Applied Ergonomics
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Module – 01
Lecture – 01
Work Systems

Hello and welcome to this course on applied ergonomics, I am Professor Shantanu Bhattacharya and I will be constructing this course along with professor Ankur Gupta of IIT Bhubaneswar who is already given few lecture sessions ahead of these lecturers. So, today my lecture is going to be based on a study of work systems how in a very highly classified an organized manner we can call something work system and then some issues which are related to the way that various components associated with those systems like human factors, machines or let us say even information or information flow affects the performance of such systems.

So, let us get started.

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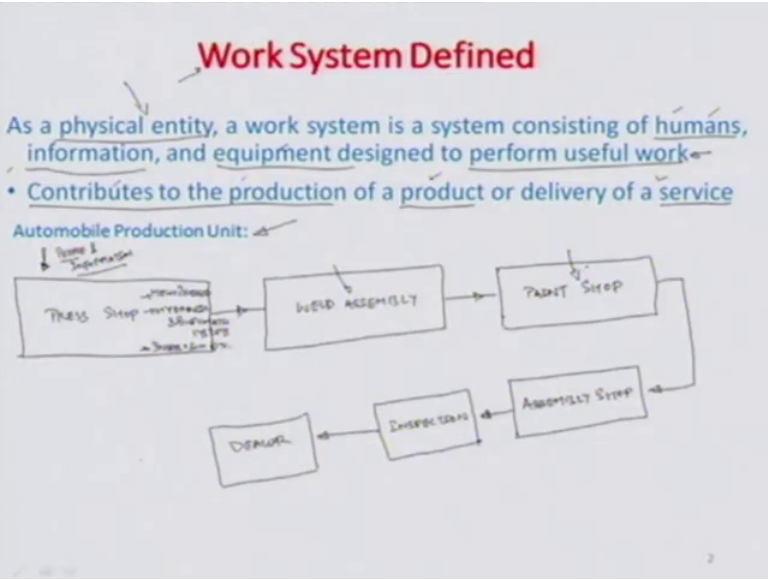

So, the first thing I would like to define here is really about your work system, a work system is a physical entity and it is a system which comprises of principally imprinciple

humans, information and equipments and the basic purpose of such a physical entity which has all these 3 components that is humans information and equipment is to be able to perform some useful tasks or work which in general improve the productivity, which is general improves the profitability and brings as such a lot of changes in towards the good directions associated with the social framework you know of human civilization.

So, that is how work systems is defined and basically a work system contributes to the production of product or service and all these terms like product or services considered the addiction of value. Value at that otherwise may not be available in the row state of some of the materials we should participate to make a product or some of the soft skills that would participate to make a service, but through this organized study of work system we should be able to pin point to a certain correlation between the various stakeholders including humans information and equipment in a manner so that you can produce this product or the service at a certain controllable manner or in a certain efficient manner. So, that it can be useful to the society in general.

So, let us consider for example, an automobile production unit which is actually a work system it is probably one of the most backwardly integrated work system. So, if I looked at the various levels across which an automotive gets produced. So, typically such a unit would comprise if I break it down into the different aspects of the automotive, it starts from shop which gets the sheet metal and tries to press form the sheet metal into various shapes we call otherwise the shop as the press shop.

Obviously, if I look at the next stage of this from the press shop there is a material flow of whatever has been pressed or whatever has been formed into different shapes, to go to the next level which is the weld assembly which is actually the point where the secondary manufacturing of joining together the different parts or components which have come from a subsystem level from the press shop is made together.

From a weld assembly further the automotive goes into a paint shop which basically looks at the exterior as well as the interior of such assembled weld components which now are taking slowly the shape of a vehicle and finally, the automotive again flows into something called an assembly shop where again there are components or functional units which are integrated or assembled to the overall vehicle including the chessy of the

vehicle or interiors of the vehicle or let say associated with all the different opening closing members related to the vehicle so on so forth.

And such operation is known as assembly shop and finally, it goes through an inspection process and goes again from this inspection to a dealer or a vendor would be eventually responsible for developing an interface with the customer which will take information or which will basically take or buy whatever is being produced from this automotive unit.

So, this complete automobile production unit with this various categories I have shown you here is typically a work system. So, you can actually make a focus study and consider each of them as independent work subsystems, but if I wanted to look at in totality how automobile production unit would function, there are different operations associate at different stages of the basic sheet metal which comes into operation and get shaped into or you call the automotive and various functional nonfunctional members associated with it and this the whole process as such between the press shop, the weld shop the assembly the paint shop you know the vehicle assembly inspection and dealers followed.

Now, if I looked at the involvement of these 3 important components namely human, equipment and information they are all available at plenty in some of these different shops for example, there is a relationship between how the material flows in into the paint shop from, you know a sheet metal manufacturer which would involve again people who are associated probably not directly, but indirectly to maintain our augment the production system. So, some people and some information let us call it people and information associated with the production, associated with the production of the press components. So, the press sheets of a press shop.

There are many equipments here including mechanical presses, hydraulic and numeric systems, inspection equipment etcetera which is being operated in unison in order to do different operations to the sheet. In fact, (Refer Time: 07:28) of such mechanical presses put in line and known as a transfer line and they are more properly known as transfer presses where there are different dies we should do the press forming operation on the sheet metal as it comes and between the different stations you have even auto carry carrying mechanism between one station to the other.

So, that you can make the transfer line completely independent of human intervention, but there are going to be people associated at every level including, let us say a people who are associated within inspection of the dies, people who are associated with monitoring of you know how much lifetime would typically be there on a single die. People, who would load, unload people who are associated with adjusting the gaps between the various components of a transfer line so on so forth.

So, although a part of it is mechanized, but there are people who are associated with such processes and of course, everything which involves people and mechanize system has information flow, because the people who are running the transfer line as such would need to provide information from time to time about the different parametrics, about the different variants which are being made on a press shop and there is again the involvement of people information. So, you have information, you have humans and you have equipments which are working in unison together to perform an useful work which is giving the press sheets or the panels we should be assembled together in a well line.

Similarly, if I wanted to look at weld assembly there would be involvement again of people of information flow and also substantially unique amount of, unique type of equipments and many number of equipments and different stations which would led to you know accomplish the welding. Mostly the welding carried out in car assemblies or spot welds and there are going to be areas related to the front and the body of the car, the side panels of the car, the areas related to let say the roof of the car or even the back door of the car or the rear under body of the car. So, all these things need to be coat, un coat assemble together in terms of spot welds. So, that the overall structure or framework comes up and so there is going to be involvement again from people, information and equipments at this particular stage.

A similar thing goes into the paint shop, where again there are associated tasks with respect to the electrodeposition coat, coatings related to spray coatings which are going to happen on the interior and exterior of such cars, where again people and again as for as possible mechanization and information flow is used for accomplishing something called the painted body structure. The most amount of involvement of people and workflow in such automotive production units would typically happen at the assembly stage where there are going to be many operations which simply cannot be automated and there has to be involvement of people and.

So, whenever there is an involvement of people automatically there has to be the involvement of information given to those people or information collected from those people and informations which passes as such from the previous station to the success of station or vice versa. So, that there is a smooth operation and flow in the system which happens and so therefore; obviously, this whole system can be considered to be a very complex work system.

Now, there are many things associated with such systems and one of the main aspects whenever there is involvement from people or involvement of processes or involvement of let say information flow happens and that with respect to automated highly automated equipments happen. They are going to be the need for a very organized study of all these individual participants and the whole idea behind such organized studies to ensure that the system works uninterruptedly and also add its lowest cost as well as its most optimized output and.

So, therefore, there has to be a quantitation of all these aspects and an organization of the knowledge based on all these aspects for defining the work system in a proper manner and this topic as such what I would be sort of going through today is in a way to summarize some of those tools which are needed to understand the work system in terms of its organization, in terms of its you know let say operating at some optimal best conditions and in terms of how to maintain those optimally best conditions with time.

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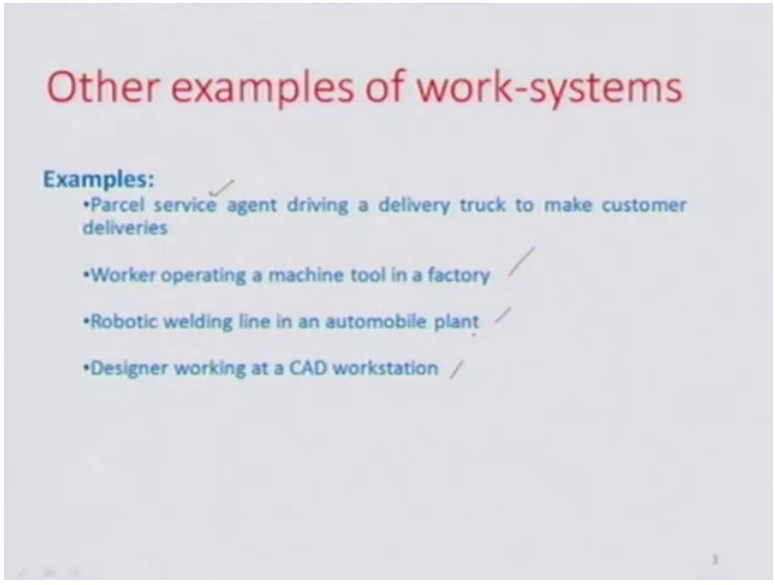

So, let us look into a little more detail of some other work systems, work systems can be associated with services for example, if I looked at a parcel boy who is going to deliver you know customers some parcels or some packages he provides a service, but again that is also involvement of people who would secondary people who would carry the parcel, the primary person who is responsible for delivering of the parcel.

The person who is going to dock all those parcels one who is going to route all of them, there is going to be also carriers involved between the place where the parcel is being sent to the place where it is being sent those carriers are also in a way people who are identified to make the system work or happen and there is also going to be information flow from the point the parcel is being dispatched to the parcel delivery point. So, that all these again come as a function in the work system. So, whether it is a service or product or in fact, anything associated with value addition to the society we can consider a model of system which is delivering that to be a work system.

Some other examples could be for example, worker operating a machine tool in a factory or a robotic welding line in an automobile plant or even a designer working at a cad workstation which can consider to be in the purview of work systems.

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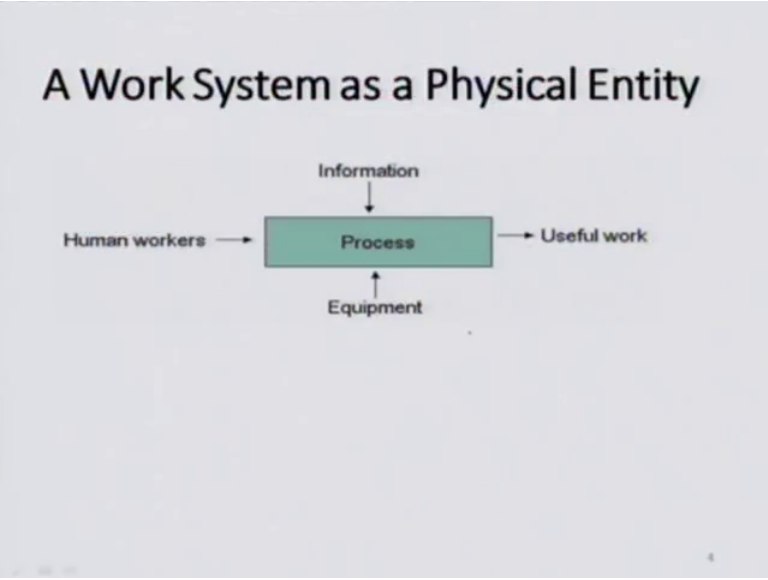

So, having said that; obviously, in the last 2 slides what I did mention is captured here on this one small you know schematic which talks about that any work system would have a process and this process typically would add value to some of the inputs which could be

related to, let us say a raw materials or even information or services and this would actually involve people. Involve information and involve equipments to produce something which is useful for the society which could be in terms of service or a product or any other work that is being delivered by such a system and. So, therefore, this is in a way summarizing what I said in the last 2 slides about what could really be work system as a physical entity.

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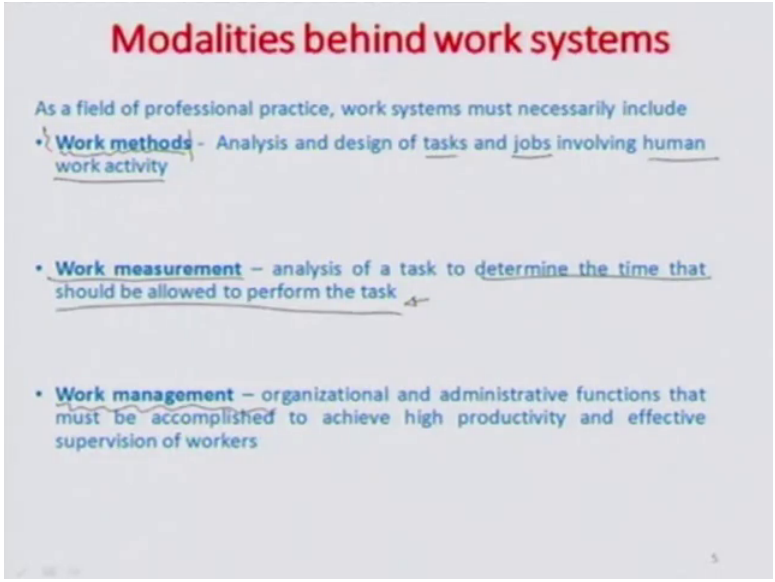

Now, when we talk about some modality is associated behind such work systems there are; obviously, the involvement of methods. So, can we really identify what are the tasks or what are the jobs which are involved in the let say associated humans which are involved in the work system. So, analysis and design of the same which falls under the purview of work methods for example, let us say for example, there is an assembly line, an automotive assembly line and there is a person who is responsible for mounting the 2 wheels on one side of the car to the disc brake on the front side and the drum brake on the rear side.

So, his task and job may be related to a lot more than what you see as just assembly of the tire or the wheel to the automotive, it may be related to even maybe doing some subassembly related to the wheel which is offline carrying the wheel all the way to the automotive on the line. Putting the wheel in place on bolts which are coming out of let say the disc or the drum and then trying to individually titan some of the screws some of

some of the nuts, I am sorry hexagonal nuts to all those bolts and then either tighten it through in automatic machine which would turn all these bolts together or nuts together or individually use guns or pneumatic guns to sort of tighten all the 4 nuts and then after that also torque them at a certain value to establish that they are safely tightened and torque.

So, this whole process that a person is following is basically broken down into small tasks and subtasks and the idea is that if we can sort of you know compartmentalize into smaller tasks the control of such tasks and elimination of the waste associated with such tasks would be much easier to happen. So, therefore, the first thing which comes is can we define the work methods. So, this becomes a part of the process that we are talking about we also talk about work measurement which is basically again the analysis of a task to determine the time that should be allowed to perform the task so; obviously, if there is a task and if there is a distribution of task to some task to formulate a major operation or major let say working method each such task would actually be at the behest of some time spent.

Now, this may vary between worker to worker, it may vary between process to process, but then there has to be a time scale assign to such tasks. So, that when we talk about quantitation of are the tasks being done in a proper manner, are the jobs being accomplished in its optimal best condition there is always a quantitation or a value available in terms of time that those tasks would take. So, therefore, if supposing now people start working on changing the task pattern or changing some of the modalities associated with the tasks, it will immediately start affecting the time which would immediately start affecting the productivity the overall productivity behaviour of the work system.

So, that is again one important aspect associated with the work systems which is work measurement. So, you have all the work methods laying out all the tasks and jobs work measurement which is about assigning times to such individual tasks or jobs. So, that the overall time frame can be established behind a certain work to be carried out and then of course, there is level at which some basic administrative decision making, some management some organizational aspects come into picture which would actually lead to the continual maintenance of the task plan and the implementation of the task plan in a proper manner over let say several years. So, people in such practices who are at the

work management level would typically look at whether what we are doing is useful or its adding value or what we are doing is probably not useful, not adding value and then eliminate the waste from the useful and try to improve productivity.

Try to improve let say the effectivity in supervising and training of some of the human factors which are associated with direct production of this systems and. So, these 3 things are very important the total number of tasks, the total measurement of such tasks and the total administrative control on the measurement and trying to define what should be and what should not be, for operating any work system and these are some of the important modalities behind such work systems.

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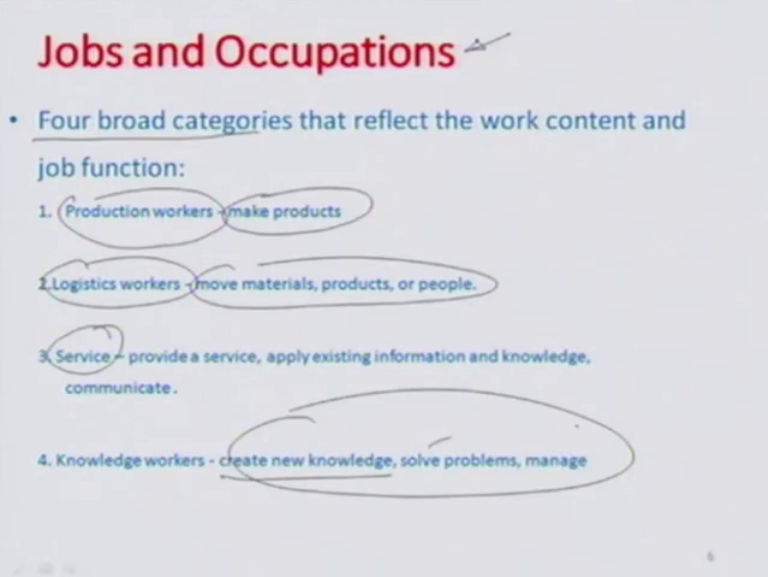

So; obviously, if we looked at all the jobs and occupations so there are many kind of people who are involved particularly in the human aspect of the work system and we can typically categorize such people into 4 broad domains or 4 categories. One are the people who are associated directly with the product a person who is making the product, who is basically a production worker.

A person who is associated with ensuring that the product happens in the way it happens by moving in a timely manner, supplying material in a timely manner, supplying the necessary people in a timely manner and. So, therefore, there are certain logistic workers this could be supervisors or materials professionals or people related to maintenance who would ensure that there is a smooth flow between the different work centers of the tasks

which are being intended to add value on the product chain and then there are people who are associated with providing some kind of a service.

For example let say some people are associated with providing domain knowledge or information about the product, 2 people who are new into the system and who are untrained some people are associated with providing you know service related to ensuring the basic comfort and safety of the people who are directly associated with the product production workers or even the logistic workers. So, these people are also very important components as for as the human aspect of a work system go and they can be called as service providers and then there are people who are knowledge workers who would create new knowledge based on some observations that they have routinely about a system and try to solve some problems for example, people in quality of an automotive workshop or an automotive assembly.

So, the basic role of a vehicle quality manager vehicle quality in charge is to sort of monitor at every level whether compliance is being made to whatever has been laid out in terms of processes and functions whether the overall assembly of the automotive which finally, gets generated is performing to an extent that it supposed to perform and if there is a noncompliance try to find out what is the reason behind such noncompliance and. So, they are basically creating new domain knowledge to solve existing problems or even creating or exploring an organized structure to the knowledge. So, that suach problems if they come routinely can get solved and so they are knowledge workers.

So, therefore, these are the 4 broad categories into which you could really could sort of differentiate all the jobs and all the occupations which are involved using any such work system.

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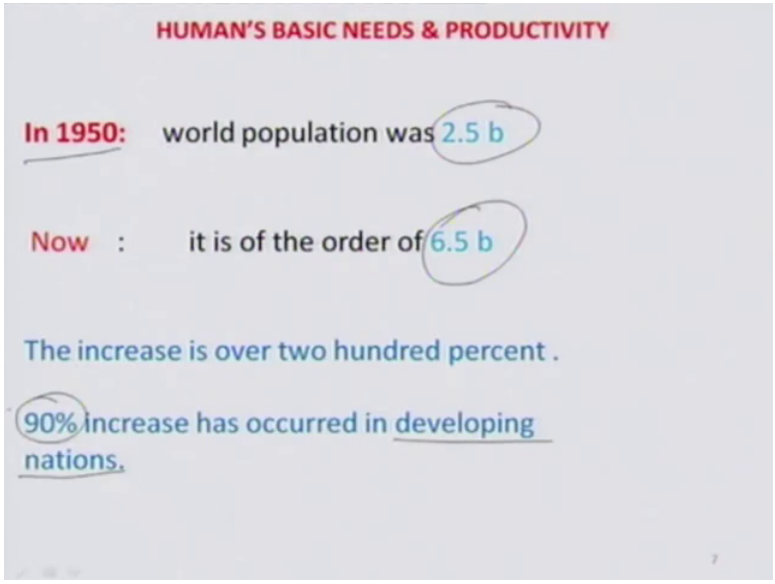

And let us now do a little bit historical prospective look at why there is really need for governing all these in such an organized manner and one of the needs that you must realize is that our population is increasing and there is a lot of demand as such which is coming because of this increase a loan.

So, if I looked at some demographics here in 1950 for example, the world population is only about 2.45 billion which has now come to the order of about 6.5 billion. So, it is actually almost more than doubled its more than a 200 percent increase and then if you look at simply the developing nations is of course, a 90 percent increase in population in such nations which makes life even more tougher and which needs to sort of you know the balance by putting over stress to some of these work systems which are continuously adding value to maintain augment.

You know rising standard of livings and in fact, life in general trying to make life simpler by giving services or products you know and so therefore, the need for efficiently doing something which you are doing for the last about 10 years more and more becomes more prominent because such social value additions are really dependent on what is the demand level and the demand level is on and ever increasing track. So, therefore, there is definitely a need to study work systems in terms of the productivity that would have, they would have in terms of how much they are adding as value and what is the kind of

involvement a what is the kind of expenditures that is involved in adding that value to society in general.

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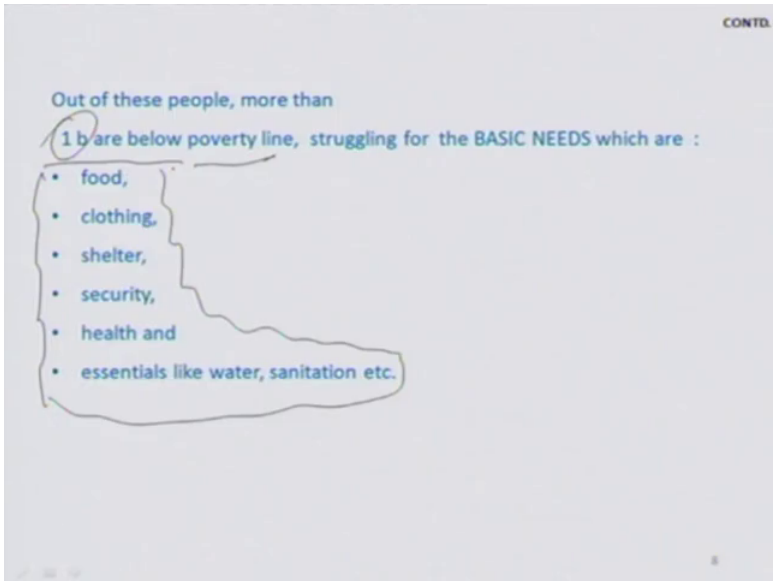

And. So, therefore, if I looked at let say these people who are currently a part of our let say overall population about 1 billion of them or just below the poverty line struggling for the basic needs which are related to food, clothing, shelter, security, health, essentials like water, sanitation so on so forth and. So, therefore, these are the people who do not even have the basic necessities that would be needed for a good sustenance and so therefore, it all gives a burning influence, to the burgeoning need of productivity management within those existing work systems which are going to cater and increase the standard of living for such in other people who are a part of resolve population.

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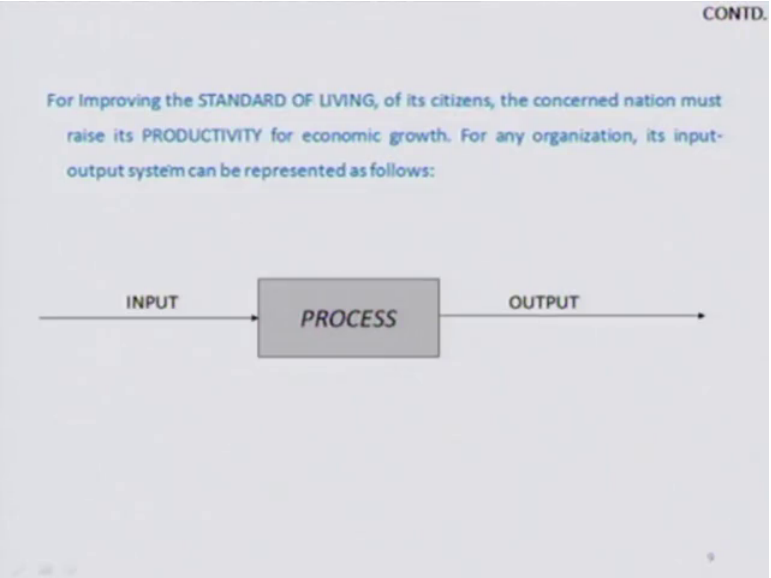

So in fact, for improving this standard of living of its citizens the concerned nation must raise its productivity, there is no other way that is again link to the economic growth which actually brings in the comfort of the standard of life or living in general. And for any organization if I looked at the organization from a work systems point of view there is a process there is a input and output and what is more important here is how much output at the behest of what input and what is kind of input.

Input could be just you know in terms of maintaining a process, augmenting a process it could also be in terms of the material that is you supplying to a process or maybe some human needs which are supplied to a process anything which is a stakeholder in this whole work system and this all would couple up together to formulate. At the behest of all such things associated with this process or this work system what is this level and can this level be changed or increased with respect to lowering of some of the inputs two such process of such work systems.

So, this is again what we mean really by productivity and this is something which is very very important for sustained growth and contribution to the economy as such.

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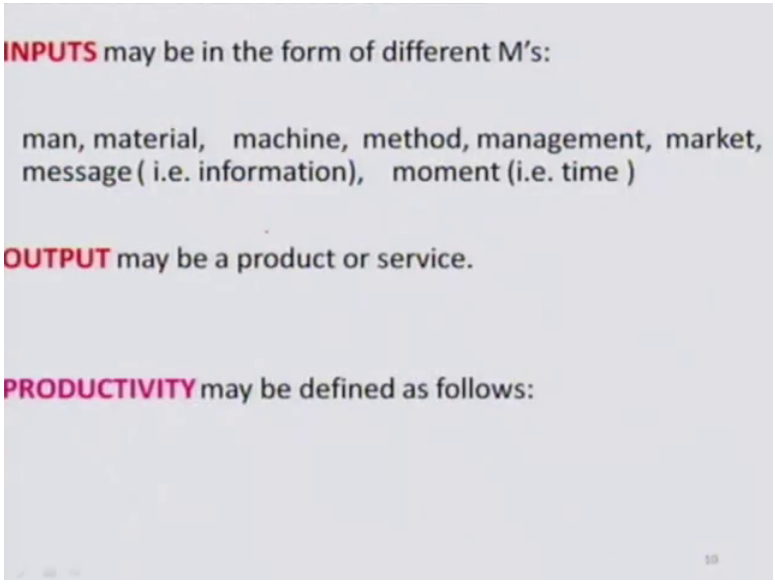

So, inputs again can be of various forms I think I have already mentioned these, but just to give you from a different perspective of Ms. So, there are a man, material, machine, method, management, market information or messages and moment that is time these are the different Ms which could be thought of sort of you know inter participating within a process to give the process to its final destination which is the output. Which could be either a productive or service and productivity in this case then would be defined simply as the output by the input ok.

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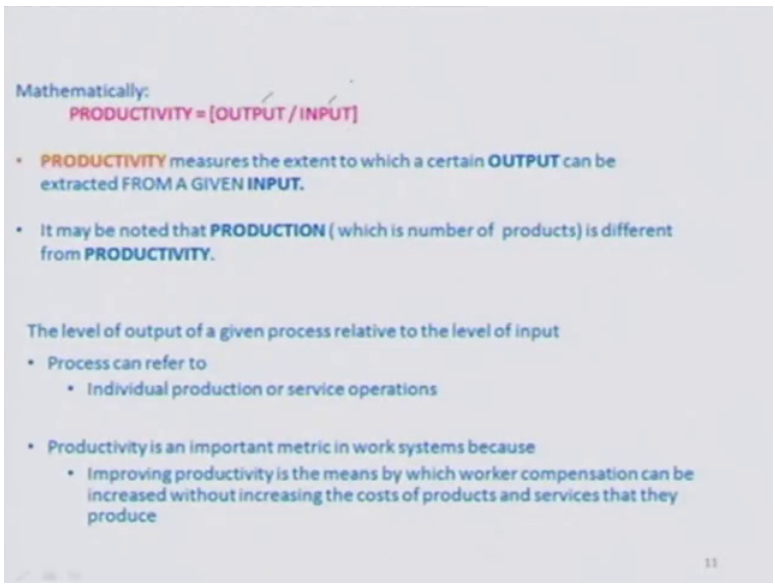

So, the idea here is that can I take this up by changing the input to go down. So, that overall there is a higher productivity increase of such systems which would then start adding more and more value at lesser and lesser expense. So, over all the standard of living can come up or the life can be better. So, it may be sort of noted that production which is a number of products is different than productivity production can be any numbers of a outputs which are coming out of a process, but at what cost it is coming out is not being considered while we consider production alone.

What is important to us is the ratio between what is your investment or what is your input, to that output or production level which is coming out and there is where the definition productivity lie. So, it is quite different from what we otherwise no standard way as production.

So, the level of output of a given process relative to the level of input would definitely be the productivity and the process can generally referred either individual production or service operations and I am kind of some trying to summarize what I said so far. And productivity is an important metric in the work system because improving productivity is the means by which worker compensation can be increased without increasing cost of products and services that they can produce.

So, it is another way of making it less expensive and affordable to all. So, you could say in a way that you know just by using knowledge management or just by using proper the right things at the right place at the right time. Let us put it this way you get to a level which is the optimum best for producing the numbers associated with a product or maybe services at probably the same level of cost or even a lower level of cost and when it comes to this there is no end to what you can do in terms of innovations, in terms of technology, in terms of systems improvement.

So, that this productivity can keep on rising and therefore, the job of person who wants to apply ergonomics into daily life is to sort of study a work system from that standpoint and try to do as much as innovation or kaizen as you say to the work system which is actually small innovations or small improvements. So, that there is a sustained increase sustained continuous increase in the overall productivity level associated with the work system.