. Yo-i-don; that is basically the synchronous manufacturing system. Integration.

In all likelihood if you adopt an automated system, you will be in a position to create the synchronous manufacturing system. Holding devices including jigs and fixtures are to be considered; energy savings, utilizations; work environment, recycling and reuse of waste products to what extent you can do, and the shift schedules.

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What is Industry 4.0?

- Industry 4.0 is a name for the current trend of automation and data exchange in manufacturing technologies.
- It includes cyber-physical systems, the Internet of things, cloud computing and cognitive computing.
- The basic principle of Industry 4.0 is that by connecting machines, work pieces and systems, businesses are creating intelligent networks along the entire value chain that can control each other autonomously.

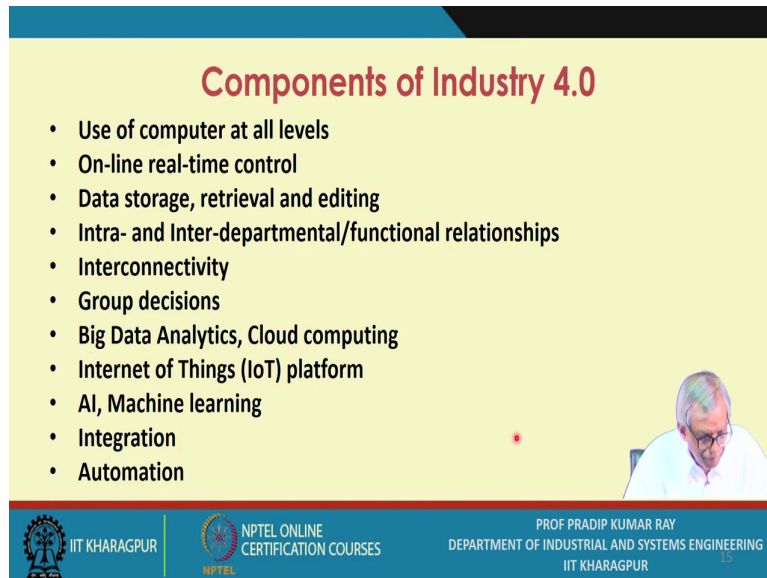
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Industry 4.0 is a name for the current trend of automation and data exchange in manufacturing. It includes cyber-physical systems, the internet of things – IoT, cloud computing and cognitive computing. The basic principle of industry 4.0 is that by connecting machines, workpieces and systems, businesses are creating intelligent networks along the entire value chain that can control each other autonomously.

Not only within the factory systems, but also within the supply chain also. Inbound logistics as well as the outbound logistics is to be established.

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Components of Industry 4.0

- Use of computer at all levels
- On-line real-time control
- Data storage, retrieval and editing
- Intra- and Inter-departmental/functional relationships
- Interconnectivity
- Group decisions
- Big Data Analytics, Cloud computing
- Internet of Things (IoT) platform
- AI, Machine learning
- Integration
- Automation

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What are the components of industry 4.0? Use of computer at all levels. This will promote not only computerization, but also automation. On-line real-time control, that is a the part of automated systems.

Data storage, retrieval and editing, Intra- and inter-departmental functional relationships and Interconnectivity.

Then the group decisions, big data analytics, cloud computing, internet of things or IoT platform that you have to create, artificial intelligence, machine learning, integration, automation.

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Impact of Industry 4.0

- Change in services and business models
- Reliability and continuous productivity
- IT security
- Machine safety
- Product lifecycles
- Industry value chain
- Workers' education and skills
- Socio-economic factors

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What will be its impact if you adopt industry 4.0 trend? Change in services and business models, reliability and continuous productivity improvement or performance improvement, IT security - you have to check with respect to the IT security or whether your automated system is a reliable one or not.

If it is not reliable, then it is not a feasible alternative. We have to check whether that automated system, the design of the automated system is also following the principles related to design for reliability and maintainability.

Machine safety, product life cycles. Suppose the product in the declined stage, and now you are producing that product, you go for automated system. This cannot be a feasible alternative when it is in the growth phase, when it is at least in the saturation phase of the product life cycle. But if you adopt the automated system this will be really feasible.

Machine safety part, product cycles related issues, industry value chain, value adding activities, worker's education and skills like say when you talk about the NC systems you will find that the many workers use MDI (Manual data input), touch screen on a NC machine tool, socio-economic factors.

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Research Project to Adopt Industry 4.0

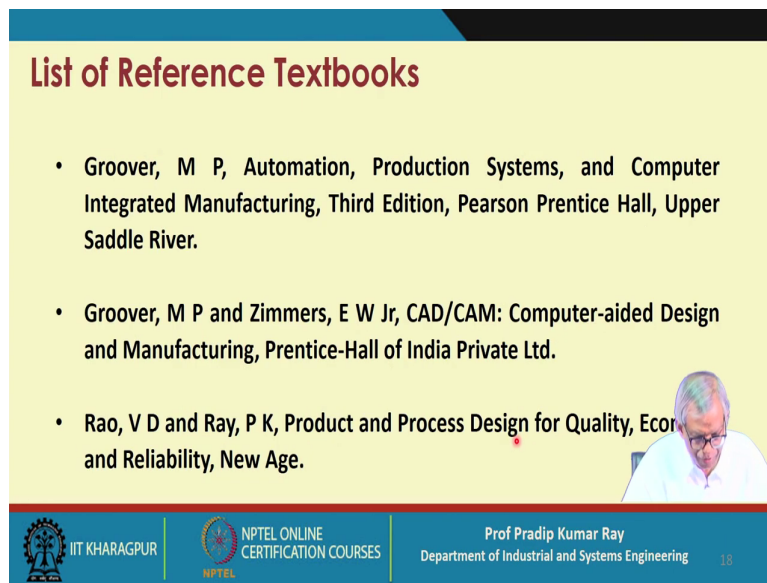
- Any research project will have a methodology for implementation. The methodology consists of a number of inter-related steps.
- **Step-1:** Selection of one specific sector following the appropriate selection norms, scientifically and objectively.
- **Step-2:** Assessment of the present status vis-à-vis Industry 4.0 requirements.
- **Step-3:** Selection of appropriate improvement tools, techniques, approaches with management and financial support.
- **Step-4:** Implementation of select improvement alternatives with benefit assessment and prediction (make money and continuous improvement)
- **Step-5:** Periodic review and benchmarking

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The research project will have a methodology for implementation. The methodology consists of a number of inter-related steps. First one particular area you have to select where you need to adopt industry 4.0. Then you have to assess the present status. Then you have to select appropriate improvement tools, techniques, approaches with management and financial support.


At the fourth stage, you have to talk about the implementation and you have to select improvement alternatives with benefit and assessment. It is true for creating an automated system also. And then you have to have a periodic review and benchmarking system.




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Now, you have to focus on creating designing and implementing an automated system.