Design for Quality, Manufacturing And Assembly
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Overview For Manufacturing & Assembly
Lecture - 41
DFM Software & Case Studies

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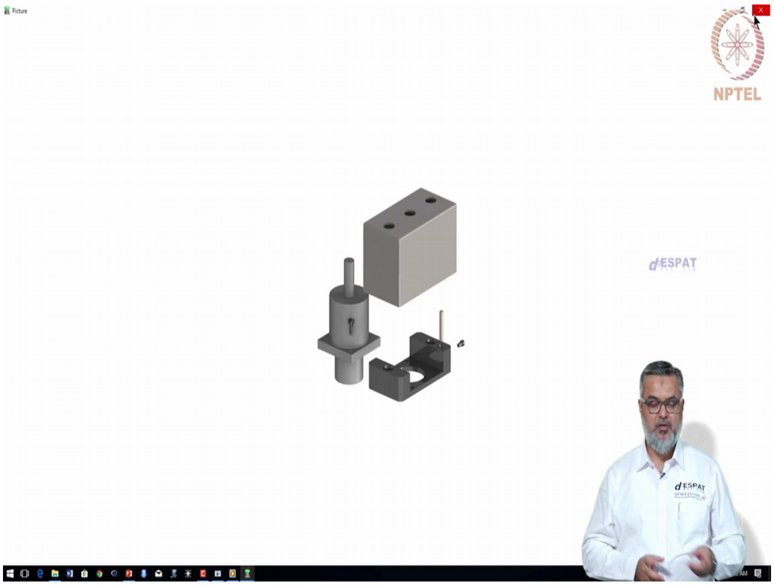

Now, that I have a new intent of a component ok, which as we are highlighting now. This is proposed new design can which looks like this. This is need not necessarily be a cad model, because most people when we would visualise, they are able to sort of they want to have a history realisation of what their product look like through a cad tool. It need not necessary be a cad model, it could just be a sketcher drawing that you came out with as you are having coffee with your friend and you want investigated. DFA, DFM allows you to do that you need not having necessarily engineered model of your design intent. So, I have this over review of that envelope shape.

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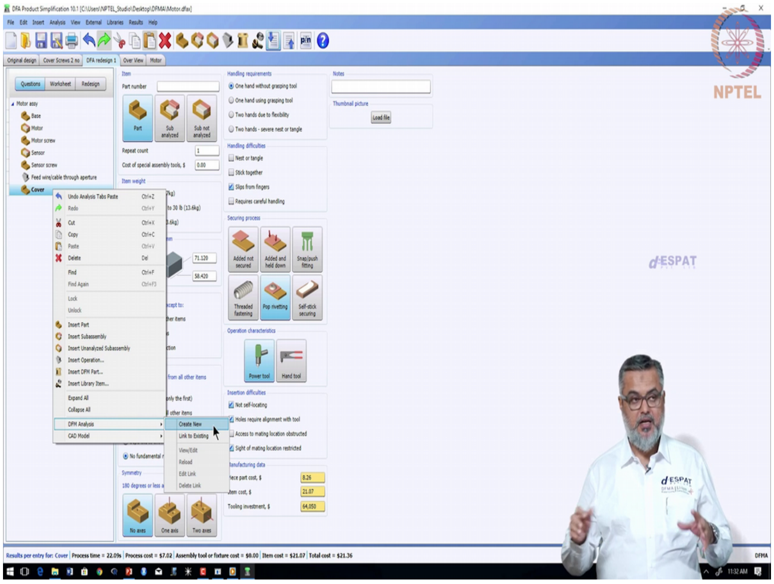

I am going to take that intent from my design for assembly tool bring it into design for manufacture.

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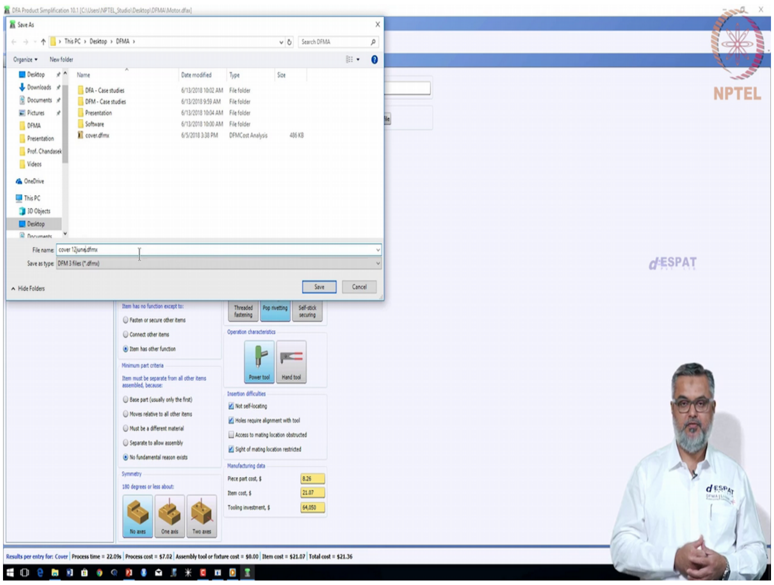

DFMA is a true conquer engineering methodology. And this tool facilitates that. So, what I am going to do here is take this design intent from design from other software and move it by asking it to open a new file for that envelope, because I want to investigate. What is going to cost me to make that particular new design that I have. And the DFMA tool help us to do it.

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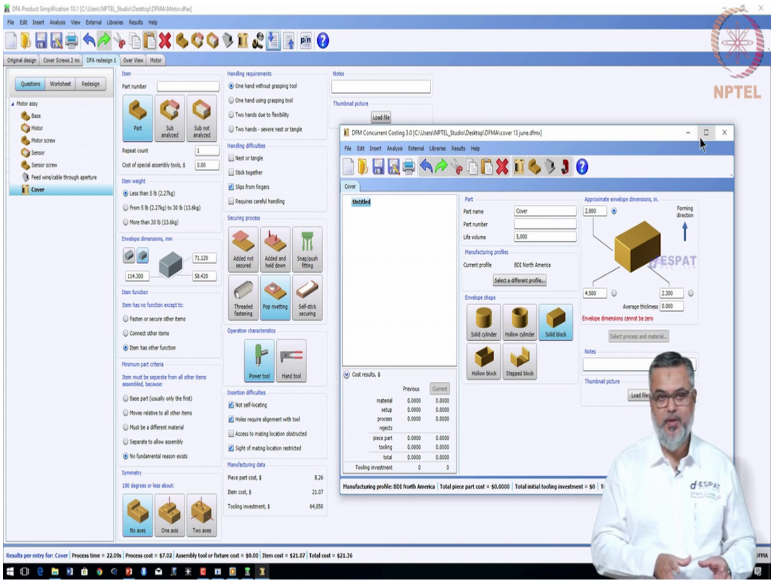

How? Once I brought it into DFM, what happens is the envelope shape, the number of components I want to make automatically come up from the DFA file. This is one way of doing things. You need not have to necessarily start from DFA to do a DFM analysis, you could do part cost in isolation all together, but we just want to showcase the strength of the tool.

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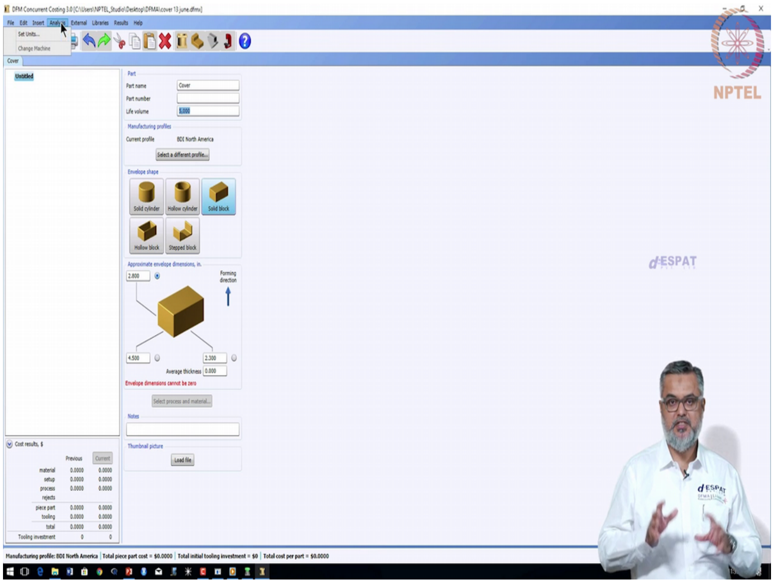

Now, that you have into DFM you maximize your life (volume, which means you need to find out how many number of these parts you intend to manufacture. In most cases, a number of parts manufacture are more than what you an organisation would work or require from an assembly standpoint. Why they would do that, because you want to plan for service warranty and maintenance, inventory also, so that is said we have the one envelop dimensions and you give an average thickness bingo you can start from there.

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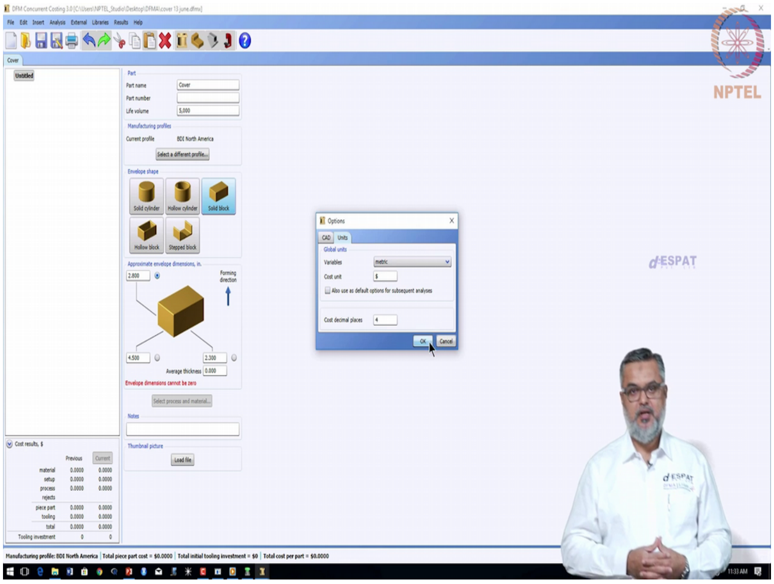

And select this process material chart. I do not think there is any tool in the world that probably help for designer to do this, even if he is not a manufacturing expert, which is to facilitate.

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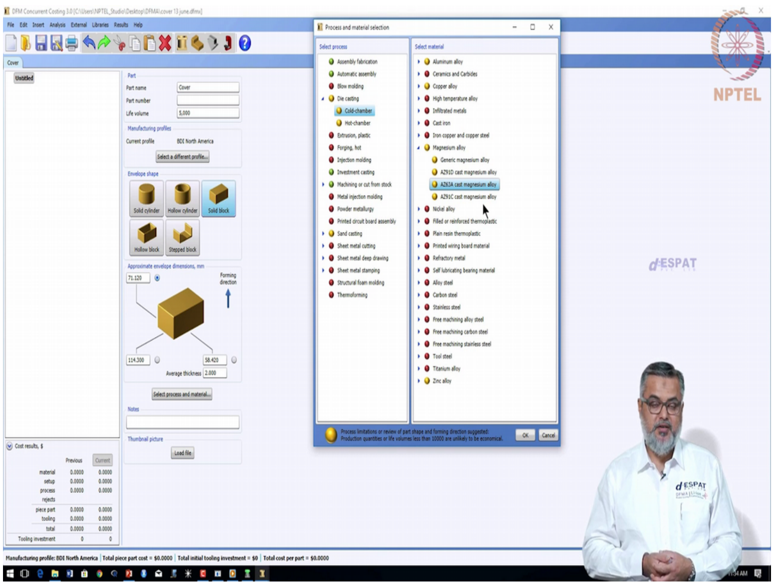

Given an overall geometry and volume and thickness of a part, you select a process, it will tell you what kind of compatible materials are available to do that part in that particular process. Alternatively, you have a preference for material ok. I like to make an such an such and such material, it will show you these are compatible processes. So, this for the sake of this demonstration.

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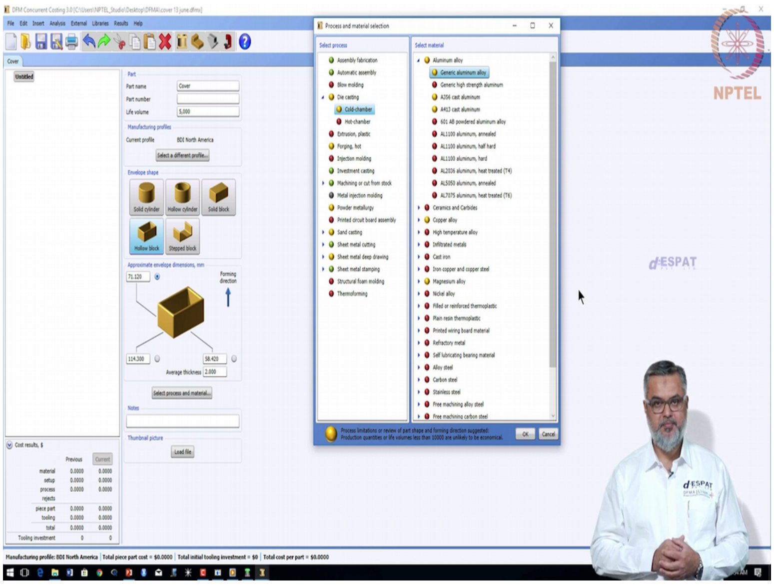

Let us look at investigating this part in three different materials and processes. We will start with casting. So, we will take by casting process, we will select aluminium. And as I select this combination, you will see this process material selection chart shows different colours. So, if I have to see a green colour on either side of the process and material chart, which means my selection is apt for the design that I have in mind. If I see yellow, then you see at the bottom left hand on of that process material window, it shows you some limitations.

Hypothetically let me create a situation for myself, I will cancel this. I will say for this overall geometry that we have what if the average thickness expected by the user was about say 12 mm right, I just input that and I go and select this process material chart, I select the same process and other material. You will see the warning that come up that the bottom reflect, what are the process mismatches or in capabilities or exaggeration that the user has in mind, that said DFM is not pure science, it is a set of guidelines that have been documented over the last four decades by a principles through industry, best practices, time studies, academic research that is a part of our system. So, though there is a warning that says more than 11.99 mm is unlikely to practical. You can still it also allow you to ignore these limitations and explore what would happen, if you were to select this process of metal combination.

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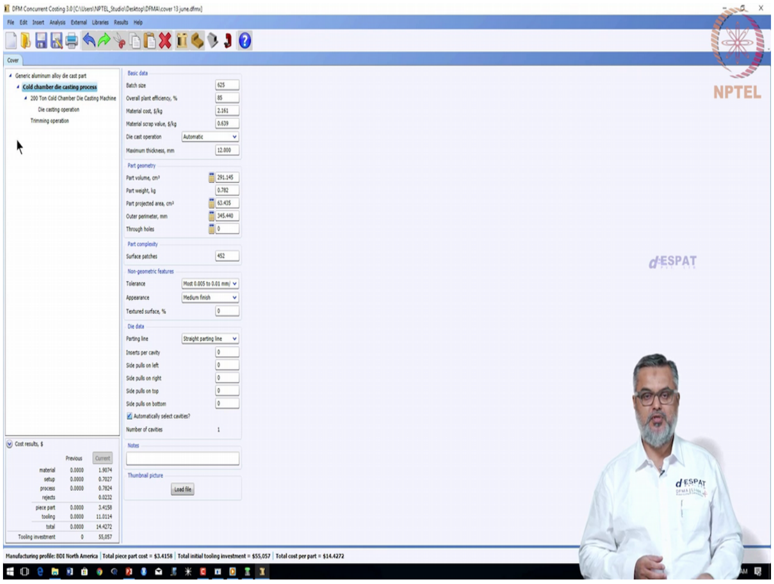

And in a less than a minute, what you have is on the left hand side what we call is a process chart that is generated for this opportunity that you have. And on the right hand side is details reflecting the process combination that you have chosen. And on the bottom of left hand corner is are area of interest, which is the cost implications of the material setup process tooling and so on and so forth that goes in this in the fabrication of the spark. So, you have tooling investment, which is fairly is the mould cost in this case and the cost of the piece part.

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Now, if I go to minimise this window for a minute and you look at the design for assembly window, from where we actually got the spare and part. You will see on the right hand side, the manufacturing cost is captured, which means I would probably be doing designs here. And I could be sharing this on a common server, where some of my friends or associate or vendors a pick up this diamond design somewhere else in the globe, do a design review of the car or do a early manufacturing analysis. And throw it back into in the same server and the matter of few minutes, so that is how we are helping organisations to squeeze a design time by more than 50 percent, if you recollect my earlier presentation..

So, what I am going to do here is we are not going to get the details of this of all these process charts. We have said that DFMA gives you a rapid feedback of a design intent. For example, if I have a process here and let us say in my set up, I do not have automatic, but it is manual. What is the going to be the implication of this, I select the option, I press on this calculate button on the cost window and what I get is comparison of what my current design, what my previous design is. So, this way if I am not manufacturing expert, I have a tool that facilitates rates us to reflect on the manufacturing opportunities.

So, in that interest, let us do at capture of the same intent in two more different processes. So, I am going to have a same design of that envelope. And copy and paste it into a new file without changing the reference of the dimensions or the thickness. And we will look at another opportunity maybe to look to explore that part in say sheet metal. And if you look at our process material combination, we will see we have several different sheet metal processes with the sub categories and the each of them. So, I will try that turret press and probably low carbon steel and that combination I am going to get a review of what that the component would look like..

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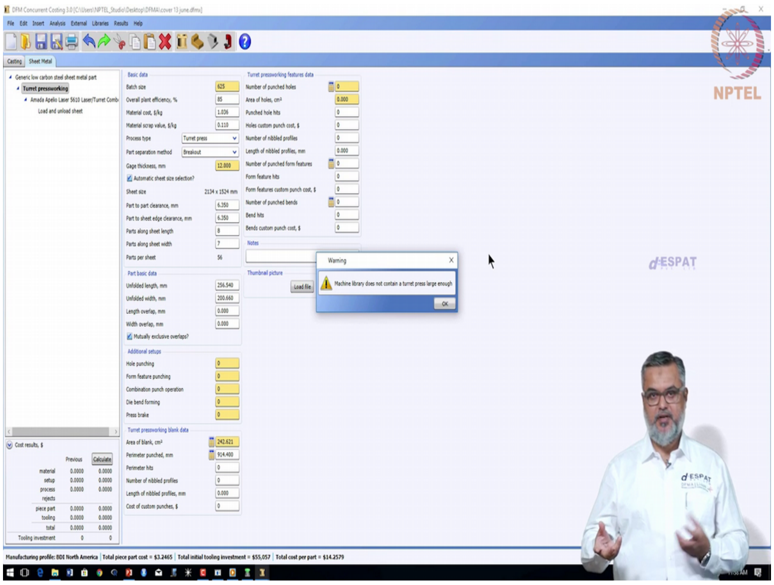

If I were to in terms of cost perspective for getting this manufacture in the sheet metal process and you will see that I switch the process from the current casting to sheet metal. And here I have another problem that the dimensions that we have taken 12 mm is unlikely to be practical, because we do not have (Refer Time: 07:17) that we can actually stamp 12 mm sheet. What I am trying to say is this tool facilitates as a as a knowledge base. To help the designer get the get a rapid feedback of his design intent by saying what are the possible and not possible with the criteria the here selected for manufacturing his part.

While it does not stop him from going ahead with analysis, he knows that these are the problem areas. Instead of facing them in at the later stages at the production, at this conceptual stage, I am able to get this feedback. At this conceptual stage, when I have not investigated or invested in a making a car or engineering model, I have a feedback of what my intent is going to be like. So, let me just make a one more copy and get this in as a plastic component, so I will select probably investment sorry injection mould and maybe a good engineering plastics say like ABS as another candidate for exploring this part for exploring the manufacture of this part.

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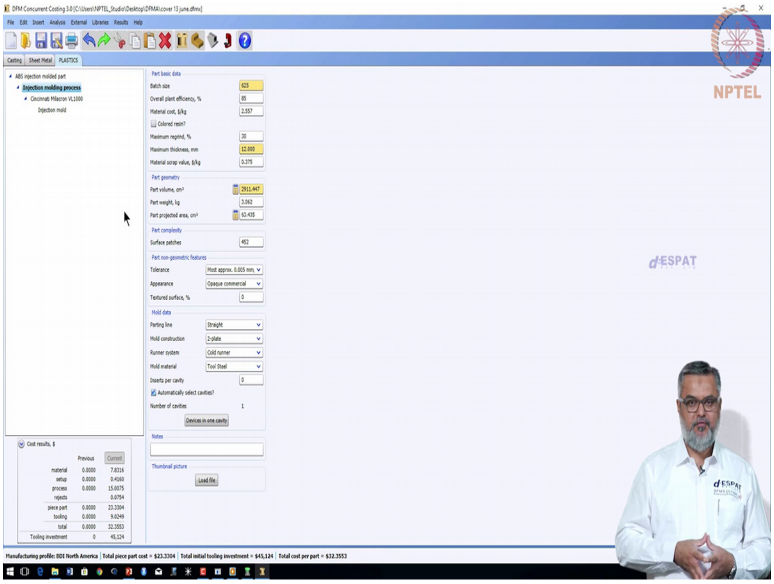

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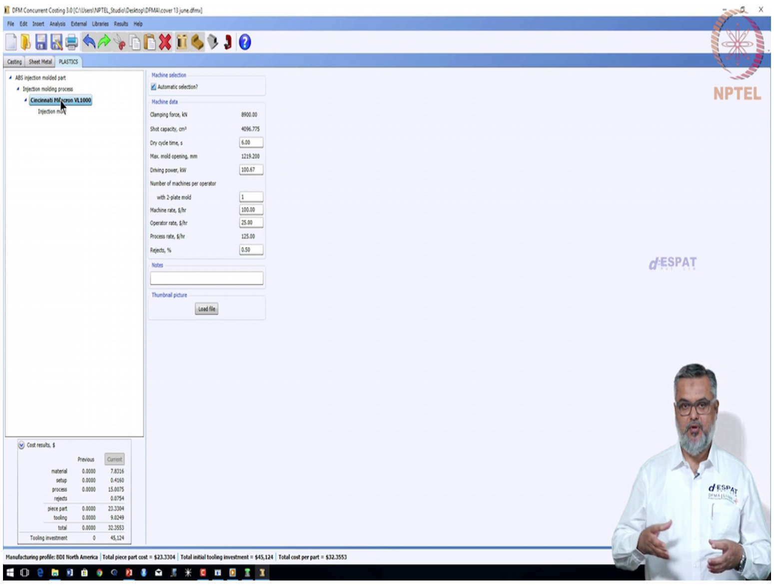

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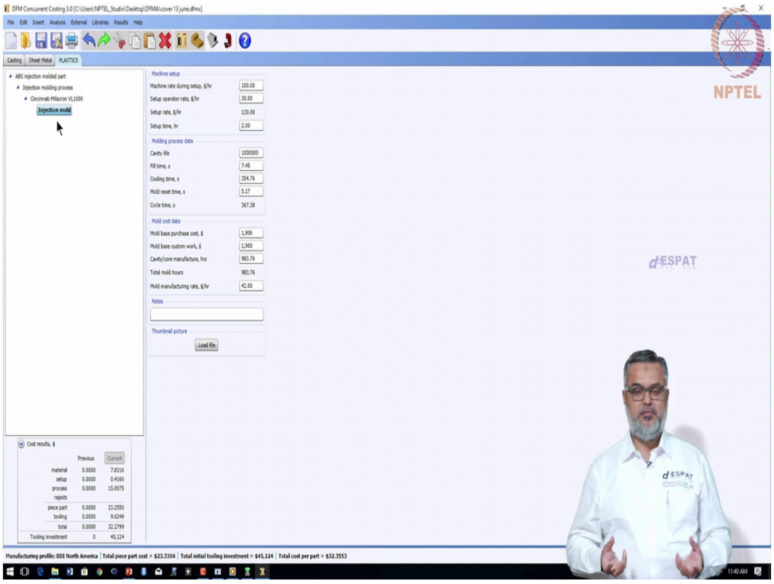

And in about 5 minutes what we have done is we had an idea for a part. And we have investigated what is going to be the possible combinations of materials to make this part and also suitably chosen the processer for operate.

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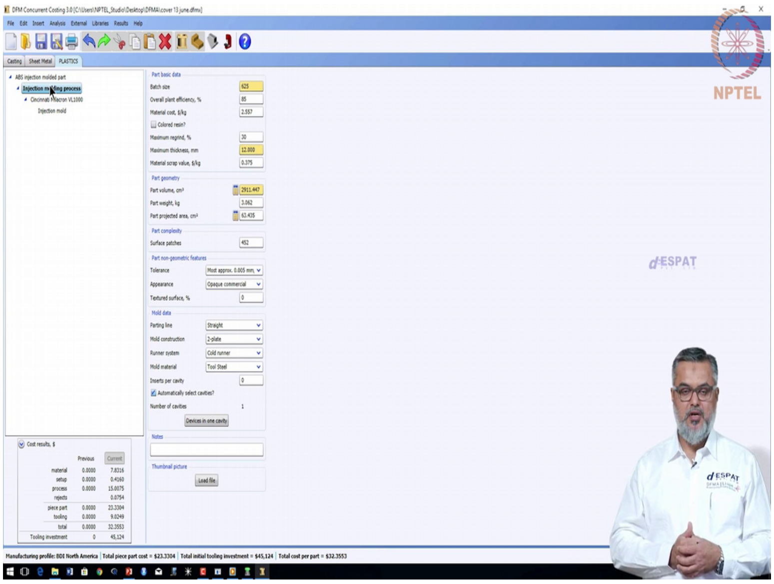

I like to highlight that the what we see here, while we are looking at cost angle just in the interest of the of this overview. The software gives you detailed analysis of what is the cycle time associated with it.

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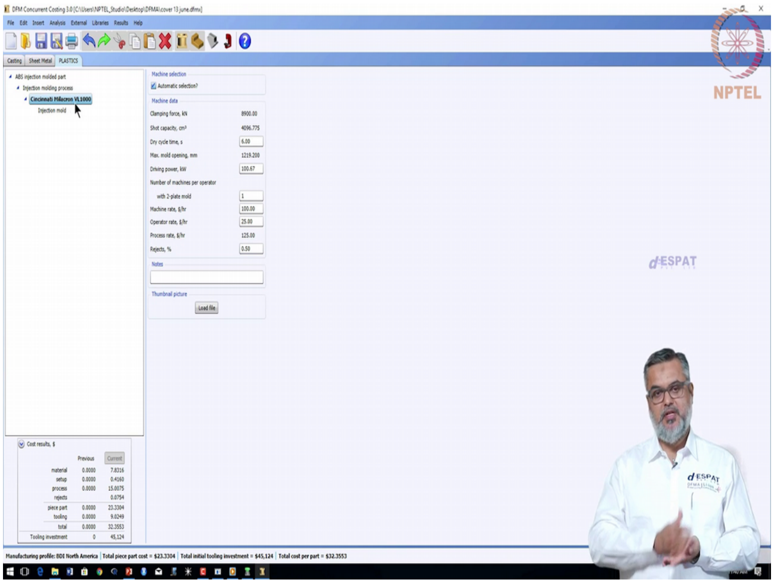

What is the let us say we know machining, what is a kind of a detail parameters related to the volume material removed, what is the RPM of the spindle speed that is required for cutting the material and so on and so forth. But, at the end of the day, the comparison will leads to time and cost is easy for anybody to comprehend. Not only us as an engineers, who may be using this tool, but everybody else in the organisation, who can also participate in making a collaborated decision or on which is the suitable a part or which is the simplified design that one should go after based on the reflection of our design intent. And the output being in terms of time and cost that is the basis of this overview. A detailed representation of what these tools get producer could be done more intensely.

So, at this moment, what I have is I had I had a DFA part, I analysed it, I came up with couple of revision of design. One of the designs I have taken into manufacture and that is the rule I am playing now. And in that we have investigated three process and materials, but as you see the lot number in the bottom left hand corner. So, we will use the tool the results generating window to create different reports. One of them is this report for breakdown of material process and tooling. So, let us expand that as a graph and accelerate all the three opportunities that we have explored.

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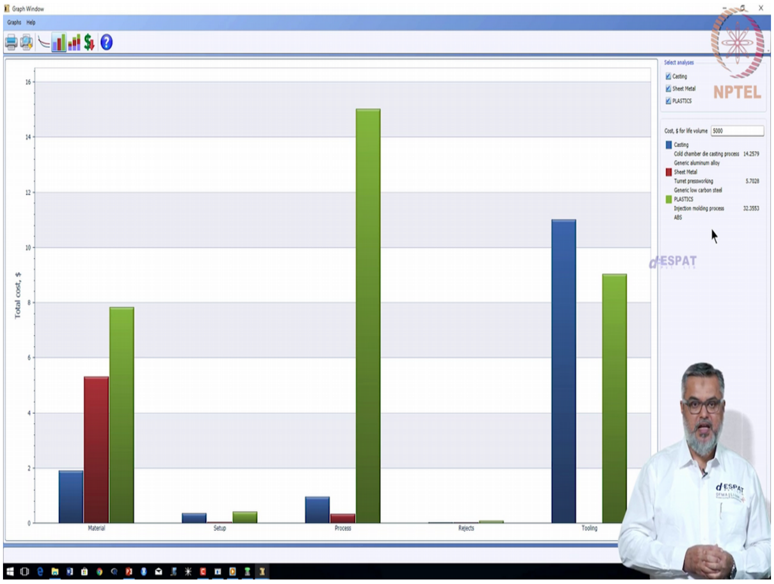

So, in this graph what you get is of one-page window, which reflects the process material combination selected by the user on the right hand side. The volume in implication that he has taken into consideration and a breakdown and say terms of material setup process rejection and tooling reflected on the bottom left hand corner. So, we move the cursor on any of those charts, you will get an implication of the cost value and also the percentage contribution.

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So, I can look at this graph and this fashion, I can break down the graph as a stacked bar graph. So, now the (Refer Time: 11:01) are little slightly different with tooling reject, process, setup and material reflected on in different colours. And as you can see if you move on each of this chunks of the graph bar graph, it shows you what portion rate is must percentage in terms of and what kind of cost value.

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More interestly, we have another feature, which is call the cost versus life volume graph. And again an important tool if you are making decisions or if you are some more like an (Refer Time: 11:32) who wants to negotiate with the vendor as to what is the right mix of this combination. For example let us say hypothetically, if I move that selection ruler from there to the intersection of the blue and the green line, you will see that if I want to make what 424 plus parts, I can actually match casting at the price of plastic..

Something somebody would want to investigate, if he is not interested have a plastic part for an automotive design or if I move that selection ruler to the intersection of the blue and red line, I am saying that If I get a number of what 20,000 plus parts, I can make casting up your much more cheaper than sheet metal. So, these kind of decisions are always happening in the industry, but this is happening today based on the gut field based on experience and know how that is resides with the organisation or with individuals. But, with the scientific tool like the DFM, what happens is a anybody who is furious to investigate his or her design, can get a rapid feedback of their design intent and that is what this tool facilities. Further if you are purely manufacturing person and you have issues in explaining your difficulty of manufacturing the part to the design team, which usually is the case with most organisations.

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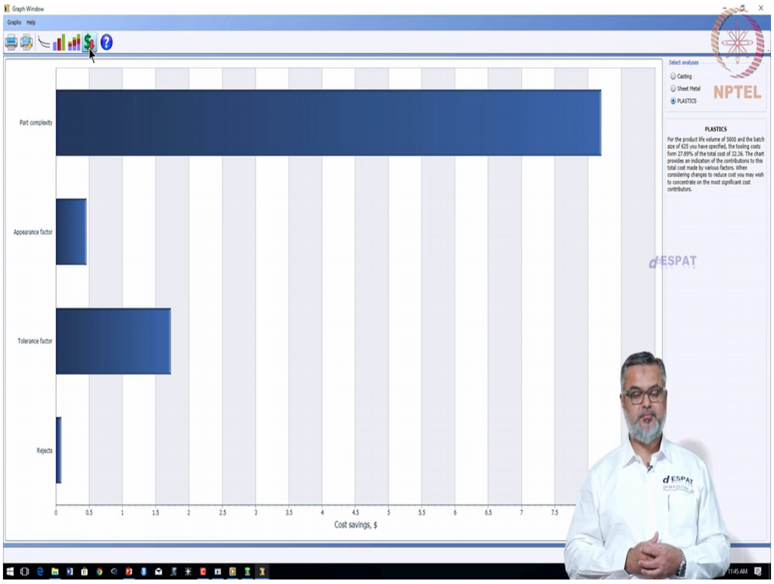

We have a interesting tool called cost reduction guide. What it does is it gives you a breakdown of manufacturing the part and the attributes that are contributing through the cost of that manufacturer. For example, in this case, it says part complexity, if you move on the graph is contributing a certain percentage is about 25 percent to the total cost. So, a simple explanation from the manufacturing experts you know what you have taking 12 mm thickness and that is unlikely for a part like this or you have that complicated (Refer Time: 13:15) plains and features.

If you turn it down to a [simple chamfer or the spirit, we would be able to reduce that cost of probably get down that part complexity parameter go much more manageable portion. So, it is an unbiased way of representing the manufacturing difficulty or capability to the design team. And this works both ways, so that you can make this collaborative decision or on the product in much shorter time in an unbiased fashion and using some of the best practices that are available without you necessity having to be a manufacturing or an assembly expert.

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So, this comes back to a question as how do we get started using DFMA, if I want actually apply to one of my own product designs or parts. So, we would say, if you consider your product, look at what is probably the low hanging foot that you could sort of start to deploy DFMA and investigate for results. Like in this case, we are highlighting a hinge assembly. In this case, we have a hinge assembly for using an enclosure. If you look at the below materials and look at the head of that hinge assembly looks as a good candidate for exploring a (Refer Time: 14:32) reduction.

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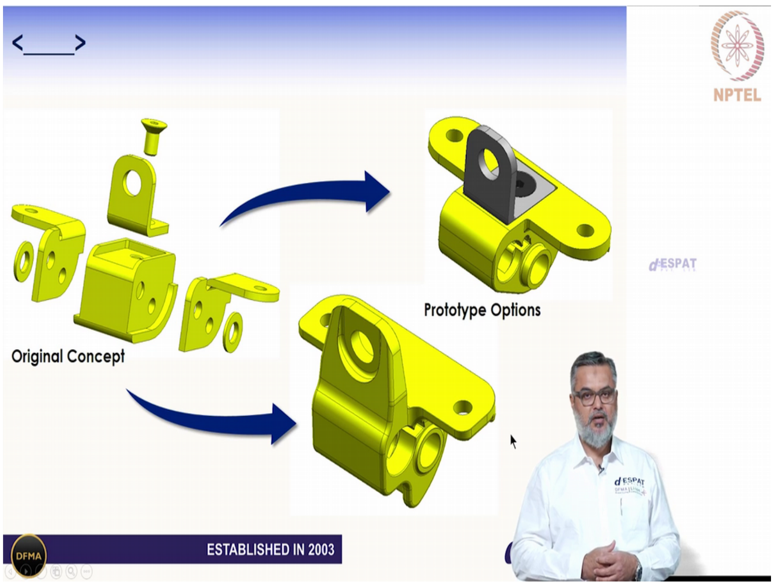

So, what is this design, which is highlighted on the right hand side, which appears to be a 7-part design? Several creative inputs, two of them I have represented here, one could be a single part cast or it could probably be a 3-part design from a original 7 part component.

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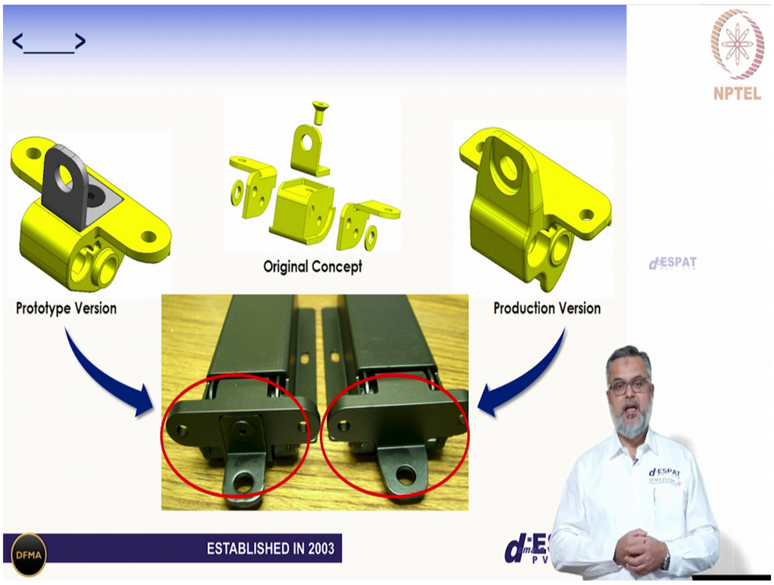

And if you were prototype it, this is what it looks like.

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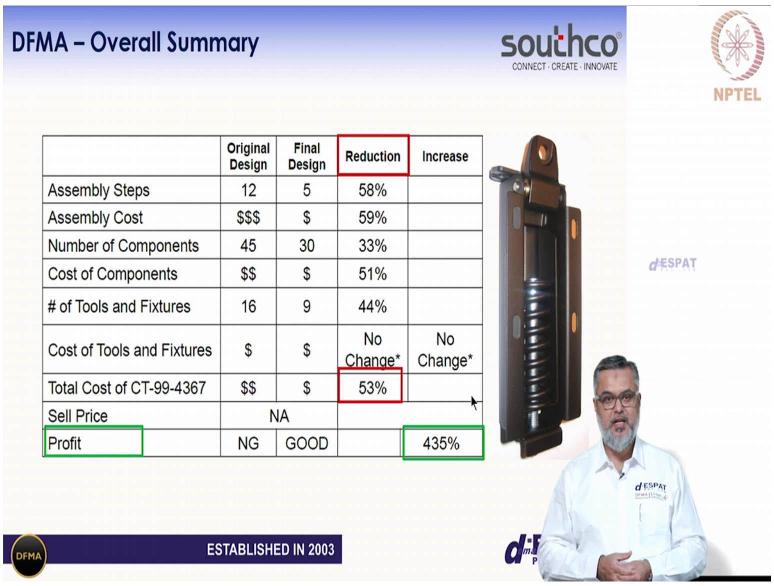

Is this a better way to approach it or if we were to investigate both are or more of these design ideas and get a rapid in the feedback of your design intent in this fashion as shown in this table here. Because, what this will do is it will give you what is the capture of your original design under these attributes, what is a proposed final design and of course what is improvisation you have done.

Apart from that, if you are a part of a industry, where you want somebody to actually invest into this propose new idea. What is the profitability or what is the cost of a reduced cost at which this product could be built that becomes a good starting point for exploring a entirely new design.

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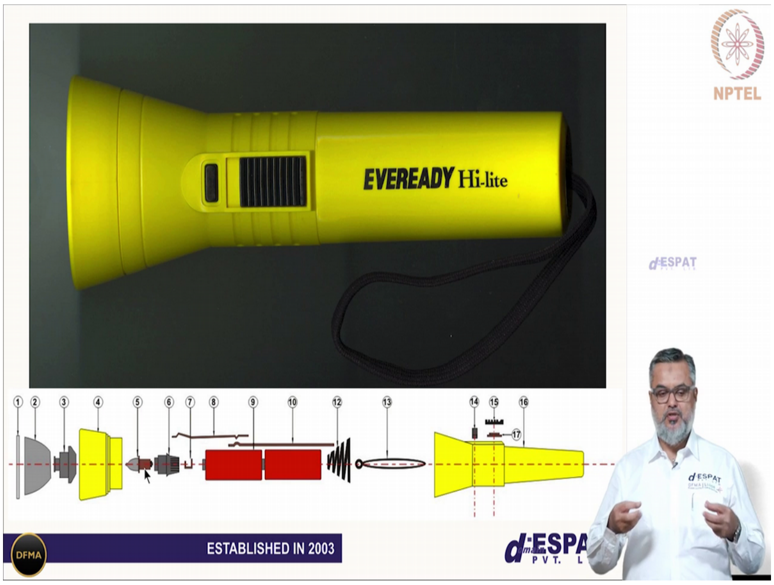

Let me take another example here. This is the product that supposed to throw out light, when you touch a button right. In main functional parts here are a set of batteries, which is a super system, which you have to probably buy from a battery supplier, get them to touch component, which can convert this chemical energy to electrical and component that convert electrical energy to light. So, fundamental if you look at this design, you should have two parts. One that converts and provides electrical energy, one that converts electrical energy to light, but why 17 parts.

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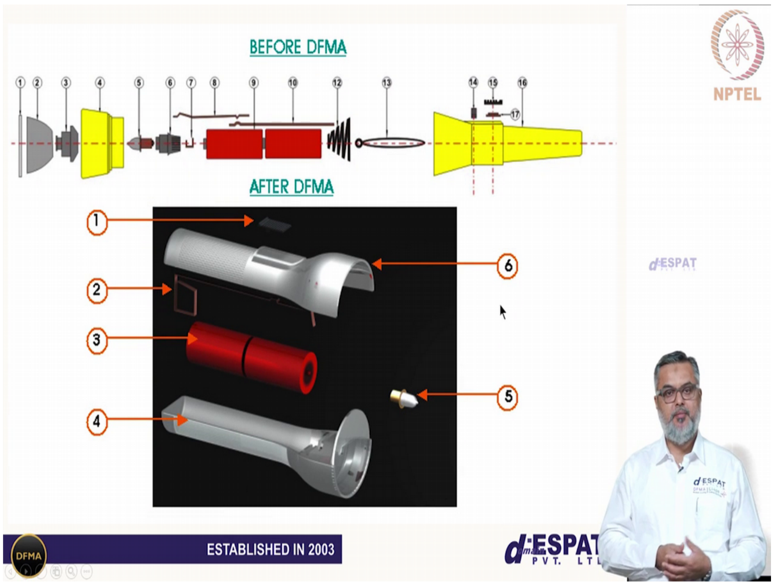

So, if you look at an investigated from fundamental design perspective like that, what happens is what was the potential 17-part component could probably be redesigned to a 6-part tool again. This goes to a sort of several cycles of iterations and a common believe among the design team (Refer Time: 16:28) that this could be done in a better way.

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And that was what we would probably like to substance or to or to highlight here, that this tool on its own would not be able to give you intelligent answers, but it is the knowledge to that can help you to do a rapid product design review very quick early manufacturing analysis and give you an update of what your design intent is. So, like I said we are not here to say let us make cheap products, but the objective is it could be done in a different way and this tool in a way could help you to investigate that.

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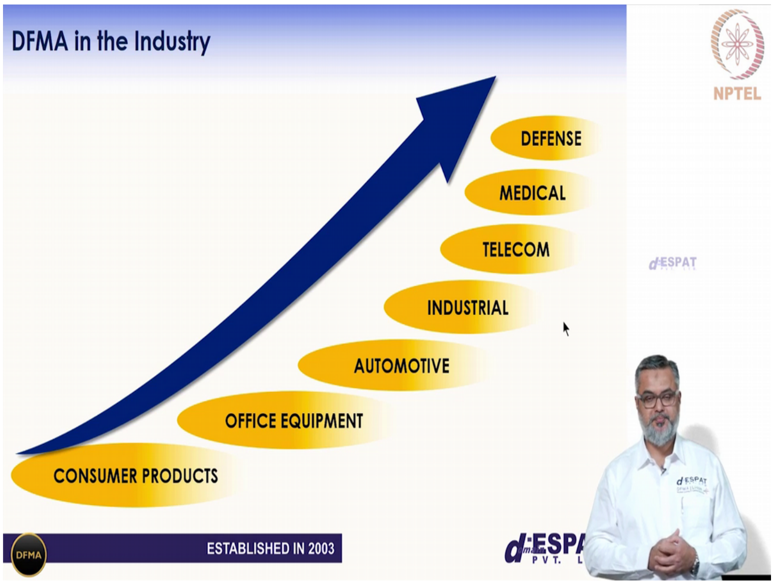

Just in continuation, I like to say how DFMA has been deployed in the industry, a few examples just for a take away at the end of the session.

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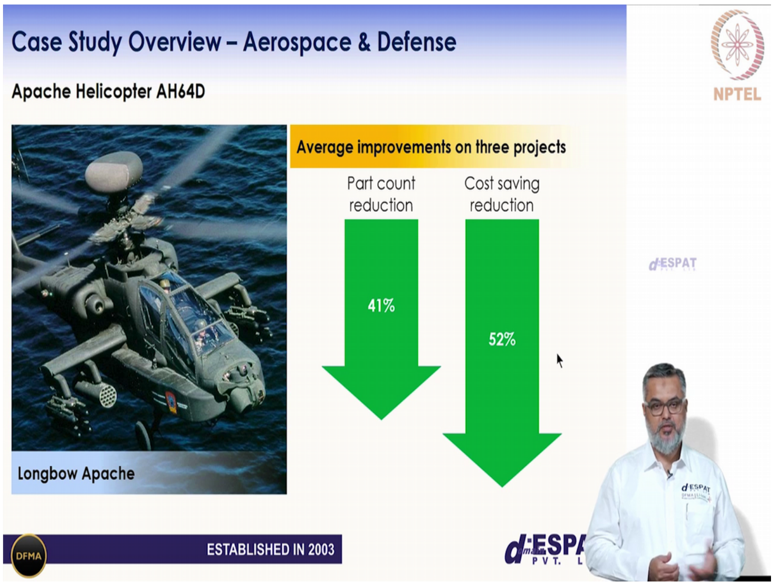

Production that are already into the market; company is always investigating whether there is a better way of doing it. One of the reasons is basically because new contemporary methods of manufacturing are available, can we take advantage of that and manufacturer or existing product or subsystem in our product in a more effective manner. So, one example here is shown of a flying vehicle like apache helicopter and if you look at the one subassembly here which we have taken for today's presentation.

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This is the (Refer Time: 17:49) anti flail bracket assembly, it is to be a 5 part sheet-metal design. And those were the number of operations that go in terms of time and tools. But, let us see if I did not have a tool like DFMA and if I were to walk out to my management and propose, let us take a block of titanium and machine it, because we have a 5 axis machining centre now.

It would look unlikely that they going to throw and say or accept my proposal unless aware to probably evaluate this idea through a tool like DFM and chart out the report, which is I am showing you on the right hand side, which is of that review. Again, if you see if the first four points highlight from a engineers perspective that which provide a single part no need of tools, it could be probably machines from one block and also it is lighter in weight compared to the original design..

All that is fair enough, but if you if you look at from a industry stand point, unable in western to something is already working and already has certification already has (Refer Time: 18:52) certification the probably would, if there is a potential to save on building that particular part and that is what this tool helps to bridge to do and review from a design and assembly in manufacture standpoint. While at the same time, give you a measure of the probability of doing in much better than it was currently done, thereby helping you to find out and make a decision in an unbiased manner, whether the design meets the obligations that the organisation would want.

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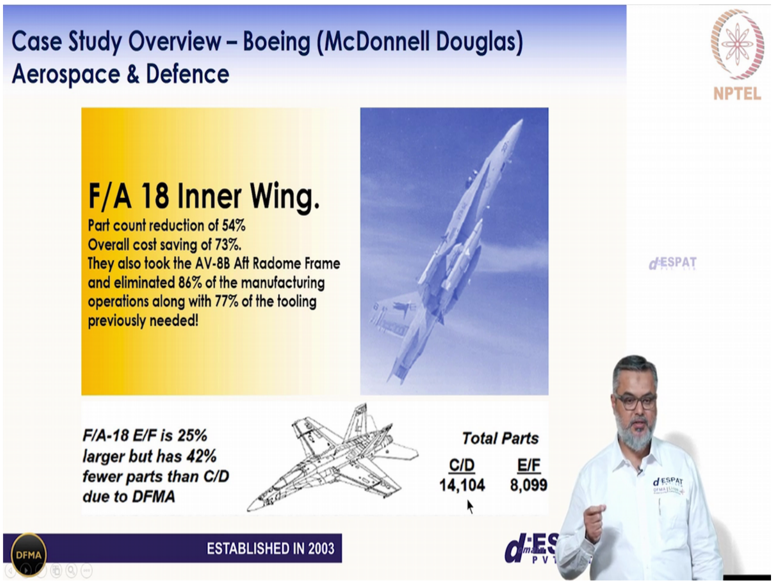

An another example from the aerospace business, aircraft like this, which is a land based system, which had about 14,000 parts had a design review where in a few more features were expected. Like for example in this case, the aircraft had to have the ability to fold wings, so it can be parked in lesser space. So, products which required 25 percent more larger size was actually built at 40 percent lesser parts. So, what is the original fourteen 14,000 plus parts assembly turned out to be a 8,000 part design. So, you can see the kind of facilitation DFMA does in helping you to do intensive design reviews using this tool.

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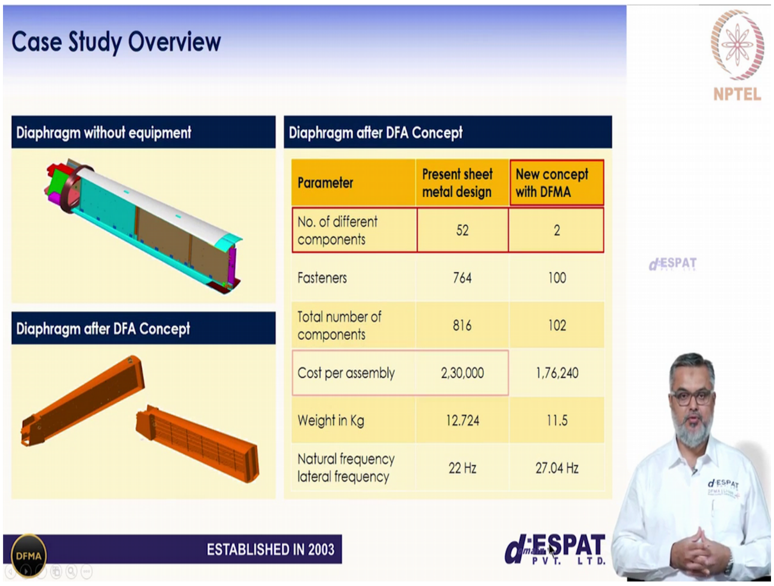

Another example I would like to bring out for part, which is used in an unmanned aerial vehicle, the one you see here. There is a diaphragm assembly, which had about 52 sheet metal parts. And with the few rounds of design reviews, we were able to come out with the product, which had just two parts made from entirely different process, so that is what you see there in terms of the part count reduction and in terms of number of production and fasteners..

Sometimes, depending on the application, it is not only cost or time. You always have a x factor that drives you to do a design for analysis. Like in this case, the excellence factory with the x as we term for excellence. Here which will I be able to reduce the weight, will I be able to pick this complex 52-part assembly, which had numerous operations and was human driven to assemble, be more standardized that was sort of met. Beyond that, what we were able to do is we were able to reduce the weight of the path. Secondly, increase the resonance frequency which means for the user, these two factors as much more exciting than just the cost angle of making this part much more elegant.

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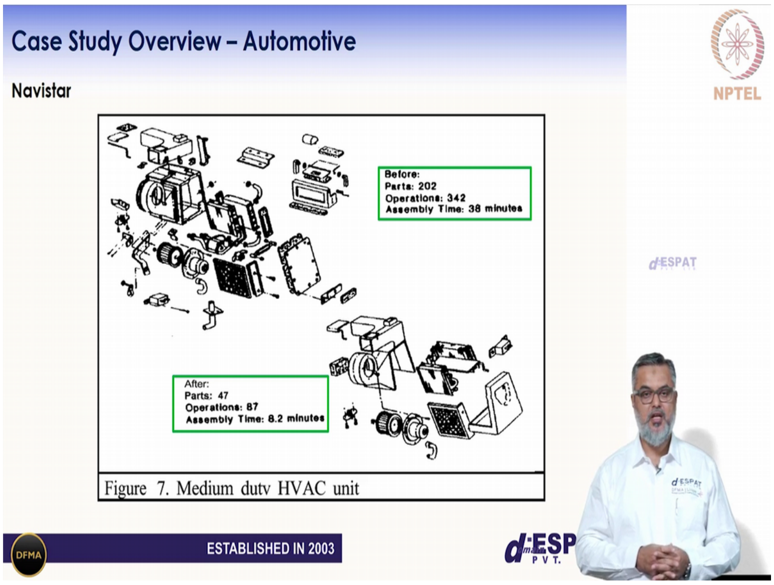

From an let us see an example from the automotive space. A product like in HVAC unit which is to take about three hundred and 202 parts bill of materials assembled in 342 steps and each assembly taking about 38 minutes on the shop floor. Through a few revisions of DFMA was built with the forty two 47-part assembly assembled in 87 plus steps and less than 8.2 minutes.

Now, what does that do for an organisation? If you take that 38 minutes and divide by 8 you getting for 4.2 plus the same 8 or 10 hour shift, the operators are able to assemble 4 times more number of products without actually causing any other demand in other attributes related to assembling the product, so that is the so, you able to improve even through put productivity depending on how intensely one can deploy DFMA as a part of the design review cycle.

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Few my example here from different range of industry, some organisations use it for doing design for service like organisation like manufacturers, who make consumer products, office equipment. Look at this angle of designing for product for serviceability, designing a product for modularity, because when you have a modular design is easy that you can sell of that module and can be incorporated in multiple product profile.

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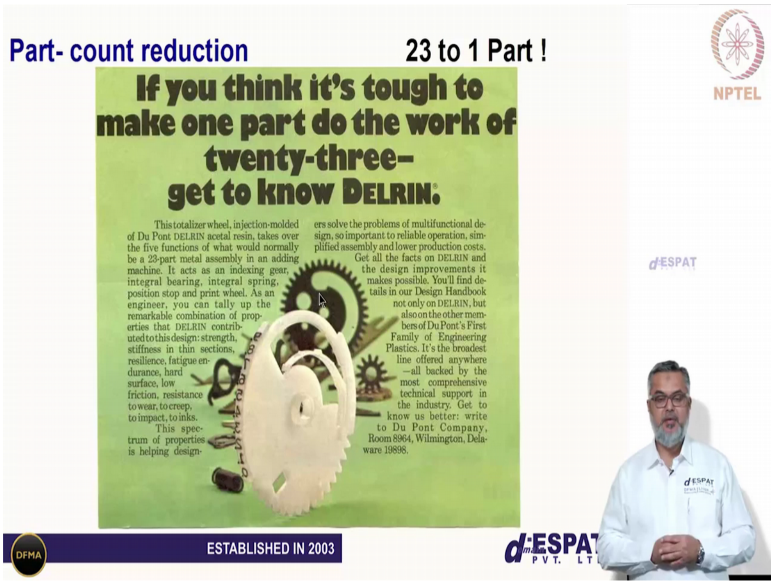

Sometimes, the you look at the software innovation and you look at materials engineering plastics that can probably lead up to helping you make your existing designs much more elegant. For example, taking advantage of engineering parts take like one shown here 23 part totalizer wheel could be redesign to a single part, all of the abilities of having the gear, the spring and the numbers, all integrated on the singular part. Of course, this kind of activity would required lot of a disruptive thinking, but it is possible and also measurable from design for manufacturing assembly prospective.

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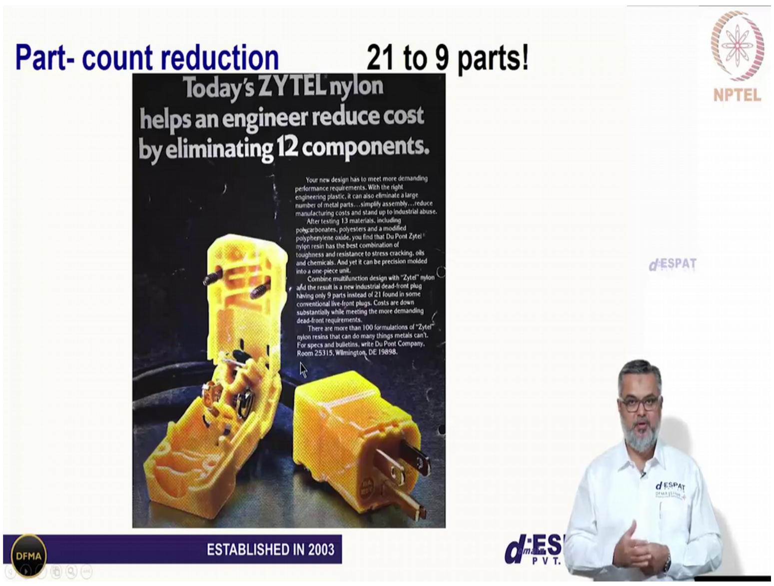

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Sometimes, when you use DFMA, you would like to investigate how the customer is using a product. And see if you can problem build integrated product like shown here in this example, what is to be 18-part assembly for a simple electrical plug. You would investigate how does my customer, would he sit down and repair our wire in the in the plug or is it is do fully integrated plug, so that in case, it is damage or we have to do is throughout the way and replace it and a much less of cost, then facilitating for assembly and service. So, different perspectives of a product build as I said earlier from a excellent criteria is the one that drives out or starts out the design for analysis and that forms the basis for doing how these simplifications..

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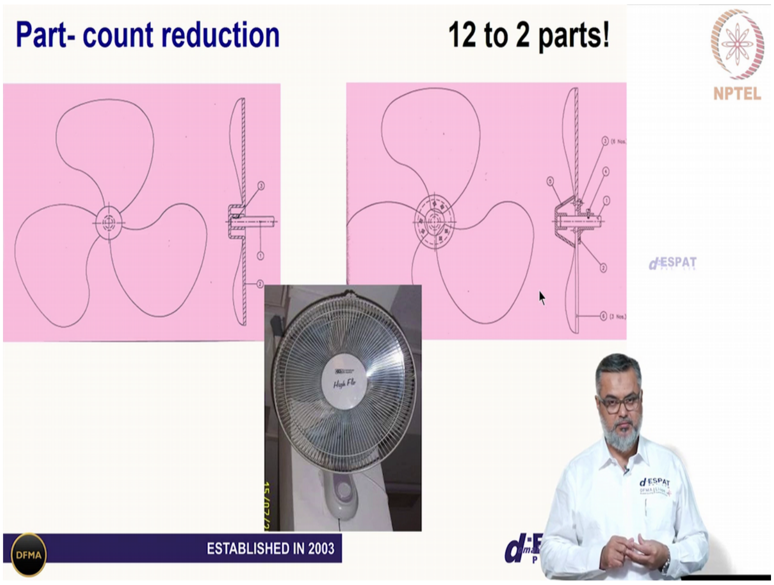

Example here again is of 5-part metal blade assembly for a fan redesign to a single part mould. The challenge is the risk of investing in such a high precision mould. But, when it is evident that the benefit of having a light weight fan blade that could be driven by the less power motor helping it to be build up highly energy efficient motor design becomes the basis for doing a review of the of this nature.

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I would like to concludes say what are the areas where designed for manufacturer supports. Basically, if you take any product these 5-steps is what you what one what you visualize in doing the review of the product; one is analyse your current design. Identification of what the problem areas is which fairly depends on the creative creativity of the team that is investigating this problem. Then come out with again redesigning options for all these problem areas; again that is purely human in how what kind of idea you can come out with. And using that is DFM DFA methods to analyse all these potential problem areas that you have investigated and come out these new proposals and which was suits the set of that you have used that reported analyse further fore actual adoption.

So, these are some six benchmark six point was that highlight what the DFM is currently being used in the industry and otherwise for deployment. One is in development of entirely new products with this no reference of existing design, re-engineering existing products which is from the big chunk of all these new product initiatives that are happening, benchmarking existing in house as well as competitor products. Making accurate cost estimations, because most of the data that lies today with organisations is history base has a legacy, most of them would like to know what is actual engineering cost of building their designs and that forms the basis for moving forward.

Sometimes, the idealistic numbers are so far away from actual that is actually surprising, but that starts the process of saying if that is what idealistic is way this way we are lacking, how do we get there and so that we can benefit probably benefit the organisation or benefit the user of the products that we are building today.

So, other things that we probably do is try to investigate and reduced shaft load time by making the assembly even more the elegant more efficient. And the other opportunity is to make decisions of trade-off. Today I making sheet metal, what if you make in plastic, I wanted in casting, but I do not like sheet metal. So, what opportunities of volume do I have to provide to my vendor or myself in order to build it at fairly profitable costs.

So, things like these are always happening in the in organisations. Today it is done based on gut field, today it is done based on history, today it is based on whose probably the loudest mouth in the organisation. But, when you have a tool like DFMA, you can probably make the decisions in an unbiased manner, facilitate everybody to collaborate in this decision making process and probably co-creating or co-owning the revised new designs that come through.

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Let us say they like to conclude saying thank you for the opportunity. Should you like to reach out was for getting trial licence of the software or evaluate will be glad to help and that is our email address and phone numbers, if you like to reach out to us.

Thank you so much.