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So, we are discussing the specifications for the products or how we develop the design specification for the product and we saw that once we have the customer needs, identify these needs based on some standard methods and then for each and every need you can identify a metric. A metric is something which is quantifying the customer needs. So, the customer has a particular need which is subjective so we are converting to an objective a measurable quantity which we call it as the metric.

And one important point is that for each and every need, you need to have a metric. If you do not have a metric for a particular need, essentially you are saying that I cannot convert it into a quantifiable thing and therefore I do not know how to design for it. So, for each and every need you need to have a metric identified. And once you have these metrics identified, you prepare a

need metrics matrix by providing the needs, metrics and their relative or the relationship between the need and metric.

So, effectively you need to identify how many metrics can be identified for each need and how these metrics are connected to the need. How strongly they are connected or how weakly they are connected can be identified or can be represented using the need metrics matrix. So, this was what we saw in the previous class and the importance of the needs and metrics can be identified and what we need to do now is to identify the target values for metrics. If you say it should be the weight is a metric, we need to know what is the value of that metric which can be provided in the specification.

So, the target values, how do we get the target values is the question now. This is what we are trying to answer here, how to identify the values for the metrics so that we can set the target values for the design. You can say the way that it should be less than some value or the time to be assembled should be less than its x seconds or t seconds. That is what we need to actually identify and then we can design to meet those specifications. So, let us see how to identify the matrix, the values.

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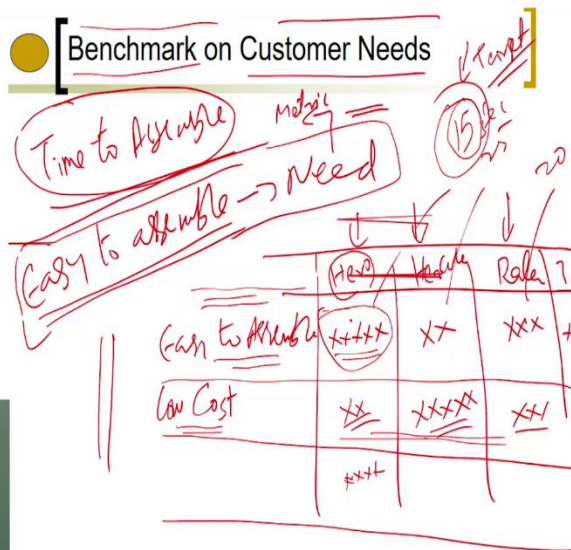
So, one of the most commonly used methods is known as benchmarking of the product with the existing product or you try to benchmark the parameters with the existing product. So, this is the first step in identifying the values. For example, you are talking about the cycle which we discussed in the previous class. So, we are saying that the time to assemble should be, time to assemble is a metric.

Time to assemble is a metric and then the customer need associated with this was easy to assemble. So, easy to assemble was the need and the metric was, so the metric was time to assemble. Now, we need to find out what should be the time to assemble when you design the cycle or the fork assembling, what should be the time to assemble. We need to set a value so that we can design the product in such a way that it meets these requirements. To do this, the first thing we need to do is to benchmark the needs of the customer with respect to other products, existing products.

So, what we do is try to identify a few existing products to benchmark so say this is a hero cycle, so this is Hercules, this is raley, some brand, brands. So, we know that these people are making bicycles and customers use the cycle but still they say it should be easy to assemble. So, now you benchmark this particular need so we say that easy to assemble is a need. Easy to assemble is a need. Now, we want to find out how Hero cycle is, how easy, how easy Hero cycle is to assemble, how Hercules is easy to assemble, how easy is it to assemble to the Raley cycle.

So, first we will look at these needs as a benchmark, we benchmark on the customer needs and then say that Hero gets 5 stars because that is the easiest one to assemble so we give some star values. It is the most easiest cycle to assemble and then we look at Hercules then we will say, it is very difficult to assemble so give it 2 star, some comparative value we give and similarly we will give this is too difficult to assemble so or we will say that this is 3 star. Like this if you have more you can give some values for here.

So, this way you identify each customer 's needs and then try to see what are the ways in which this product satisfies the customer because the products in Hero. Hero has got a product and customers are very happy with this product design. It has a 5-star rating, so it is very easy to assemble and the Raley cycle is not that easy to assemble. You need to understand that when you

design something it should be equal to or better than this. So, that is the understanding you need to get from the benchmarking.

So, you look at the existing product and try to find out which one is satisfying the customer needs in a better way. So, this represents the satisfaction of the customer with respect to their particular needs. Similarly cost, you can say low cost is a customer requirement or customer need. Then you say which one is the, which cycle actually satisfies this customer need. We will see that the Hero cycle is very costly so probably customers are not that happy but for this product it is low cost so it is very satisfying the customer need of low cost.

Similarly, you will see something like so this way you can actually benchmark each of the needs against the existing products. This is the first step in benchmarking the or getting the target values for the products for the metric. So, we are what we are trying to do is to look at the existing products and then see how these products are satisfying the customers, how well they are satisfying the customers and based on that information you add these values I mean, this rating and then try to find out who actually satisfy this product or this requirement very well.

So, what we get from this result is that we know which product is satisfying the customer very well and then we can look at what the value Hero cycle is using for the easy to assemble. So, how much it takes, how much time it takes to assemble the Hero cycle. So, we will get some value, say, that is 15 seconds for example. So, I will say this is 15 seconds and this takes maybe 25 and this maybe 20.

So, we will be able to identify these values from the product and then we can say that since we have to make this cycle easy to assemble and existing products are using these values either you have to use 15 the minimum what is there or maybe less than that. So, that is some understanding you can make your product should be the target value should be 15 or somewhere near to that depending upon what you are actually looking for.

So, this is how you get the target values or the ideal values for the metric that is known as the benchmarking to get the specification for the product. So, what we do is we look at the existing products, try to find out how these products are satisfying the customer needs, how well they are

satisfying the customer needs and then try to take the values that these manufacturers use for the particular metric and try to see whether that can be actually used as your target values.

Not necessary you should always use their values that depend on many other factors. So, you can say that though the customers are asking for low cost that does not mean it should be always the lowest among, in the market you can decide based on the values you can decide where actually you want to fix your target values. So, that is the way how you go with the values for each metric, get it. Any questions? Alright, Yeah. Pardon.

Yeah, that is what instils pride, there is no metric per se, that is why subjective metrics can be used. There, there is no value for that. So, in some very special cases you use a subjective matrix instill price so there is no value so that is basically coming from your brand name and your many other things which you use so it cannot be part of the design percept. You cannot have it actually as only the part of design, it comes from many other fields but we will add this customer requirement and then say it a subjective part and then we will leave it like that.

No need for a benchmark. Benchmarking you can still use but then you do not value it. Benchmarking you can say which one gives you higher pride so you can say Hero gives you higher pride then you can take that as the best one and then see what are the features they provide to make the pride for the customer and try to bring in that one and say separate entity not as a particular specification in the product. Cost need not be instils pride because instils pride of course the cost will be always high because of the features they provide so cost need not have a direct relationship to instils pride.

So, brand value is one measure but brand value you cannot bring it as a design specification. I will come to that because then we need to analyse all these. So, first we will say that these are the values they use then you need to decide what should be your value because you will be having a target customer and based on the target customer you need to fix the price or you need to have 2 versions of the cycle one for the high cost and one for the low cost that is to be decided based on all these information.
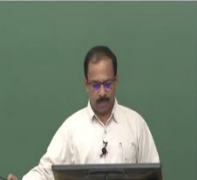
So, in this stage we are trying to collect all the information and then put everything into a proper what you call an analysis tool and then decide what should be the value. So, here we do not directly decide the value we will say, ok, this person is using this value that is all we are telling. What should be our value we need to take a call on, based on many other features. Any other questions?

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Benchmark on Customer Needs

No.	Need	Imp.	ST Tritrack	Maniray 2	Rox Tahx Quadra	Rox Tahx Ti 21	Tonka Pro
1	reduces vibration to the hands.	3	*	****	**	*****	**
2	allows easy traversal of slow, difficult terrain.	2	**	****	***	*****	***
3	enables high-speed descents on bumpy trails.	5	*	*****	**	*****	**
4	allows sensitivity adjustment.	3	*	****	**	*****	**
5	preserves the steering characteristics of the bike.	4	****	**	*	**	***
6	remains rigid during hard cornering	4	*	***	*	*****	*
7	is lightweight.	4	*	***	*	***	****
8	provides stiff mounting points for the brakes.	2	*	****	***	***	**
9	fits a wide variety of bikes, wheels and tyres.	5	****	*****	***	*****	***
10	is easy to install.	1	****	*****	****	****	*****
11	works with mudguards.	1	***	*	*	*	*
12	instils pride.	5	*	****	***	*****	***
13	is affordable for an amateur enthusiast.	5	*****	*	***	*	***
14	is not contaminated by water.	5	*	***	****	****	**
15	is not contaminated by mud and dirt.	5	*	***	*	****	**
16	can be easily accessed for maintenance.	3	****	*****	****	****	*****
17	allows easy replacement of worn parts.	1	****	*****	****	****	*****
18	can be maintained with readily available tools.	3	*****	*****	*****	*****	**
19	lasts a long time.	5	****	****	*****	***	*****
20	is safe in a crash.	5	*****	*****	*****	*****	*****

So, I will give some examples. So, last time we discussed the customer needs for a, for the suspension, for the suspension, bicycle suspension then we found that the reduced vibration to the hands and similarly allows easy traversal all these things are the customer needs - light weight, instils pride. We can see that there are many companies which actually make suspension for the mountain bicycle.

So, we can see which one is actually satisfying the customer. You can see this one 4 star and this is 5 star and in some cases you have some particular needs you can see for reduced hand vibration this seems to be the best one Rox Tax Ti and for instils pride you can see these two this is the best one. So, here also it is the best one. So, like this you can identify which company provides you the maximum satisfaction and then try to see what values they use for each one.

So, it is not necessary that only this value you can find out the value whatever is available sometimes all the information might not be available so you need to make assumptions but we will try to get this information and see who actually satisfies the customer needs in a best way. For example, last long time you can see this one most of them are actually good I mean, except for this the life of all these are good but this one the life is not that good. So, if you try to improve upon this and try to provide all these values you will have a better than this product. If you want to make a better product you can actually go for it.

Like that you will get an idea what should be the ways in which the customers get satisfied. Customers are satisfied with the existing products and that gives you a rough idea of the value to be used for various metrics.

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Now, we try to get the values here. So, now we move to the corresponding metric so each need, there is a metric then we try to find out what is the value that these companies are using for each metric. So, one metric was attenuation. So, we can see that it is 15dB attenuation here and that is why it is satisfying the customer very well and these all are using 15 and some of them are using 8 some of them are using 9 etcetera.

So, you have no idea if you want to design a bicycle, if you want to make it better, then you need to go for a better value than this or you are looking for a cycle in this range then you can actually decide what should be the value. You can say it should be at the maximum 15 or it can be a minimum of 8 needed to be provided. So, this is how you can decide about your target values. Each one you can see the total mass, this company this weight is about 1.364 but this is 1.222 only. So, less the weight, the better the satisfaction of the customer. So, now you need to decide if you want to go for this and this is the weight.

Whether you can have this or you want to have a different weight? So, it varies from 1.1 to 1.4. So, that is the range of weight that is normally provided for this and you can take a call about what should be the approximate weight that you want to have for the product. Similarly, each one you can see what are the parameters they use. The wheel sizers, tyre weight, time to assemble to frame; you can see this is 45 and this is also 45 and these are 35, 35 and 35. So, all these are using 35 where customers are more or less satisfied, not very high. And this uses 45; it is actually less.

So, you can decide to make it 35 or you can make it 45 or you can make it less than 35 or so that customers will be more happy. But it cannot always be possible to have a very random value like that. That is why you need to look at these values and then take a call on what the approximate time you can consider for this particular metric. For like this, for each metric you will be able to get the values from the competitors competitive benchmarking. So, this is known as competitive benchmarking and based on this you can get the target specifications for your product.

So, whatever the product, we need to identify the metric and then benchmark this with respect to other products in the market and then find out what should be the value to be used or what should be the range of values that you can use to get the customer satisfaction. When it comes to design, I may not be able to provide all these but you know if you go beyond the particular value the customer would not be happy and therefore you need to make sure that you are able to meet this specification. This is the way how you get the target values for the product.

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So, we got this values you can have an ideal value which you say that, this is the ideal I would like to have but then you need to have a marginally acceptable also because you may not be always able to reach you can say, my time to assemble should be 30 seconds ideal value but then I will be happy if I get between 30 and 40 also that is the, this is ideal, the lowest I would like to have but if it within 40 also I am fine. So, that is basically known as the marginally acceptable values where you have at least x, at most x, between x and y, exactly x like that.

So, that is basically known as the target values. So, ideal value is the one which you prefer to have but because of the design constraints you may not be able to reach the same but you can say that 30 is my ideal value but anything less than 40 I can accept. So, that is what we call marginally acceptable value. Now, once you have all these, you have the design specification ready for the product each one, the number of tools you will be saying should be less than 3. Ideally it should be 2 but less than 3 is fine. Time to assemble is 35 seconds but anything less than 40 may be acceptable.

So, like this each and every metric you will be having some value and then you are saying if you can make these values in the design then I will be able to satisfy the customers. Because it came from the customer needs so if I can meet these metrics or the values then I will be able to meet the customer needs. That is the fundamental understanding in making this the values that finally

if you meet these things the customers will be happy with the product. That is the ideally and marginally acceptable values for the metric. Fine.

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So, this is the way it will finally look like. So, now you are saying that this each metric you will write each metric and then say this is the metric and these are the needs which the metric is satisfying and now you will say, these are the marginal values and this is the ideal value. So, 15 is the ideal value you would like to have an attenuation of 15 dB but 10, anything above 10 should be always good. This should not go below 10 as you will not be able to satisfy the customer needs. Similarly, everything you can see the wheel size is 26 inch is the ideal value set and here you can see the total mass should be less than 1.4 preferably less than 1.1.

So, 1.1 was the least used by the competitors but if you are not able to get it, at least make it sure to make sure it should be less than 1.4, So, like this you will be able to get all the values for the metrics and then your specification is complete. So, this is known as the specification for the design or the design specifications for a product. So, we start with the customer needs and then identify the metrics corresponding to each need then try to find out how these needs are satisfied by the competitors and then based on what values the competitors are using you decide your design values and that completes the design specifications.

This is the adjustment range; it is not coefficient so whether you can adjust the damping within the system. I mean, if it is an adjustable one or fixed damping coefficient, So, you would like to have an adjustment, but even if it is not adjustable, it is also fine. So, see every shock absorber will have a set value already designed whether you, a customer can adjust the value or not is the question here. So, if the customer can adjust it will be good but if the customer cannot adjust it already has the requirement then also good.
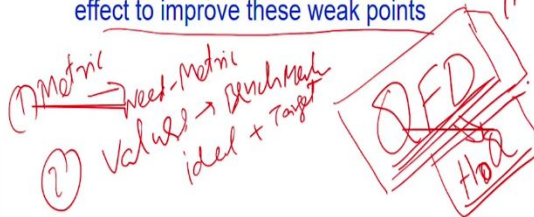
The customer can decide depending on the road which he is travelling, the damping coefficient to be varied. So, whether you can vary it or not is the question here. So, you are telling it cannot be varied, it can be varied. So, if you can vary this that will be good but even if it is not varying that is still acceptable.

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So, now finally with all these information you need to find out few things because now you have all those information and you have to see which are the customer very weakly satisfied by your design, based on your metrics and values you have to find out which are weakly satisfied and how they are depending on each other because some of the metric you may try to improve then other metric will get affected.

Suppose if you want to reduce the weight then the strength will go down but you want to increase the strength and reduce the weight also. So, there may be some kind of interdependencies or inter relationships. So, we need to find out which one is going against our requirement or against our expectation and then what product changes we can effect to improve these weak points. What are the weak points and how do we actually improve upon this need to be identified so this we need to do in a particular way that is known as reflecting on the results and use some standard tools to do this and this is known as House Of Quality or we call it as a QFD Quality Function Deployment.

Quality Function Deployment is basically a tool formally used in many other fields as well not only in design and we use this tool to analyse these and to find out the all the interrelationships between these needs and finally to say which one I should really touch and change and which one I should not touch and not change. So, that is basically what the QFD tool helps us to do. We will look at the QFD and one of these tools is known as House of Quality.

So, we use this HOQ or House Of Quality to analyse the metric values and competitive benchmarking, everything we will try to put in one single page and then see which one is going against us which one is in favour of us and what change is to be brought in the product in order to make it more and more user friendly or satisfying the customer needs that is basically the next stage.

So, in the specification development, the first one is to get the metric so the first one is to identify the metric and then you do this and get the need and metric relationship and then look at the benchmarking to get the values. So, values will go to the benchmarking. Identify the ideal and target values. So, once we have this information we will try to put it in a more comprehensive analysis tool it is known as House Of Quality and try to find out how they are whether they are satisfying properly or what kind of inter relationships are existing and then decide which one we should try to adjust change in the product to get the customer satisfaction

Because you would not be able to make everything change because if you change something the other one will go against you. So, you need to find out which one is the right metric to be

controlled in order to get the desired performance that is analysed by using the tool house of quality. So, before going to that let me talk about the midterm examination.

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Mid-term exam

Part A : (Open book)

Question paper release: 5th March 2020

Submission of Answers: 11th March 2020 (ONLINE SOFT COPY by 11.55PM)
                         (12TH March – Hardcopy)
Part B: Closed book   12th March 2020, 11.00 hrs (Completion of Part A is
                         compulsory to appear for Part B)

Compensatory class on Wednesday, 4th March, 1.00PM

So, your midterm examination will be held on twelfth March which is the closed book. Twelfth March is Thursday and eleventh March you need to submit the, there will be 2 parts- so, part A is an open book exam and part B is a closed one. I already gave you the marks distribution in the beginning. So, you will be having some marks for the open book part you have to submit as an individual report and this need to be submitted softcopy on eleventh March and twelfth March you need to give a hard copy and then write the exam here.

So, this is the schedule for your midterm examination. So, I will be releasing the questions for the open book exam on fifth March, fifth March is this Wednesday. So, this should be available on Mobile. Visit the Mobile site and check the question. Questions will not be same for everyone. There may be differences and you have to submit the report on eleventh March. So, the report is basically it will be a design problem the question will be a design problem. You need to go through all the steps what we learnt and what you practiced in the lab. Same steps you need to follow and then bring a, bring the report, I will design the report for this it will be covering the design specifications including the House of Quality.

That is going to be the open book exam and closed book will be more like the conventional examination again based on what you have learnt there will be questions. So, if you have done this very well you have done it on your own then I think this exam will be very easy. So, let us see how we actually develop the House of Quality.

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This quality function deployment transforms customer needs into engineering characteristics so that is basically known as the QFD. So, the voice of the customer or the customer's needs is now completely converted to engineering characteristics. Now, no more customer needs are there and everything we convert into engineering parameters and then you look at how these engineering parameters can be adjusted, modified to make the customer happy.

So, that is basically the QFD while simultaneously setting the development targets for the product. So, what could be the development target or target specification for the product is decided is done in the QFD. So, it was initially developed by Yoji Akao and first applied in the 1970's by Mitsubishi in their product development.

Now, most of the companies use this tool in order to when they start a new product development they try to use this tool in order to understand the whole spectrum of customer needs, customer needs, their importance of their needs then the metrics, the importance of the metrics then how

the metrics are related to the customer needs and then how the benchmarking is done for the competitors what are the values they use, how do they satisfy the customer. All these things are put into one single tool and then you try to analyse what should be your design goals that is basically known as the Quality Function Deployment.

So, in this Quality Function Deployment we use the graphical representation called House of Quality. So, this is known as House of Quality as a graphical representation in order to have a clear summary statement of the product specifications and supporting data consisting of benchmarks, target values and technical difficulty etc. So, what we try to do is summarize all the information whatever we collected so far. Put it in a graphical representation which is known as House of Quality and this graphical representation helps you to understand all the information in a single sheet.

So, all this information whatever you collected so far can be put into a single sheet and that can be used for analysing the design goals and then deciding the specification or deciding the design goals that we need to satisfy in order to satisfy the customer. So, that is known as the House of Quality. So, why is this known as the House of Quality?

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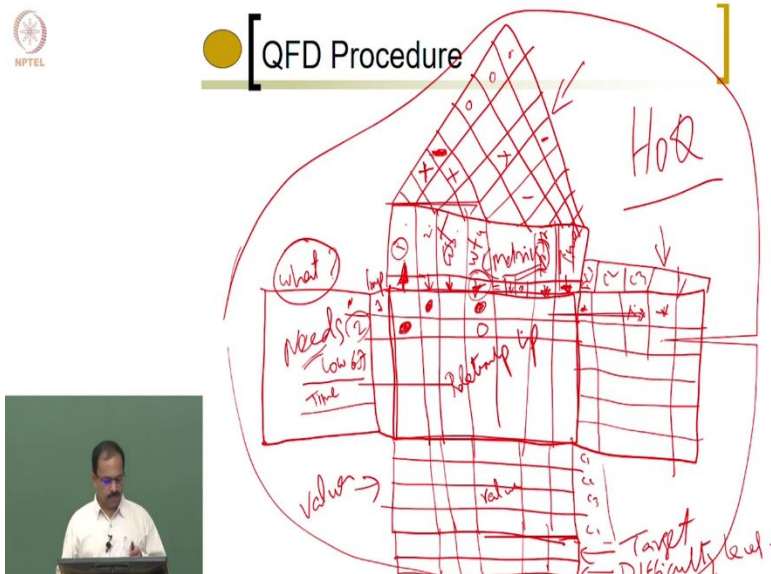
So, what we do here is so what we need to do is we try to write down what is needed in the product. So, what is needed in the product is decided by the customer's needs. So, this is known as what is needed. So, customer needs are there that is what is needed in the product and then we will try to find out how important these needs are. So, what is needed is what is the importance of each need we try to put down as a graphical representation and then see how to achieve these customer needs.

This is known as how, how to achieve the customer needs and this is the metrics. So, now we are saying these needs can be achieved through these metrics, less cost can be achieved through some of the metrics that you use, low weight can be achieved through some of the metrics we use. Then, we try to see what, then we will try to write down the relation between these metrics and the needs; how they are related, how strongly they are related. So, you have many metrics here.

Now, there is a need here, I will say these 2 metrics are related to this need. Similarly, this one has a strong relationship and this one has a slightly weak relationship. So, these 2 metrics 1, 2, 3 extra so metric one and metric 4 are related to the second need, need 2. So, by changing these 2 needs I will be able to control the metric 2, the need 2. And if I make changes in this one it has got a very strong relationship so it will be very fast changing. This has got less influence or less influence.

So, this way I will try to get the relationship between, relationship between the metric and the need here. So, this is known as the relationship matrix. So, you will be having a relationship identified in this part which actually talks about the relation between needs and metrics. Now, we want to know what should we change in order to or what should we do with the metric in order to get an improvement in the need?

For example, if this is the low cost as the requirement; customer requirement is your cost and we know the cost of the product is the metric, cost is the metric and we know that we need to reduce the cost in order to get the product satisfaction or customer satisfaction. So, we write the change in the direction of what is needed, which direction we need to change the metric to get the satisfaction. Similarly, if it is time to assemble then time will be a metric so if this is the metric

which is time, we know the time should be reduced so we can put an arrow to say it can be reduced.

So, this way we will try to identify the direction in which the metric to be moved where we want or increase it or you want to make it the same or you want decrease or increase. So, for each and every metric we will try to find whether something is to be increased or something has to be decreased or something has to be maintained the same way in order to satisfy the customer. Time to assemble we know that time has to be reduced.

Similarly, you have the number of tools; you know the number of tools will affect the number of tools should be metric. So, the number of tools will be a metric which can be identified here number of tools and that also to be reduced. So, we write that we put an arrow saying that this has to be reduced. Now, this is what is to be achieved and this is how to achieve and in what direction you should change to achieve this is done here and how they are related is done here. Now, we need to get the values; to get the values we do we try to do the benchmarking here. So, we will try to find the benchmarking using the competitors so competitor 1, 2, 3, 4.

So, you have competitor 1, competitor 2, competitor 3 and whatever we saw in the previous section we try to find out which need is highly satisfied by this particular customer. So, you can put it as 2 stars, this can be 4 stars or whatever the stars you want to give. So, you are trying to bring in the benchmarking information also into this chart. So, we know who actually satisfies this value properly. I mean a customer's product.

So, we have for this particular need this company is the best. Now, we use what is the value these people are using for each metric, what is the value the competitors are using. So, this is the value of the competitor. So, we have the competitor 1, 2, 3, 4 etc. Try to find out what is the value which they use for each metric. Again, we saw how to get these values. So, here we view the customer satisfaction. Here we try to get the values of the competitor.

So, whatever we saw in the previous class slides we will try to bring everything into a single sheet. So, the needs here, the metrics here, the direction of change here, the competitors satisfying the customer needs here and the values of the competitor are shown here. So,

everything is there in the same diagram. Now, based on this you have to decide what should be your target value. So, look at this satisfaction, if one company is satisfying a particular customer need very well look at there what is the value there you are seeing for the corresponding metrics and then decide what should be the target value you have.

Then we will have one more thing to say how difficult it is to change the metric, difficulty. Some metrics are easy to change, some metrics are difficult to change. So, which one is easy to change which one is difficult to change? We try to identify here the difficulty level of each and every metric, easy to change or difficulty level in terms of some ranking you can give to how difficult it is to change? So, why we need to identify this is to see which metric can be easily changed to get customer satisfaction. So, that is known as the difficulty level.

Now, based on all these values we will be able to get the target values that can be obtained from this chart. So, we have needs, metrics, competitor values, competitor satisfaction and competitor values here. The last thing we need to know is if I change this metric one, suppose I increase the metric I have given this as a metric and I want this to increase what will happen to the other metrics. Is there any other metric which will get affected by changing this? For example, I am saying the cost, the time to be reduced or the weight to be reduced I put it as weight.

Weight is reducing. If I try to reduce the weight is there any metric going to be affected by this? So, what we do here is to have a correlation matrix here to see if I change this one, is it getting affected if any one of the other one getting affected can be shown here. So, if by increasing this if this is getting affected the cost is getting affected I will say it has got a strong positive relationship that is by increasing these I can reduce the cost then I have a positive relationship because anyway I want to reduce the cost but I simply increasing these can reduce the cost not here, the cost then I will say there is a positive correlation between these 2 metrics that is by increasing one, I can actually move the other one in the desired direction then there is a positive correlation.

So, I can change any one of these to get the desired movement. But if the other way if I increase these the weight increases then I have a negative relationship because I want to reduce the weight but when I am increasing these the weight increases then I say there is a negative relationship.

So, like this not everyone should have a relationship. Like this, whenever you have a relationship when there is no relationship you can put it as 0 also or you can leave it blank.

Same way I can identify for each metric how it is actually affecting the other metrics in the whole system. So, this is the correlation matrix. So, here I am trying to find out what is the relationship between individual metrics and when I change a metric how the other metrics get affected can be shown in this diagram. So, you can actually show it as a plus, minus depending on the requirement you will be getting this. So, this chart shows you a complete picture of the whole thing that you identified so far.

It gives you all the information in a single sheet and that is why this is known as the House of Quality and it looks like a house that is why it is known as a house of quality. With a roof on top and then the rooms and foundation it shows like a house so we call this as the house of quality diagram which summarizes all the information whatever we collected so far into a single sheet and which can be used for analysing all the needs, metrics, benchmarking information, the direction of improvement, technical difficulty, target values everything can be put into a single sheet. So, that is the House of Quality diagram. Thank you!