Design for Quality, Manufacturing and Assembly
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Lecture – 30
General Design Guidelines for Manual Assembly

So, let us see first from a part handling perspective, what are the guidelines simple guidelines, ok. We will just get expose to, it is not a comprehensive set of guidelines. This is similar to the example that we saw, what it says is; this particular design is asymmetric and this particular design is symmetric which one would you choose?

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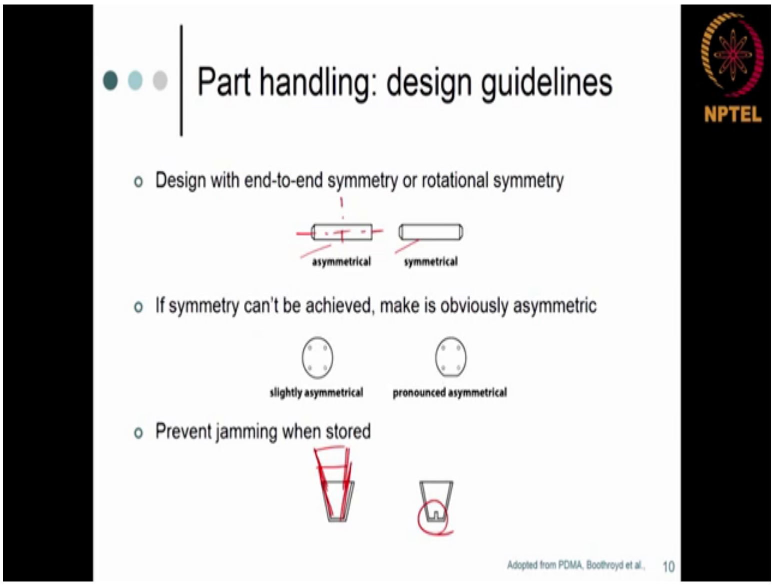

From my designer perspective you choose this because, for this particular stuff you need visionary inspection or you should be able to feel it which side it is, ok, that is one thing.

Design with end to end symmetry or rotational symmetry. There are two things here, right. If you take an axis here that is one symmetry and this symmetry; it is also rotational symmetry correct. This is like a difference between a nail and a screw. Is there a particular angle in which you put a nail? A nail is a nail, you want to put it here you just put it there ok, but then when you put a screw you want to use a screw driver. The screw driver has to be correctly inserted on the edge right whereas, the hammer can directly go on any point you cannot say the hammer should exactly go only in this particular line no just pose on the head of the nail it is fine.

This is the difference between the nail and the screw, in name the difference between the screw in handling and insertion perspective, of course, they do two different jobs in a very large outset they actually fasten two different components both the screw and the nail, they fasten two different components, ok.

The second one is about it is again symmetric, but what it says is slightly asymmetrical versus pronounced asymmetrical. What this guideline tells you is if you cannot make it symmetric make it pronounced asymmetric, do not make it like this. It is actually asymmetric, this design is actually asymmetric, but it requires very carefully investigation to find out in which direction it is asymmetric because this is going to go and sit on another part. You imagine that there are going to be four pillars on which this is going to sit. You will have look at it and properly align, ok.

So, what this say is you kind of show a pronounced asymmetric or you kind of have an indication here that this side will sit on this for sure. If symmetry cannot be achieved make it obviously asymmetric, ok. So, that is the guideline the third one I am just showing the picture you will get an idea what is this.

Student: Fix anything in a particular direction so.

Fix anything in a particular direction what does this look like?

Student: (Refer Time: 03:45).

Cap (Refer Time: 03:47). Have you guys come across thermo foam cups for example, paper cups thermo foam cups and they stuck one on each other or you have seen stainless steel tumblers the anywhere in the hotels? If you see majority of the places they do not put them on one into the other there is an issue. Sometimes they go and get stuck, they are like this they are like this. So, you can put another stuff on this surface and then you can keep building this. You can look at the chairs you remember the plastic chairs could be used one on top of each other. These are designed carefully ok, but then there are some designs where you put it you will never be able to remove them.

This is what this idea says. You need to have a projection that will save you this from jamming when you store them, ok. It would not let it go beyond the particular level. The jamming happens because it goes all the way down and you are not able to pull it off, ok. So, hence you have this.

Student: (Refer Time: 05:15).

Sorry.

Student: (Refer Time: 05:19).

Yes, (Refer Time: 05:21). But, these are majority sometimes what people are give us this is usually for the transportation purpose, ok. These are stuff that you can eliminate at a later point when you are going to use it that part can be eliminated, ok. This is for only for the transportation.

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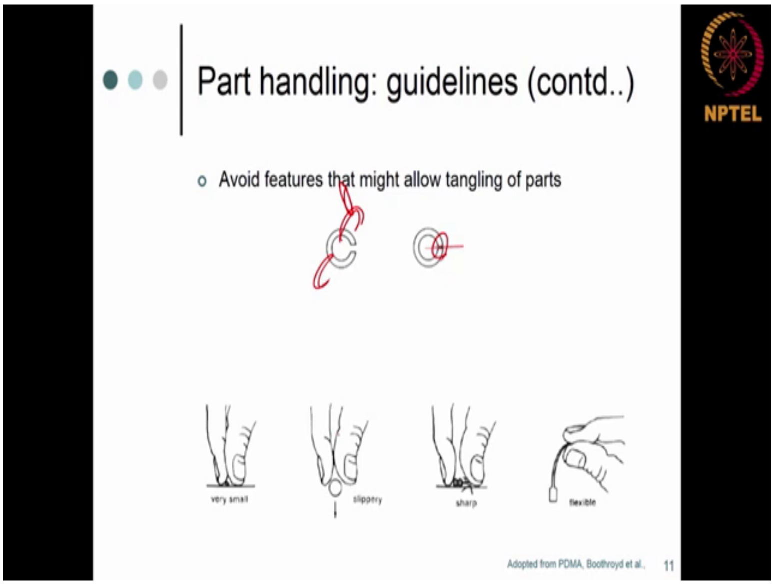

This is some in a similar sense some guidelines for instance this one, ok. If I want to make many such components and you are shipping them what could be a problem, when you have put so many of these together?

Student: They will get tangled.

Sorry.

Student: They will tangle.

They will get tangled, they will do this multiple sets there could be another one that will get tangled like this, right. This might get tangled into something else this might get tangled into something else. So, then it becomes the problem, you need people to be able to remove these things. So, instead when you design see look at this your design this is a perfect design from a design perspective, but from a transportation perspective it is good to have such a design such that it does not go into through this.

I will tell you one guy, I do not know did you guys meet did Mr. C. Varadarajan? Spoke to any of you guys? No, there is one group that he spoke. He is pretty senior designer. He once told about washing machines. He said there is the limitation for the companies not to increase the height of a vertical axis washing machine. This you can you can see anywhere. You will take a particular Samsung, you take Whirlpool, you take Godrej and you look at all their vertical axis or horizontal axis whatever the front open or top load does not matter. All of them will be of the same height. Any guess? What.

Student: (Refer Time: 07:28).

Sorry.

Student: (Refer Time: 07:30).

No, I did not mean to say that this height and that height, that is understandable, right. This height and this height also it is not allowed you all always over the years they all have stayed the same. Why? I was surprised; I do not know whether you will be surprised. The reason was the transportation. They have trucks, that they have leased the trucks were built for them and they can only take whatever the height is 3 or 4 washing machines then they are aligned.

If you adjust it by few centimeters each of them instead of 4, I can only take 3 which means in a container let us say that 4 times if I am taking 100. So, some 25 combinations are there I can take hundred washing machines I take only 75 washing machines which mean 25 percent I am using that as ether in terms of transportation, that they cannot they cannot allow that to happen. That is the amount of tolerance that they work on. So, you can imagine when I designing I should know the transportation that constraint comes into picture, ok. So, there is another interesting example, ok. Cars have you seen how cars are taken from one place to another?

Student: They are (Refer Time: 07:30).

Correct. So, let us let us leave that let us come back to that, ok. The glass that is used for the cars the front windsheild and the back there are all the toughened glasses. So, people said that this needs to be of this quality the toughened glass ok, highest toughened glass in the front, so is the case at the back also. So, one designer had a question on why the front one I understand, because it is going in this direction and there is lot of the air hits the front one, right. So, you need to have a really toughened glass there, but why you need to have a toughened glass, this is purely from a performance perspective.

This is not going to save you from burglary and all that. Today people can break even those toughened glasses, right. These are purely from a wind perspective,, but the company said no, no we need to have toughened glasses. They had a reason can you imagine what the reason is because, see wind I understand you will get wind from the front when you drive and sometimes in the side sometimes, but not as much as you get from the front. Why you need an equivalent toughened glass at the back? You have an answer?

Student: Maybe a cyclone tendency.

Even in the cyclone stuff, the cyclone is going to come from back yard, but in the cyclone your entire car will get lost. Let us not worry about the windshield. It is a cyclone your entire car is gone, right. So, windshield is not going to save you.

Student: (Refer Time: 11:09).

See they are not structural methods. You talk about your the frontal portion, you talk about your back portion, you talk about your seats they are structural members they will affect in terms of impact. But, these are not load belt they are only for visibility and to prevent the wind that is all these are the only two purpose of your glass that is it. They are not structural members in terms of impact over their design in such a way that they will break into small pieces and go such that they will not hurt the (Refer Time: 11:48), that is all. They are not structural members they are not designed save you under an impact. It is related to the point that I raised first do you know how they are shipped.

Student: (Refer Time: 12:06).

Not all the cars that taken in the frontal direction, they are actually also on the truck they are parked in the reverse direction. So, you never know which will be parked in the reverse direction which one will be parked in the frontal direction. This is an example where you need to know even how a particular car will be transported let us say these divisions were entirely different and there was no feedback. That car company will probably you know shutdown in probably a years time ok, because that is why they record failures, modes of failure they record, ok.

Today we have a watch company which comes us comes back and asks us that there are hundred and 20 checkpoints in spite of that we are having these many losses in our stuff. So, we need to figure out where the problem is, ok. Their mechanism is fine when it get out of their shop. There is nothing wrong about it there they have had a very nice protocol to check it. There is no question about that somewhere in between there is a problem it could be shipping problem, it could be the as some I mean the packaging problem it could be the how they get it down from the that truck load unloaded and how they put in the showroom there are different. So, they want an FMEA done on that to understand where the fuses, ok.

These are interesting problems if you look at it. So, the point is one need to be this is the challenge for a product company, right. So, it is not just that I build a product and I send it off. No, you need to establish the entire chain. It needs to be shift like this, it needs to be handled like this, it needs to be showcased like this, it needs to be handed over to the person like this. Subject to all the uncertainties, performance wise there is another problem until you handed over to them and performance wise there is going to be other sorts problems as well, ok. So anyway, for instance from a design perspective there is nothing wrong about it, but from a transportation perspective it is useful to have at this phase, so that they do not tangle.

So, I avoiding stuff that are very small that are slippery if you try to design something like this maybe bit sharp edges like square, like a cube rather than a sphere because it is always easier to handle a cube than a at this level, that is why the fingers are also given and then not to have a sharp design, flexible design. If you cannot avoid any of these situations then proper handling needs to be advised. You cannot use the fingers because you will end up hurting your fingers as simple. You remember one of the best practices in the product design lab is to. You never know who is going to put what, ok. It might not be your fault. You just turned around and that guy was doing something, you hit his elbow they were tightening something that went and fell outside the desk, it will land like this on the other guys foot.

So, that is why we insist and we always even sent you back I guess, unless you had some big no like wound and then you had plaster around your foot. We never allowed at least in my PD lab I made sure that people do not sneak in with the floaters or flip flop or a what whatever sandal, it should be toe cover that is our point, ok. I immediately get reminded of the toe injury always, ok.

Anyway, then you can see you go to a hotel there is a best practice people always wear a.

Student: Hair cap.

Hair cap because one of the major things that you can always see do not ask me whether that saves, it does. It does reduce it for sure, because this is something that is the out of your control you do not even know it comes on right. And then there are multiple things like that earlier people used to small digration, but then earlier they use to bring the glasses from inside with water, right. So, they will put their fingers and then they will bring it like that ok, but today now you see they will keep the glass and then they will pour the water the water was always there for you they will only come and refill the water there is no way to with all due respect to the server, ok.

But, point is they touch multiple things. So, anyway it is not going to be as clean as the water that there. So, that is that is the best practice if you look at best practices is all the there at all places, ok. See, best practices is not necessarily only for doing good, in an adopt manner also for doing something there is a best practice ok.

So, avoid pots that stick together that are slippery in nature, that are very delicate, that are flexible, a very small or very large. It is not applicable in general let say that you are looking and flexible electronics, then it needs to be flexible, today there is a pressure sensor that you want to do it is flexible you hold it like that it will be only flexible. These are general guidelines, ok. If there the nature is that yes it is a nature is this. Diamond can only be like this diamond cannot be like this diamond can only be small then you need to have appropriate handling techniques that is what it is diamond can be like this, but then you need to be a country to hold that, right you cannot be an individual to hold, anyway.

So, the one thing is the first one as I pointed out is this is this is done. Now we have finished talking about handling. Now, we need to talk about the insertion, ok, so that it becomes a assembly from this can you imagine what could be what might be there in this slide guideline what guideline can you think about.

Student: The orientation (Refer Time: 18:54).

The orientation, good, that in one sense we talked about it already, then?

Student: Insertion.

Insertion; anything else? We will see. So, you want to assemble, this guy is going to go and sit inside this, ok.

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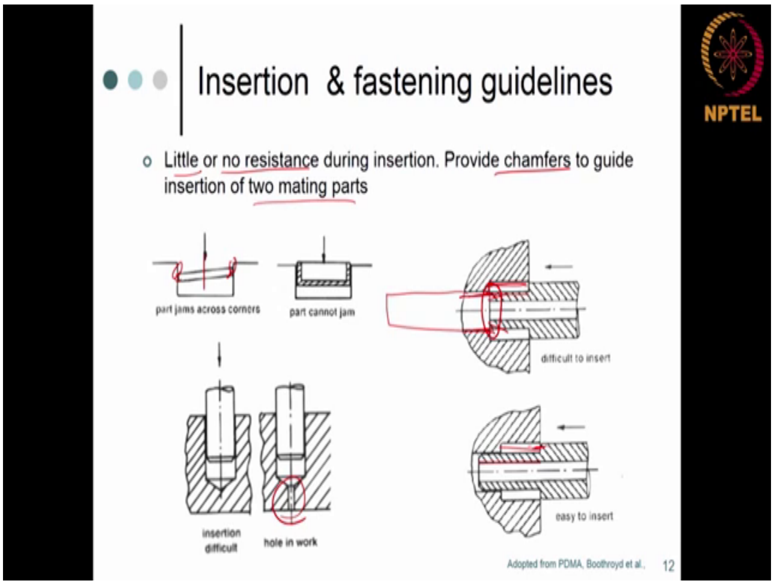

But, there is a problem if I want this guy to sit here, but he got jammed here. What could be a potential solution?

Student: (Refer Time: 19:30).

Sorry.

Student: Tilting (Refer Time: 19:32).

Tilting is further. No, this is jammed you see when I say jammed or it means it get it got stuck.

Student: Round edges.

Sorry.

Student: Round edges.

Round edges will.

Student: (Refer Time: 19:47).

Might, might help, not always might because it usually get stuck here. You understand right, what is happening here. Then sorry, someone said something that side.

Student: Guide on the sides.

You can have a guide I understand, guide on the sides you can have and then you push it, so that it will pass through that. Now, one of the best guide example is your calculator, if at all you guys used calculator, ok. That calculator cover has a guide. So, it will go on that. What is the other one? Hold sorry hole you said, where?

Student: Hole for the inserting part.

For the part that is being inserted, where?

Student: (Refer Time: 20:38).

So that way, you can put your finger and remove it. Why do you need that?

Student: (Refer Time: 20:42) guide is kept like a calculator.

You mean to say that this will have something like this?

Student: Yes.

No, no that will affect your design and all, fine.

Student: calculator like they have along with the guidelines on the other components or have to (Refer Time: 20:59) guidelines (Refer Time: 21:01).

Ok.

Student: That particular (Refer Time: 21:04).

Fine So, I will show all the three cases then we will look at the solution, ok. There is an insertion difficulty in such a case when you are trying to do that. Why? If know why you know the solution. So, there is a hole and I am trying to push something inside this. It could even be a screw, but beyond a particular level it is very difficult.

Student: Air is trapped. Air is trapped.

Air could be trapped. Air trap, this is actually a major (Refer Time: 21:52) and imagine of that. So, what could be a solution?

Student: (Refer Time: 22:02).

That is too much.

Student: (Refer Time: 22:04).

Every hole that you try to screw you go and like vacuum and then you have to go.

Student: (Refer Time: 22:09).

Student: Yeah.

It is not like air means it is not like so much air, right it is only like this particular space. So, you just need some space for this guy to squeezen. So, what you do is this you just put a hole in the screw itself. There are several screws you can see that there will be a hole you can see that, ok. Well made screws will have those holes because it is not easy to put a hole in the threaded screw and those screw are naturally expensive than the regular screws that you look at, ok. You see the problem in this? This is a nice problem. You see the problem right, this is the hole and I am trying to insert this guy to this guy, is designed perfectly.

Student: (Refer Time: 23:04).

What is the problem?

Student: There should be a thousand more when they have hole diameter should be more than.

Which one should be more?

Student: The hole diameter should be more than the inserting pipe, at least by (Refer Time: 23:14).

No, you want fastening kind of a stuff know. So, fit wise it is still a not fit kind of a stuff.

Student: Like (Refer Time: 23:22) width (Refer Time: 23:23).

No fine, but the deal is this.

Student: Shape of the edges.

What you are talking about is this. I am talking about this you get a point. The axis that we are talking about are different, your smudge fit and all that comes from this axis. I am talking about this, the length. The length is [FL] only this much it is designed, correct. You have you ever had the problem where you have thread mismatched? Is the thread inside and then you put the screw and then it got mismatched; it will not go beyond a particular stuff. Something of that sort could happen in this instead of putting it right exactly here, a small tilt will mean that this guy will mean that it is like this it will end up being like this. What could be a potential solution for this?

Student: (Refer Time: 24:23).

Sorry.

Student: (Refer Time: 24:25).

Sorry, one on time, sorry slope where?

Student: There, front (Refer Time: 24:32).

Here you will have a slope.

Student: (Refer Time: 24:36).

No, the slope will not help you man you are saying this, right.

Student: (Refer Time: 24:42).

But still this length is still the same. I mean I have almost given the solution. I gave the solution when he answered. You said something.

Student: Same.

Same, I do not have a problem in entering even with whatever you are telling the slope or the cut edge and all that I might still have the same problem. I am not addressing the problem. You have a solution?

Student: It can be like the diameter for the entry part with this part enters. That can be larger and the other end can be smaller. So, it can slowly fit through.

How comes? How can it be larger here? It cannot be larger here.

Student: No, I mean this shape can be like this so.

I do not know whether you guys appreciate the problem. The problem is not this, not being able to go into it that is fine. I never said that there is a problem with these dimensions this fine. The problem is this length is so well designed to this length here for a small mismatch also I might get locked, ok. So, we will see what the solutions are this one you design it in such a way, so that you still have control from outside that is one thing or guidelines. Many of the solutions that we will discuss in the rest of this course is not unique. There are always other solutions that are available, ok. These are textbook solutions that are taken of the textbook.

So, in such a case the part cannot jam, ok. Hole in the work piece not only screw or I mean if it is a screw you can have a hole otherwise it is a hole on the work piece itself for it to release, that is one thing. In this it is simple you just increase the length of this guy, that is all ok. So, what is happening is you are able to reach out a little bit and then of course, you need to have this hole you need to have the scope to have a longer hole. So, that I push this you understand right, this hole is not dependent on this size.

Let us say for design purpose you wanted this guy to be the same ok, but from assembly perspective you need this guy to be longer. So, this second level hole should be longer that often times you will be able to do, then you will not have this issue, because it will get inserted first and then you keep driving it, then automatically this part will get fastened, ok.

So, what you try to look at is little or no resistance during insertion. So, this will be it is never it will be no resistance, it will be you should do it in such a way that there is little resistance, ok. He kept winding out to this provide chamfers to guide insertion of two mating parts Whenever there are two parts that are trying to mate you might want to have chamfers that will align with each other.

We have discussed lot of guidelines right now in terms of insertion handling, do these really help? If so how, because these are just the bunch of guidelines right there are like some I do not know 5 plus 3 we discussed and these could be specific also.

Student: (Refer Time: 28:30).

What?

Student: (Refer Time: 28:34).

Ok.

Student: (Refer Time: 28:42).

So, that the idea of this question is how do you convert this into knowledge these are some information that you have how do you convert this into a knowledge, so that you can systematically deploy them.

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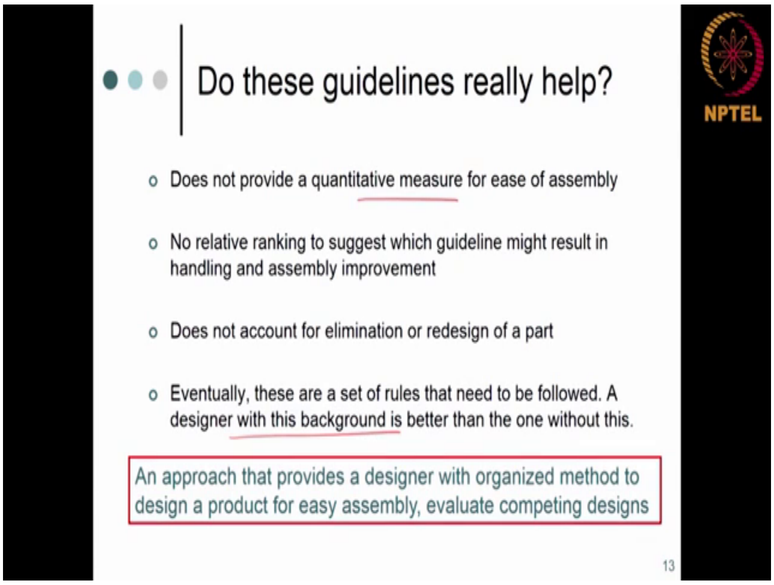

The other stuff is this does not provide a quantitative measure for the ease of assembly. It does not give you a relative ranking. To suggest which guideline might result in handling and assembly improvement that that is what I said there could be multiple things, right; which one would you choose, because you always wanted to reduce the cost or time or whatever that, right, efficiency perspective.

And, again this does not give you a perspective on can I eliminate a particular component or can I think of it from redesigning a particular part this does not give you a guideline yet. It just says you if you have this condition you do this. So, then if you have a particular problem you need to go through all the conditions then figure out that hundred and second was my condition. Eventually these are just a set of rules that needs to be followed, but I can you know you need to be there to understand these problems over the years.

And, usually a designer with this background is better than the one without this. So, basically you are trying to what you like imbibe the legacy, instead of an expert you might want to imbibe the knowledge that is not what we want. Instead what we want is an approach that offers a designer just like a (Refer Time: 30:25) tool or something with an organized method to design a product for easy assembly, you should be able to evaluate the assembly before going into production be able to compare it with competing designs. These are the thing you want to do and that is what essentially DFMA does.

So, what it does is it tries to quantify all of these simple guidelines that we saw and more much more guidelines and it will try to quantify all that such that finally, it will give you a number, so that you can compare 9 versus 10 and you are not comparing a versus b.

So, we will today wrap it up with this.