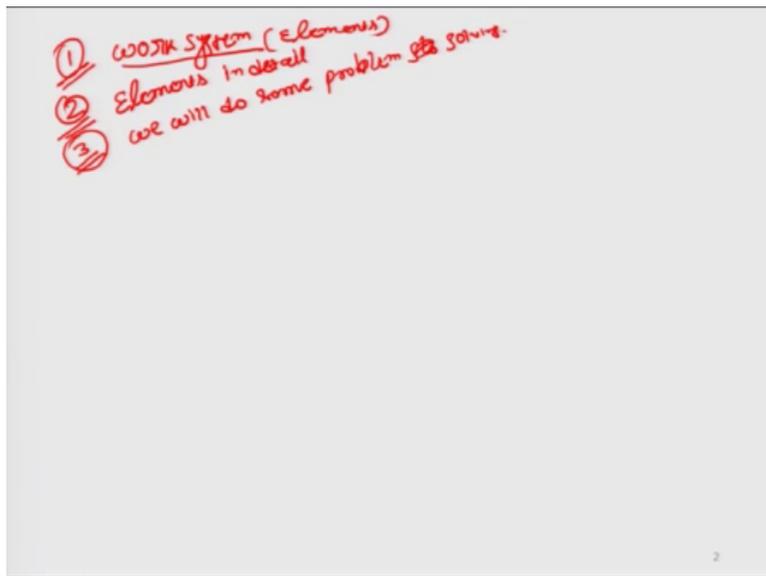


**Design Practice**  
**Prof. Shantanu Bhattacharya**  
**Department of Mechanical Engineering**  
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**Lecture - 31 and 32**  
**Design of Work Systems**

Hello everyone. welcome to the course Design Practice, lecture module 31 and 32, I am Sanjay Kumar course TA, and again I will continue this week also for. And I will in this week I will cover design of work system. This is a new topic and in this topic you will learn how to design if your job, and your workshop or your method, process, and how you can continue quantitatively measure the time which is required to process any product which in a workshop.

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In this module I will cover, first one that will be our what are the work system, what are the elements of work system. And after that I will cover what are the all elements in detail, there after we will do some problem solving.

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### Work System

As a physical entity, a work system is a system consisting of humans, information, and equipment designed to perform useful work

- Contributes to the production of a product or delivery of a service
- **Examples:**
  - Worker operating a machine tool in a factory
  - Robotic welding line in an automobile plant
  - Parcel service agent driving a delivery truck to make customer deliveries
  - Designer working at a CAD workstation

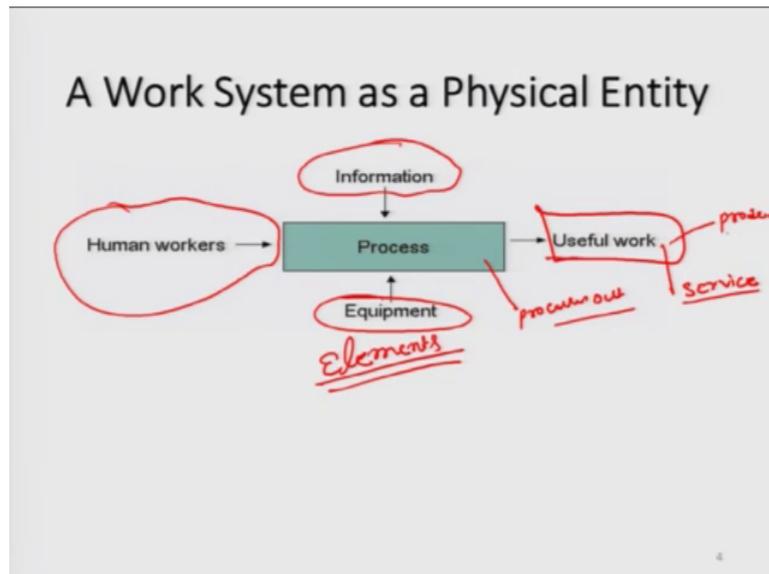
*Handwritten notes:*  
- worker's case you will have to satisfy their need  
- For your organization  
- money  
- Sustainable System  
- develop a successful organization...  
- work system

So, what is the work system work system is a physical entity that is a system that consists of humane, information, equipment designed, to perform useful work. And it contributes to the production of a product or delivery of a service. Suppose that if you want to develop a system for your organization.

So, how you will have to develop a system for that, So, it includes everything, man power, machine, money, and you will have to integrate all the things in such a way that there should be some suitable system, that is required to develop a successful organization here for example, here what you are saying worker operating a machine tool in a factory ok.

So, in factory in actual case in each machine m1, m2, m3, in every machine they are certain 2 to 4 or maybe one worker is assigned ok. So, for worker case you will have to satisfy their need, robotic welding line in an automobile, plant parcel, service agent driving in a delivery truck to make customer delivery designer working at a CAD workstation.

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So, you can see here these all elements, when you will integrate all elements, then there will be a formation of work system here, elements of a work system here, you can see human workers are involved equipment are required, and certain information are required so that when you will integrate all the things, then it will get process out. And it will convert in a useful work can be either in a form of product or service.

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### Work System

As a field of professional practice, work systems include:

- **Job design (or Work methods)** - analysis and design of tasks and jobs involving human work activity
- **Work measurement** - analysis of a task to determine the time that should be allowed to perform the task
- **Work management** - organizational and administrative functions that must be accomplished to achieve high productivity and effective supervision of workers

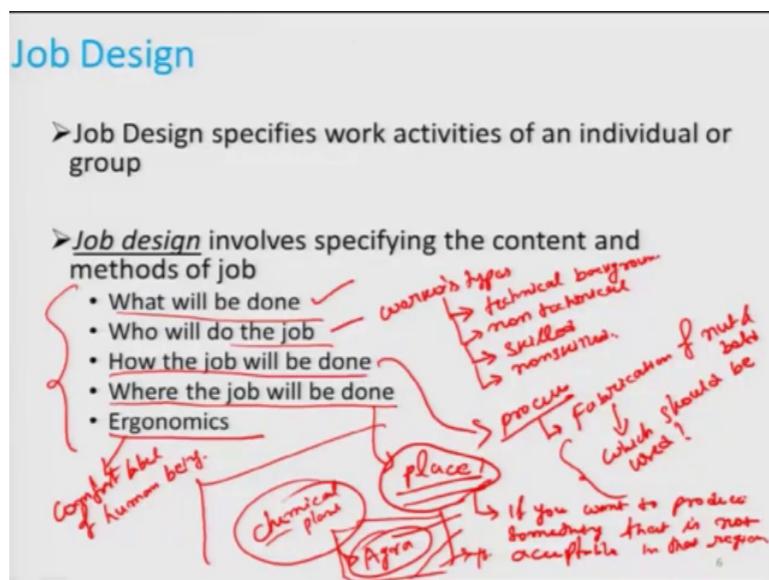
*management*

I will discuss work system in detail now. As a field of professional practice work system includes three things, that is first one is job design, second one is work measurement, and third one is work management. Job design job design is related to workers. This is the

analysis and design of task and jobs involving human work activity, third one is work measurement when worker perform some work, then how you will quantify their effort ok.

So, you will have to use certain methods. So, that you can quantify their effort, that is the analysis of a task to determine the time that should be allowed to perform the task, and third one is a work management ok. This is the actually more basically related to a management ok. It is an administrative function that must be accomplished to achieve high productivity, and effective supervision of workers ok.

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So, first I will discuss job design what is job design, job design specifies work activity of an individual or group, it involves specifying the content and method of job here, certain questions must be asked before designing a job. So, what will be done, what are you going to produce in your factory, what will be the job, who will do the job, and means it related to workers type it may be either from technical background, non technical either you can divide in a skilled or skilled and non-skilled labour, how the job will be done, and it means related to your process.

Suppose that you are going to make a nut, fabrication of nut and bolt, then which machine should be used that is the question ok, then other question is where the job will be done, that is related to place, and this is very important in a work system, because if you want to produce something that is not acceptable in that region for example, so if you want to open a chemical plant. So, you cannot open this plant near to Agra, because environmental and

pollution board you will you will not allow you to establish a company related to chemical, that may harm to the Taj Mahal.

This is the one aspect another aspect a lot of aspects technical aspect is also there, to in a selection of process, and place and last step is ergonomics. This is related to the comfort level of human being ok, and I will discuss everything in detail in next slides, job design success.

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**Job Design Success** (proper design of job)

**Successful Job Design must be:**

- Carried out by experienced personnel with the necessary training and background
- Consistent with the goals of the organization
- In written form
- Understood and agreed to by both management and employees

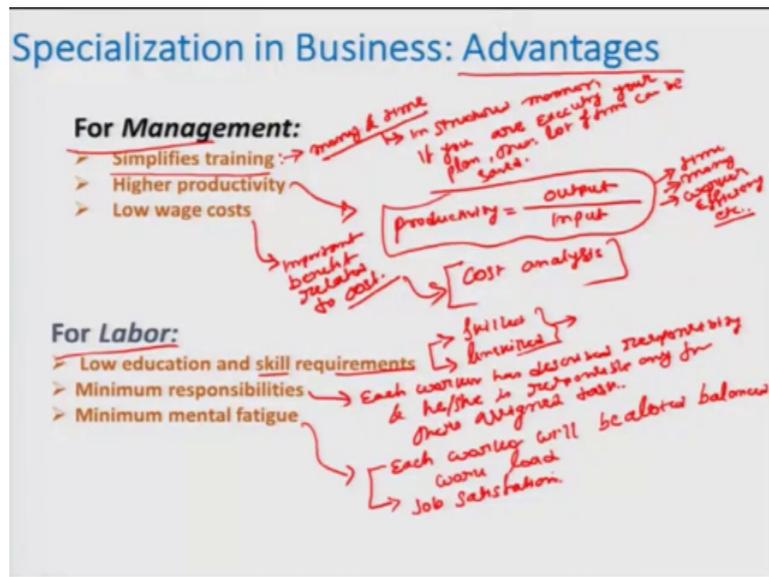
Top priority

Experienced personnel matters in Job Design

If you are designing a job properly, that resulted in it for that you must be carried out by experienced personal with the necessary training and background, consistent with the goals of the organization, because experienced person is very important, because in last slide you seen that there are a lot of factors are involved in a job design. So, experienced person matters.

And second thing consistent with goal of the organization means, whatever you are designing for a work system, always keep in a mind that what is the goal of your organization, without goal of your organization if you are deviating from that, and you are designing a proper work system. So, it will not work in actual condition, because goal is in top priority it must keep in top priority.

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Now, specialization in business advantages what is the advantage of job design, for management, and for labour, is as a for management simplifies training, and higher productivity low wage cost. Simplifies training it means it saves money, and time, because in a structured manner, if you are executing your plan, then lot of time can be saved.

Higher productivity proper job design results in higher productivity, what is the productivity, productivity is the what is the output of your organization in a certain input ok, and productivity may be in form of time, money, worker efficiency, etcetera. So, proper job design resulted in higher productivity and low wage cost, this is the also important benefit related to cost.

Because in a work system you all of you will also perform cost analysis, and for labour, for labour low education, and skill requirement means, if you have planned proper job design for your organization, then you know how many worker is required for skilled one, and unskilled one.

So, you can estimate the number of skilled, and non professional labour is required for organization minimum responsibility. So, each worker has described responsibility, and he or she is responsible only for their task assigned task, third one is minimum mental fatigue. If you have designed a proper job design in a work system, then what will be happen each worker will be allotted balanced workload and job satisfaction. So, they are the benefits in a business of job design.

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**Disadvantages** Approaches to Job Design

Table 7.1

<u>For Management:</u>	<u>For Labor:</u>
<p>1. <u>Difficult to motivate quality</u> [you can't improve your quality of product in a short notice]</p> <p>2. <u>Worker dissatisfaction, possibly resulting in absenteeism, high turnover, disruptive tactics, poor attention to quality</u> [The company may be lost in near future]</p>	<p>1. <u>Monotonous work</u></p> <p>2. <u>Limited opportunities for advancement</u></p> <p>3. <u>Little control over work</u></p> <p>4. <u>Little opportunity for self-fulfillment</u></p>

William J Stevenson, "Operations Management" McGraw Hill

Now, job design has a certain disadvantage also here, for management you can see difficult to motivate quality sometimes you cannot improve your quality of product in a short notice, because you have already planned, and you have already proper plan for your work system. So, you will have to change everything, if you want to motivate the quality of your product, worker's dissatisfaction possibly resulting in absenteeism, high turnover, disruptive tactics, and poor attention to quality, it means in a competitive world what happens.

Quality sometimes quality is sacrificed to compete with another industry at higher pace. So, this may result in a poor that in a technical term you that may result in a poor work system design, and the company may be at loss in near future, for labour monotonous work limited opportunity for advancement and little control over work, little opportunity for self fulfilment, with the others some limitations of job design.

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**Behavioral Approaches to Job Design**

- **Job Enlargement**
  - Giving a worker a larger portion of the total task by horizontal loading →
- **Job Rotation**
  - Workers periodically exchange jobs
- **Job Enrichment**
  - Increasing responsibility for planning and coordination tasks, by vertical loading

*Handwritten notes:*

- Level of difficulty (vertical axis)
- motivation of worker (vertical axis)
- [e.g. In any educational institution, or industries, the assignment of guard is rotated periodically & rotated periodically]
- She/He may feel motivated for doing new work
- Diagram showing levels L1, L2, L3 and productivity X, Y.

Now, at the behaviour approaches to job design, what are the approaches first one is job enlargement, second one is job rotation, and third one is job enrichment, job enlargement here, giving a worker a larger portion of the total task by horizontal loading horizontal loading means, suppose that that is the level of difficulty level one, level two, and if you are assigning more work suppose that a labour is working, and he is capable of producing something suppose that X amount of product.

And if you are assigning him Y now Y amount of product, So, at same level, and Y is greater than X, then it means he is getting more workload, and difficulty level is same, there is no change in difficulty level that is called horizontal loading, and it you can say job enlargement.

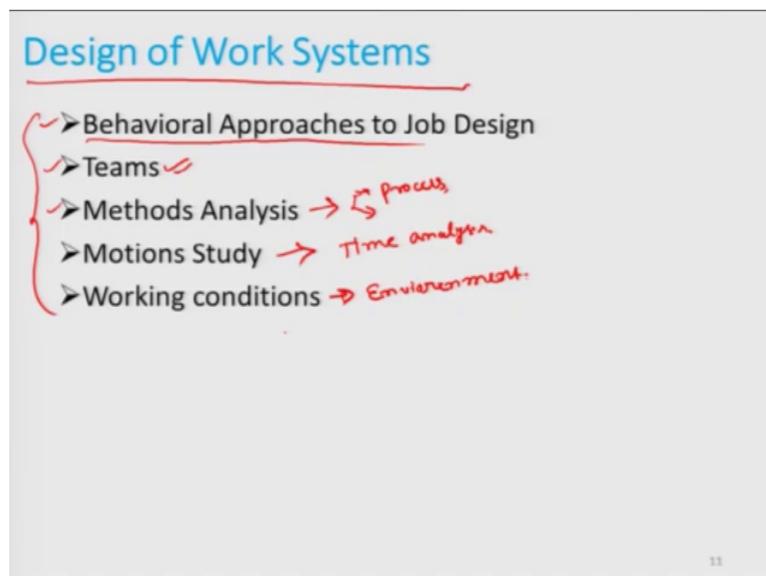
Now, second one is job rotation workers periodically exchange jobs, and example you in any educational institution, or industries, the assignment of guard is rotated periodically, one day he will be assigned in a main gate, he will another day, it may be possible that in another day he will assign in the hostel. So, this is the job rotation and it helps a to motivation better motivation of worker.

Third one is job enrichment here as name suggests increasing responsibility for planning, and coordination task by vertical loading it means, same I am taking same example here, that is the level of difficulty, and here is L1, L2, L3 here. Suppose that a worker is working at this level of difficulty, and he is producing x amount of work.

So, now, if you are assigning him some different work which has a difficulty level of L2 and L2 is greater than L1, and amount may be same will be same or lesser than X, then that is called vertical loading of a worker here, what you are doing you are you are making him a more responsible to the organization. So, he may feel motivated, and she or he may feel motivated for doing new work.

So, here you can see that you are not changing, you are not replacing the worker, your worker is same, but you are only tweaking here you what you are doing you are assigning him more work. So, here you are rotating there his job periodically and here, you are making him more responsible. So, that is the approach for a successful job design.

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Now, design of work system, these are the tool of the earning of work system that I have already explained behavioural approaches to job design, second thing team is required for a designing of a work system, and some technical tool that is called method analysis, I will explain in later motional study, working condition.

This method analysis so, this is more related to process, and this is related to time analysis, and here it is this is more related to environment. So, for designing of work system these things are required team, team member, some technical analysis that is methods analysis motions study working condition.

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Method analysis for job design *method analysis*

**STEP 1 : JOB/TASK/PROCESS SELECTION**

It involves following considerations:

- Economic Considerations
- Technological Considerations
- Human Considerations

➤ **Economic Considerations**

- Cost effectiveness i.e. to check whether or not the Work study application would pay. For this, key-profit giving/ costliest operations with largest waste/scrap should be attacked first. *Cost analysis of each process at every step*
- Next bottleneck operations, repetitive operations, repeated material handling operations should be studied.
- For locating most important operations, PARETO ANALYSIS could be used. *↳ tool for analysis*

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Now, first I will explain method analysis for the job design. So, here are certain several steps you which I have to follow to for analysis of a method analysis steps. First step is job and task or process selection, it involves following considerations economic consideration, technological considerations, human considerations, first I will explain economic consideration.

Economic consideration here cost effectiveness to check whether or not the work study application would pay, first you will have to check what you are planning, and it should not be go in a task, it should be implemented in an industry. So, first you will have to check whether whatever you are going to design for a for a work system. So, that should be cost effective, for this key profit giving cost costliest operation with largest waste scrap should be attacked first here, you will have to do cost analysis of each process at every step.

Then only you can make a system more cost effective, next after analysis next bottleneck operations, repetitive operation, repeated material handling, operations should be studied, and if required if necessary, then it should be repetitive operation it should be minimized or removed. For locating most important operation Pareto analysis could be used, this is the again this is a technical tool for analysis, and I will explain later.

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**Technological Considerations**

- The analysis involves application of Work study for the selection of the operations/processes where new technology e.g. automation should be introduced.

**Human Considerations**

- Analysis involves location of those operations which present the sources of dissatisfaction and/or annoyance to the workers due to fatigue or monotony or unsafe environment or a work which is clumsy in nature.

Handwritten notes in red ink:

- Automation is required
- minimization of worker
- Accuracy, production rate etc.
- Job Enlargement
- Job enrichment
- Job rotation
- reducing absenteeism of worker
- improved self-motivation
- Job satisfaction

Second one is technological consideration after realizing that your work system design is going to be very cost effective then you will have to check you have to go in a technical aspect you will have to check.

The analysis involves application of work study for the selection of the operation process, where new technology for example, automation should be introduced here, continuously progress to improve productivity of a system automation is required, and automation actually it means main drawback of automation is minimization of worker.

And this is and this is also a benefit to adopt a automation, and what another benefit of automation is it will improve accuracy production rate etcetera, then you will have to take consider consideration human being that analysis involves location of those operations which present the sources of dissatisfaction, and annoyance to the worker due to fatigue or monotony or unsafe environment or a work which is clumsy in nature, that is why we are studied in earlier slides that is the that called job enlargement job enrichment, and job rotation.

This is a one kind of method which may help in reducing absenteeism of worker, improved self-motivation, and job satisfaction. So, this is the first steps.

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**STEP II : RECORDING THE FACTS**

Related to the existing process/ job **ALL THE FACTS** should be recorded **ACCURATELY**.

**TOOLS OF FACT-RECORDING** are:

**(A) CHARTS**, which may be of **two** types:

- > **Based on SEQUENCE**
  - Outline Process Chart
  - Flow Process Chart
  - Two-Handed Chart ( or Operation Chart / Left Hand & Right Hand chart)
- > **Based on TIME scale:**
  - Multiple Activity Chart
  - **SIMO ( Simultaneous Motion) Chart**

**(B) DIAGRAMS:** which may be of the following types:

- Flow diagram
- String Diagram
- Travel Chart
- Cyclegraph, &
- Chronocyclegraph

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Now, second step of method analysis that is the recording the fact; so whatever you are in visualizing in your industry or analysing you're in an industry, you will have to make a documentation of that. So, for that you would have to record those things.

So, there are various tools are involved in a recording for first recording purpose, first is chart, is a basic tool which may help you in a quantification or separation of work, in a system. And charts are based on sequence that is a outline process chart, flow process chart, Two-handed chart, they are the variety of charts are available for in a method analysis in a work system, and second one is based on time scale. So, you can make you can take consideration of time a in a process. So, that that is first method is multiple activity chart second one is SIMO chart.

And another method is diagram. So, diagram is a very convenient, and fast way to record the fact, it may be of the following types flow diagram, string diagram, travel chart cycle graph, and Chronocyclegraph. So, these are the very important tools for in a method analysis ok, and I will explain each one of them in next slides.

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**Type I. Operation Process Chart:**

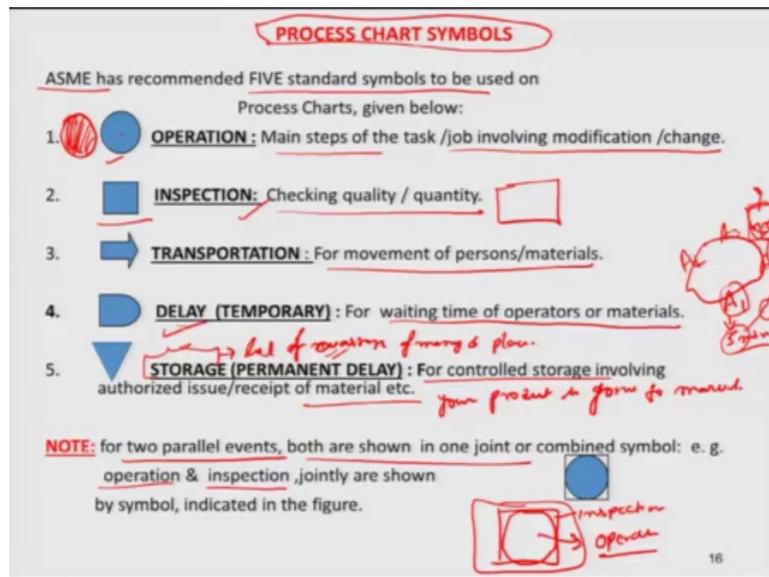
- This is a graphic representation of the sequence of all operations and inspections involved in the process. *By any worker (skilled/unskilled) can understand.*
- In this chart, all components or materials entry points are indicated by the horizontal lines and the processing of these materials are shown vertically.
- Operation process charts provide a compact overall view of the whole system of operations involved in the manufacture of a product.

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So, first one, first type of chart is operation process chart ok, what is the operation process chart this is a graphic presentation of the sequence of all operations, and inspections involved in the process. It means it is a graphical representation. So, it graphical representation mean any worker is skilled, or unskilled can understand. So, this is very popular method, in this chart all components or material entry points are indicated by the horizontal lines.

And the processing of these metals are shown vertically here, all operation and operation process chart provided a compact overall view of the whole system of operation involved in the manufacturing of a product. So, these are the benefits of the operation process chart here.

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To make a graphical representation of your system, you will have to use some symbols. So, these are the five basic symbols which is used in a process chart, and it is recommended by the ASME, and there are five standard symbol. First one is operation.

And this is represented as circular solid circular, if you see so, this one this is the main step of the task job involving modification change. So, if in a chart you are saying this one so, you may consider that there is an operation is going on. Second one is inspection that is the checking quality and quantity, and this symbol is used for there is a quality department ok.

They are where sample is going to an inspect. So, this symbol is used in a for inspection purpose, and there is arrow you can see that is for transportation or movement of person or material fourth one is delay if, if suppose that you an assembly work system, here is A1 Workstation A1, A2, A3, and A4.

So, suppose that it takes 5 minute to produce one part, and it takes 7 minute to process next step. So, here you can see that produced part from A1 workstation it will move through transported through some automated guided wheel, and it will reach at A2 point, but he has to wait till this save up to the for extra two minutes. So, that this part should be completed in a A2. So, that two minute is a you can see represent it as a delay temporally for waiting time of operation operator or material. And fifth one is storage.

After inspection everything this is a storage department from where your product is going to market ok. So, that is why it is sometimes it says permanent delay, and this delay results in lot of money wastage of money, and place.

And suppose that if there is a in any workstation where two operation is happening parallel, then you will have to make this kind of symbol for example, suppose that in a work station where operation inspection is happening parallel, then you will represent it as a square one, and in centre there is circle, for square that is the inspection, and for circle this is used for operation. So, this symbol is used for parallel operation next here.

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**Process Charts types:**

- **Outline process chart.**
  - It gives the overall view of the whole process by recording in sequence only the main operations and inspections.
  - It uses only operations and inspection symbols.
- **Two handed process chart.**
  - Provides a synchronised and graphical representation of the sequence of manual activities of the worker.
  - Records the activities of the left hand and the right hand of the worker as related to each other.
  - A time scale can also be provided on the chart. (Time study)
  - used for repetitive works of short duration.
- **Flow process chart.**
  - Records all the events in sequence using process chart symbols and marks distance and time taken for completing an activity.
  - ↳ distance & time measurement.

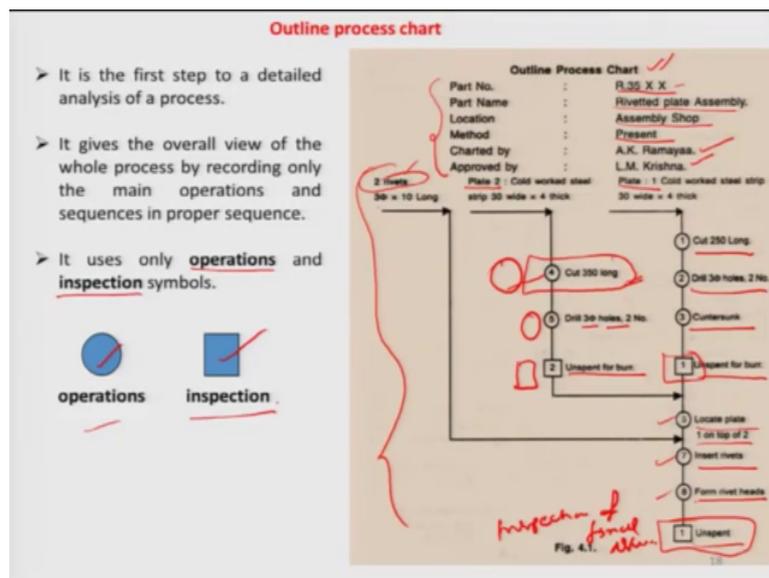
There are variety of process chart first type is outline process charts, it gives the overall view of the whole process by recording in sequence only the main operation and inspection ok. In this chart only operation, and inspection is measured means operation you will represent it as a circle, and for inspection you will represent it as a square.

So, it uses only operation and inspection symbol here, in Two handed process chart, it provides a synchronized and graphical representation of the sequence of manual activity of the worker, Two handed as name suggest here whatever you are doing. Suppose that you are assembling it nut and bolt. So, you will have to your both hand will be involved in assembly of nut, and bolt.

So, so whatever you are doing from your left hand, it should be recorded and whatever you are doing with your right hand it should be recorded parallel. So, that is why it is called Two handed process chart, records the activity of the left hand and the right hand of the worker as related to each other, and a time scale can also be provided on the chart.

So, benefit of this chart is that, you are parallel you are making counting working time of both hand, and that is the time study you are also doing here, and this is used for repetitive work for short duration. And third one is flow process chart here records all the events in a sequence using process chart symbol, and marks distance, and time taken for completing an activity. So, this is more beneficial from both chart as compared to have A Two chart, because it gives you distance, and time measurement ok. So, I will explain each chart with some examples.

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So, first I will explain outline process chart. What is the outline process chart? It is the first step to a detailed analysis of the process, and it gives the overall view of the whole process by recording only the main operations, and sequence in a proper sequence. It uses only operations and inspection symbol, as I told you in earlier slide operation and inspection symbol.

So, this symbol is for operation and this is for inspection here, I am explaining using one example here, this is an outline process chart it is made in some industry ok. So, here you can see here each word has some significance part number. So, this is the part reorganization

purpose, which in which for which part you are doing this chart is for part name part name is riveted plate assembly location, where it has been done assembly shop method, which method is used charted by who is the working personnel, who had made this one, who has approved it.

So, we will focus in this part only. So, here you can see there are Two rivet of this size, and they are plate 1 and plate 2. So, here you can see, what you will do you will have to rivet it both plate so, that there will be rivet joint between Two plate, both plate will be joined by rivet using rivets. So, what first what you will do for plate 2, first you will have to cut with a specified length, it means cutting means it is operation. So, that is why there is a circle.

Again you will have to make a drill of certain diameter. So, that rivet joint can be injected. So, again it is the operation. So, it is again it is invented as circle by a circle, then unspent for bar. So, whatever you after drilling the plate, you will have to inspect whether there is a notch or bar is there or not. So, that is for inspection purpose so, it is square again here, plate one again you have to perform some operation you will have to make a cut of certain size of that plate will again drill.

Then countersunk for you have to take inspection purpose, unspent for bar, then locate plate after doing both you are making closure you are making closure to both plate, and then locate plates one on top of plate Two, then injured rivets and from formed rivet heads, and unspent it means again here all steps you can see that either they have used operation or inspection operation inspection, operation, operation and here is inspection final assembly inspection of final assembly.

So, this kind of chart is known as outline process chart here, you can see the only operation and inspection is used.

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**Two handed process chart**

- Operation/Job : To assemble two washers and nut to bolt
- Part No. : .....
- Operator : .....
- Chart starts : Hand empty material in boxes.
- Chart ends : Completed assembly.
- Method : Present.
- Charted by : xxxxx.
- Approved by: \_\_\_\_\_

*so you cant have to use both your hands & process a machine.*

<u>Left Hand Description</u>	<u>Symbol (L.H.)</u>	<u>Symbol (R.H.)</u>	<u>Right Hand Description</u>
1. <u>Move to bolt</u>	⇒	⇒	<u>Move to first washer.</u>
2. <u>Grasp the bolt</u>	○	○	<u>Pickup/grasp the washer.</u>
3. <u>Move to position</u>	⇒	⇒	<u>To position</u>
4. <u>Hold</u>	▽	○	<u>Assembled to bolt.</u>
5.		⇒	<u>Move to second washer.</u>
6.		○	<u>Pickup/grasp the washer.</u>
7.		⇒	<u>To position</u>
8.		○	<u>Assembled to bolt.</u>
9.		⇒	<u>Move to nut.</u>
10.		○	<u>Pick up the nut.</u>
11. <u>Move to box</u>	⇒	⇒	<u>To position.</u>
12. <u>Aside to box</u>	○	○	<u>Assembled to bolt</u>

Now, second one is Two handed process chart, here again I am going to make a take example and explaining what how Two handed process chart is going to make, here I am taking an example to assemble Two washer and nut to bolt. Can you wherever you will get this kind of chart, then there should be some coding should be there that for part number for recognizing purpose, operator, what made it again chart starts, chart ends completed assembly method, and charted by an approved by, in some chart date is also there ok.

Here you can see you have to assemble Two washer and nut to a bolt. So, you will have to use both hand to do this assembly. So, in a left hand what you are doing move to bolt ok, first you are moving your hand to bolt and that is for transportation symbol, again here parallely what you are doing right hand with a right hand move to first washer.

Again since you are moving, your hand to the first washer again it is a transportation, then with a in a left hand grasp the bolt after reaching the bolt location you just you will grasp the bolt, and that is the operation, because you are grasping the bolt. Again here in a parallely you are what you are doing here with a right hand pickup grasp the washer, then you are pick picking up washer so, it is an operation, then in a left hand move to position, again make an alignment. So, that assembly should be done. So, again it is a transportation, again you are you are doing in same thing with the right hand, then you are holding your bolt that is for storage permanent storage.

And here assembled to bolt then, after that you will have to make a stationary, and you will have to hold till the rest of the operation is done by your right hand move to second washer pickup grasp the washer, then to position then assembled to bolt after that move to nut here, transportation pick up the nut again operation and after that move to box. So, move and to position.

So, again now you are after assembly you are moving your left hand. So, that it will be kept in a box again due to the position aside to box you are moving aside box, then assembled to bolt ok. This is the so, here you can see that you will have to use both hands, and process is recorded. So, that is why involvement of Two hands make it name Two handed process chart.

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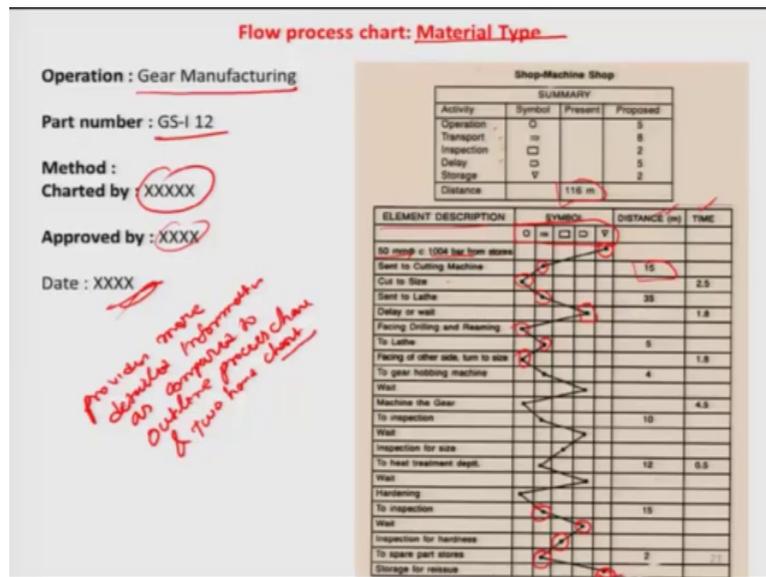
**FLOW PROCESS CHART**

- It uses ALL THE FIVE SYMBOLS and provides the total sum details of the process/job under study.
- A Flow Process chart may be of the following types:
  - MAN-TYPE in which every symbol is related to his/her activity only.
  - MATERIAL TYPE in which every symbol is related to the material of the job or a document (e.g. in offices) or a machine/equipment.  
*↳ machine type*

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Now, third one flow process chart, now I will explain you what is the flow process chart. It uses all the five symbol like the outline process chart, it uses all the five symbol, and provides the total sum detail of the process and job under study here, if flow process chart may be of the following types that is called man type, metal type, and another type is called machine type. Machine type and there is another type that is the hybrid type you can say man, and machine type man and material type. So, I will explain some of them here material type.

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For operation is gear manufacturing part number is something like that, method charted by someone approved by someone, and dated someone on some date.

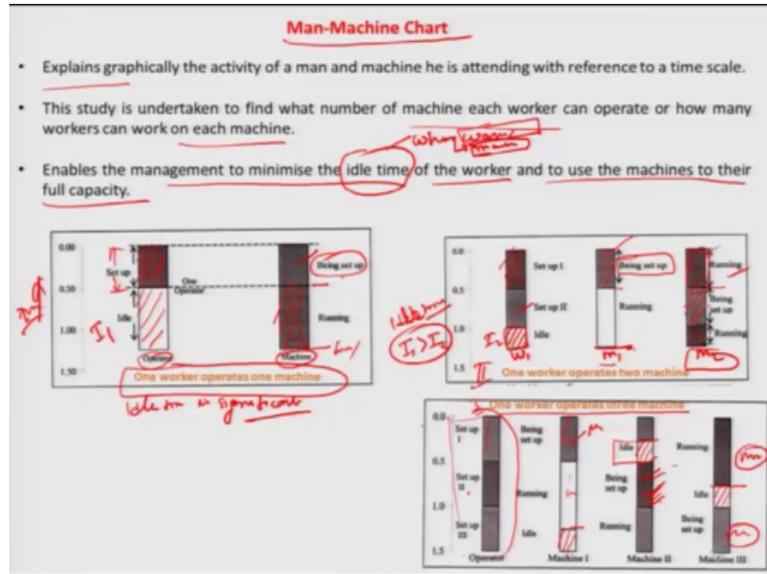
Here you can see in this example shop machine shop here, these are the operation, transport, inspection delay storage, and distance is counted as 16 meter, and each has assigned some coding 5, 8, 2, 5, 2 here, since in a material type chart here you can see element description for gear manufacturing. So, first you have to take a bar of diameters of 50 mm, so from a store so this is placed somewhere. So, if this is a storage sent to cutting machine. So, you will have to transport it. So, there is a symbol and here it will reach. So, you will have to count distance. So, parallel it is counted at fifteen meter, again cut to size it means operation this is related to operation, send to lathe again transportation then from delay or wait.

So, there is some delay suppose that there is some delay. So, there will be this one again facing drilling and dreaming ok, they again it will there will be some operation to lathe again transportation again, facing on other side turn to size again, it is a operation. So, this is going on and after finally, what happens after make heat treatment, weight, hardening inspection, then we will have to inspection for each one every property. So, that gear can be selling out to spare party stores that is for transportation and storage for reuse, so either for reuse or for selling.

So, this is the metal type flow process chart here, you can see here you have taken all the symbols to make a chart for gear manufacturing here, distance and time is parallel if counted

ok. So, this is providing more detailed information as compared to outlined process chart, and Two handed chart.

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Now, next is man machine chart, this is the hybrid chart, this explains graphically the activity of a man, and machine he is attending with reference to a time scale. This study he undertaken, it means in this chart man and machine involvement of man, and machine is recorded in this type one study undertaken to find what number of machine each worker can operate, or how many workers can work on each machine.

That enables the management to minimize the idle time of the worker, and to use the machines to their full capacity idle time. This is the time when idle time may be related to worker or machine both, sometimes machine is waiting for next operation, and sometimes worker is waiting till the operation in a machine.

First I will explain, I am taking three example for man machine chart, here condition one is that one worker operates one machine. So, in this example you can see that, this is the time in the Y axis this is a time. So, what he is doing first this is the setup time, this is the operator and this is the machine. So, what he is doing he is setting up machine. So, that machining can restart, and this is the time required ok, and this time machine is being set up and he is because only one machine, and one worker is there so, he is doing this work. So, he is involved somewhere in this machine.

So, that is for your this time is set up time or working time for work operator, but you for worker, and after that when machine will start processing, and he has to wait till that part is fabricated machined or fabricated. So, suppose that that machine is taking this much amount of time. So, till this time this operator will have to wait. So, this is the idle time of the operator. So, here in this case you can see that if you are have assigned one operator to one machine. So, he has to wait most of the time, until that work is finished in that machine.

So, here you can see idle time is significant ok, in the second case you can see one worker operates two machine here are two machine is available m1 and m2, and worker only one workers there. So, what first what we will doing here, you can see in a machine 2 is already running from the previous analysis.

So, in meantime in that time worker what this worker is doing he is preparing the that machine setting up that machine. So, that machining can be start in a m1, in meanwhile in that time m2 is already running ok. So, that is the here you can see all m1 is m2 is already running m1 is being setting up, and worker is involved in m1.

After that here m1 will start working so, and here after that here, what he will do now worker at that time that m2 will finish his machining process. So, he left to again removed that part, and again being setting up for the next operation. So, again worker is busy in m2 now.

So, after that it will start working. So, that is the running and here for m 1 it will finish at this time, and here again it starts working. So, this is the main idle time here all both machines are busy, and worker is in rest position ok. So, that is the idle time. So, you can see here idle time from case 1 and case 2. So, if I can say idle time I1 here I2. So, I1 is greater than I2 idle time.

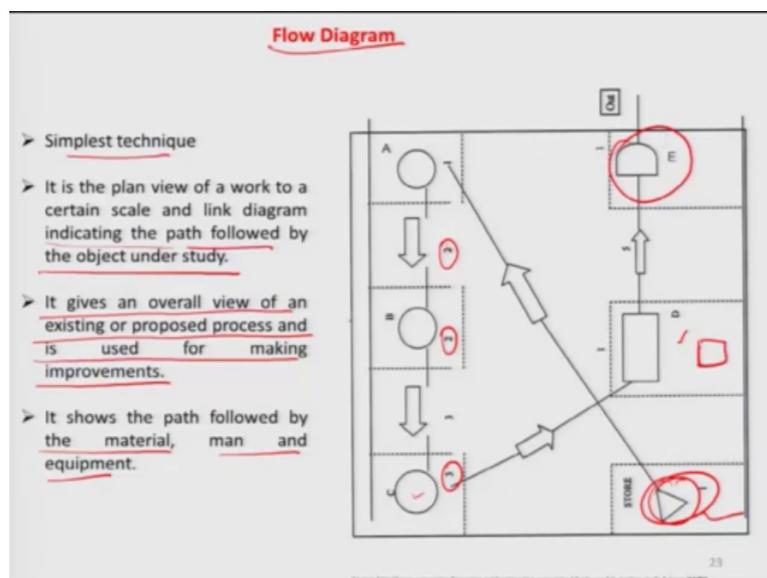
Now, I am taking third one, one worker operates three machine here, you can see m3 already working and m1, m2 is already working, and m1 is being set up by worker one , here worker is involved in a machine one, after that what will happen it will start working running to processing something. So, in that time that machine will get stopped, and here machine is waiting for being set up for another operation. So, here is this idle time is for machine, and here worker because worker is not free in this time because he is involved in setting up m1 ok.

After that what will happen that worker will again go to the machine m2, and he will start some pre processing. So, that machining will start, and at that time in some between in that

time what will happen m3 operation of m3 will complete. and again it will start it he will wait for another operation.

But because here worker is busy in m2, and after that again this will finish their work, and he will go to the m3 for being set up for another operation, and you can see there for each machine there will be some idle time, but worker will always busy. So, this kind of arrangement is made in an industry. So, that idle time can reduce or finally, productivity is improved.

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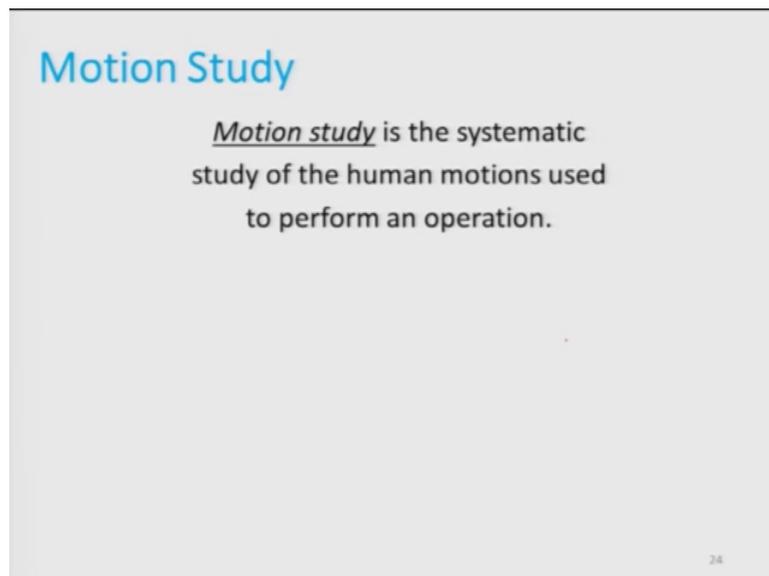


Now, flow diagram this is another way to represent your operation here, this is the very simplest technique, and it is the plan view of a work to a certain scale, and link diagram indicating the path followed by the objective under study here, path is made by flow diagram. It gives an overall view of an existing process, and is used for making improvement ok, it shows the path followed by the material man and equipment.

Here for example, here you can see that first one material is taken from store, that is for already in storage point, you can see the symbol, then it is transported to that workshop A here, there will be some operation after that again it will transport to workshop through the two route, and it will reach that workstation two here, they will be again some operation on that machine that product.

Again it will transport it to workstation three, where again some operation will be there, then it will have a some temporarily delay, and after that here you can say that after some inspection will be also there, and after that it will transport it to the storage six, and again and from that this product will go out to the market. So, this is the simplest way to how it will movement it records movement of your material.

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Now after that was the all the things for the method of study, till now we have studied what are the how we will do a machine shop method analysis, and we will how we will perform job design so that for a work as a system.

So, in this module now I am closing this module, and in the next module, I will cover the next topic that is called motion study, it means either you can say time measurement for a work system design.

Thank you very much.