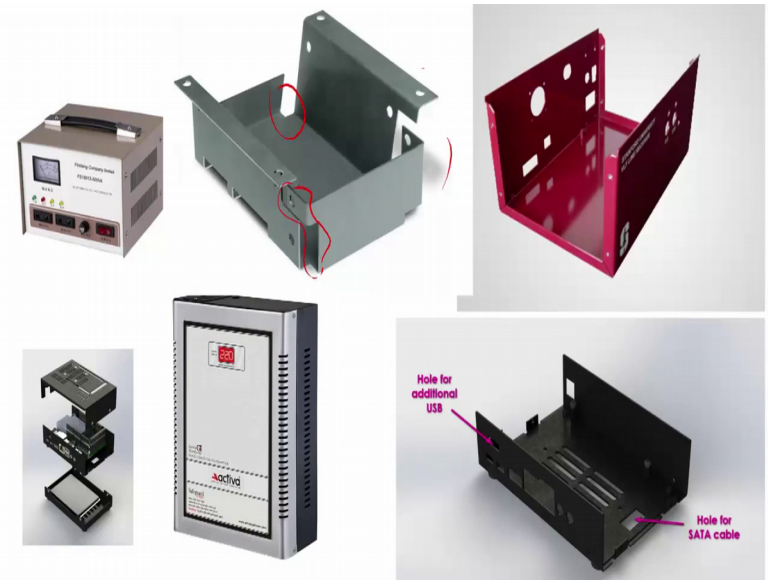
**Enclosure Design of Electronics Equipment**
**Prof. N. V. Chalpathi Rao**
**Department of Electronic Systems Engineering**
**Indian Institute of Science, Bangalore**

**Lecture – 20**
**Development of Enclosures for bending**

See this here.

(Refer Slide Time: 00:14)

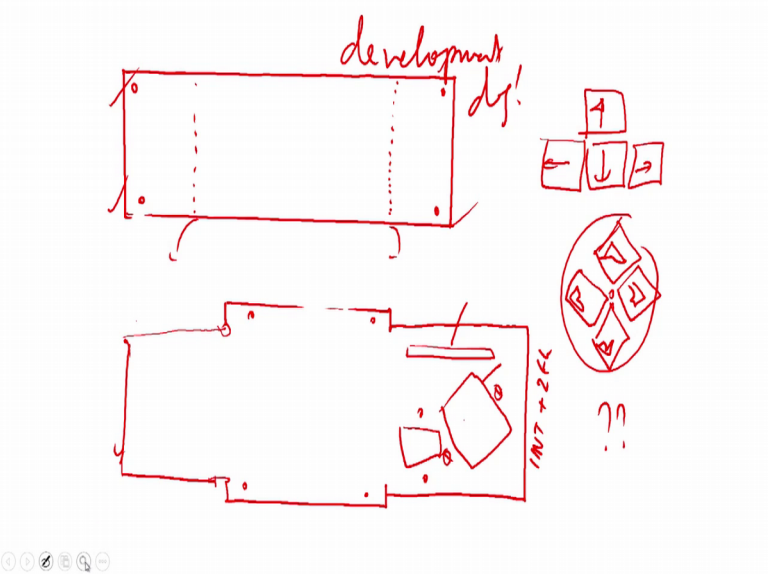



We have lot of openings here we have this then we have opening here, somebody has to take all the trouble or

(Refer Slide Time: 00:24)


Fabricating or laying out the front panel. So, again I keep telling you why it was important for us to make the card board simulated model, is that we need to layout a proper front panel. If you remember first class, first slide I showed you a power monitoring box that had the same thing here that had these 3 this thing, except that it is in the right side and then there was no keys were on another side. So, you see here we are in a nice very comfortable this thing, you see here all this peculiar notching and all what even looks a very simple thing, you have a 45 degree cut here you have seen this.

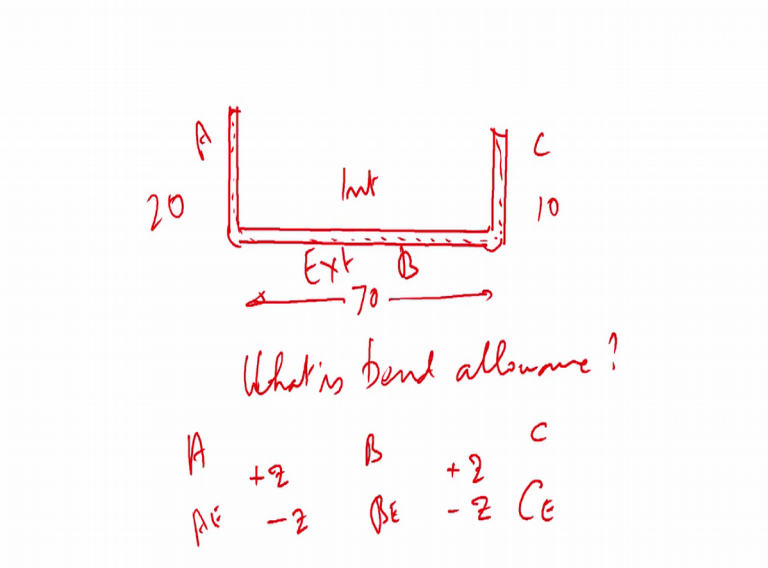
(Refer Slide Time: 01:25)



If we were to have like that slide what I have shown here may be with needs to, I mean we need to make something like this and then give a 45 degree notch.

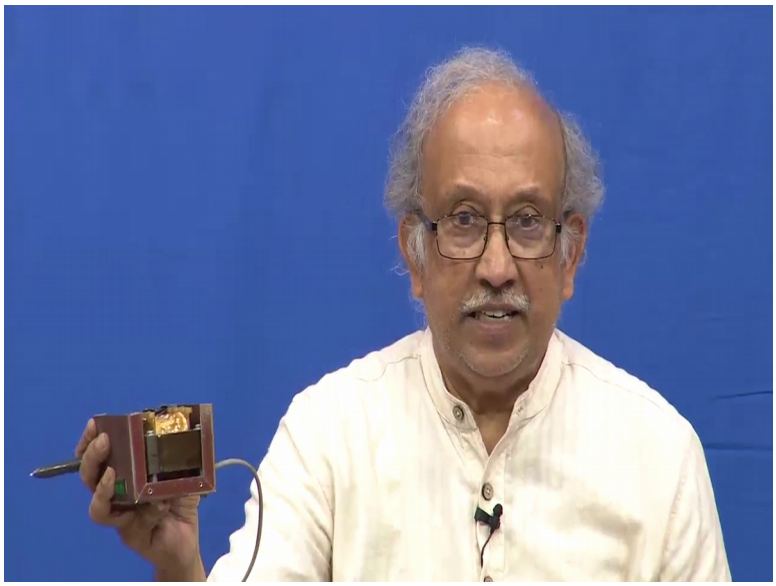
So that, it.

(Refer Slide Time: 01:47)



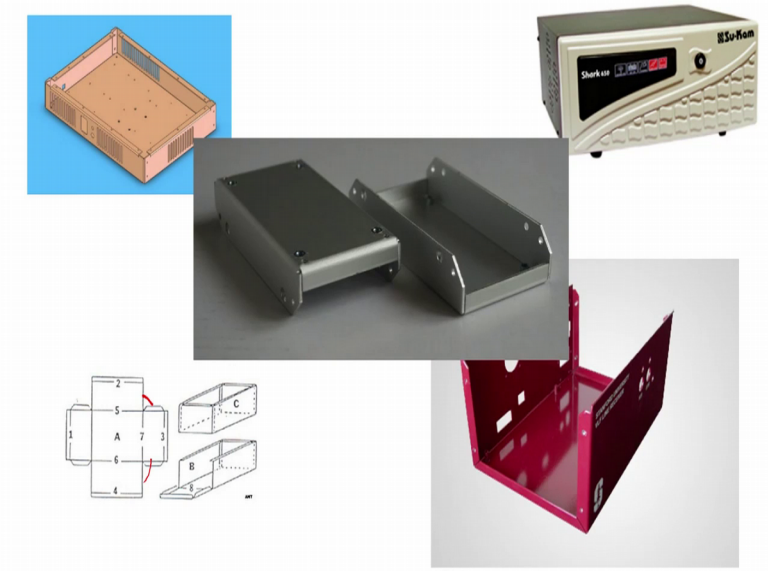

Sir, if you can kindly show me this. So, I have my box earlier

(Refer Slide Time: 01:53)



You see here we have a 45 degree cut here. So, when you spread it out you have a beautiful 90 degree notch and while sometimes it is this corner is very unsightly, it does not come out well that is how they give all the other things.

(Refer Slide Time: 02:19)



Maybe it is about time I showed you these pictures a fully laid out with all tabs is probably going to look like this, not this tab goes and attaches to there, this tab attaches here, have then you see here there is some small projection here and there is a much bigger piece this, I have shown you already and you see this how this parts look like that notch whatever talking about you watch this notch here this is a same part that I have just turned it over and showed it here, why I am showing you things which are available is it is a classical would you learn the technology and look for an application for it or you find the application or develop the technology.

So, in this case the sheet metal has been around for quite some time, probably from the Iron Age when people were using rot iron, so it keeps going absolutely no issue about it. Now, coming back to the, we are come to this beautiful what you call drawing related to all these funny notches and all that I will remove and then try to fair it up, basically it is ok, and here you will notice one of the very very important rules when you are working with sheet metal.

All operations have to be done when it is in the flat condition you will be just you can know it, once the what you call the bending or the forming is over if you attempt to do

any further operations except some speciality things the chances are you will lose the dimensions. So, in this case most likely these operations, these holes have to be done these holes may have to be transferred here alternatively you make these holes and transfer them there or if you are in mass production and you have a fixed to make all these make them and in the front panel has any openings, including that you know power thing here and then may be a key pad you make everything here and think up front we shows think everything up front this is where you know that making our model will help.

So, we are all of us have seen the characteristic piece the keys like this. Now, we have what use write this is generally means up, this means down, this means left and this means I am sorry; that means, right and this means left. Well, it look it looks fine there is no reason why things needs to be here like this, this we are know little element of your creativity helps why not make them this way more friendly. So, we have up, right, left and down as arrow keys meant to work with a gimbal movement and what you call a joy stave probably the work reasonably well, again you still have that problem of can you make it fast and slow then we work with two handed operation are beers in small thing here and the centre which operate everything. Whatever decision you take 2 options need to be considered here, one is do you reflect the all those openings here you reflect all the openings here or alternatively.

It is a small printed wiring board which goes and sits on top of it, in that case know probably we will have a big opening here and no more of this small slides have a big pcb printed circuit board here and that may require some mounting holes. Probably you just need 1 mounting hole here and 1 mounting hole this is for us, enough for us and then the whole thing is covered by a sheet on the top which will make it invisible and in case you wanted it as a lighted panel it is possible for us to work in all these things. I will see, we can look at the slide which we has trying to show you, you see here you see here in the corner something else has been played with a little.

(Refer Slide Time: 07:40)

You see here, this is characteristically what you know we do, so this is what has trying to draw and show for you. So, we have a front panel here this is inclined and then you have the keys and then there is an overlay sheet here and then you see here, we can even have displays we can have led's at the back we can have grouped controls same thing here at the bottom.

So, we have a big this thing you know a portable what you call inverter for cfls, why you have picked it up this boxy saying you can usually. So, even today a large number of items continue to get made by this type of sheet metal work, you have see a small detail here in the corner whatever is talking to you is there, how things overlapped each other and then you have a handle and now you take a decision whether you know that that the you see these 4 mounting screw, which is for the you know top cover you have a top and bottom cover and then you have a small front panel advantages of such that devices you can take things out and then service them. Now, we come to the important the very very first question if you remember, very first question is.

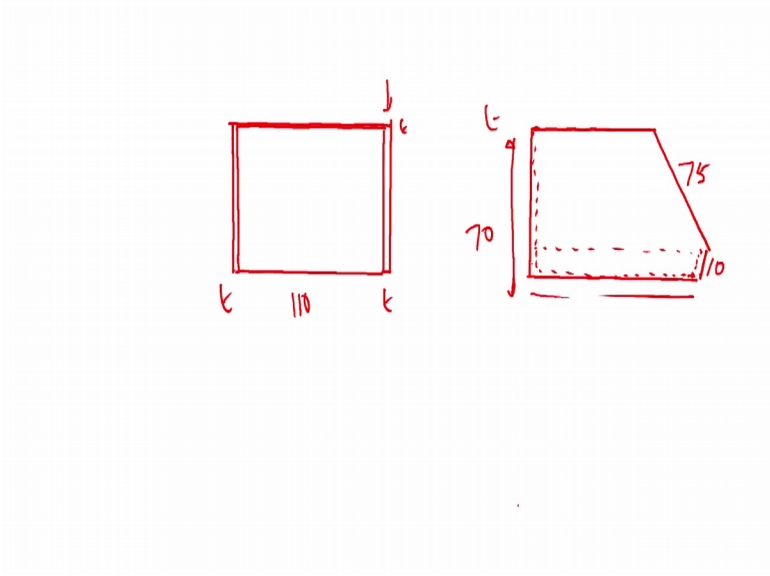
(Refer Slide Time: 09:12)

| purpose | 1 | 2 | example |
|---|---|---|---|
| | | | |
| form | organic ( rounded) | Boxy ( Flat) | |
| quantity | small batch | Mass produced | |
| material | metalllic | 'polymer' | |
| tooling | gen purpose | Job Specific | |
| prototype | working | production | |
| purpose | proof of tech | Batch products | |
| concept | Design features | Technical demo | |

On what way do we decide on this? You understood know decisions, decisions, decisions. So, if it were very one of this what you call inverters are housing things they continue to be boxy, it is a production proto type you are making and they continue to be mass produced advantage being still buy it that is cheap, very very cheap.

So, it is for you to take a call on all these whatever has been made here and then see what best you know, decide on how to produce a thing and then my own metallic if you are a small entrepreneur, is to going for the, over the well design if you concentrate on what is a dirt you would like to make and present, it is very much possible for you to make something learn a little about the sheet metal work and then try to do, various drawings and get our cells into this and then try to make a box like this, which I feel is the a very simple and easy way to go.

(Refer Slide Time: 10:27)




Now I will take you back to our two more slides and show you what things can be done. So, I thing I have shown you all these, these are all smalls and ultrasonic welding equipment and this is what you will probably, you see this equipment all around with you, this looks like one of the what you call cables for your apple and then these are all various boxes, this is probably something related to a biomedical equipment.

(Refer Slide Time: 10:50)

(Refer Slide Time: 11:07)

You see here this is a normal monitor. So, this monitor has been mounted in a, this thing which we I do not know we had this probably some part of ecg or something. So, they try to make, this is partly made out of sheet metal and all that, now we have these ubiquities amplifiers and dj equipment invisibly all equipment you know, they come with massive power, power, power and all that racket and this probably a 20 or 30 years old and still it goes and used in harsh environments and you see here we have a beauty only thing which I thought I will point out is that, the side panel which itself an aluminium heat sink and then on the top they have we have some openings and on the top of these you have some dvd or some vcd player and enduing any of these designs the last forever.

(Refer Slide Time: 12:10)

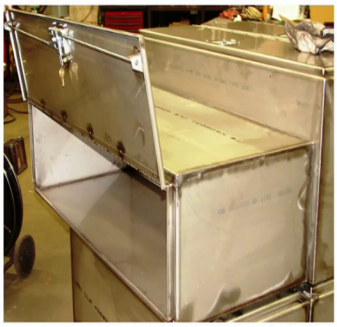

It is an old very very well known telephone form, this has been find out and you find who are convenient and then there people use it and then you have a this model, what could be a very ordinary what you call table thing based on the semiotics. Now, you see they have added a few things here I am not sure what is the purpose of it, but I know it makes a desirable and this is a purely technical thing it is a what you call conducted semi filter and by because of the technical cap, what you call nature of a it has to be made out of a single piece whole thing is made out of a drip down can I no comments about the material but expect it is a special material and well this is purely for a technical reason this is purely technical.

Here, it is partly a setic, a setic reason we have this is ergo plus a setic this is more as a what you call cells are this thing that things are made to be made a little softer, if you have to make something like this chances are people would not want it if you were to keep it on your table or somewhere in a visible place; obviously, things like this continue to help.

(Refer Slide Time: 13:43)

Now, we come to several equipments several things which are of an one of so, this is from a clore equipments are studio equipments is studio we have much smaller version of it, if you see here part of this furniture and all is all you know assembled, but the other details of I know you end up with small boxes I expect this is probably a mouse or something and then you have a mounting real and all these things they are made with structural elements which are taken from the technical furniture field. So, I will just go down to towards I am sorry to the end of this slides and see where we go yeah, see this.

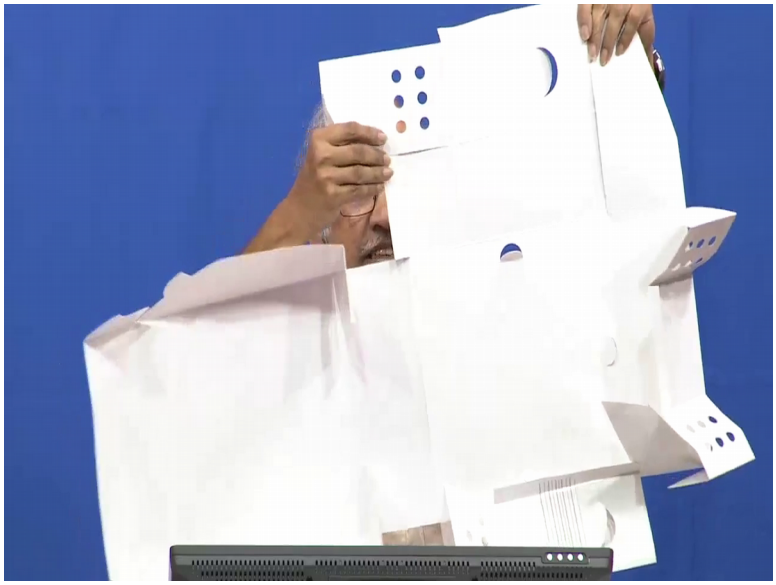
(Refer Slide Time: 14:32)



Now, we come to what I was telling you about a job shop, in the case of a job shop things like this I do not know whether it is a riveting machine or a drill or something and then we have several you know things and what you call in a small work shop we are all available.

But, conditional to you are being able to imagine a proper product and then make sketches make a proto type which you can demonstrate, it can be in the form of a card board model or some sheet metal thing and if you now give it to this what you call job shop people they will make a very very you know beautiful, beautiful, equipment which will keep going more and more and more you will never end up with a failure, you continue it will have equipments which will work 100 percent all the time . So, over here it is lunch time and then I will stop here. Before going I thought I will show you a beautiful cake box.

(Refer Slide Time: 15:44)

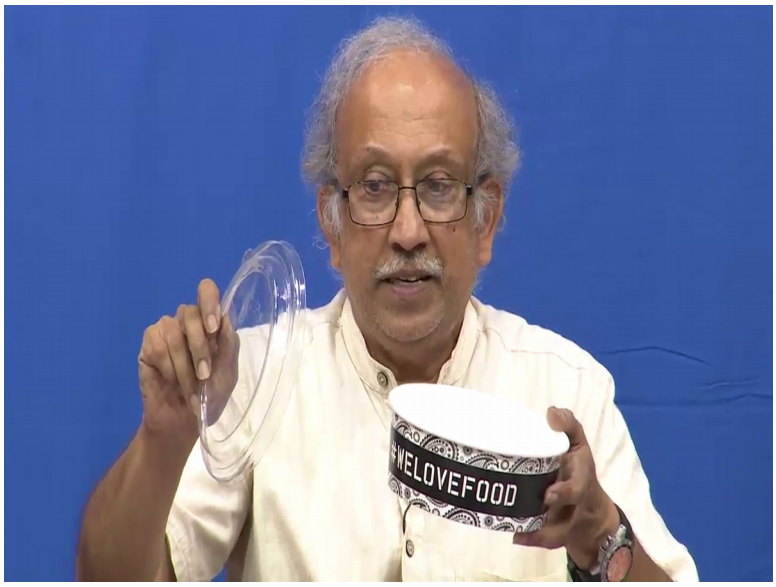


This is probably one of the best cake box I had it, open it opens beautiful cake box of course, this is not a what you call cake cover, but then we had used it as that you see here the way they have made boxes will made such that you can even have a fasted pack.

So, you can have an ice cream cake in it and then as you open it, it is a wonder to me to see who has imagined such a beautiful, getting better and better and better you see here I have such a beautiful box, whole thing is made out of a single sheet of paper nothing is wasted see here every corner every bit of material has been used a little bit of overlap

and what is lost probably is used as packing somewhere. So, I have a beautiful huge cake box here sheet metal as yet as not come to this stage that is about a as much there you have seen that know sadly, I here I cannot give you the food because I have already finished it.

(Refer Slide Time: 17:16)

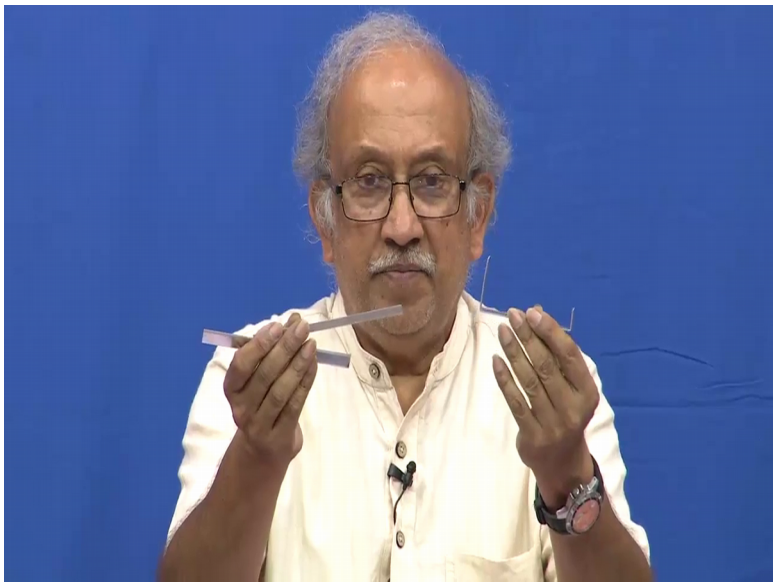



Even if you take routine things like, oh I think I should avoid the trade name. This one is a throw away box, well it throw away does not necessarily mean it is a waste it can be recycled easily, this part of the top portion is made out of thermo forming.

So, this can be shredded and used and this is classical card board. So, you can do some craft out of it or probably it can be recycled without any problem, the same concept slowly entering into our electronic field any of our enclosures and all that what we make its expected that, we can reuse the materials one of the easiest way of reusing the materials is to use standard recyclable materials and as much as possible make them detachable, yeah something is stuck together and laminated poly laminated materials cannot be recycled, but if they are made different materials and they can easily be separated very easy to get them reworked again.

So, you can supply them all send them back to the factory and they deal with all that and overall the environmental load is reduced severely. In the next class I will see if I take you to a workshop and then try to show you how this sheet metal work is performed.

(Refer Slide Time: 18:48)



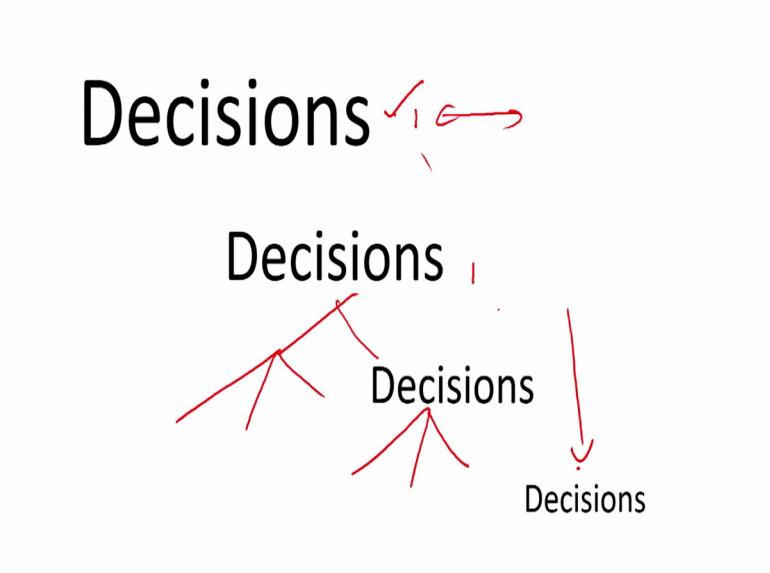
So, what the sheet metal in this case that I have showed already, I have two sheets both of them are about the same size and then I (Refer Time: 19:00) marked, marking you cannot see here and then after you finish so bending it you will notice that because of the variation in thickness both these will not give the same job outside the limps may be slightly different and this is part of it as a an equipment designer you need to be familiar with these items and this particular course has been run in this department for the last, I thing is been running since 75 that will make it 40 years.

So, people have benefited by it I expected that in the next succeeding class I will see if I can show you how to mark out a sheet how to make this thing. Now, if my video people can kindly take me back to the this what you call ppt, see as I said we make a honest attempt and trying to make a development drawing that we need to have a development drawing, we need to have a development drawing because after bending it should form the original dimensions what we intended and why do we need to make it that it is an electronic engine at that need to make it yes finally, you do not need to make it, but you need to work with these people on you know how will a final production is going to be in the reality it is, both sheet metal work standard enclosure which I have shown you in the first or second slide and thirdly rapid proto typing or real.

Now if you have one person in the team who can help you with these things you can the team work can help you with the saying this this this it need to take a decision about it

and then any decisions taken at the highest level, decisions taken at the highest level have for reaching impact down.

(Refer Slide Time: 21:21)




So, if you work if you think about it or little here and then come and implement those things here, you know your you will save a lot of time, money and effort and contrary to popular consumption that it takes time it is otherwise in the longest run cycle to the market, probably the least cost and the least timer spent in it and the movement you know that you know the down sting this these are down string decisions and then you incorporate them up in your design at the highest level, it will become routine for you now it is easier for you to make things which you know are quick to market and easy to produce and economical and finally, recyclable.

So, thank you for today's lecture and then, hopefully when we meet again I will take you to the workshop and then see how we go about making a small unit. So, there again two issues for it they will make what you call a sample unit based on a, what you call or a product or not it is both. So, you it is fine to learn you will make a small exercise learn then you have a concept in mind and eventually when you implement all these and make it things work. Because of me working with computers and all that and using a digitiser has spoiled my capacity to draw straight lines, I cannot draw a straight line it is a sad, it does not mean I am thinking or anything it is just that you know the manual density has

come down not long ago only about 30 years back we had a drafter and then we had to make everything proper and there is no simple way of modifying it.

Now, that we have the digital what you call tools are available it is possible for us to make beautiful repeatable structures without too much of effort. So, after learning a little about the workshop practice and also may be learning a little about what can be done and using plastics, probably I will introduce you to some sort of a compute rated drafting. So, there are 3 things about it one is simple drafting you understood know. simple drafting it will take a drawing and you know sort of make sure that lines are horizontal and vertical the same ways I have drafted it has and then design with assembly once you make things in three d you can make things fit together share dimensions and all that and thirdly the analytical part of it, analytical right now that that is a different field and I am sure other these things what you call other people can people can help you better at the conceptual level if you have things a little in the background probably once you make some idea or a one design concept later on taking it and Optimising it will be slightly easier.

It comes the old egg and chicken question saying how do we select a particular option not the at solved one is work through all the details of each option and then decide which option is good. So, that is from the optimization point of view whether it is stress analysis or its about materials or fabrication, another is because we have accumulated lot of these things as get feelings we can ask somebody who familiar with its saying what you thing which works, but then people come back to this saying if a customer who are asked once upon a time when the motor car has not been invented what would you want in your new car age, car age.

So, that do not know it is very smelly is there a way of getting rid of all that smell and can we be clean, I thing in the very first or second lecture I told you the allegorical representation of the horse power has not gone I have more horses, but things I have changed a lot except as I told you if you have the thing one of them is, the horse carriage suspension continuous to be made very heavy things you know only may be around 10 years back even your railway rolling stag they have changed over from the leaves springs to other what you call helical springs and later on to rubber elastomer mounts. So, the elements have and then the analytical part. So, if you see the original steam engine it had that wits governor. So, parallely on how to you know control or have the mechanical thing and how to do controlling these things including, what is a loop? What is loop

gain? What you, how do you amplify? And what is the error signal? What is PID? They also have been developed parallely.

Now, these days you do not need to worry too much about it, if you want to give a small advances what you call injection in your diesel engine or anything not a big deal anymore a multi jet engine is understood I cannot make one, but it is understood so, but if you see an old what you call locomotive diesel, I mean the steam locomotive the actual part which produces the power it just a small cylinder. So, big engine may be the cylinder is so much, but the locomotive is so big and then just to give a small advance to all that linkages were required. So, that steam can be injected a little in advance. Now thanks to electronics and all that is very easy for us to work with all these things.

Thank you. Let us meet again.