Product Design and Development

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Lecture - 17
Product design for Manual Assembly

[FL] friends, so we are into lecture 17 in our course on Product Design and Development. And in week 4th or the last week we are discussing the design for manufacturing guidelines; design for manufacturing and assembly guidelines. And we are seeing that as a product designer, what are the various guidelines that we should know, or at least we should have an idea for products that are going to be manufactured at a later stage.

If you remember we are learning different tools and techniques for product design. So, maybe if we can divide 3 stages of product development process or product design and development process initial is conceptualization and the concept design, then the detailed design, then the prototyping, and finally the manufacturing. So, we will not be going to actual manufacturing of the product, but our focus will be limited to the first 2 stages that are the product design and then the prototyping of the product.

In this week our focus will be on the guidelines that should be taken into account, when we have our detailed design is ready or we are in the process of doing the detailed design, to initially we will have a concept and that concept we will develop into the detailed design with all specifications tolerances settings whatever has to be given for the product design or the detailed design, but as we have seen in the last class there are certain guidelines that we need to follow in lecture 1 if you remember last class we have seen what are the DFMA guidelines, but 2 different authors we have seen that what are the generic guidelines for products when they have to be manufactured.

So, that they are easy to manufacture as well as they are easy to assemble. We have seen DFMA guidelines in the last class; today we are going to cover the product design guidelines for manual assembly. Now suppose the product has to be assembled manually there can be 2 methods of the assembly one can be a manual assembly, another can be a automatic assembly.

So, the product design has to be facilitated or has to be analyzed from these guidelines point of view, that when the product will be assembled whether the assembly operations would be easy or the assembly operations would be cumbersome or troublesome or difficult. We will see that: what are the guidelines to be taken into account force products, which are specifically going to be assembled using manual assembly.

So, in automatic assembly yes we can have a automatic system and which can fairly deal with complicated products also or the assembly operations can be little bit complicated, but when the manual assembly has to be done a man is going to perform the assembly operations we have to see that what are the features that we should incorporate into our product design. So, that the manual assembly becomes easy or it becomes easier for the person or the worker who is working on the shop floor to easily assemble the different parts together.

So, what are these guidelines, what are the problems that we usually see, when the workers try to assemble the various parts together, and what are the things that we should keep in mind, rules of thumb we should help us in the design of the product in such a way that the worker is easily able to assemble the product.

Let us see the guidelines now the general guidelines for manual assembly means these are the product design guidelines that we should keep in mind the process of manual assembly can be divided into 2 separate areas.

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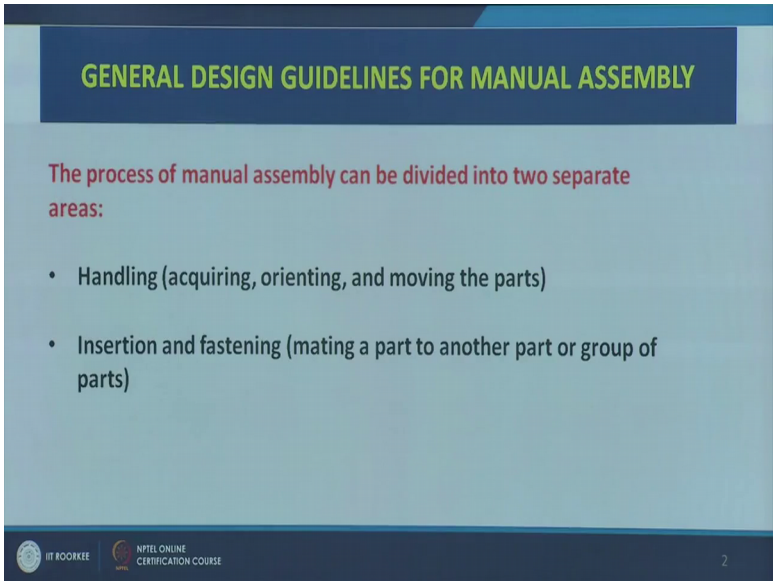

Now, when a person is going to assemble 2 parts together what are the 2 important things he does during that operation. First is handling the first he will acquire the job he will lift the job or he will just take the product or the component from the bin or the component from the bin, and then that is that particular section of his work can be classified as handling.

So, first is taking the job, taking the component. So, handling can include acquiring, orienting, and moving the parts. So, first thing is he has to acquire the part, sometimes he may have to move the part, suppose he is taking up nut from this bolt; the sorry nut from this box, bolt from this box, then he is moving them together and just putting them at place. So, that can be orienting, he is orienting the 2 parts together. So, he is taking nut from one box, bolt from another box and bringing them together.

So, that will fall under the first category that is handling, second is insertion and fastenings, then the second stage he will insert the nut the bolt into the nut and start the fastening operation. So, that is insertion and fastening mating a part to another part or a group of parts

In manual assembly these are the 2 fundamental basic motions or functions that a worker is going to do he is going to take the 2 individual components, that have to be assembled manually and then he is going to assemble them. Sometimes in the assembly operations it may so, happen that there may be a bigger structure or a bigger product and a smaller component has to be assembled on top of this bigger component. So, that will also fall under the manual assembly part only and we will see very briefly that: what are the various types of assembly stations or assembly operations.

So, first thing to understand is manual assembly; manual assembly means handling and insertion and fastening taking the part and bringing the 2 parts together and then doing the fastening operation.

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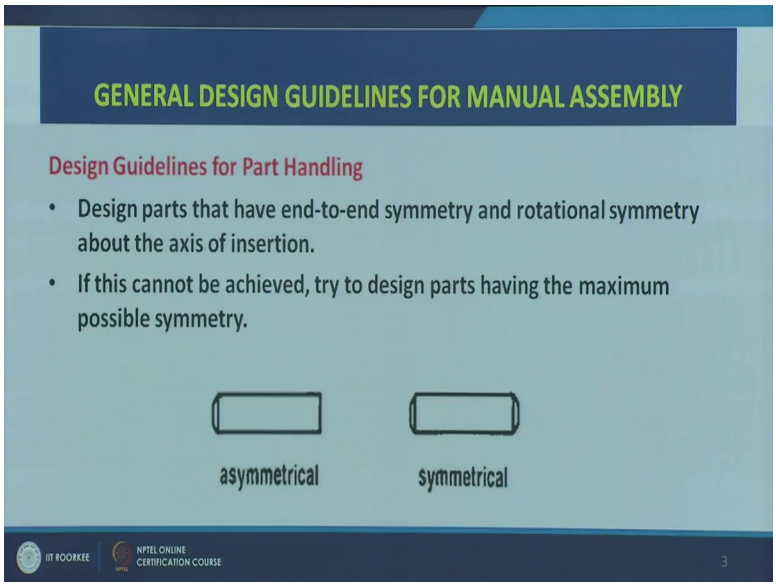

Let us see what are the General Design Guidelines for Manual Assembly so, with these are the design guidelines for part handling. Now we have seen in the previous slide there are Handling operations, there are Insertion and fastening operations.

Let us see for the first part that is handling what are the design guidelines, when the product has to be handled manually and it has to be fas10 to another part, what are the things that we should keep in mind. First thing is design the parts that have end-to-end symmetry and rotational symmetry about the axis of insertion.

So, here we can see 2 examples are shown this is the symmetrical part. So, easy to handle, if there is the symmetry in the part it becomes easy to handle, if this cannot achieved try to design parts having the maximum possible symmetry this is also a symmetrical, but still it is symmetric about the horizontal axis and there is maybe chamfered portion on the other side.

So, first thing that we should keep in mind is that we should try to design the product if possible as much symmetric as possible. If it is not possible to have all axis of symmetry we should go for maximum possible symmetry that can be incorporated into the product. This is the another feature you can see provide features that will prevent jamming of parts that tend to nest or stack when stored in bulk.

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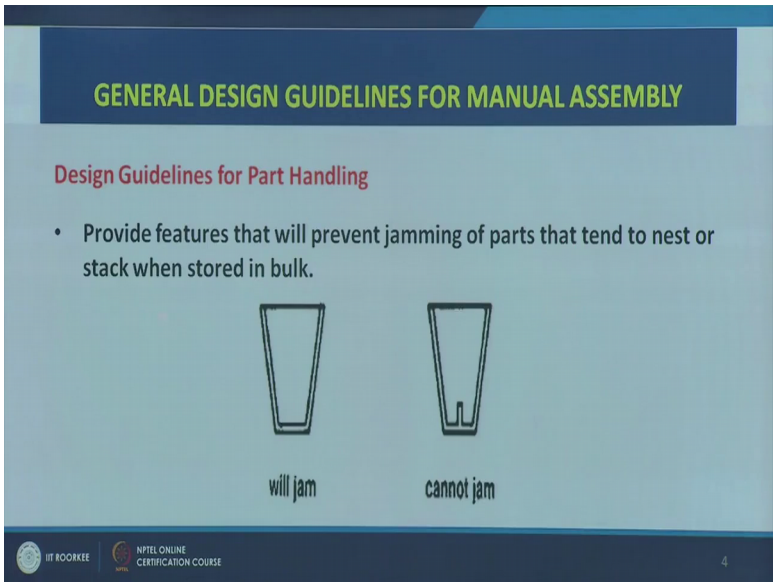

If you remember in case of steel glasses, sometimes you will see they will stick one inside the other and it is very difficult to bring it out. So, steel glasses may stick to one another. So, that type of feature, if that type of products are there what we can do this product will definitely jam. If there is another product which can fit inside this, another can go then further inside this, difficult to open them or separate them. But if we have this additional feature here inside and this is not interfering with any functional requirement of this product.

This additional feature that we are providing here, if it is not interfering with any functional requirement of this product definitely we should try to incorporate this feature here, because then this will not jam other part cannot go inside and sit inside very easily we can take out even if the product goes up to a particular depth we can very easily take it out. So, this is a one feature which can be added in order to prevent the jamming of parts and it is easy to handle the part for the assembly operation.

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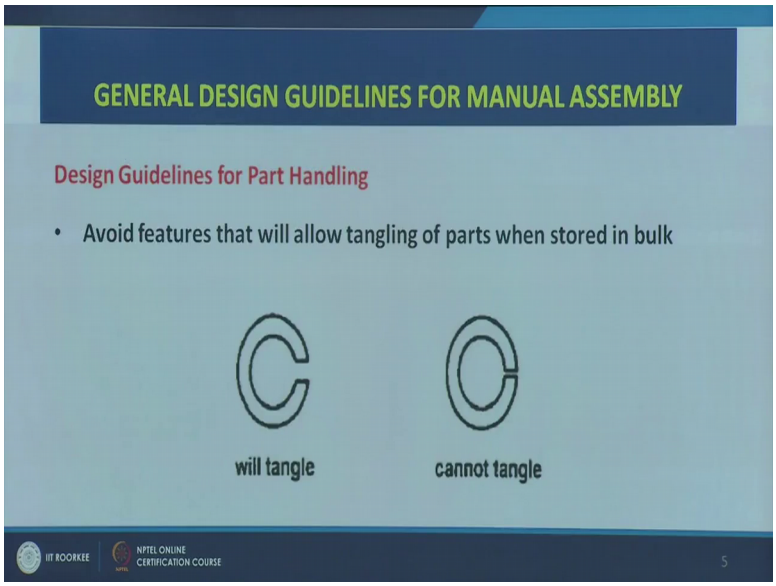

Let us see other examples for part handling here we can see avoid features that will allow tangling of parts when stored in bulk. So, we need to avoid the features which will maybe lead to tangling of the parts and then when your handling it becomes difficult to take the part out, other things can be we can store them in a particular for this particular example; if we have a rod and we put all these parts on the rod it is it becomes easier to take out one part at a time, but many times we store the parts in the bulk and therefore, they have the tendency to tangle into each other that thing has to be avoided.

We can design the part in such a way that even we store them in the bulk they will not tangle to each other, which means we can reduce this opening here in the design. So, that no other part can easily tangle with this part, this can be easily done if it is not compromising with the operational requirements of this product or with the functional requirements of this product definitely we can reduce this opening. So, that we can avoid the tangling of the parts let us see some other examples.

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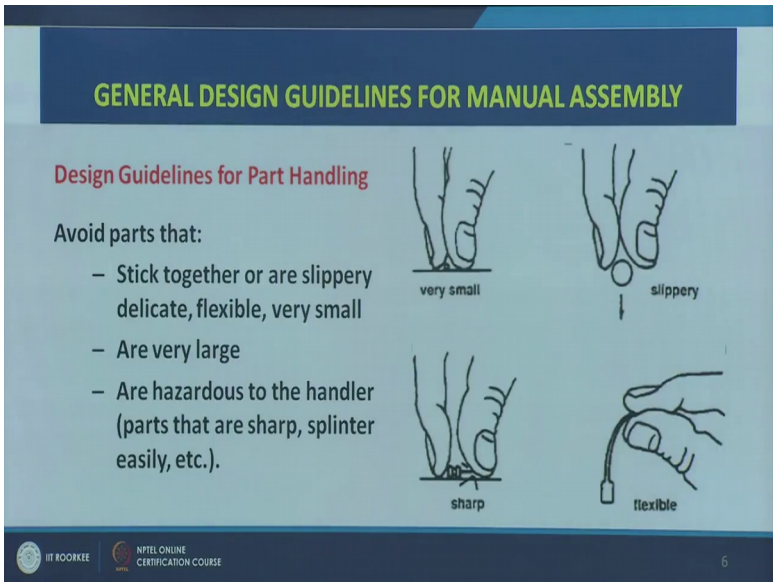

Now, we should avoid the parts some specific parts there are some guidelines related to handling that we should avoid. First thing is we should avoid parts that stick together or a slippery, delicate, flexible, or very small. So, here you can see this is a very small part even with our fingers we are not able we may not be able to lift it. So, for manual assembly there maybe requirement of a tong very small tong or some assistive device for lifting this part; we can avoid if possible we can increase the size if not possible then an assistive device has to be provided to the worker so, that he can lift this part easily.

So, we should avoid the parts there are 3 4 things mentioned here, which is slippery in nature number one, which is delicate in nature, which is flexible means difficult to handle or, which is very small also we should avoid the parts, which are very large in size we difficult by to handle them by hand so, that those type of part should also be avoided. Also we should avoid the hazardous to handle parts such type of parts which are hazardous to the handler which what are the examples parts that are sharp, splinter easily all those parts should be avoided. So, this here you can see a pin on one side it is very sharp. So, the sharp part should be avoided such type of flexible part should also be avoided.

When we are handling a particular component we should take care that if possible we should not make it very small, we should not make it very large, it should not have sharp

edges all those parts should be avoided because it will be difficult for the manual worker or the person doing this manual assembly to handle it properly.

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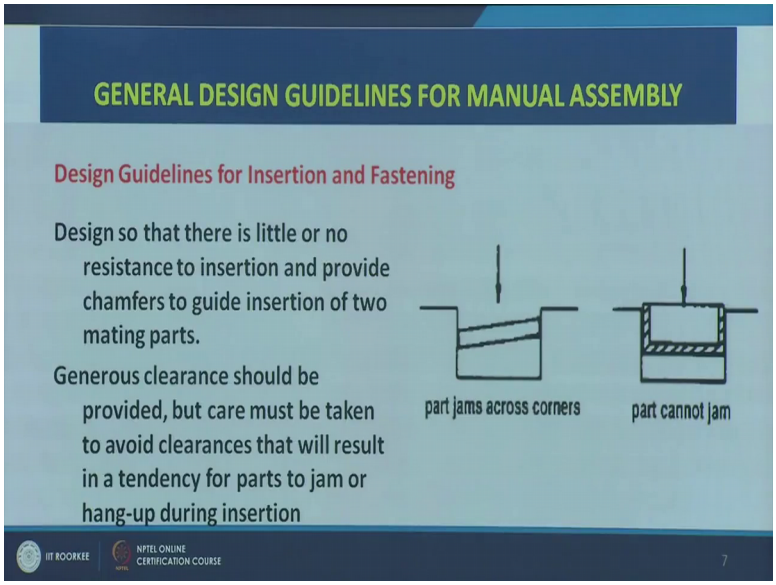

Now, first part we have seen that there are 2 parts in manual assembly; first part is the handling part, another part is the mating part or the insertion or fastening or the actual operation that is done. So, when we are designing a product we should see that we design the part in such a way or design the component in such a way that it is easy to assemble by insertion and fastening.

Let us see what are the design guidelines that we should take into account for the product which has to be assembled design. So, that there is little or no resistance to insertion and provide chamfers to guide insertion of 2 mating parts. So, here we can see parts jam across the corners.

So, we have to provide the chamfers to guide insertion of 2 mating parts. So, if we provide chamfers here maybe it may become slightly easier for this part to go and settle down there and we should provide the parts. So, that it offers little or no resistance to insertion and chamfers to guide. So, we have to give proper clearance here, that this part can directly go inside and fix or set at it is designated place so, chamfers and minimum resistance to the motion of this part. Then generous clearance should be provided, but care must be taken to avoid clearances that will result in a tendency for parts to jam or hang up during insertion.

So, there is a optimal level or optimum value of the clearance that should be provided between the 2 mating parts. So, that they fix properly if it is more clearance is given still it will lead to problem. And if there is no clearance given then it will become a press type of it maybe it we may have to apply force to force fit the 2 parts together that is also not desirable. So, we have to provide this optimal clearance. So, that the 2 parts fit together properly.

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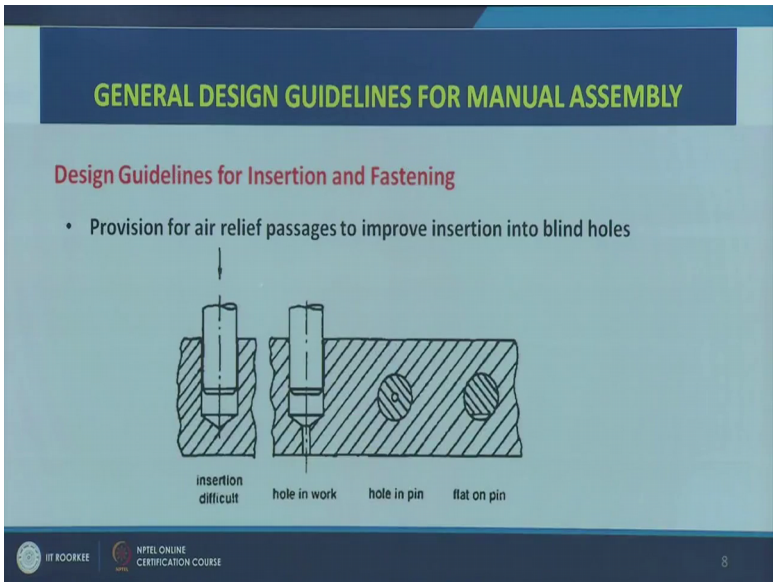

So, this is the design guidelines for insertion and fastening; this is another guideline this is here we can see this is a blind hole insertion is difficult this is the part which is going inside this blind hole. So, we should what we should do we should provide for air relief passages to improve the insertion into blind holds.

Now, here it is a blind hole we can provide this passage here this passage you can see for the release of air which is inside this blind hole. So, provision of air relief passages to improve the insertion into blind hole. So, we can see here this part can now easily assemble because the air inside will move out from this air relief passage. What else can be done we can have hole in the pin; this is the pin, which is going inside the blind hole. Now in this pin we can have a centric hole here a central hole along the axis, which is shown here and the air can just move out of this hole when this pin is moving down into the blind hole what else can be done we can give one chamfer or a flat on one side of the pin. So, that the air can come out from here this is flat on pin.

So, we should provide the air relief, so that it is easy to insert and the worker need not apply excessive pressure for this insertion and fasting operation. So, this is simple design guideline which can be taken care during the product design stage.

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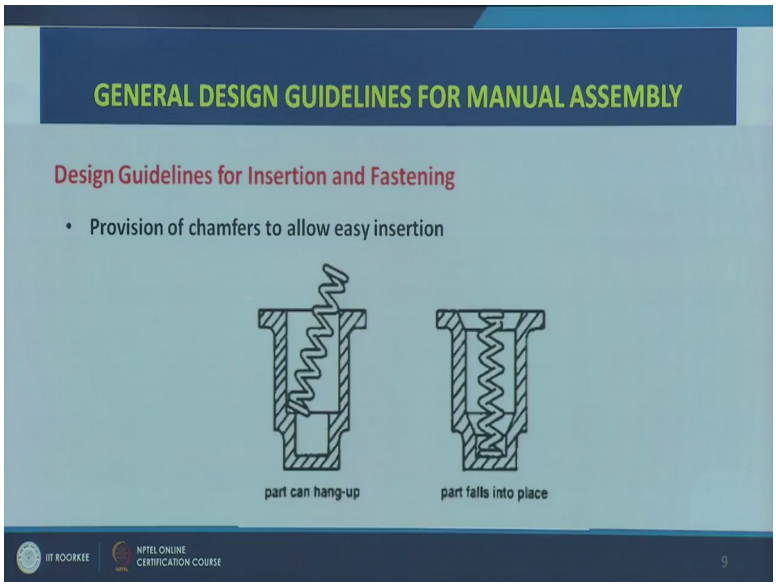

So, that the product is assembled easily; this is another example you can see design guidelines for insertion and fastening again as we have discussed there are 2 broad categorization of the manual assembly operations the handling and the insertion and fastening. Now we are looking at design guidelines for insertion and fastening and this is another guideline for insertion and fastening.

Provision of chamfers to allow easy insertion so, here we can see this particular part has to be inserted in this part or component. So, here this when we try to insert it may stick here or maybe may not facilitate the easy setting of this part inside here also we see there is the sharp corner. So, what can be done we can chamfer this part, even this part goes there it will be guided to it is direct to it is designated position, if even if it goes in this direction it is guided through the slant or through the chamfer into the into it is designated position.

So, we can provide chamfers on both sides to parts. So, that the part falls into it is place or it is guided to it is designated position. This is a simple design guideline which can help us for assembly operations when the part will be assembled during the final manufacturing.

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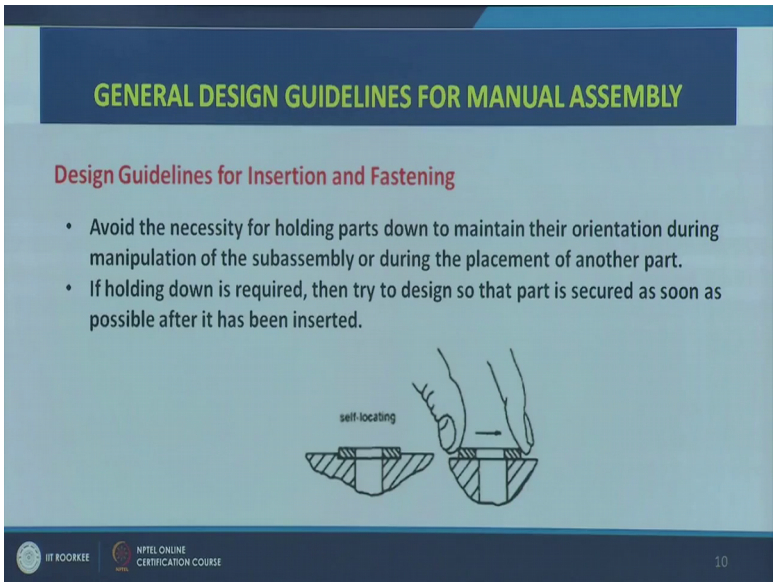

Now, here we can see design guideline again for insertion and fastening avoid the necessity for holding parts down to maintain their orientation. Sometimes we need to design the part in such a way that it is self oriented here we can see there is no position. So, this will move here and there and we have to insert ensure a certain that this particular hole or this particular feature matches with the feature in the basic or the base part or the part to which this part has to be assembled.

This is slightly may be cumbersome process or slightly time taking process, but if we provide a slot here. So, that self locating feature is there directly this top part can come and at it is designated position, it will make the work of the worker or it will make the job of the worker for more easier as compare to this thing; only thing that we need to do here is we have to provide this (Refer Time: 18:02) or we can say pocket here. So, that this top part can come and sit here. So, we can just read this the explanation for these figures avoid the necessity for holding parts down to maintain their orientation during manipulation of the subassembly or during the placement of another part.

So, we should avoid the necessity for holding this part and then using the other hand to fas10 it should be self locating in nature. If holding down is required then try to design, that the part is secured as soon as possible after it has been inserted. So, we have to ensure as soon as the part is inserted into the base part in on which it has to be assembled it should have self alignment and self we can say locating characteristics. So, that it is

located and then we can do the fastening operation. So, we should not have that you can say requirement of holding it down until we fas10 it. So, that can that type of design should be done. So, that it is easy to perform the assembly operation.

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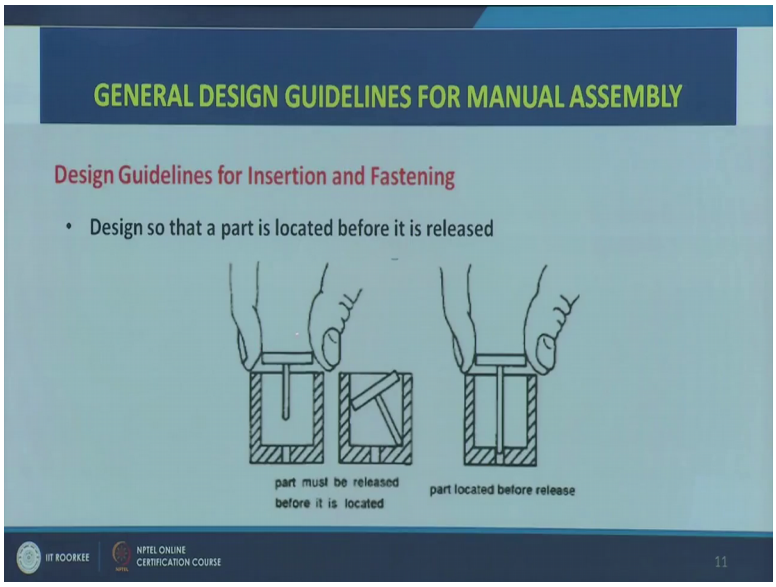

Now, here we can see we have to design the part in such a way now here you can see this pin has to be fixed here in this slot it is difficult to do it manually. If we try to drop it down it may take this position and this particular section may not enter into it is designated point. So, part must be released before it is located which is not a desirable thing. So, here we have to release this part before it is inserted here. So, part must be released before it is located. Before location we have to release the part and then we have to wish that this particular pin will directly go there and settle at it is designated place, which is just probabilistic it is we cannot say it deterministically that this will go and settle down here only.

But if we increase this length and we locate it before releasing then we are 100 percent sure deterministically we 100 percent we know that this will definitely go and set there, before releasing this it is getting positioned here. Now we can use a screw driver to fas10 this thing. So, this is another design guideline we should be taken into account that the parts should be located at it is position before we are releasing that part. So, only design change is the length of this section, which is helpful in locating it before we release the part. It will make the job of the manual worker easy when he is performing the assembly

operation and will also improve his productivity and efficiency of doing his work satisfactorily.

So, here we will now go to the types of manual assembly operations one is the Bench assembly here.

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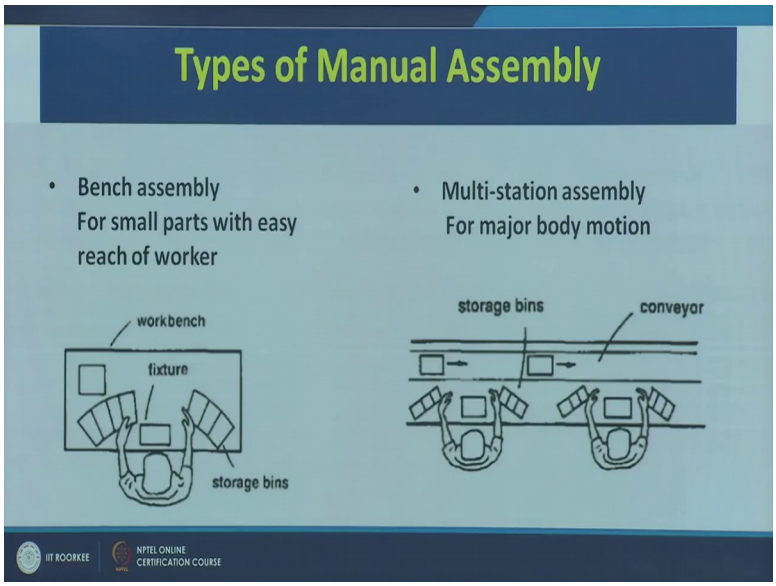

We can see the bench assembly operation a worker this is a worker these are the storage bin most common type of assembly operations and here we have a fixture in which he will fix the 2 parts. So, he may take one part from here another part from here and then he can assemble put the 2 parts together in the fixture and perform the assembly operations. So, is a storage bins are oriented in a semicircular fashion which are standard design guidelines for design of the workspace and are usually taught in a subject a work system design that how a work place should be designed for a worker.

So, here this is a standard practice of putting the storage bins in this fashion. So, that it is in the maximum and the minimum working area for a average able bodied person. So, this is a standard you can say workplace design and this is standard design for manual assembly operation also. So, this is first type of bench assembly for small parts with easy reach of worker.

Then we can have a Multi-station assembly that the product is moving around on a conveyor belt and the people or the workers are performing their operation on that

product. These are the storage bins for him for worker number 1, these are the storage bins for worker number 2 and there is a conveyor belt on which the product is moving and the workers can use the storage bin take out the components which have to be assembled on this product from the storage bin and then do the manual assembly here, then the product moves down to the next worker and the operations are done whatever are the required operations done by the second worker on this product.

So, this is second type multi station assembly operation first one is bench assembly second one is multi station assembly and this is for major body motion. So, maybe this is the characteristics of multi station assembly then.

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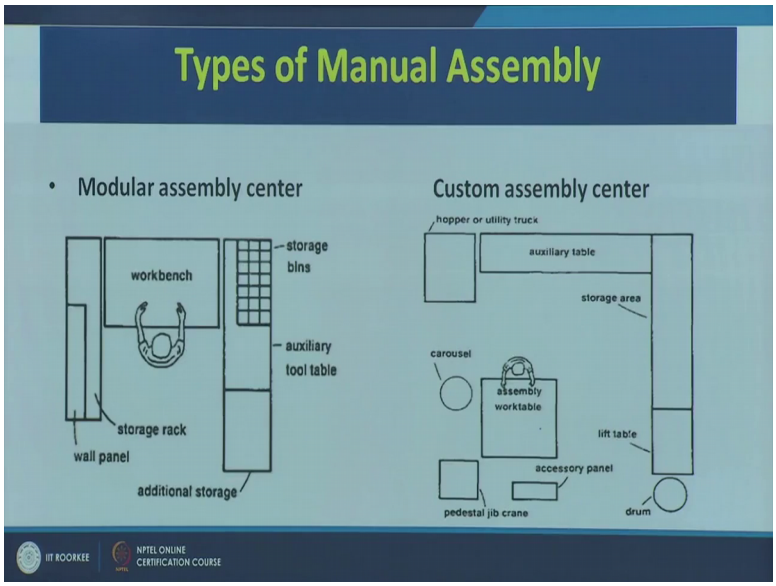

We have a modular assembly centre you can see here in which this is a worker this is a storage rack these are the storage bins, auxiliary tool table, additional storage. So, maybe when the job is slightly bigger in size we can have a modular assembly centre in which the different parts or modules can be combined together, finally by the worker. So, he may get different modules from different stations and the final assembly may be done on the work bench here.

Then other type of assembly centre can be the custom assembly centre, which is given here auxiliary table, this is a work table, lift table, this is pedestal jib crane. So, we see there are lift table, pedestal jib crane, which means that custom assembly centre will be

used for you have assistive devices for the assembly per the person whose doing the assembly operation.

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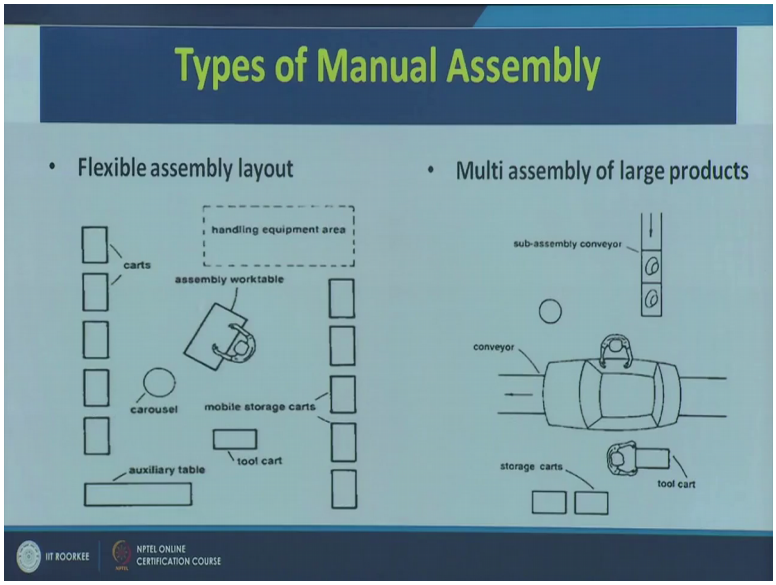

Flexible assembly layout is also there this is the person there is the carousel tool cart. So, we can bring the material who which has to be assembled to the work table here assembly work table then there is a handling equipment area there are mobile storage carts mobile storage carts means that they can move more flexible nature of the assembly layout that is flexible assembly layout. Then we have the multiple or multi assembly for large products you can see one worker is working here tool cart, another worker is here all these are storage cart multi assembly may be used for very large products.

This is just to give you an outline that what are the type types of we can say manual assembly which is done. So, different types of layouts or this thing your given, but our focus majorly is on the design guidelines as a product designer. So, this particular section may not be relevant from the product design point of view, but definitely relevant from the engineering point of view.

So, that we know that when we are designing our product how it will finally be assembled it maybe you it may be assembled on a bench assembly it may be assembled on a line or a conveyor belt it may be assembled as a custom assembly section it may be a modular assembly type of a product. So, we at least some idea we should have that when we are designing the product how the product will finally be assembled.

So, the second part is not much relevant to the product design, but is relevant from the application point of view. So, we have seen today that what are the 2 major section or 2 major operations during the manual assembly; one is handling, another one is insertion and fastening and what are the product design guidelines that we should take into account, when we are handling the part or the part has to be handle and what are the design guidelines in the product that we should incorporate. So, that it is easy to fasten hand insert and if we take care of this guidelines during the product design stage our assembly operations would be easier.

And when the assembly operations would be easier the productivity and efficiency as well as effectiveness of the worker will be more and when the effectiveness of the worker will be more. We the company will be able to produce more number of parts and more number of parts means that the company will be able to judiciously or efficiently utilize the resources at it is disposal and that will lead to the profit of an organization.

So, starting from the design of the product the company can be into the profit. So, all these guidelines should be taken into account when the product is being designed. In our next session we will cover may be the other aspects of DFMA that is we will see that if the product has to be manufactured by casting process what are the guidelines to be taken into account, if the product has to be manufactured by forging process what are the guidelines to be taken into account. There is a long list of guidelines for casting and forging and extrusion and machining and injection molding we may not be able to cover everything in our short duration of time

But we will definitely like to cover at least 1 or 2 guidelines of each of the operations, so that you get an idea that such type of information is available. And then you can use the various knowledge basis and resources for getting the further or the detailed information on these types of design guidelines.

So, maybe in next lecture we will focus on design guidelines for products to be manufactured by various manufacturing processes.

Thank you.