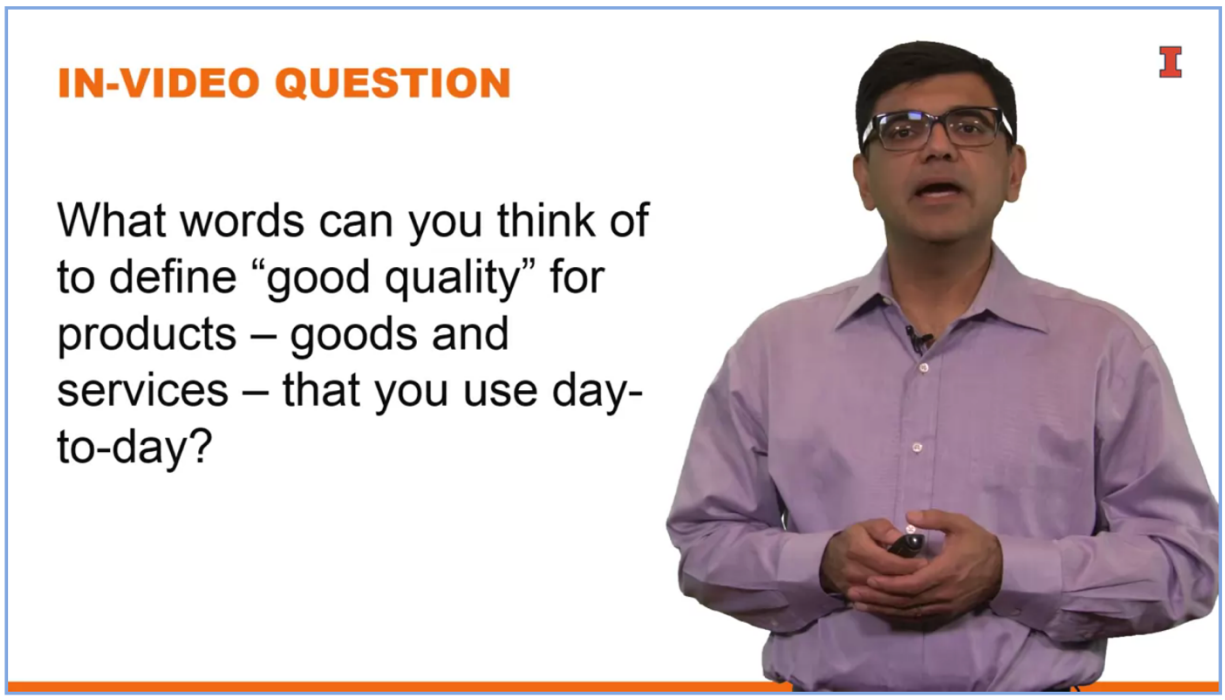
Module 1: Course Orientation & Quality Management and Process Improvement

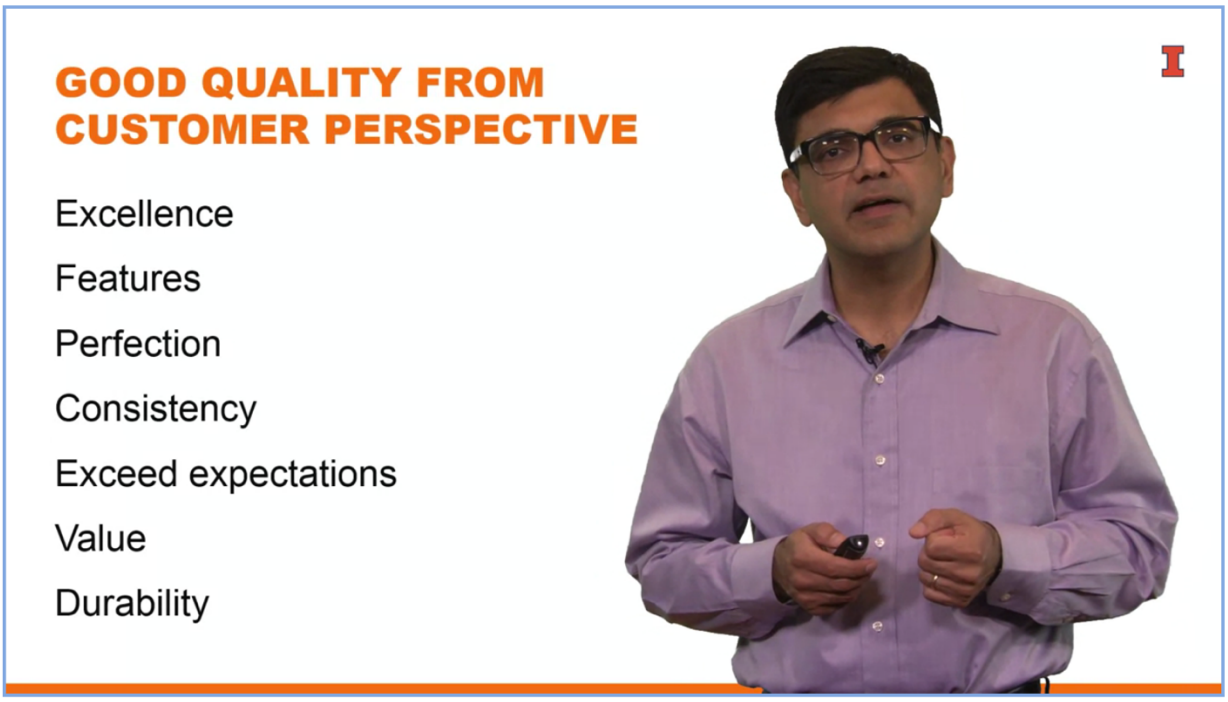
Table of Contents

Lesson 1-1: Defining Quality

Module 1.1.1. Quality as Customer Needs



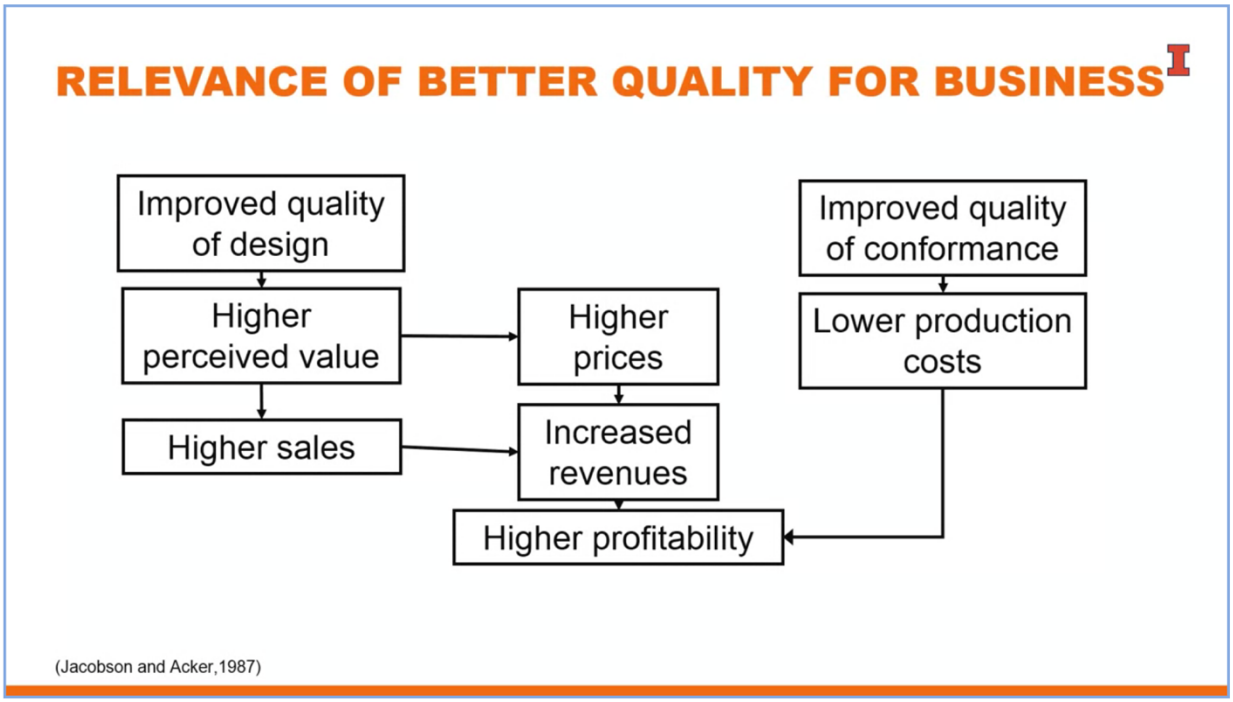
Here's a question for you to start us off. If I were to say good quality to you and ask you to think about any product, any physical good, any intangible service. What are the things that come to your mind when you think about describing the quality of that product? So, take a minute and think about what are the things that come to your mind and we'll come back and and see what you find. All right, so, the kind of things that you probably came up with war, it satisfies my needs, it's a product that satisfies my needs, it gives me all the features at a reasonable price, it gives me ability to use it for a long period of time. So durability, these are some of the things that you may have come up with.



So, here are some words that I thought of, that I was doing the same thing, quality to me means product is excellent, it gives me the features that I want. It gives me perfection, it gives me what I expect from it in terms of when I'm using it, it's working as it's expected to work. It gives me consistency over time, I can depend on it, a good quality could mean it exceeds expectations. So, when you're talking about, for example, a service, like going to a restaurant, good quality, there means, I was wowed by the service that I got there, it could mean value. If you're putting in terms of the investment into the product and what you're getting from it, then you're looking at the relative I paid for this and this is what I got kind of value or it could mean durability. How long does my car last, how long does my cell phone last? And that would be something that you could be thinking of, so as you can see, quality can mean different things to different people, it can mean multiple things for the same person. You might have many different expectations in terms of good quality.

So what do we mean for when we say good quality from a producer perspective? Now, we talked about it from a consumer perspective, from your perspective, what does it mean from a producer perspective? Taking the same things that we talked about earlier and sort of flipping the coin over, you have a good usable product. Total customer satisfaction, thrilling the customer, eliminating waste, customer doesn't have to wait for a long time, customer doesn't have to pay for something that they don't need. Availability of the product, it's available when the customer needs it. That might be a company's definition of good quality, compliance with procedures, compliance with policies. So, if you're talking about compliance with regulations of environment, compliance with regulations of food and drug administration, that's something that producer needs to do at a minimum. When they're talking about goods and services, doing it right the first time. So for a producer, good quality might mean when not having defects, when it is produced the first time. Again, it might be a service that's delivered to a customer or a physical good, but it might, it applies. The same thing applies in terms of doing it right the first time and finally delighting customers, having customers say, they were wowed by the good or service. They got something that was beyond their expectations. So that would be from the producer perspective.

Module 1.1.2. Garvin's Dimensions of Quality



Let's take a look at the idea of quality from the point of view of profitability. So how does good quality lead to higher profitability? And this is based on study done some 30 years ago looking at the idea of higher profitability based on good quality. And it's basically saying that your profitability comes from higher sales or higher prices which can be achieved through higher quality. So higher quality can get you more demand for the product, it can get you higher prices for your product, and higher quality can also get you on the other side, low cost, so you can get higher profits based on that. So this study is telling us that higher profitability can come from three different avenues, higher prices, higher sales and lower production costs.

Let's take a look at, and this is again based on research that was done some time ago, but it's very much applicable even in today's world. Let's take a look at the dimensions of product quality. So putting them in a framework, what are the different dimensions that customer might want from a product? So what I've done here is I've taken the eight dimensions that were mentioned in this research by Garvin and divided them up into three different categories. So dimensions of quality could be based on product. And when you're talking about a product, it's the basic performance of a product, what you expect from that product, what is the product expected to do? So let's take an example here and we'll try to follow that example throughout these different dimensions.

DIMENSIONS OF QUALITY – PRODUCT

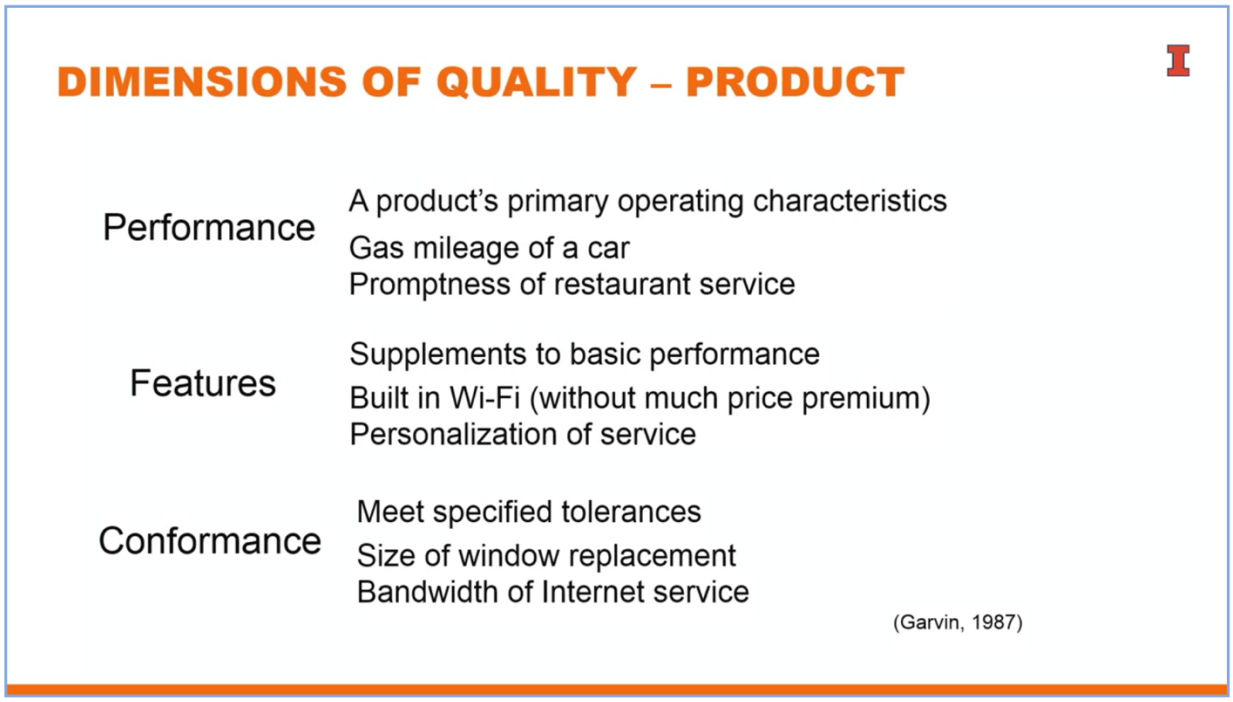
Performance	A product's primary operating characteristics Gas mileage of a car Promptness of restaurant service
Features	Supplements to basic performance
Conformance	Meet specified tolerances

So if it's a car you expect it to have a good gas mileage. That's the performance of the car that you expect. Let's also take a service example and we'll try to follow that through these 8 dimensions. So let's take restaurant service and performance there. Your basic performance would be promptness of of the service in that restaurant.

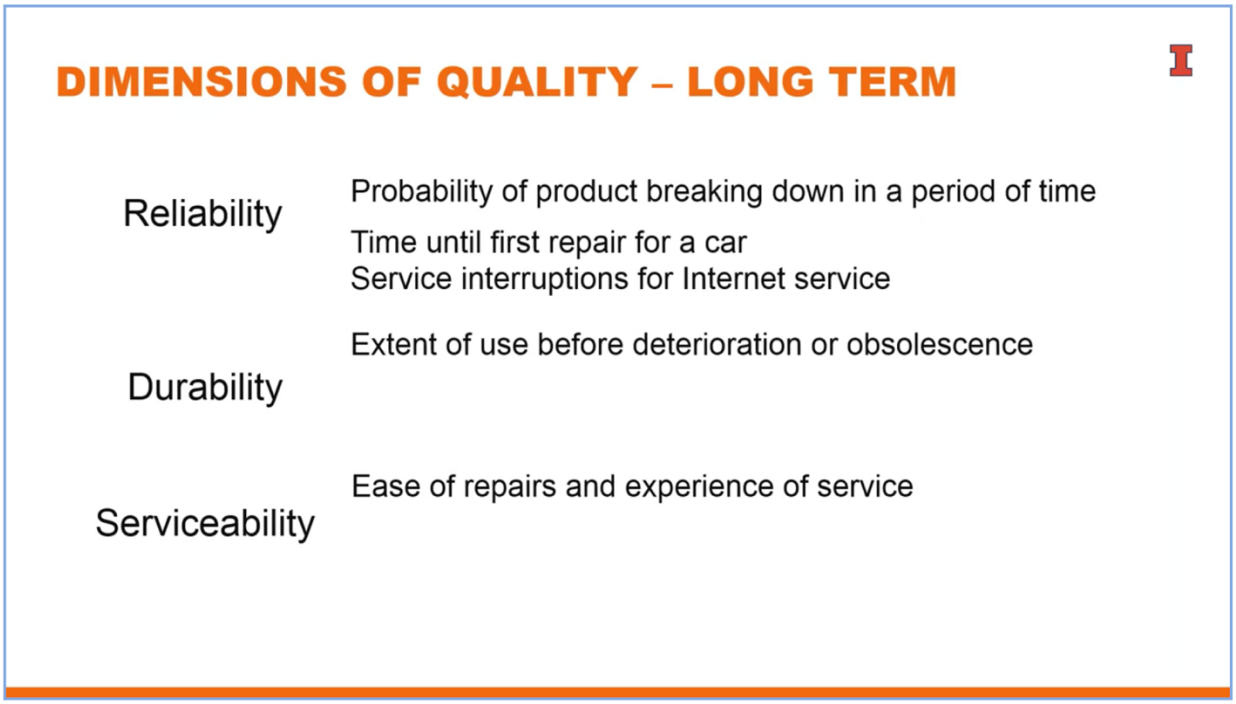
DIMENSIONS OF QUALITY – PRODUCT

Performance	A product's primary operating characteristics Gas mileage of a car Promptness of restaurant service
Features	Supplements to basic performance Built in Wi-Fi (without much price premium) Personalization of service
Conformance	Meet specified tolerances

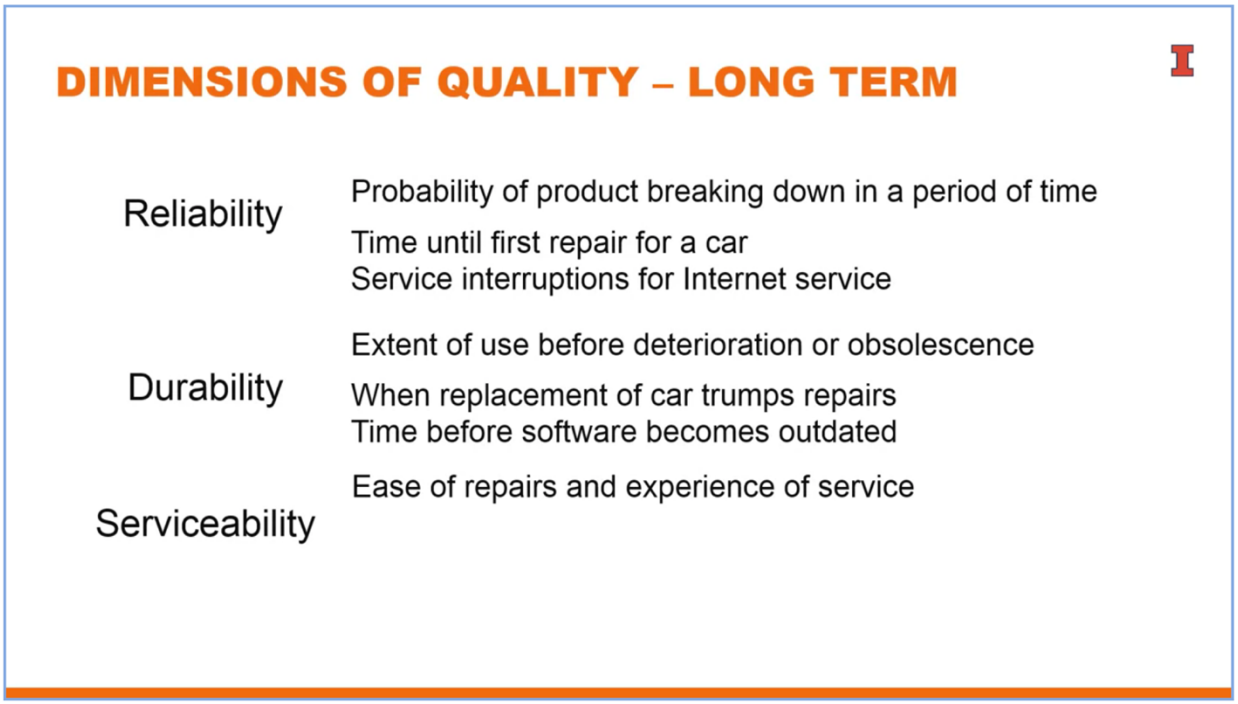
There might be some things that you might be surprised by that supplements to basic performance and those are called features. And features for a car could be, it has built in Wi-Fi, and of course, without paying much more price for that built in Wi-Fi for a restaurant it might mean not just being prompt but also personalizing the service. So it's gone beyond that basic performance that you expect and it's giving you some features that you as a customer value, but at the same time you don't expect it. So you value this but you don't expect them and you're getting that from the provider of that service or the manufacturer of that physical good.



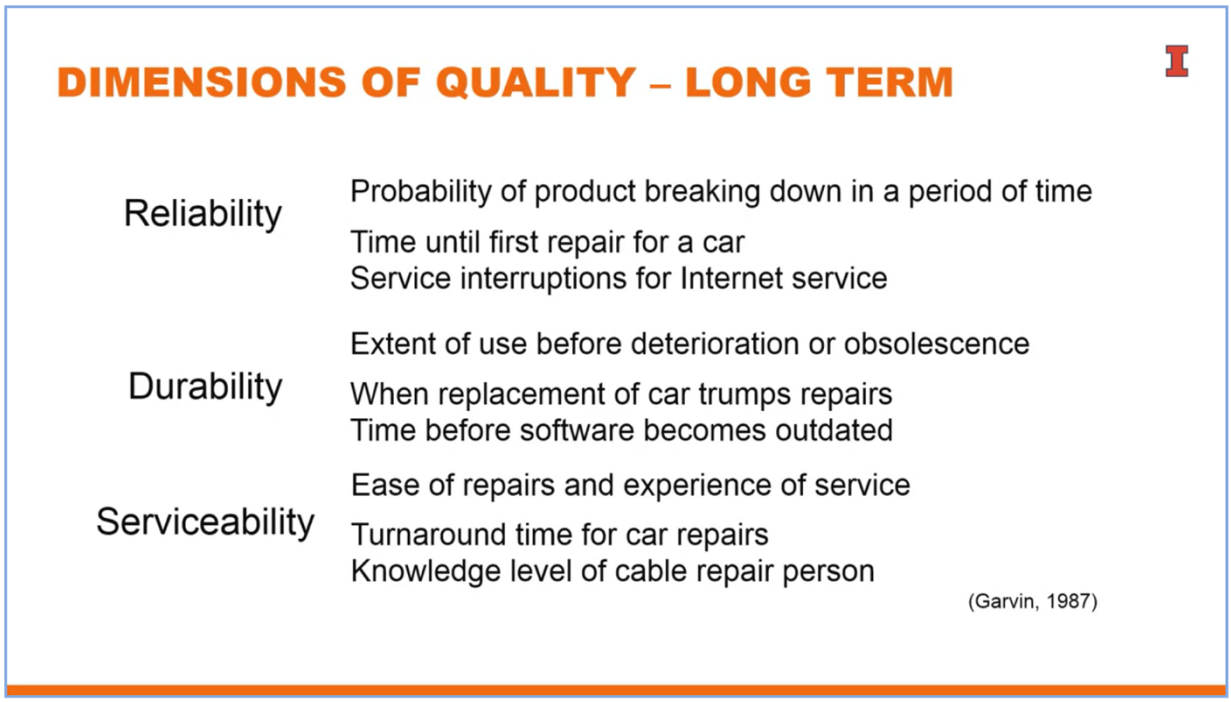
Conformance to specifications. So when you're talking about, for example a car, the other day I had the rear view mirror for my car break and I was able to get a replacement, a standard sized replacement for it pretty quickly. So I was happy that they were making these two specifications and I was able to replace it without much trouble. So that would be for a customer meeting the specifications of what the product is. When you're talking about a service, here I have an example of internet service. So it's a particular band width when you buy the service, your promise to bandwidth conforming to specifications there would mean how much it stays within that band width.



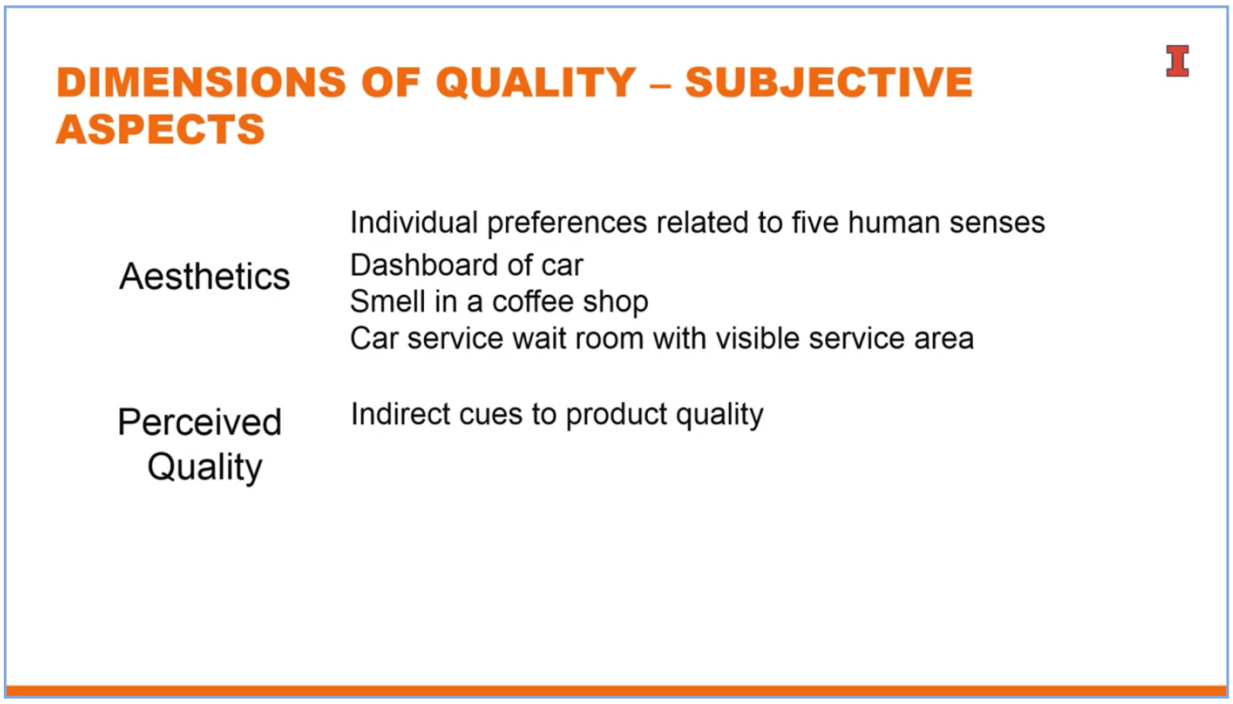
Moving on to the second category that I put dimensions of quality under is the long term and if you're thinking about a product that you purchase and its reliability, the idea of it not breaking down for a certain period of time. So for a car it would be, it doesn't break down or it it doesn't start to need replacement parts for a certain period of time, you have a certain expectation and that's the dimension of quality. For service it could mean your expectation that you don't have interruptions if you're talking about an internet service. If you're talking about a restaurant, you're expecting the same kind of service to recur over time when you go back to that restaurant. So that's the kind of reliability you expect from the service.



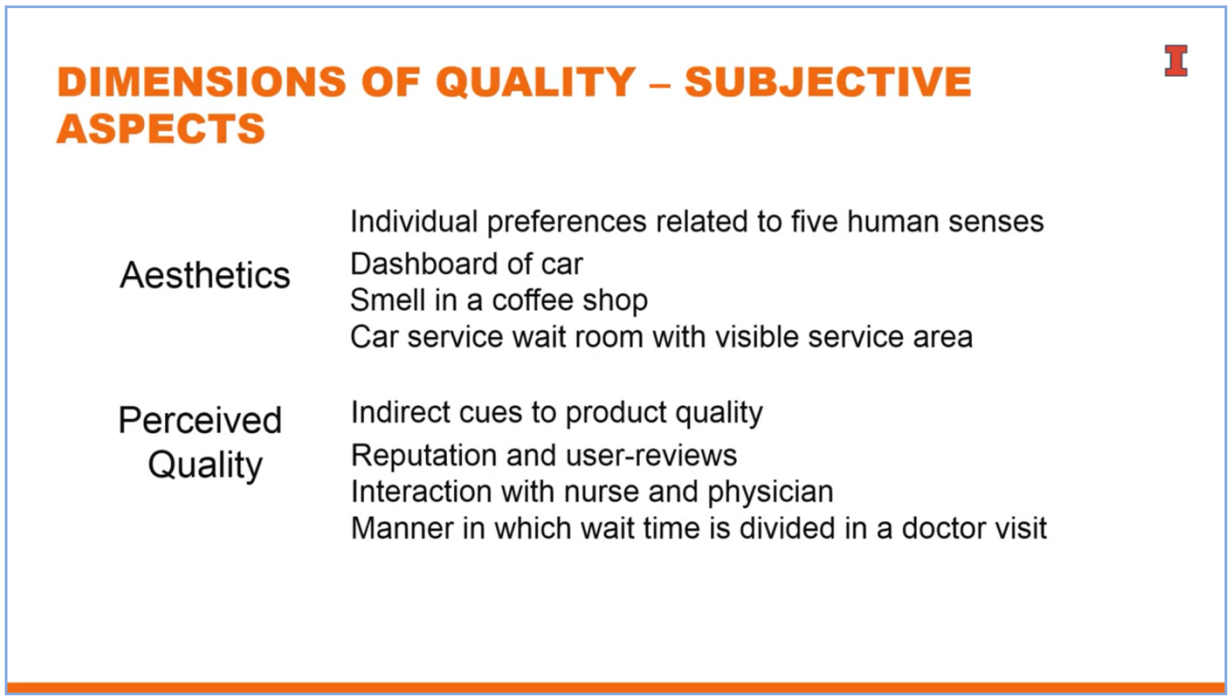
Durability would apply more to manufacture goods rather than to services, but it's the extent of use before you have to actually replace that car that you purchased. And durability may or may not be valued by customers, if you're thinking about cell phones nowadays, you want to change them more often. So maybe you don't think about your ability that much. And there's also talk from the manufacturer's side to build for obsolescence, so that you're not going to use it beyond a certain period of time. So there's no point for the durability, but for some products you still expect that for example, for a car you still expected to last for some time. For services it might mean that you purchase some software and it has possibilities of upgrading before it becomes completely outdated and you have to go and buy something new. Again, another dimension of long term quality that would apply more so to manufactured goods is the idea of serviceability.



The idea that it can be repaired or or how easy it is to take it in for repairs and then how easy it is for that dealership, for that car to repair it for you. In terms of serviceability, in terms of services you can think of, you have internet and the cable guy has to come in to fix the internet for some reason. What is the knowledge level of that person and that would be the serviceability aspect. So that's something that you expect in a longer term in terms of the quality of the goods and services.

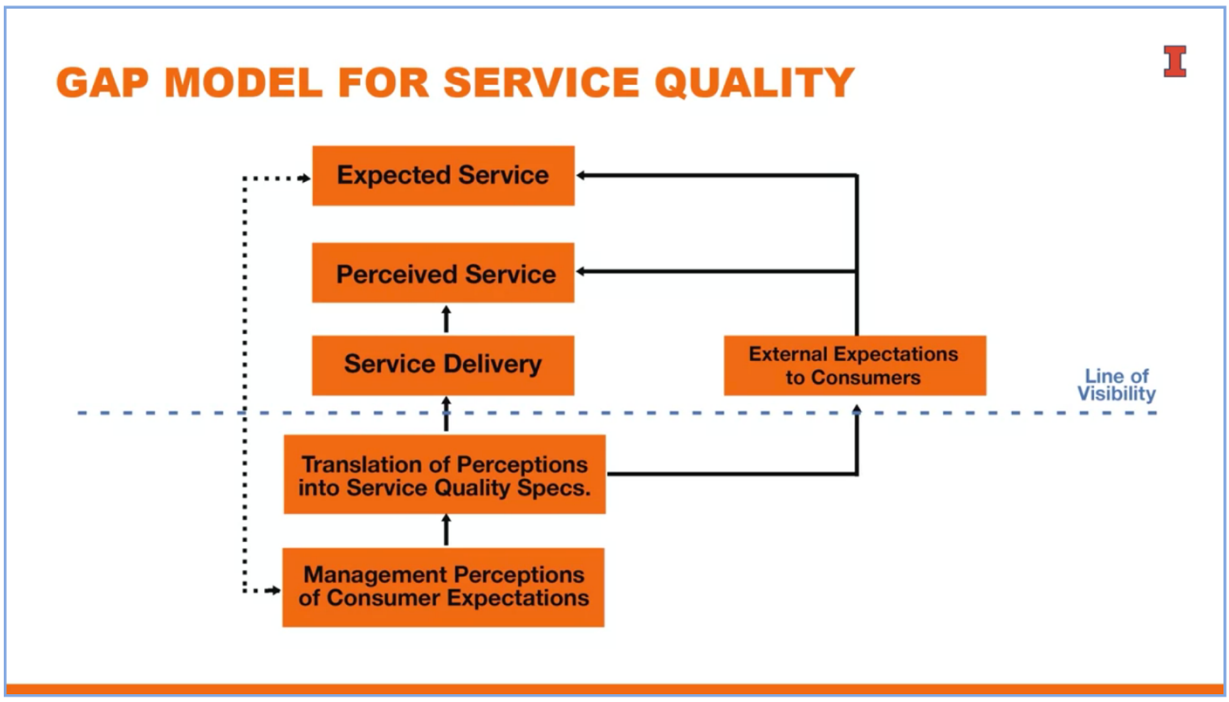


Finally moving on to the last two dimensions that were given to us by this research and I put them in the category of subjective aspects. So these would apply more to services than to manufactured goods. And the first one here is aesthetics. How do you feel when you use this product or service? So it may not have to do with the core product or service that you're purchasing, but what is the impression that you get? What is the perception that you get? And that brings us to the last category, which is perceived quality.

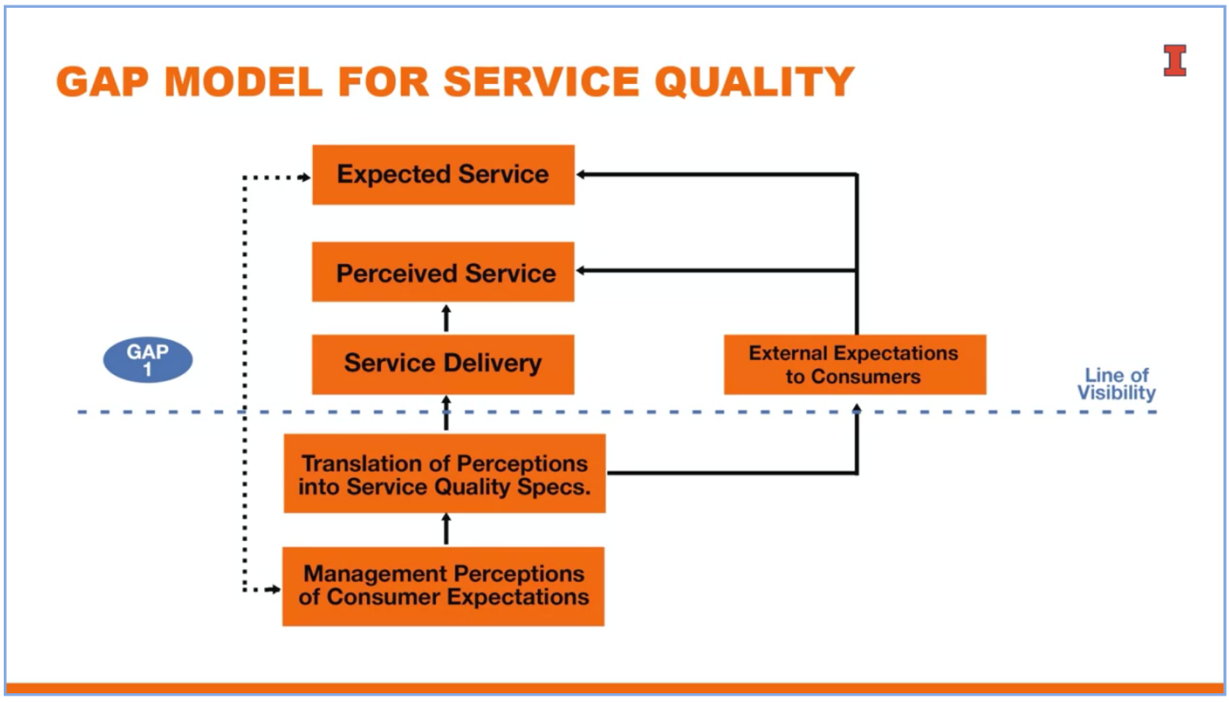


So that would be the indirect cues to product quality. Now what's different about these two categories, they are going to be as the name suggests subjective. Different customers will have different expectations for sure about what they expect to feel or how much they would be willing to pay for something like what they expect to smell in a coffee shop, and how much they would be willing to pay for the fact that when they go to a car service place that they have a good service place where they can relax and use the internet as well as even watch how their car is being worked on and how much do they value that. In terms of perceived quality you also want to think about indirect cues, which means that they don't even have to do anything with the actual service that you're purchasing. So for example, when you go to a nurse or a physician to get some treatment done. When you walk out of there, you probably do not have much of an idea if your problem has been completely resolved, right? You are relying on things like the manner in which you were talked to, you are relying on the fact that when you were waiting there the atmosphere was good, that the waiting room was nice and brightly lit, they had fresh plants in there and things like that. And that is what is going to affect your perception of that service experience. So it's indirect cues that you're relying on.

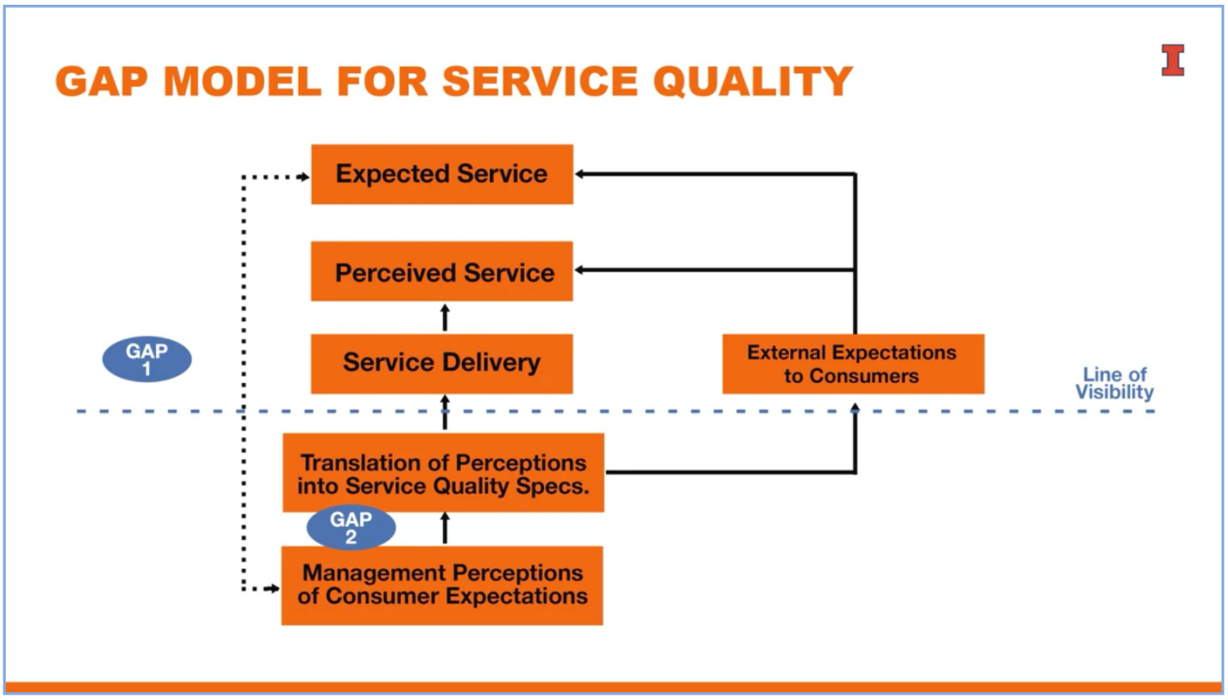
Module 1.1.3. Gap Model of Service Quality



This next thing that we have, this next model that we're looking at here is called the Gap Model. This applies more to service quality. What do we have here? We have three different aspects that are being reflected over here. One is the aspect of management perception. One is the aspect of what does the employee see based on what management is telling them and what customers are telling them. Finally, we have the customer. Then you have the horizontal line going across, that's the line of visibility. You have management, you have customers, and then you have employees. This model talks about thinking about service quality from the point of view of filling five different gaps. What are those five gaps?

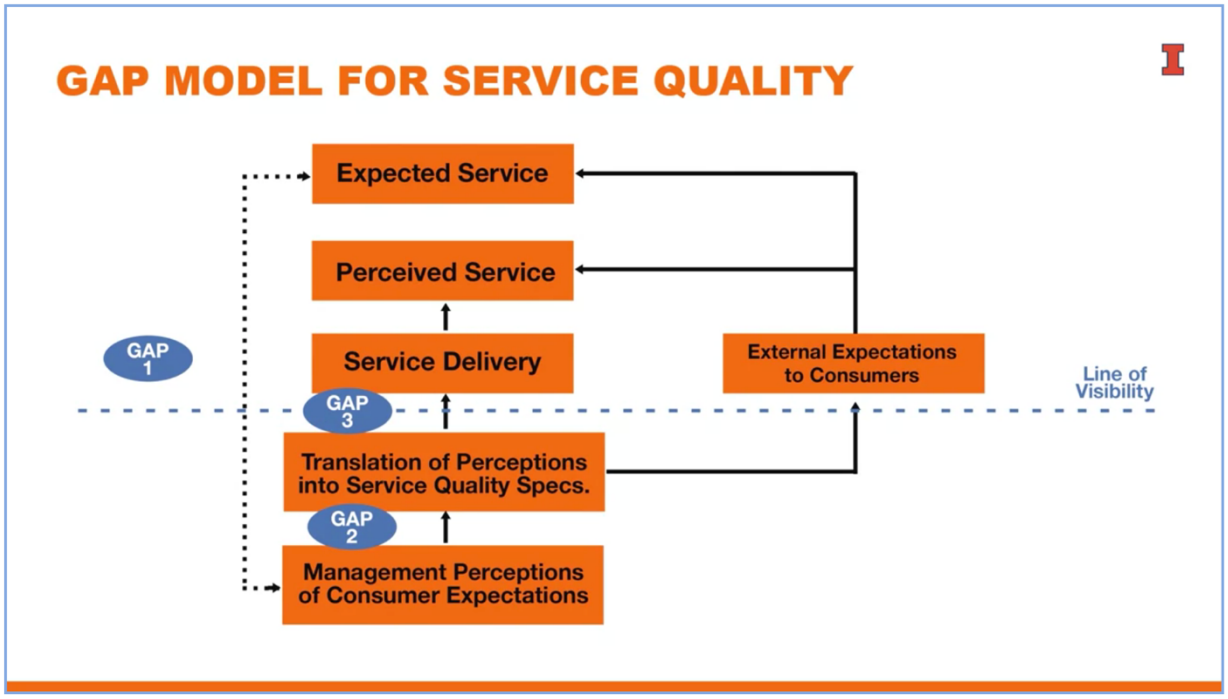


The first gap is the gap between management's perception of what customers expect and what is the customer's actual expected service quality. What is the customer expecting versus what is management believing that the customer is expecting?

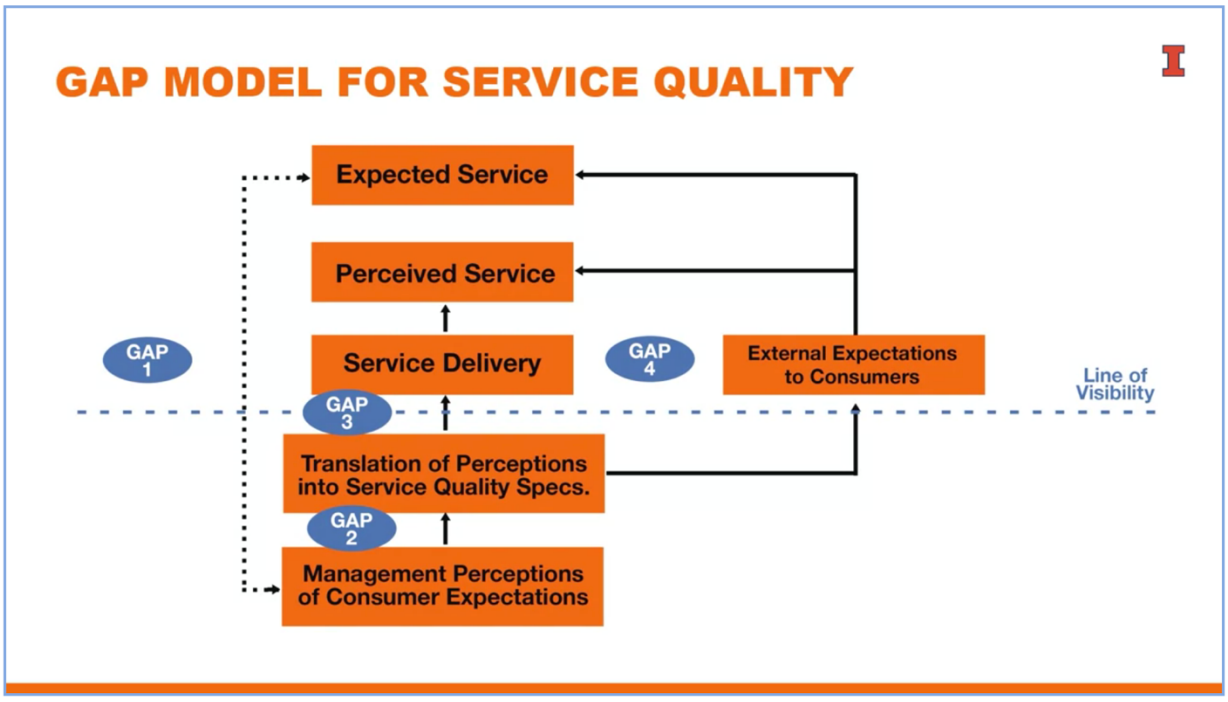


The second one is between management and translating it into specifications for employees who are going to deliver that service to customers. Management is not going to be facing the customers, but it's going to be the day-to-day employees, the people

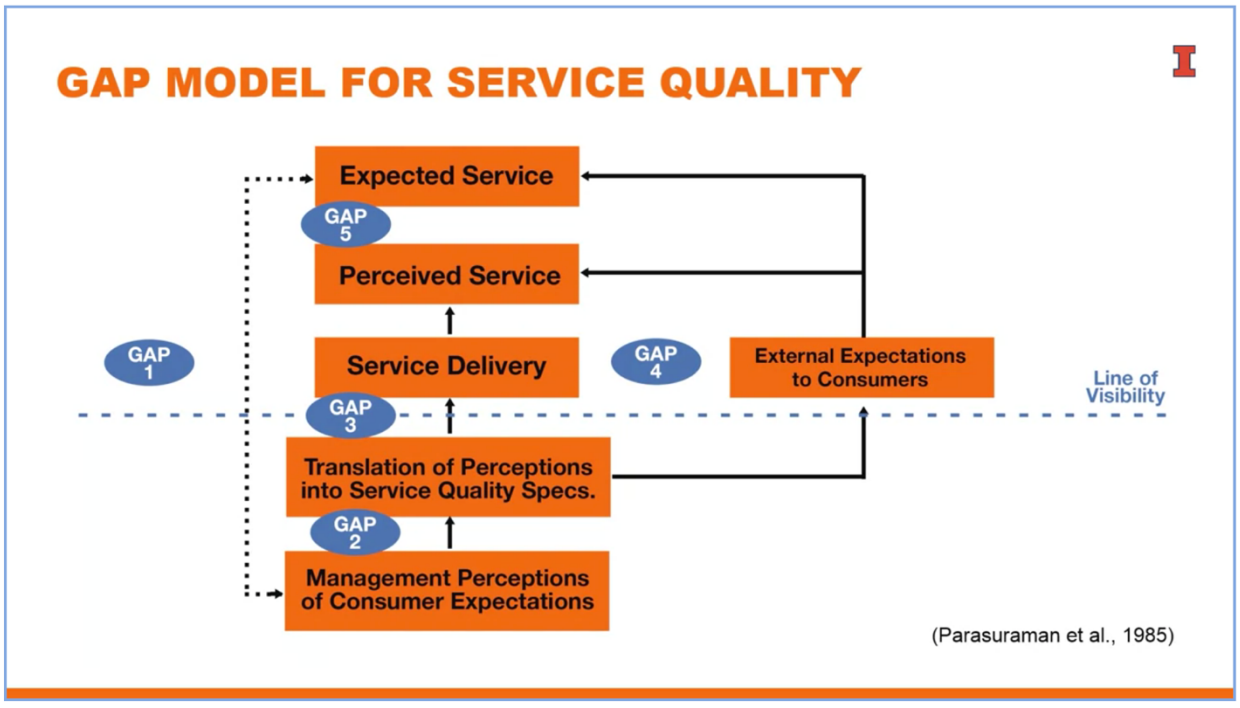
who do the day-to-day work for that service who are going to be customer-facing. Management being able to convey to employees, and that's the gap that exists or that can exist, and that's something that companies can think about if they want to improve their service quality, is to reduce that gap of management perceptions and the perceptions of the service providers, the employees.



Third gap is between the service person, service employees' perceptions, and how they're actually able to deliver. Here, you also have to think about how it's getting translated to the service employees, but also, do the service employees have the tools? Do they have the autonomy to be able to deliver good service to the customers? If that's not the case, then there's a big gap 3.

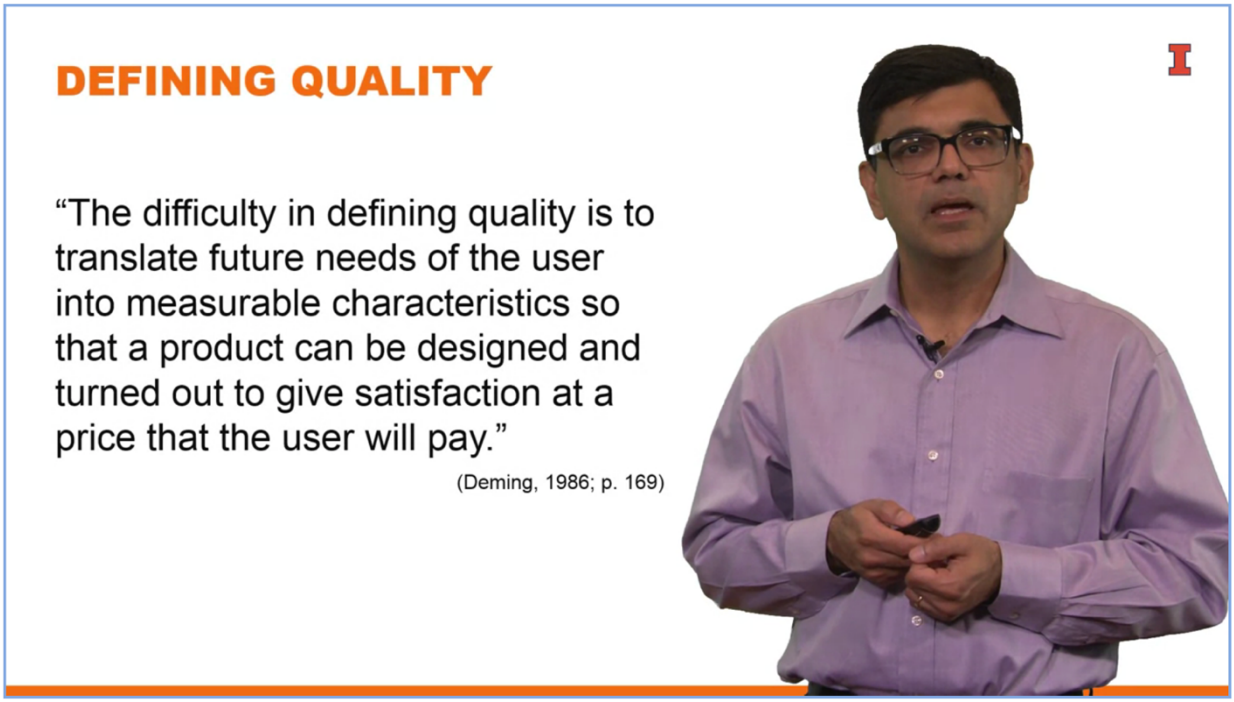


In terms of gap number 4, and this may have less to do with operations and more to do with marketing. Nevertheless, what we're talking about there is, what is operations delivering from that service business, and then how is that being communicated to customers? What should they expect when they purchase the service from this particular provider? It's a gap between expectations of customers versus what the operation is designed to deliver.

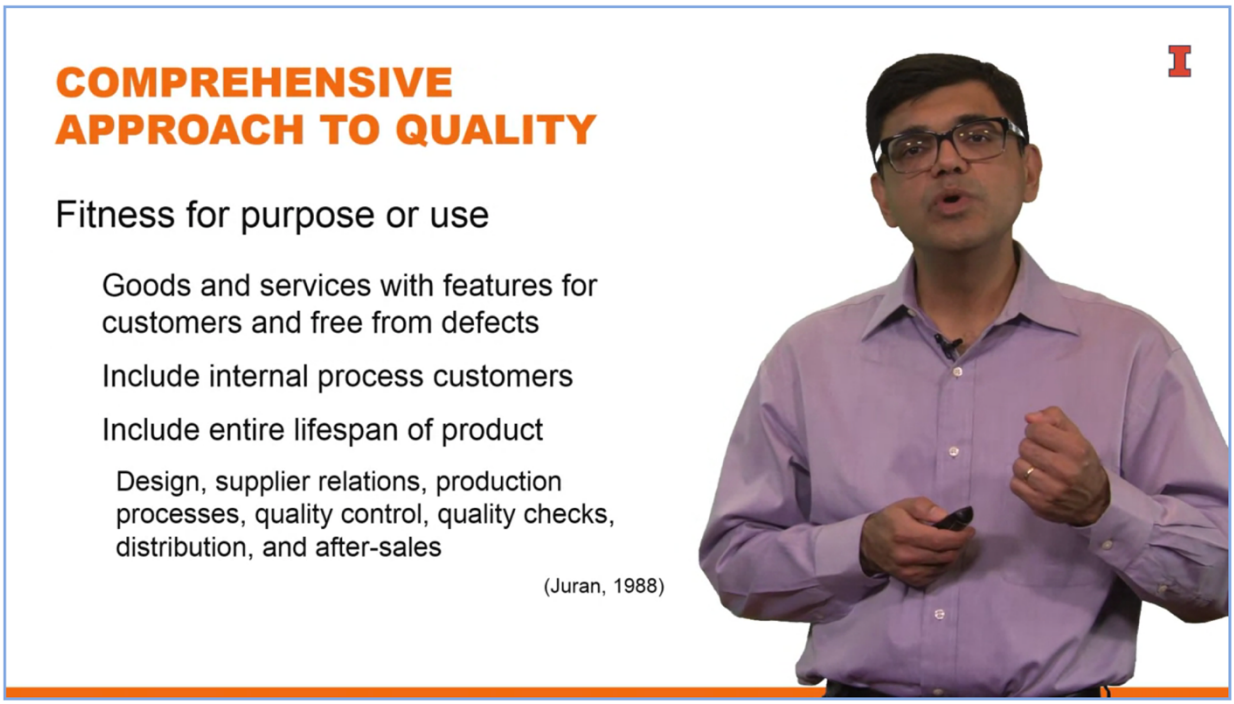


Finally, gap number 5, under this model is what the customer expected versus what they perceived being given to them. So there we're talking about what the customer actually got versus what they were expecting. Because in services, it's how they perceive is pretty much going to be the determinant of their rating of the service quality. Their perception is going to be the rating of service quality. So what you have here is a nice way of looking at service quality from the point of view of five gaps that need to be thought about when you're thinking of service quality.

Module 1.1.4. Defining Quality



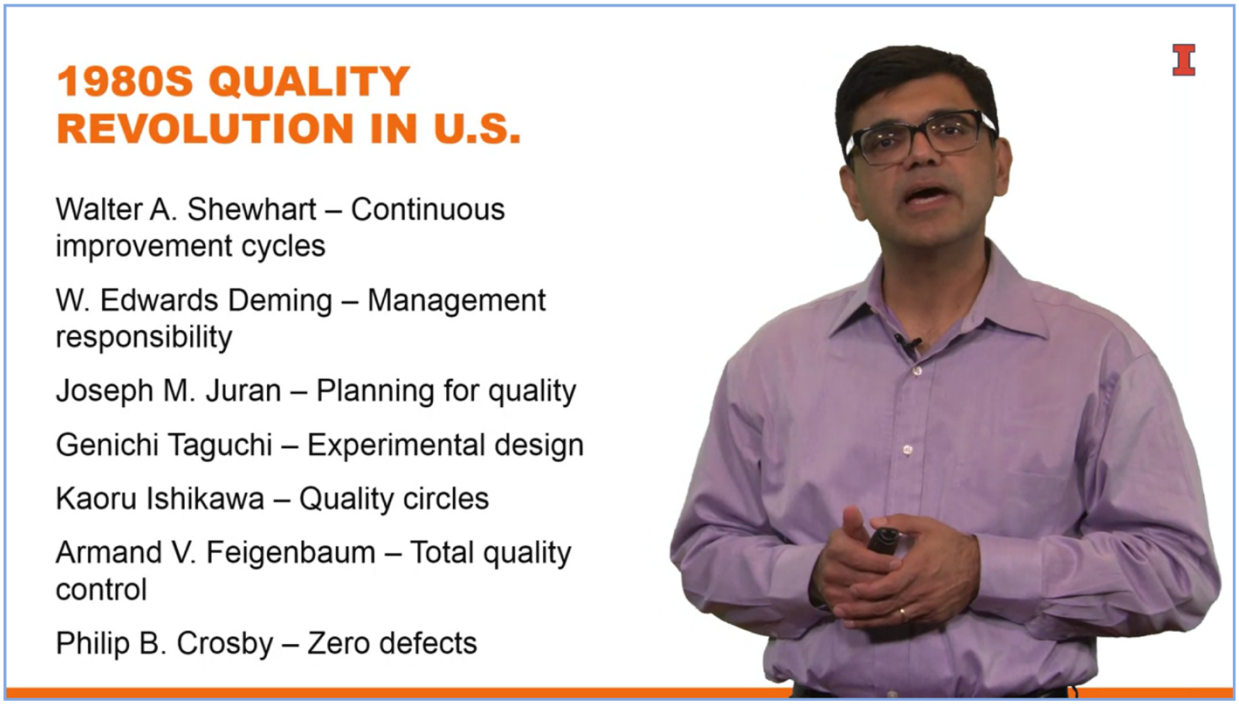
If we were to define quality and Deming put it in a very nice way. Deming is or was a philosopher in quality management, and he was responsible in a big way for the quality movement in Japan as well as in the United States. He put it in a nice way and he said that it's difficult to define quality, it's difficult to pin down a definition of quality because you're talking about future needs of users: what are users going to want from this particular goods and services, and because it's difficult to define that, it's also difficult to measure that, it's also difficult to get employees to get encouraged to deliver that. His point of view was that it's going to be a difficult task to define quality.



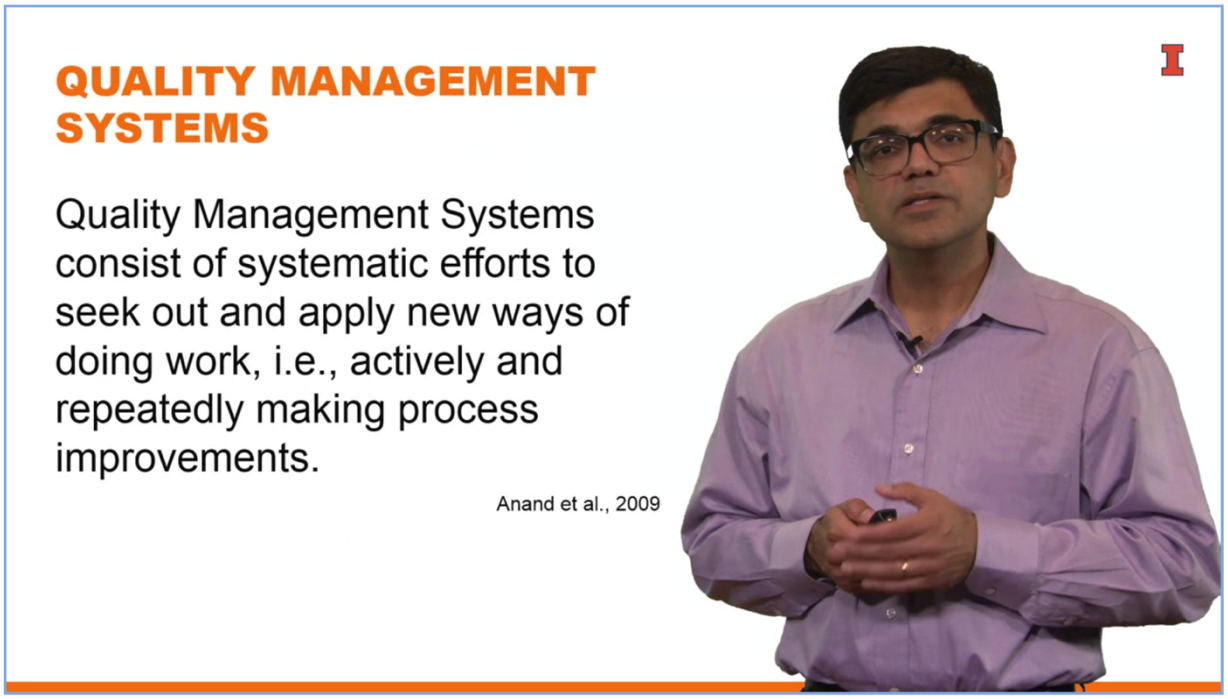
However, we do have a nice definition of quality that I'd like to close with, and that's based on another quality philosopher named Joseph Juran. Joseph Juran's approach to quality is one that we can use from the customer's perspective, from the consumer's perspective, as well as from a producer's perspective, from the service provider's perspective or whoever the company that's producing the physical goods from their perspective as well. What was his approach or what did he give us? He said, "Well, it's fitness for purpose or use." Whether it's fit for what the customer expects, so goods and services that fulfill customer requirements and fulfill them in the first shot that they don't have to be repaired. They're not defective. It's whatever the customer is expecting, and he made this even broader. In fact, made this even more generalizable if that's a word to make it generalized across different goods and services by saying that you also include internal process customers. When you're talking about goods and services, you're talking about at each stage in the production cycle, in the supply chain when you're talking about delivering goods and services. He said include process customers as well in this definition. The other aspect of this that makes it a nice comprehensive definition is the idea that he said, "Include the entire lifespan of the product." When you're thinking about quality, when you're thinking about product quality, think about process quality, but also think about process quality all the way from design to dealing with suppliers, dealing with employees, having quality control, quality checks, and then after-sales service. That to me is a very comprehensive definition of not only a customer's perspective of quality but the approach that companies should take when they are thinking about delivering good quality, goods, and services to customers.

Lesson 2-1: Origin and Evolution

Module 2.1.1. Quality Management Certifications



When we think about quality management in the United States, It was after the end of the Second World War, there was a sense of complacency and companies in the United States, in terms of the products that they were making. The markets were doing well, their products were selling customers were tolerating quality defects, customers were tolerating things going wrong, even companies were tolerating defects. They were inspecting things at the end and and we're okay with finding a certain percentage of defects because they could charge more in terms of charging extra for that low yield that they had in their production. And American companies didn't really wake up to the need for total quality management for for the idea that they needed to control quality at source. Until there was competition mainly from Japan, in terms of technology, in terms of managing quality and in terms of offering things at low prices to customers. That the Japanese companies woke up and and they said, well we need to get on this bandwagon of quality management as well. So, not to treat this idea of a bandwagon in a skeptical way, it was the right thing to do in the sense that if you want to make continuous sustain progress towards offering better things to customers. You have to make quality management the base of any kind of development that you're going to do. So these are the philosophers that I have listed here that you see over here, that were responsible for giving some of the ideas which became the basis for total quality management for quality management systems.



So, here I have a definition of quality management systems based on my own research. And quality management systems are taking the ideas of all of these philosophers that you saw earlier and converting them into real things that companies can do. So taking all the all the principles that these philosophers were talking about and translating them into things that everyone in each company, right from the front line to top management, needs to think about. The quality management systems are systematic efforts to distinguish from ad hoc efforts, right? That's the idea, it's not somebody thinking about here is a better way of making this, let me just try it out, especially if it's going to be in a part of a larger organization. You can see the problems there in terms of coordination if one person tries to make ad hoc improvements to their particular task. So, quality management systems are systematic ways of getting everybody together and thinking about quality and moving in the direction of good quality. They're also about continuous quality improvement. So, the idea that quality management is not a one shot deal, it's not a something that you say, we have reached good quality, it's a continuous journey. If you think about the comprehensive definition of quality, it's about giving customers what they need and that is something that changes over time, that that gets better and better over time in terms of what they expect. They expect better things in terms of the cost of the product, they expect better things in terms of the durability of the product. So, it's a dynamic kind of thing that you need to think about when you're thinking about quality management.

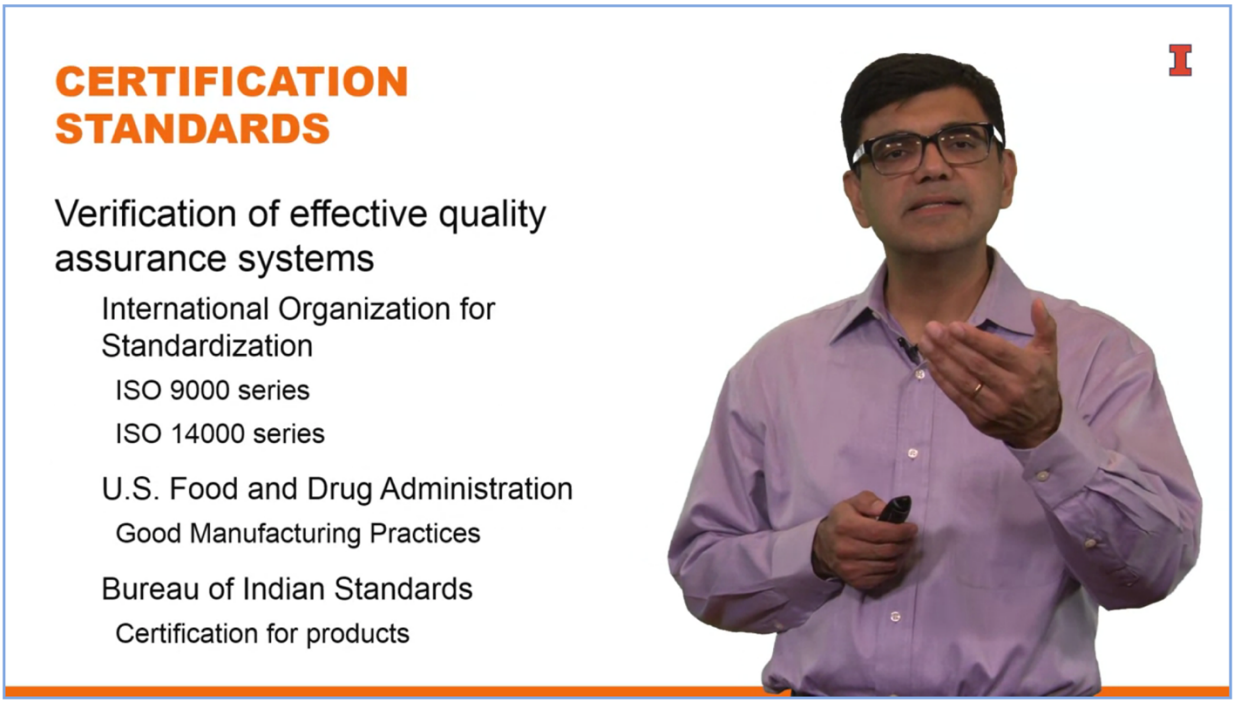
IN-VIDEO QUESTION 2

As customers, we frequently rely on certifications aimed at providing confidence about the quality of the products we purchase.

Try to recall one such certification that you have seen on product packaging or a company website.

(flickr.com/taymazvalley, 2015)

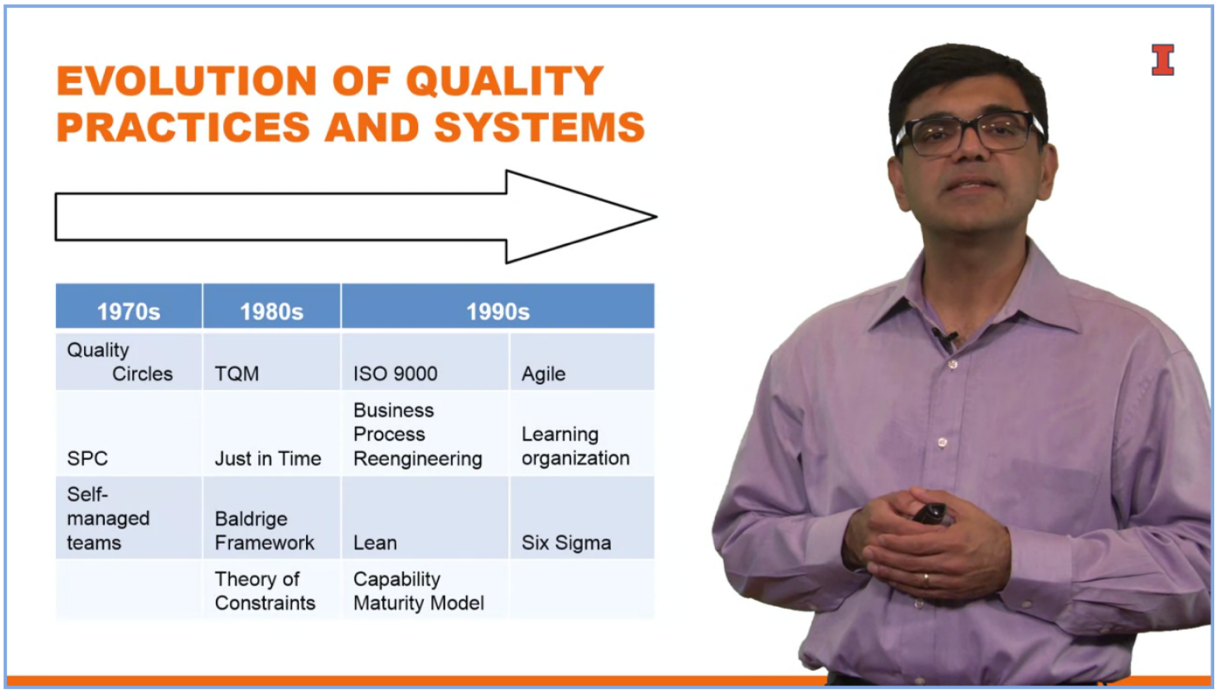
It's a moving goal in that sense So, here's a question for you. As customers, you may have seen some kind of quality marks on different products. You may have seen some kind of quality mark on the letterhead of a company. So, for example, let me give you an example here to make to make clear what the question is. You may have heard of this LEED Certification which is a certification given to buildings that are built based on green practices. And, if you pass all the tests for their certification, you are able to put that mark on your building. And you're able to advertise that to your customers that you have a building that thinks about the notion of or that has complied with the notion of it being a green building, a sustainable environment kind of a building. So, think about some other kinds of certifications that you may have encountered and we'll come back and see if you've been able to come up with a few. All right you must have thought about this question for a minute.



So let's take a look at some examples that I have that may ring a bell for you. So in Europe we have the certification that's popular called the ISO certification. And it's a series of certifications ISO 9000 is a series that deals with quality certifications. ISO 14000 deals with environment compliance certification. In the US we have this certification from the US Food and Drug Administration that certifies that good manufacturing practices are being used. And if you think about it, what is that certification doing? It's assuring customers who are buying things like pharmaceuticals, who are buying things like food. And who need to know that the manufacturers have complied with the regulations, the clean room environments, the lack of contamination in anything or keeping contamination away. In other words and that's something that you get based on the stamp of approval that the FDA the Food and Drug Administration gives them. Another kind of certification that you may have heard of is the Energy Star Certification that in the US you see on appliances on refrigerators, on your heaters, your furnaces and those kinds of things is giving you a certification. The Energy Star Certification is telling people that these are efficient appliances. In India you have the certification called the ISI and it's based on the Indian standards and they're basically telling you that there are some minimum standards that this company is following. And that's why you're able to put that mark on the packaging of your product you're able to put that mark on your on your letterhead. So what is the importance of this? The importance of this is that it's giving consumers the assurance that a company is following the guidelines for manufacturing that product that they should be following. An it's giving the customers some assurance of that. So that's one way of assuring that good quality is being maintained from the producer's perspective.

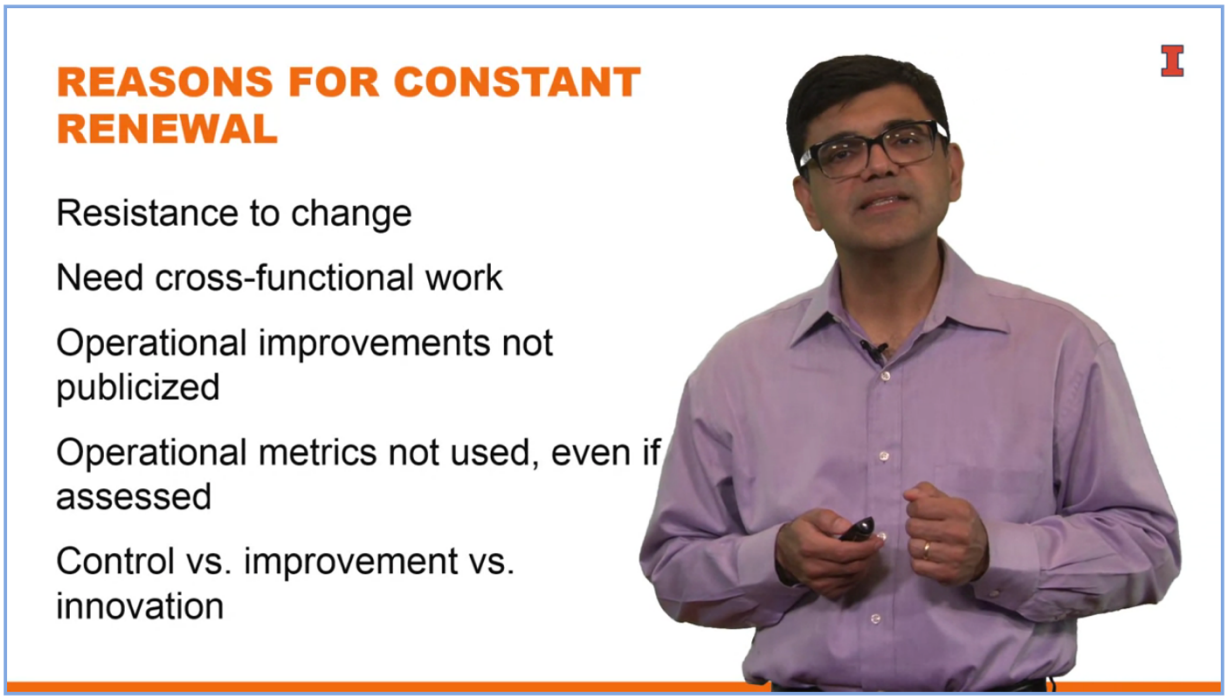
Another way in which companies try to portray that they are active they're proactive in quality management is applications for awards. So this was popularized in in Japan by the by the Deming Award. It's an award that's given to companies that not just produce good quality products. It's about having processes in place, having a system in place. That shows that they are continually thinking about improving their processes to make better quality products. So it's about process quality, not just about product quality. In the US we have the Baldrige Award, it's called MBNQA award Malcolm Baldrige National Quality Award and it gets after the same thing. So the idea of these awards is to give a snapshot at this point this company seems to be following these criteria and and that's why they get the award. Similarly, the EFQM award in Europe, and then the Shingle Prize, which is also a US based price that's given to companies. So the idea is that the company is following the requirements of that award. And the nice thing about these awards is that just the fact that companies apply for these awards makes them aware of some of the things that they should be doing from quality management perspective. And so even if they might not win the award,the application process gets them to think about quality in a serious way it gets employees involved. They get more excited about this idea of quality management. And what has been shown that they get more bought into the objectives of the company, if they see that the company cares about quality for customers

Module 2.1.2. Evolution of Quality Management



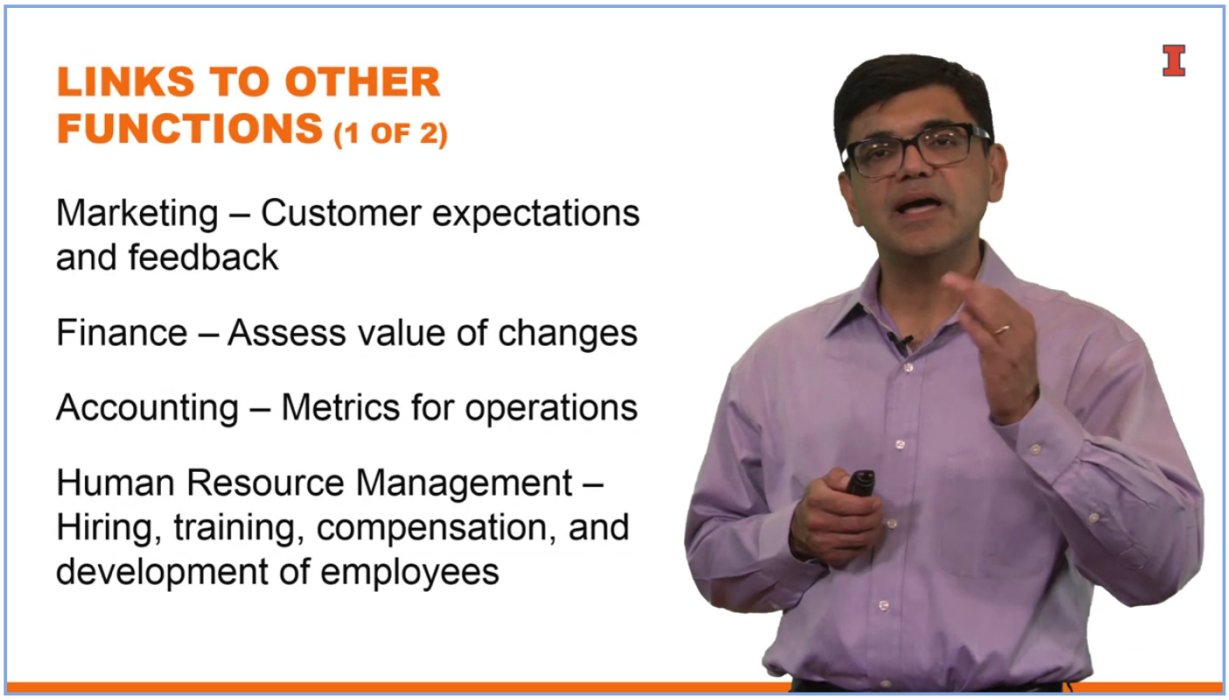
In order to appreciate the idea of quality management as we see it today, it's worthwhile for us to trace the evolution of quality management systems. Quality management systems, as we saw earlier, these are systems that are put in place in companies and organizations for them to think about quality management in a long-term way, in a continuous way, in a sustained way. In the 1970s, we had things like quality circles. We had SPC, which stands for Statistical Process Control. The emphasis was on quality control, controlling the quality of products. Then they also got into this idea of self-managed teams. Involving employees in controlling the quality of the products. All of that got combined into this idea of Total Quality Management or TQM. Where you're thinking about not just employee involvement in terms of quality improvement. You're also thinking about the customer perspective. What are customers expecting and how do we incorporate that? You're also thinking about it from a supply chain perspective. You're not just thinking about it from how can this company offer good-quality, but what can we do in terms of our suppliers and our customers? That has become even more important today, thinking about suppliers and your buyers from the point of view of globalization of markets. Just in time, kind of systems became popular in the 1980s and the idea there was you make products just in time. You don't keep excess inventory, which in turn forces you to make good quality. Because what is inventory? It can be used as a buffer when you have not so good quality. The JIT movement or the just-in-time movement also gets at the idea of forcing you to have good quality, otherwise, you are going to run short because you don't have buffers. The Baldrige framework, we

already talked about the idea of the theory of constraints, the idea of focusing on the bottleneck task and then trying to improve that bottleneck task and then going back and finding the next bottleneck and then improving on that in a continuous fashion was also popularized in the 1980s. In the recent times, we've got external agencies like the ISO getting involved in it. We've got external agencies that are giving out certifications like the Capability Maturity Model or CMMI, as it is known popularly. Then we also have lean and six Sigma, which we'll talk about a little bit later, and then you have agile technologies that are popular when you're talking about software development. What you can see here is that the idea of quality management has evolved over the years and we seem to be coming up with new quality management systems that we put in place in organizations.



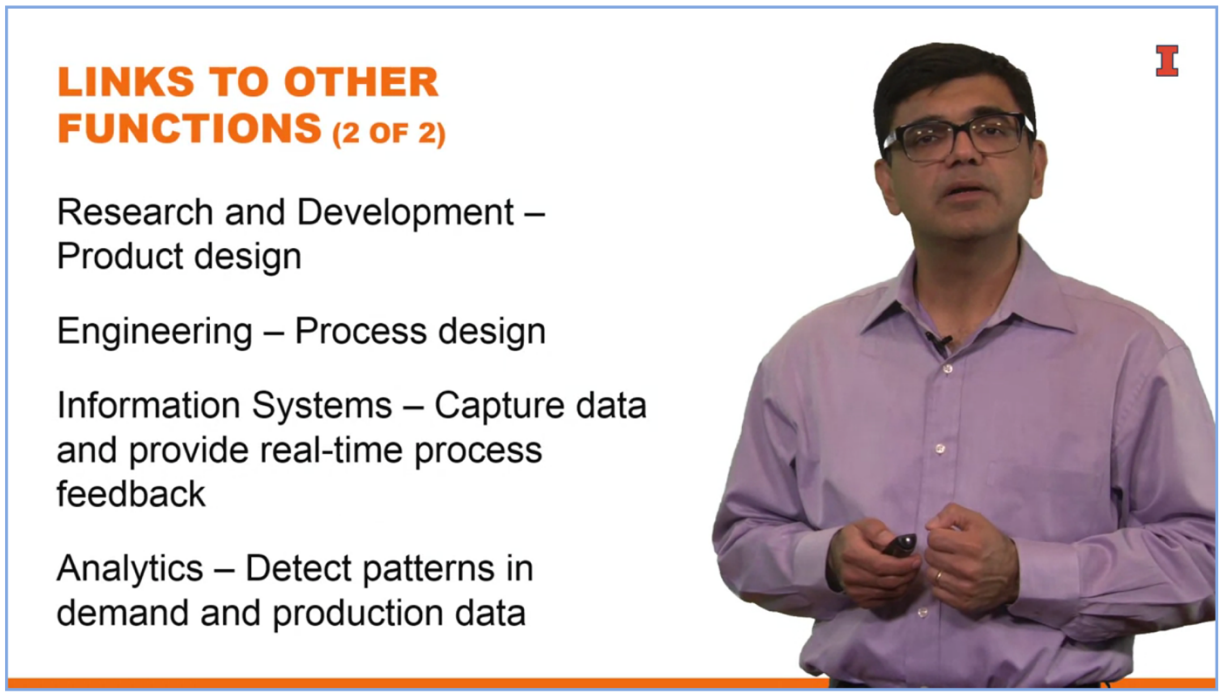
The question that you should be asking is why, why do we have this evolution? I mean, quality management is about employees getting involved.
It's about asking what the customer wants. It's about quality control, making things right the first time. Why do we need these different programs, these different initiatives that have been coming, emerging through the years, is it just a gimmick? Is it just something that, because it's new, it comes into fashion, or what is it? The perspective that you can have about this is that there is a reason for this. One of the reasons that I offer here is that it's hard to do all these things and that's why we seem to be inventing new ways of getting people in quality management, of putting in place a good, sustainable quality management system that can be continued over a long period of time. Quality management needs cross-functional work as you will see in the next few minutes, we'll talk a little bit about who else is involved in quality management other than the manufacturing organization or the service delivery organization. Operational

improvements are not talked about too much. Usually talk about mergers and alliances, and companies. You don't talk about what companies are able to achieve as a result of their quality improvement initiatives. There's not too much publicity given to them and that's why it's hard to get people involved. That's why we seem to come up with new ways of trying to put in place a quality management system. Metrics, operational metrics, we don't publicize them too much. They're supposed to be internal knowledge. We talk about cost accounting metrics that stay inside the company. We don't talk about them in balance sheets and in annual reports and also this idea of should we be focusing on improvement. That seems to be a constant struggle. If we focus too much on improvement, are we giving up on innovation? If we focus too much on quality control and quality improvement, are we saying that we're going to encourage a culture that stays away from innovation, from getting creative ideas out there. My belief at least is that the struggle, trying to balance these things is what has led to many of these new initiatives, such as lean and six Sigma and then design for six Sigma and trying to put in place a system that sort of takes care of this idea of quality control, quality improvement, and innovation at the same time.



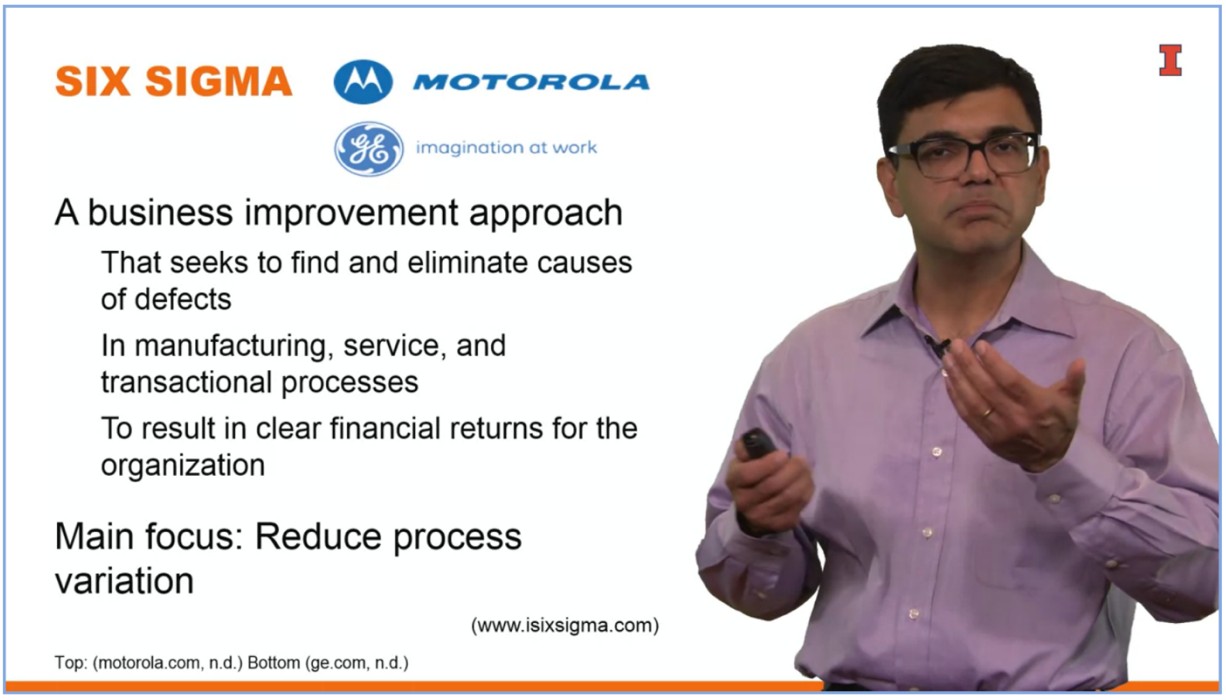
As we said earlier, quality is linked to all of the other functions in the company. When you're talking about quality management, you have to incorporate customer feedback. You have to the value of changes. You don't make quality improvements just for the sake of making quality improvements. Unless they make sense in terms of; are they going to give us more sales? Are they going to give us lesser costs? Are we going to be able to work with lesser inventory as a result of this quality management initiative. Quality management relates to cost accounting measures. We have to see how our

operations are doing so it relates to that. It's closely related to human resource management. When you try to put in place a quality management system, you have to consider the idea of unions being involved and whether there's going to be push back from employees, even if their union or non-union, whether there's going to be pushed back from employees in terms of what you're trying to tell them to do in terms of quality improvement. Sometimes it may seem like extra work. You're telling me to do my day-to-day work and now I have to think about quality improvement as well so, which one should I be thinking of when I'm doing my day-to-day work.



You think about research and development. Quality management is very much involved in building quality into the production system, building quality into the product. Product design is a way of impacting quality of products. Engineering, process design is involved in the same way. Information systems can help you track day-to-day metrics of quality and also are able to give you longer-term feedback in terms of what customers are getting from your products in a long term. Analytics is the field that takes all of the data that you get from customers, as well as from the supply chain metrics as well as from quality metrics within the organization, and uses that to say that these are the relationships between what we are doing, the actions that we're taking, and how it's showing up in terms of quality metrics. As you can see, quality management has a link with all the different functions that you can think about in an organization, in a company.

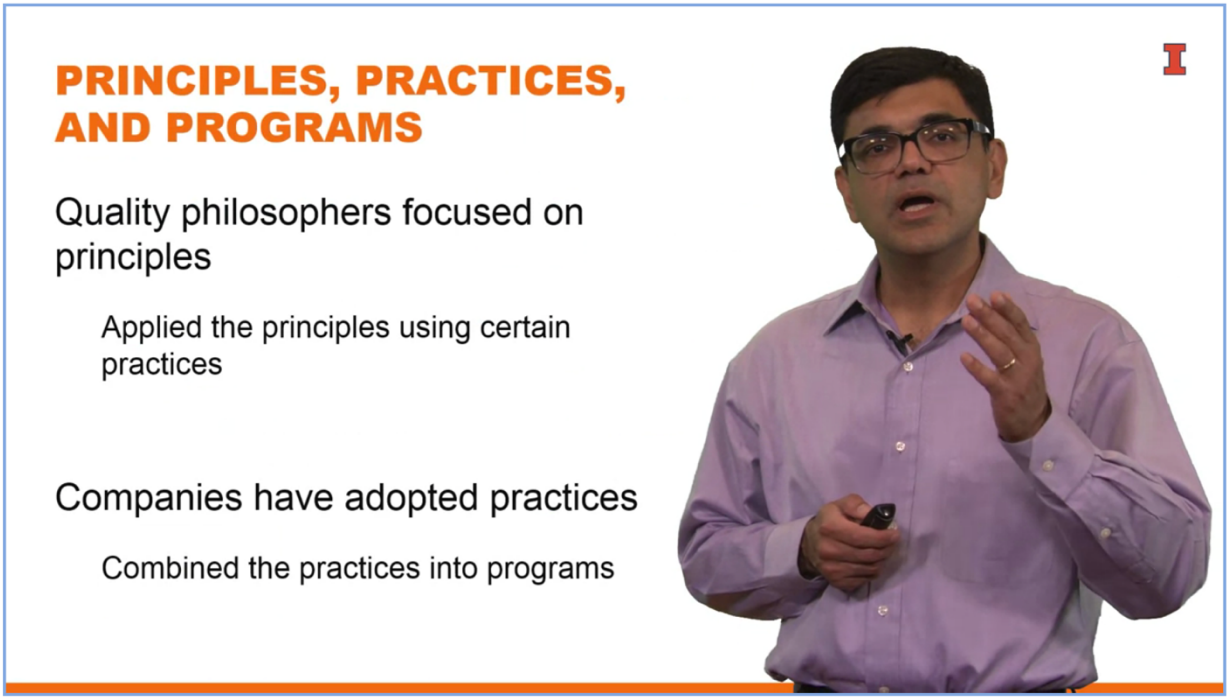
Module 2.1.3. Continuous Improvement for Better Quality



So just to give you an idea of two kinds of process improvement initiatives, quality improvement initiatives, continuous improvement initiatives, whatever you want to call them. The one that is popular is nowadays a six sigma. So this has been popular since the 80s. Motorola is the company that started using this idea of six sigma. And then GE is the company that popularized the idea of six sigma. So what is the main focus of six sigma? It starts off with the idea of reducing variation, starts off with the idea that variation in any product. Any process is not a good thing if you can reduce variation to a great extent without getting into too much detail of what six sigma actually, where the name comes from. Its talking about reducing variation to a very great extent. And it's a comprehensive approach because it talks about all the different processes, focusing on making improvements towards reducing variation.

The other approach that's popular is the approach that became popular as a result of Toyota. So the idea of lean management and the idea of lean being that you take out all of the waste in the process. So the idea there is focus on reduction of waste start from that. And waste is defined briefly as anything that a customer would not pay extra for. Anything that the customer would not be willing to pay extra for is waste. So the main focus of lean process improvement initiatives is a reduction of waste.

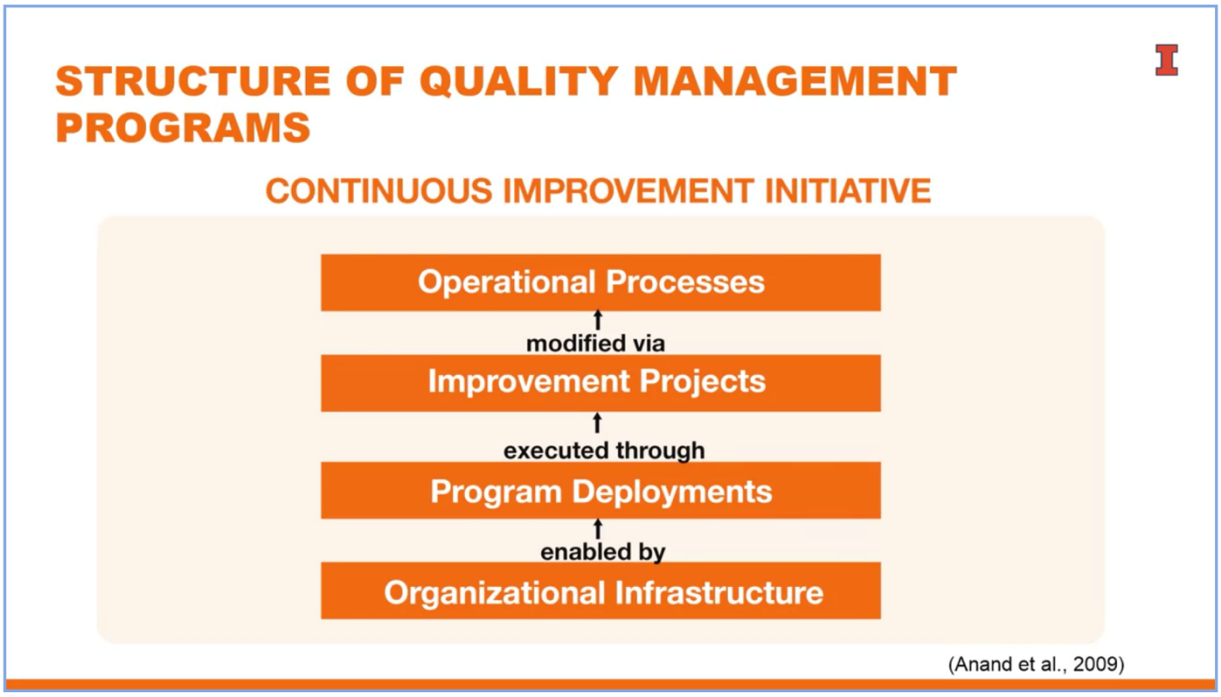
So as you can see there are many different companies who are adopting these initiatives. And these are companies that are multinational, these are companies that you may be familiar with. They're adopting different initiatives, they're adopting different combinations of different initiatives. So what is popular in the US is currently the idea of lean six sigma, combining the idea of reduction of waste, with the idea of reduction of variance and calling it lean sigma or lean six sigma.



So to close this idea of quality management and quality management initiatives. What you can see hopefully from this lesson is that quality philosophers gave us the principles on the basis of which companies should be thinking about total quality management. The idea that quality should be front and center for everyone in the organization. And what have companies done, they have adopted these principles. But putting them in these sets of practices, these bundles of practices that we call quality management initiatives, quality management programs, continuous improvement initiatives.

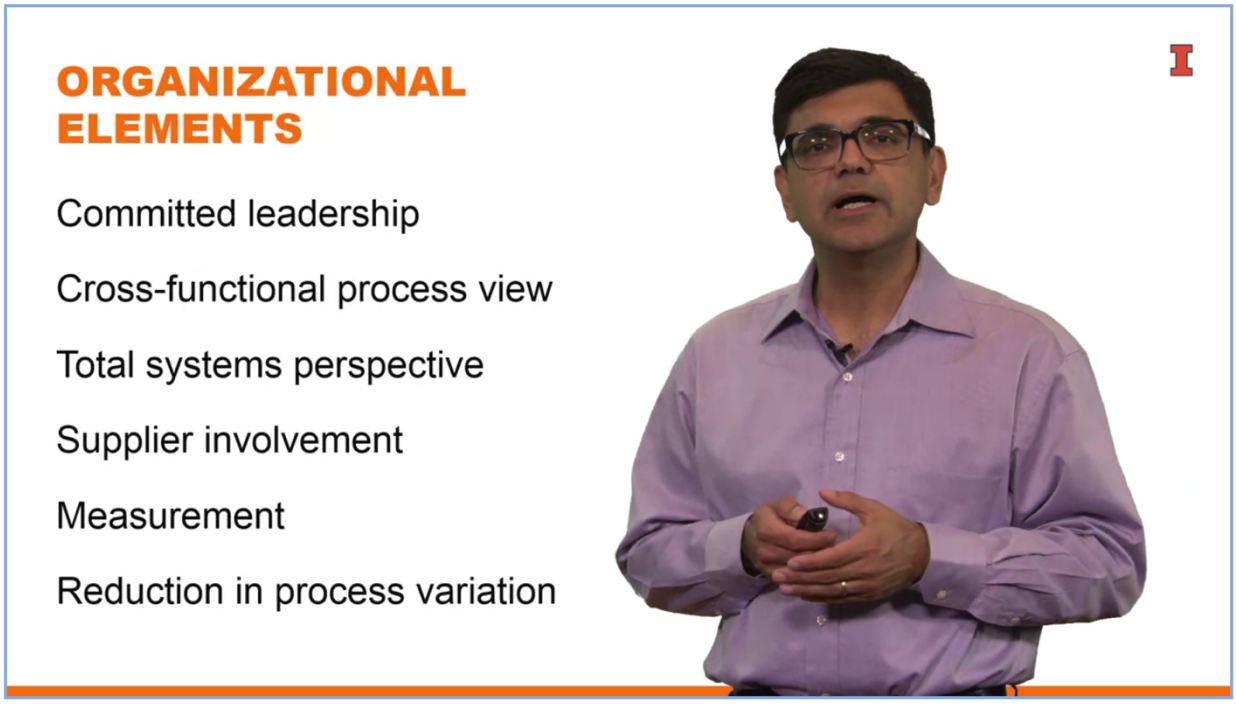
Lesson 3-1: Common Elements

Module 3.1.1. Continuous Improvement Initatives



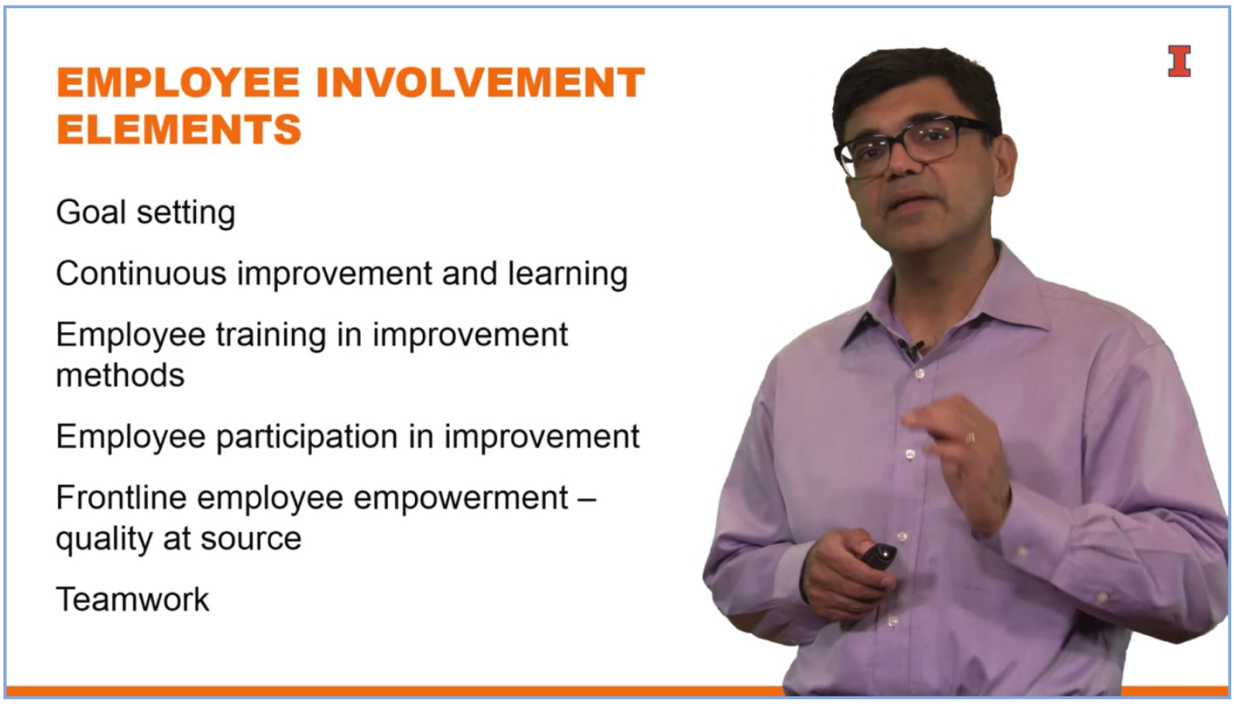
Companies use continuous improvement initiatives, Total Quality Management, Six Sigma, Lean these different initiatives. But if you think about the common elements across each of these different initiatives, you can boil it down to what you can see in this picture. The idea that there are going to be operational processes that need to be changed. They may be changed because you're trying to make an improvement or they need to be changed because conditions have changed, so operational processes are being modified. Typically, each of these programs, like Six Sigma and Lean, they modify these operational processes through improvement projects. You start with the objective of the project and you try to achieve it through some cross-functional team project that is aimed at getting that objective of that improvement. These improvement projects are typically handled by an office of project implementation. There's a program deployment, there's an initiative deployment that is being done at the organizational level, at the company level. Finally, this deployment has to be funded by resources. There has to be time given to it. There has to be an infrastructure in place in terms of people who are experts in these deployments and who have different roles in this deployment. There's a superimposed infrastructure, there's a superimposed organizational structure dealing with the program like Six Sigma or Lean, superimposed on top of the normal organizational chart. You have the normal organizational chart, and then you have this organizational chart that is focusing on Six Sigma or Lean, or whatever continuous

improvement initiative is being used in that company. This seems to be a common way of how continuous improvement initiatives get implemented in large organizations.



If you can study each of these continuous improvement initiatives, what you'll also find is that there are some common elements that they are trying to achieve. They may achieve it to different degrees of perfection, but they are trying to achieve these elements. I've divided these up into organizational elements. Things that need to be done at the organizational level, and then the employee elements. What are the different things that employees need to do? From an organizational perspective, leadership that is committed to the idea of quality improvement, of maintaining quality, of improving quality. The idea of the cross-functional view, the horizontal view that incorporates the process that is serving goods and services to customers, that is producing the goods or providing services to customers and the cross-functional view focusing on the customer. The total systems perspective, not each function focusing on their own particular performance, not just purchasing, focusing on reducing the cost of the things that they're purchasing. But thinking about it from a total perspective, from a total cost perspective, if you're talking about purchasing, thinking about, well, if we buy products that are just focusing on lower cost, how are they going to impact the quality of production? How are they going to impact what the customer ultimately gets? The idea of supplier involvement is common across different quality improvement initiatives. The idea that you need to move beyond your organizational boundary and select your suppliers based on something other than cost. Then keep communicating with them about your quality improvement initiative, emphasizing the fact that you focused on quality, working with them on quality on their end. Measurement is an important aspect of any process improvement initiative. Without getting the metrics, without knowing a

baseline that you can depend on, you cannot think about making an improvement. Where do you start from if you don't have a good baseline? Reduction and process variation seems to be a common theme. Although Six Sigma is the one program that specifically focuses on reduction in variation, it's not a new idea. It's not an idea that came up with Six Sigma. These things have been talked about in quality management initiatives, quality improvement initiatives since the time of total quality management, since the time of quality circles, after the Second World War, when Japan started looking at quality management and quality improvement in a serious way.



Now let's look at the other side, the elements that deal with involving employees. You can think of this as being bottom-up. The organizational elements that we saw were top-down. There's a top-down sense to quality improvement and then there's a bottom-up setting goals for employees based on the metrics giving them particular goals, what they do on a day-to-day basis, how does that translate into good quality and good performance for the company? Giving them training, giving them the idea that they need to do this in addition to their day-to-day work. As they're doing their day-to-day work, they have to think about continuous improvement. They have to think about learning from their iterations of doing their day-to-day work and participate in a systematic way of continuous improvement. That seems to be a common element of continuous improvement programs. A front line empowerment, giving employees the autonomy to make some changes in terms of how they're delivering things to customers. Not to say that they are to make ad hoc changes to the entire process, but giving them some sense of ownership of their work, giving them some flexibility in how they take that last step of delivering the goods and services to customers. What also seems to be common

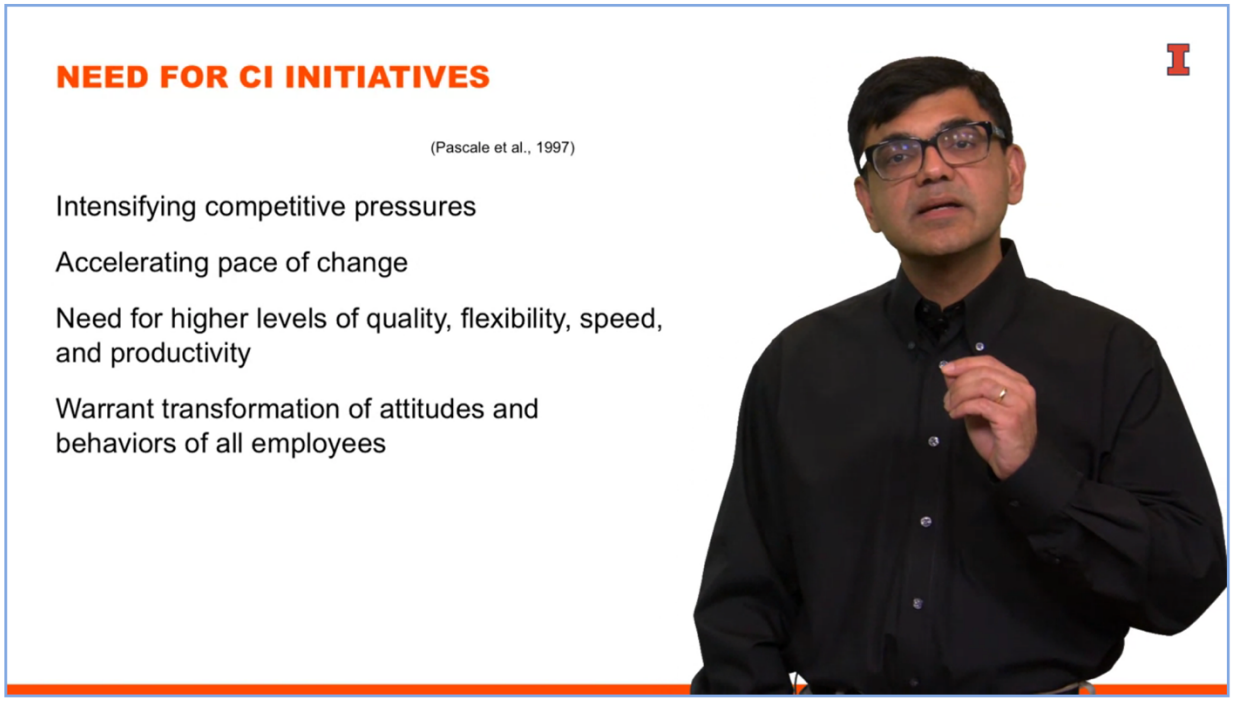
across different continuous improvement initiatives is this idea of teamwork, that there's not one expert in any particular way of doing work, in any particular area of doing work, that it should be a team that gets together. That you get all the perspective of all the different functions as well as you are able to get buy-in from that team. Because the team is going to be made up of people who are in some way connected to whatever work is being improved, whatever process is being improved.

Lesson 4-1: Elements of Continuous Improvement Initiatives

Module 4.1.1. Need for New Initiatives

We're going to start here with a question for you. You know that there are a lot of continuous improvement initiatives out there such as, total quality management, TQM, business process re-engineering, BPR, theory of constraints or TOC, CMMI, which is the framework that's used to assess process level maturities in the software industry, and Lean and Six Sigma; and then we've also got Lean Six Sigma and a combination of all of the different initiatives under different names that are used by different organizations. What I'd like you to think about is, what is the impact of this constant renewal, constant emergence of continuous improvement initiatives over time? What happens because of this in organizations? Whether these are necessary or whether these are some things that are just being rehashed, just being put fresh paint over and starting off as being something that should be used in organizations.

You may have taken a cynical view to this and you may have thought, well, TQM, business process re-engineering, theory of constraints, these are all the same things just repackaged so that companies can adopt them and appear to be doing something new. Or you could have taken the perspective that these initiatives really have something more value-added, that there's something different from what was being done in the previous generation of initiatives. You can take one or the other perspective. We actually did some research on what is it that's going on, and we'll talk about it in this lesson in a minute.

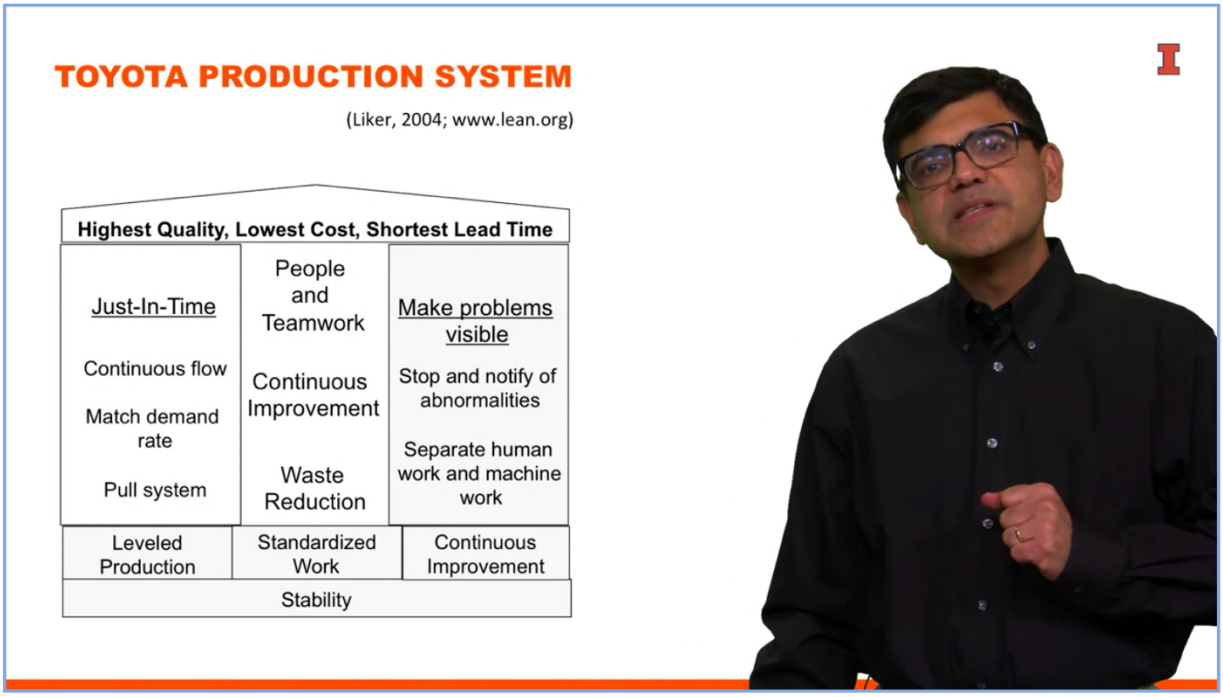


But first, let's take a look at some basic reasons for why companies have to have many different continuous improvement initiatives. If you think about competition, the competitive pressures have only increased over the years for all kinds of businesses; and that's something that companies are constantly worried about when there's a new continuous improvement initiative that comes up that shows that some other company is doing really well. GE has done really well after they implemented Six Sigma. Maybe we need to implement what they are implementing, otherwise, we're not going to be able to compete with our peers because they may be using those. There's this idea of the herd mentality, everyone needs to do this. Otherwise, we're not going to be able to compete with everyone else who's doing this. The pace of change has been accelerating. Things are changing at a much faster pace, especially since we've experienced the Internet, especially we've experienced the big data revolution. We're talking about using a lot of big data that is also coming from sources on the Internet that can be used in order to make better decisions, and continuous improvement initiatives
have to keep up with the idea of these kind of changes in the environment. Simply the idea of offering customers products at lower prices, or at better quality, or with more choices is not enough anymore. Companies today have to think about being a lot of things to a lot of customers. Be able to give good quality at a lower price; be able to give customization choices at the same prices without increasing the prices. That's something that process improvement has to incorporate into its objectives and say, how can we add all of these features for customers through process improvements? Some of the changes in process improvement have had to occur because of that reason. Finally, if you think about all of these process improvement initiatives, take from total quality management today what we have as Lean and Six Sigma, what is the underlying

theme behind all of these? If I would to point out just one underlying theme, they all seem to be focusing on involving frontline employees in process improvement. Six Sigma has the idea of doing projects in which there are team members who are from the process who are working in order to make improvements to the process. The idea of lean projects is also the same, and there it's taken to an even greater extreme in terms of talking about involving frontline employees in making improvements to their own processes. That's something that companies seem to have a struggle, because this was the same theme that existed when you study total quality management, it's exactly the same theme that keeps coming up. How do we engage employees in order to work on continuous improvement? How do we engage them in such a way that they keep the perspective of the organization in mind? That they don't forget the perspective of the customer on the process, and at the same time, they do work in a standardized fashion. They follow standard work, they do quality control, at the same time, they think about quality improvement. That's a challenge for companies that has existed for a long time, and that may be the reason for why we keep on coming up with new continuous improvement initiatives. In some sense, we are trying to improve continuous improvement and come up with better continuous improvement initiative.

Lesson 5-1: Philosophy of Lean

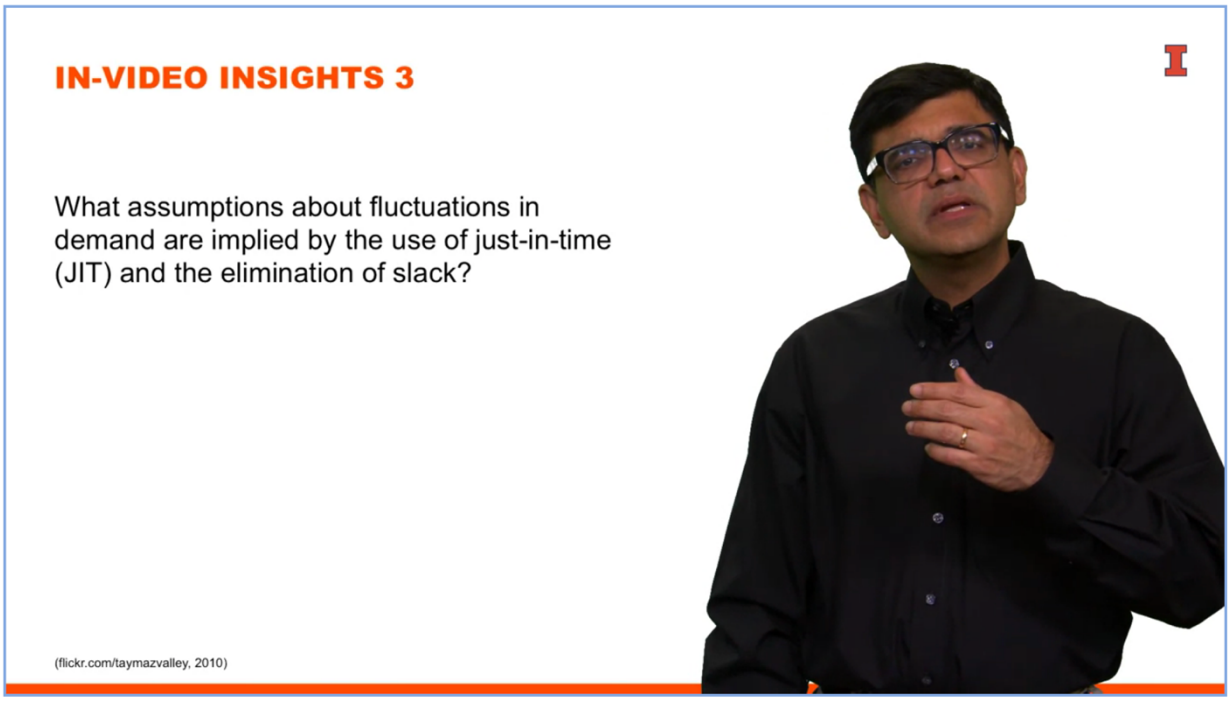
Module 5.1.1. Lean as Toyota Production System (TPS)



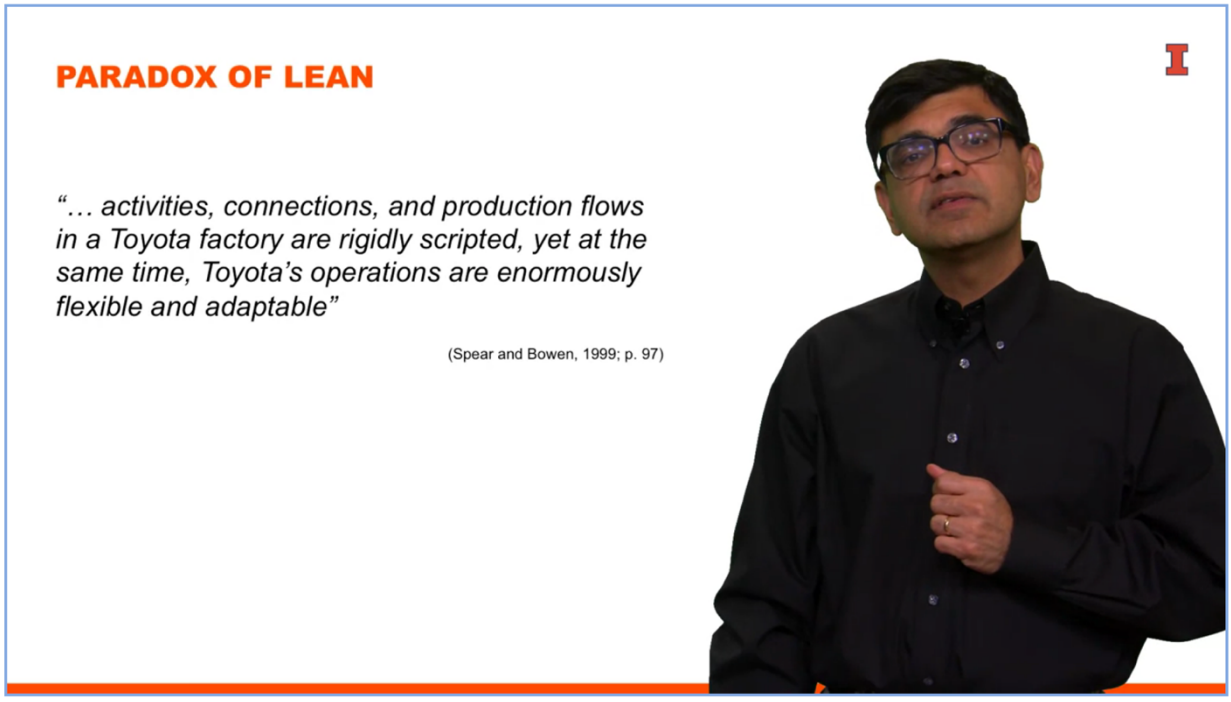
The lean management system comes to us from Toyota. And this book, the Toyota way describes the Toyota production system as this House of Toyota which has two pillars. The two main pillars of the Toyota production system are described as just-in-time and making problems visible. So just-in-time is the idea that you don't have any waste in the process that you produce only what is needed in whatever quantity it is needed. And when it's needed and there's going to be no defect there, there's going to be perfect production, there's going to be a defect reproduction. So, if you need 100 units, you produce 100 units, you don't say we're going to keep a buffer because some of the products may not be good quality. So that's one pillar of the Toyota production system under the Toyota way that the House of Toyota. The other pillar of the Toyota production system is the idea of making problems visible. The idea that whenever there's a problem, it should come out. Now if you think about it, the idea of just-in-time is related to the idea of making problems visible. In the sense that when you do have buffers, if you're not doing things just-in-time, then there may be some inventory, some extra capacity, some extra stuff extra slack that is going to cover for any kind of mistake that you will do. So, the idea of just-in-time also feeds into the idea of making problems visible. And the idea of making problems visible is that when you do have a problem in the process, it should be seen immediately. It should become apparent immediately and when it does become apparent immediately, there should be something that's done

about it immediately. They should, problems should not be batch and kept aside. Problems should be taken care of immediately and again when everything is just in time, you have to take care of problems immediately because you don't have any kind of spare. So these two pillars are sort of related to each other. Now, how does Toyota accomplish this? If you look at the centerpiece of these two pillars, you have the teamwork and the involvement of people, you have people who are involved in continuous improvement, you have the idea of continuous improvement itself. And you also have the idea of continually looking for ways in which waste can be reduced. And that's how the people at Toyota, the employees at Toyota are thinking about continuous improvement is where can be reduced the waste, what is the ways that we can eliminate? At the foundation of this House of Toyota level production sanitized work and continuous improvement again. So level production is the idea that because we are making just-in-time, we will make product which is going to not be batch in quantity. So for making five different modules and we do have a certain quantity that we know that is required from those five different modules. We're not going to batch them in the sense that will make one module one week and one module the other and then the other. We're not even going to be making it one module one day and and one the other, we're going to make it one at a time, we're going to make it if possible. I mean that's the ideal that Toyota likes to talk about is we should be able to make a unit one at a time and switch to another model and make another unit and switch back to another module and make another unit of that module. And in that sense having completely level production, never having to batch production and make it in larger batches. So that is the foundation, the foundation of the production system is also standard work that work should be done in exactly the same way. And we'll take it we'll see this idea of standard work in even more detail as we go through this lesson and the idea of continuous improvement that there's always going to be scope for making improvement to the process. So the final foundation you can think of as a total production system of the Toyota production system is its stability that they want to have stability in the production system. And although there will be ways in which this will be challenged, they want to try and maintain stability in the production system to the extent possible. At the roof of the Toyota production system are the objectives. So the objectives are highest quality, lowest cost and shortest lead time because Toyota not only focuses on making things with minimal waste. But part of that is also focusing on having continuous flow through any process, having continuous flow through any value stream. So the idea of shortest lead time also incorporates the idea of having continuous flow. There are no they try to have no stoppages in the flow of a product from the raw material to the finished goods. And so in that sense, they're looking for shortest lead time as well.

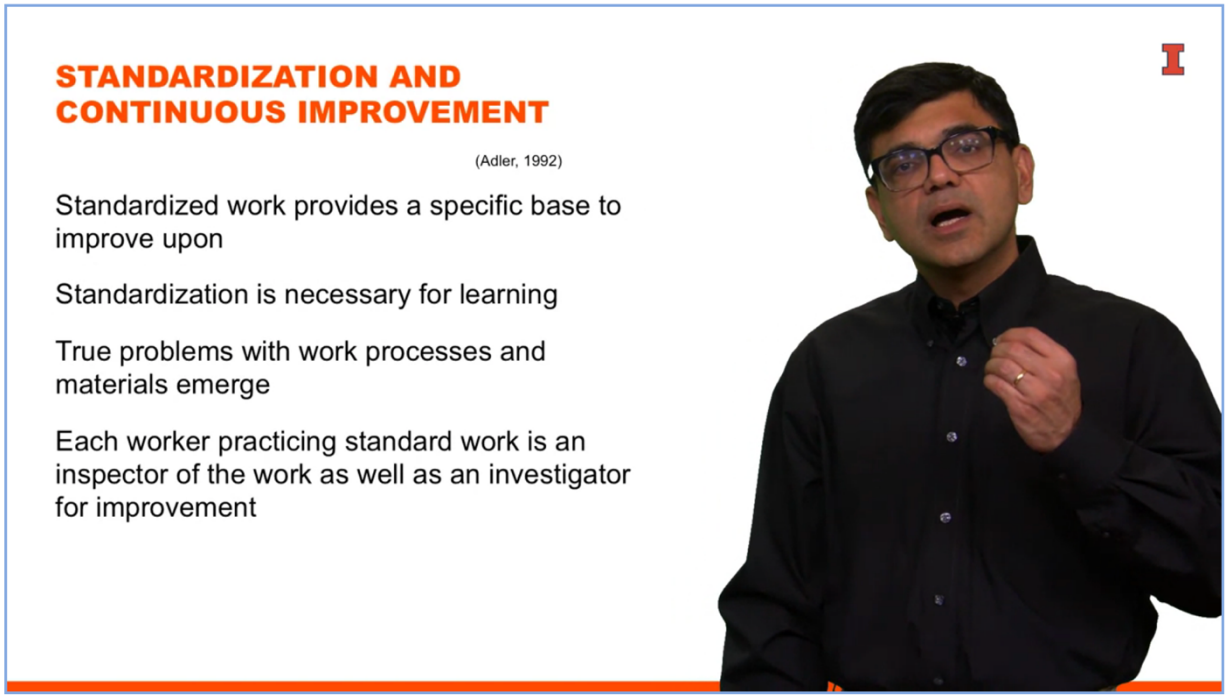
Module 5.1.2. Paradox of the TPS



So normally if you think of a system that doesn't have slack in it, you'll say well they probably have a steady demand, the demand is very stable. There's no fluctuation in demand and that's why they can do with having a just in time system, having a system that doesn't have any slack in it. They definitely are not expecting any changes to customer orders. So customer orders are not only stable, they're going to be no changes. But in fact if you look at some research that has been done on Toyota, it's quite the opposite. Toyota is trying to come up with a stable system in order to implement just in time. With the assumption that demand is going to fluctuate and that there are going to be changes in what customers demand and they might make changes to the orders when they need to.

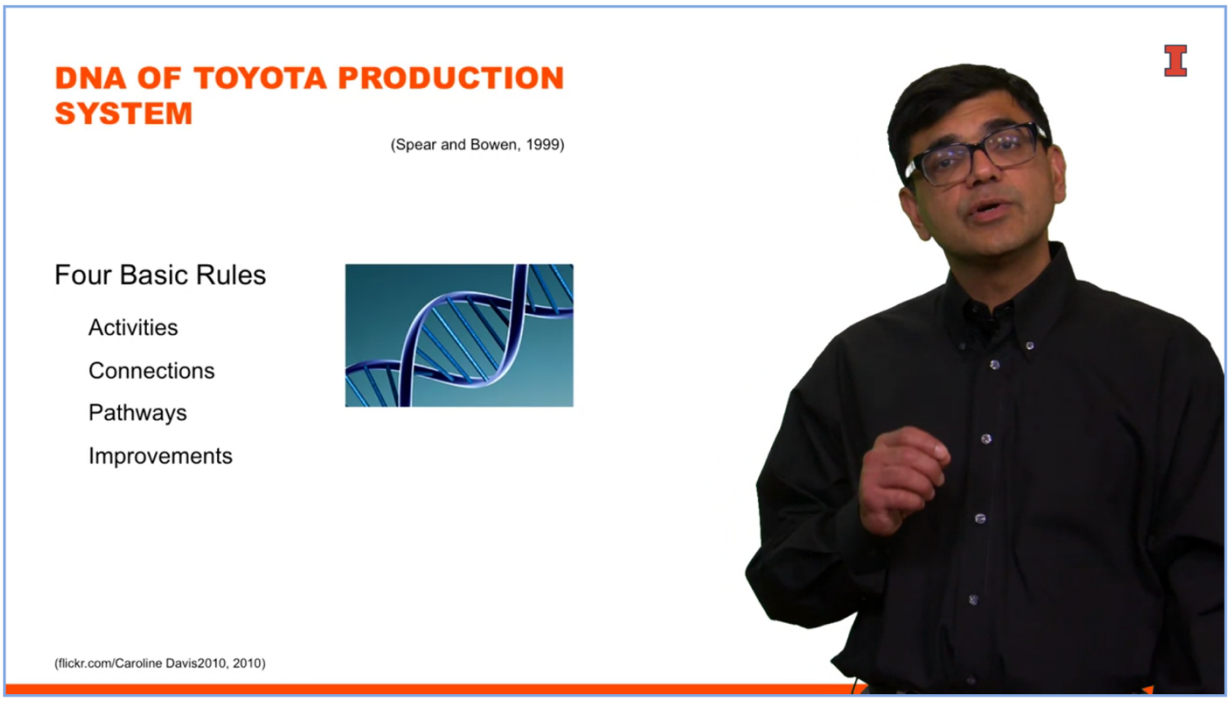


So the paradox of lean as put by spear and bowman in the article which is called the D N A. Of the Toyota production system. So this article looks at the underlying philosophy of the Toyota production system. And it starts off with this idea that there's a paradox underlying the Toyota production system. All of the activities in Toyota are very rigidly scripted. Their standardized to the point of the extreme, their standardized to an extreme and at the same time. The output from Toyota is very flexible, they are able to make different types of models from the same assembly line, they are able to make a model change over even when you're going from a large model changeover from one year to the other. They are able to do it in record time as compared to other car manufacturers. So that is the paradox of lean that spear and bow in this article, DNA of the Toyota production system, try to unravel, they try to look at it from the point of view of what are the underlying principles that Toyota is following, which gives them, which helps them achieve this paradox.

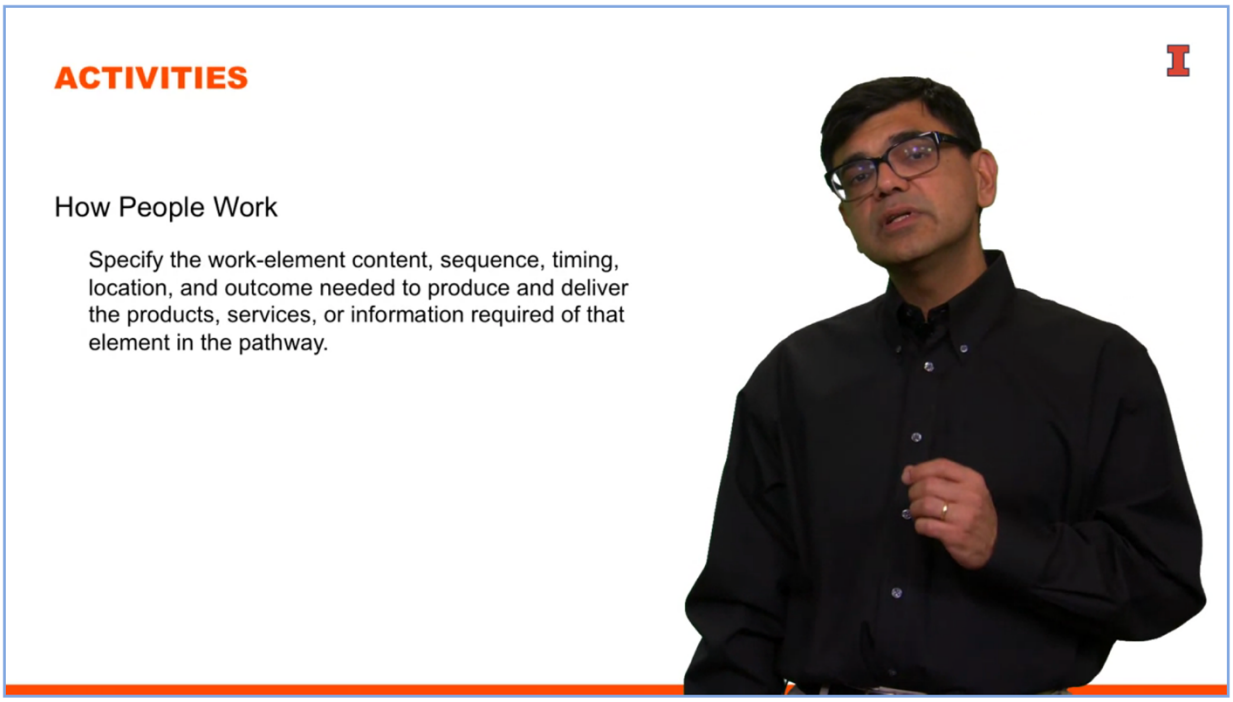


So what is this paradox? It's standardization and continuous improvement. It's doing standardization and continuous improvement, both in parallel. Another article written by Adler focuses on new me, the joint venture between General Motors and and Toyota in California, and they're what Adler saw from observing the Toyota production system firsthand is that Toyota uses standardized work practices as a base on which they can make improvements. So they consider standardization to be very important for learning. They consider that when you do have standardization, you'll be able to see any kind of deviations. If you don't have standardization, you're not going to be able to see any deviations because you don't have a baseline, if you have a huge variation in the standard work, the variations are going to get captured within that particular variation within that base baseline and you're not going to be able to see them. So unless you make it very standardized and you'll be able to see the variations when they happen from that baseline in itself. What what Adler also saw was that standard work. When there is standard work? Each worker becomes a scientist. They have a baseline from where they're starting. And when they know this is a particular way of doing work, then they can answer questions like is this working? Is this not working? Is there a better way of doing this? So, Standard work also helps engage frontline employees in process improvement. So this gets at the idea that Spear and women are also talking about in terms of the paradox of the Toyota production system.

Module 5.1.3. Four Principles of TPS

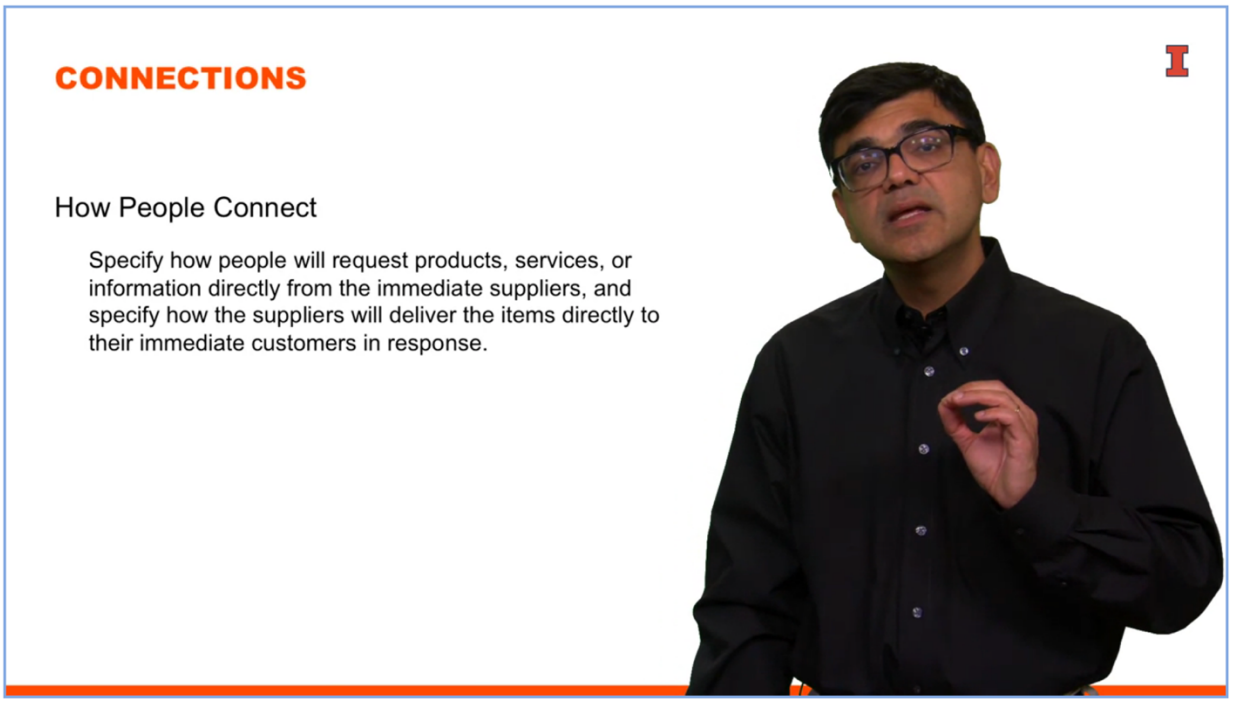


Going back to the DNA of the Toyota Production System by Spear and Bowen, they trace the philosophy of the Toyota Production System to four principles. Four principles in which Toyota seems to follow a very standard path. The four principles are the four rules, focusing on activities, connections, pathways, and improvements. Let's see in some detail what these four basic rules are.



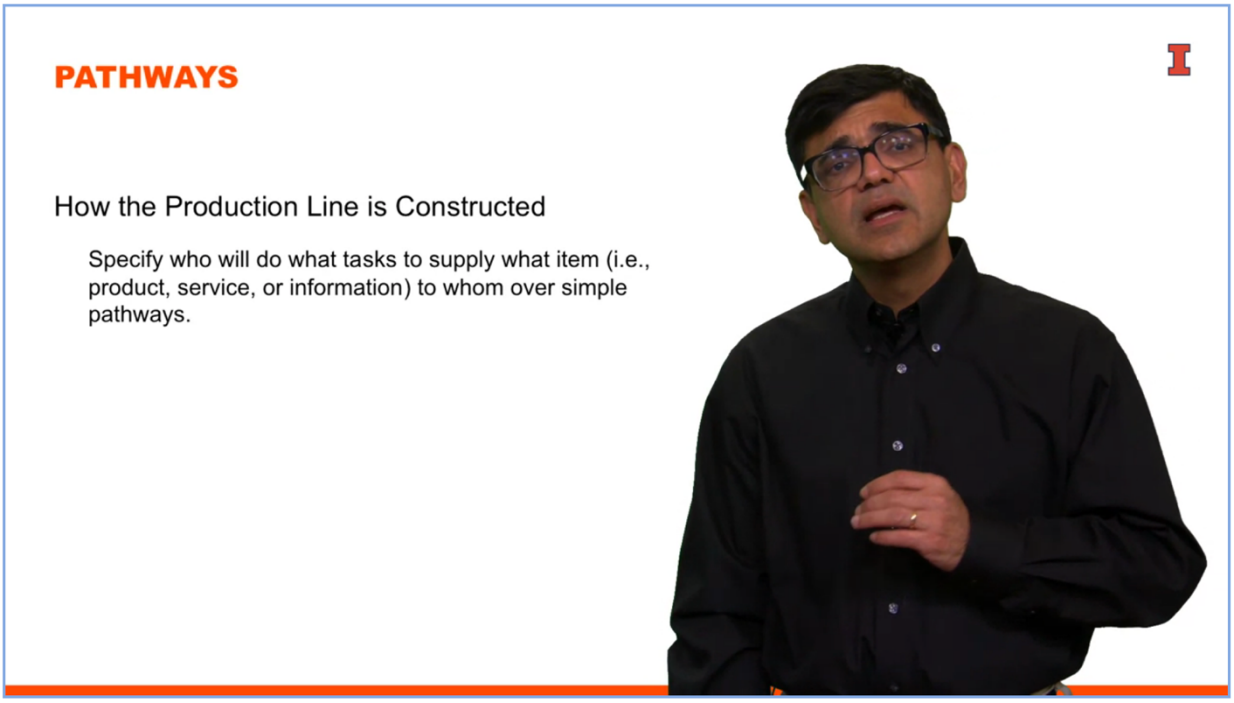
The first rule is activities, and it focuses on how people work. If you think about giving somebody instructions on how to do work, the instructions at Toyota are highly specific to the point that the employees who work on an assembly line are told not just that they are going to be fixing four nuts and bolts at a particular spot on the engine, but they are told in what order they will be fixing those four nuts and bolts. That is also specified when they are trained to be doing that what may seem to be a very trivial job on a large assembly line. They're told what order to put them in, they're told the torque that they are supposed to use on the implement that they'll be using to put those nuts and bolts is also specified and they are expected to follow those instructions to a T when they're doing that work. It's not only that, it's the time for each of those things is also specified. When you look at a assembly line at a Toyota assembly plant, what you see is that, people stations are timed from the point of view of, if I'm a person standing at a particular station, the automobile is going to enter that station at a certain time and it's going to leave my station at a certain time. It may be one minute or 90 seconds that I have to do my job and I have to get my job done in 90 seconds because the car is going to move on to the next station because it's a moving assembly line. Now, the timing is specified to the extent that the workers have a sense of how much work should be done by the time that assembly line has reached the 45-second mark in my area, or the 60-second mark in my area. If I have a total of 90 seconds to get the work done, I have some sense of how much work should I have gotten done by the time. If it's a 90 second cycle time that I have, it's the 90-second time that I have to get this work done, then by 45 seconds, obviously, I should get about half the work done. I'm trained to have a

sense of that all the time if I'm working on the Toyota assembly line. It's that specific in terms of the activities.

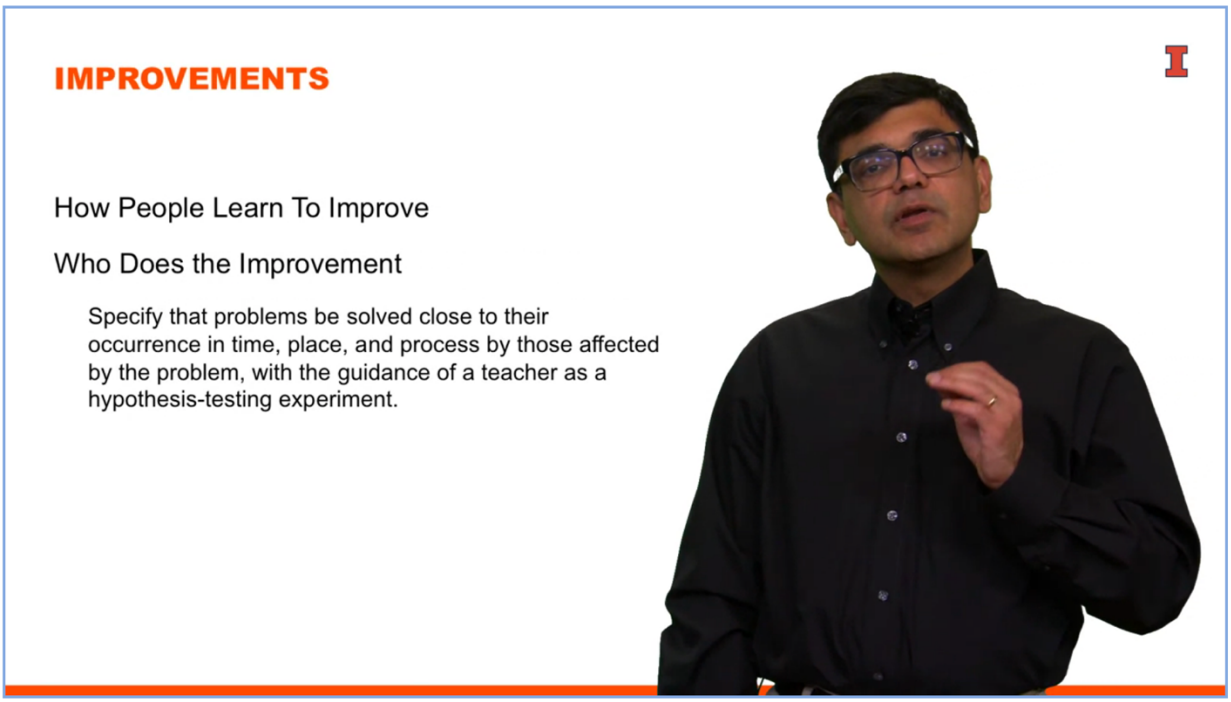


The next thing, or the next rule that Spear and Bowen talk about is specifying the connections. Here we're talking about, Toyota is highly specific on where the parts are going to come from, where the information is going to come from. For each internal process, the input and the output or where the input is going to come from, which supplier is the input going to come from, and the output, where is that going to go to, which customer for that task or the process is it going to go to is highly specified. What do we mean by that? If I'm a worker working on a certain task on the assembly line, I have a very specific channel from where I will be getting additional parts for working on my station. There will be a particular way in which I will communicate. It'll be a kanban container. It'll be a container that's when it's empty at my station, signals to my provider, the person who's going to supply the materials to me. It signals to that person that I need parts, and that person will be able to get those parts exactly from a specified area and in their specified quantity. The kanban container or the container in which those parts will come, automatically specifies that quantity because it's designed to fit a standard quantity. Again, it's standardization to its extreme in terms of the connections. Also in terms of information. If I have a problem at my workstation, if I have a problem in the task that I'm doing, it is highly specified as to who I will contact about that problem and how I will contact, how I will signal that I have a problem on that particular task and then who will come and help me first and if it doesn't work, who will come and help us second and third, everything is highly specified in that sense in terms of the

connections. That's something that is an important part of the Toyota Production System according to Spear and Bowen in this article.

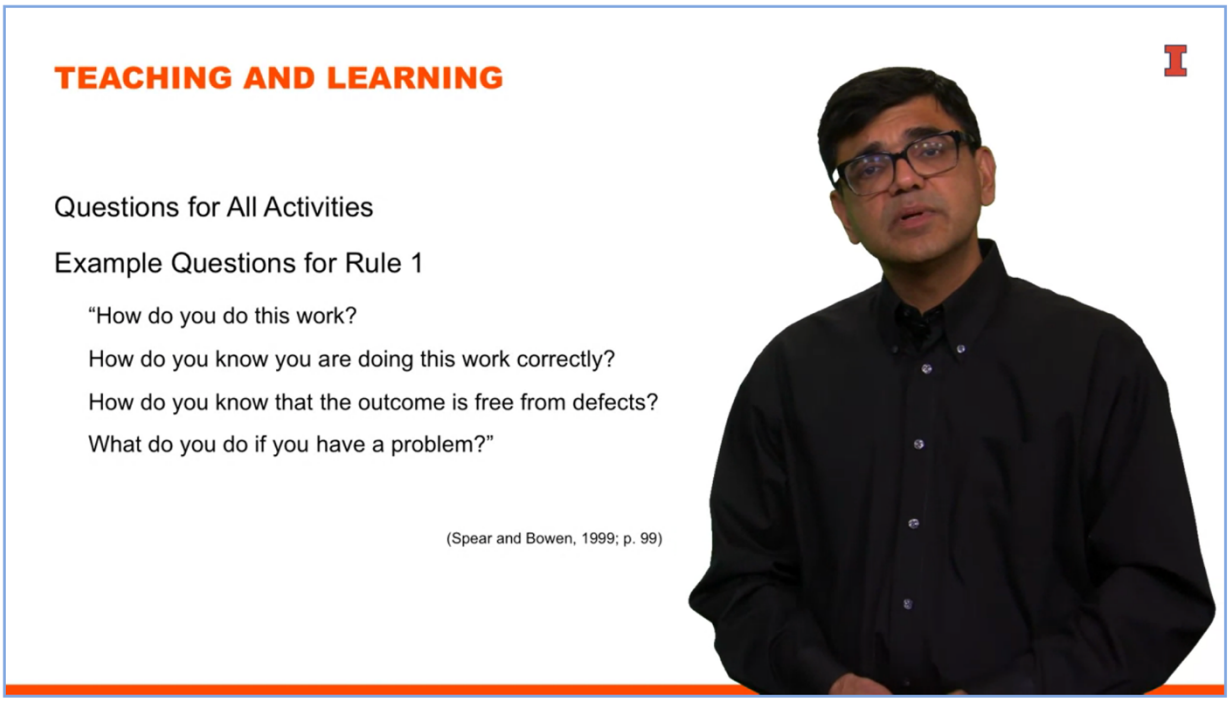


The pathways are highly specified. We talked about connections being specified and this is related to connections being specified. What do we mean by pathways being specified? If I'm making a part on an assembly line and I have two options of the next task. It is going to be highly specified which of those options my production is going to go to. It's not going to go to the next available machine, it's going to go to a specific machine and that's how it's going to travel throughout. This goes back to the idea of specified connections as well. Where am I going to get the parts from is highly specified. The path by which I'm going to get spare parts or additional parts to work on my station is going to be highly specific, the pathways are also highly specific.

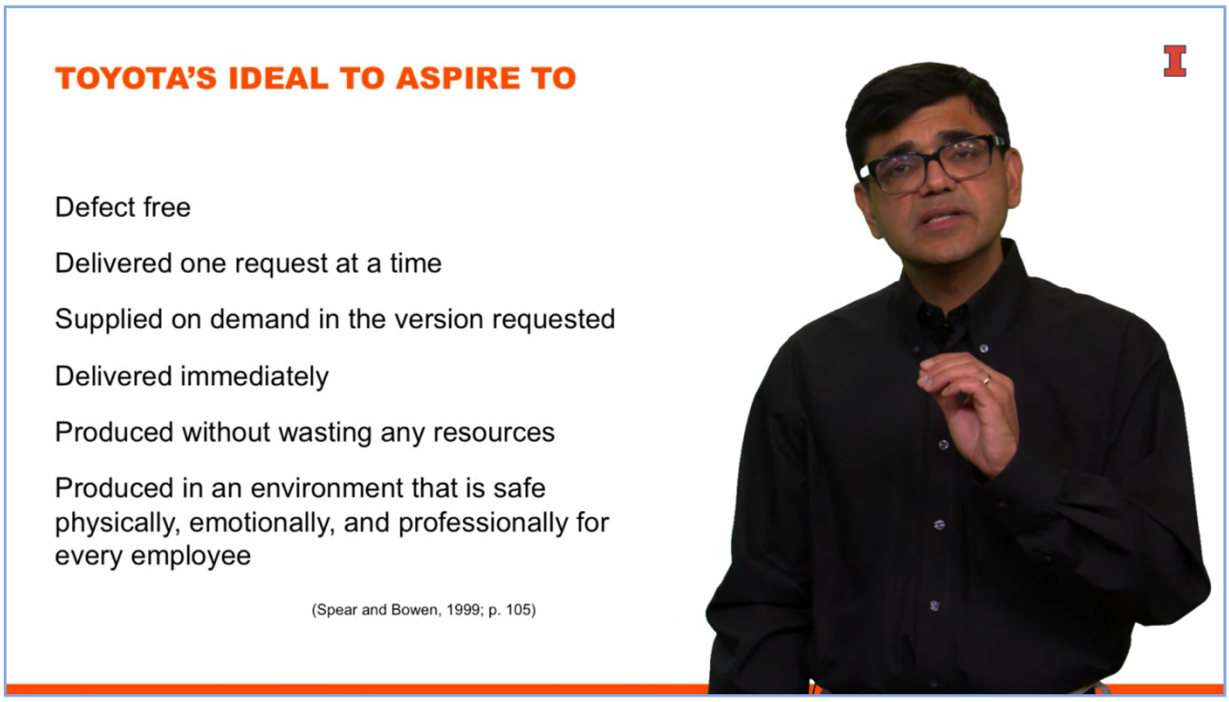


The fourth principle or the fourth rule that Spear and Bowen talk as being part of the DNA of the Toyota Production System is how improvements are done on the assembly line. First of all, every individual who is working on the front line is trained to be a scientist. They are trained to do hypothesis tests with every iteration of work that they're doing. They might be doing the same thing over and over in a day, many times, 100 times, 150 times, but they need to be trained to check every time they do that task or at every iteration if they've done it correctly, if there's a way of improving it and if there's a way of improving it, how should they go about improving it. That's also very specific when we look at the Toyota Production System, the way in which they will make the improvement. Because guess what, it's not going to be an ad-hoc improvement. If there's an improvement idea, it's going to be tested and then it's going to be implemented everywhere that the same task is being done.

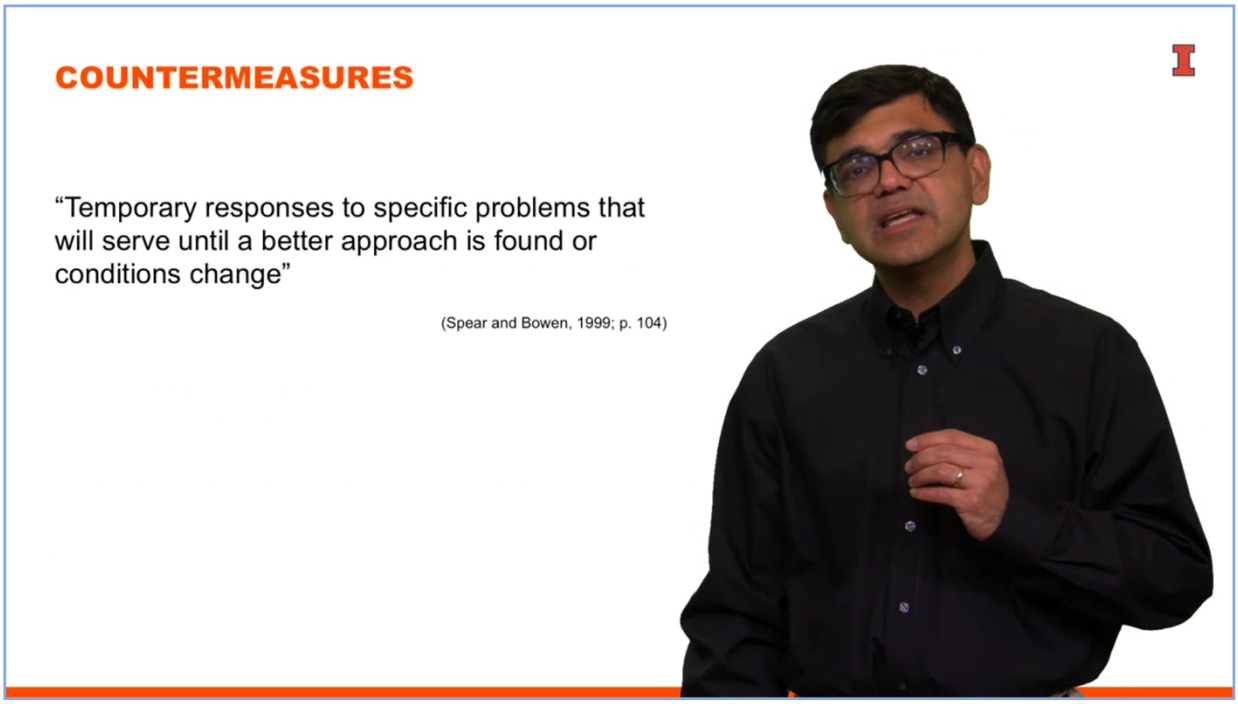
Module 5.1.4. TPS in Action



So if you think about looking at these four principles, what we are going to find is that these things are not documented in Toyota, you're not going to be able to find these four rules written anywhere. This is something that the authors were able to sort of glean from studying Toyota very closely. They were able to get this from Toyota, but they were wondering, how do people in Toyota, how do the employees, there are thousands, tens of thousands of employees working at Toyota. How do they know that these are the things, how do they get trained? And it seems to be a very Socratic method of training according to Spear and Bowen. It's asking questions. So if you're thinking about the first principle, the principle for standardized activities, all the activities have to be standardized in sequence, timing. And what is going to be the outcome from that activity? The way people get trained in that is through questions. So their leader, their sensei, their continuous improvement guru is going to ask questions like, how do you do this work? Show me how do you do this work. How do you know you're doing it correctly? How do you know that the outcome that you're getting from doing this in this way is going to be defect free? And what are you going to do if there's a problem from this work if there's a problem? And you're doing this work. Or if there's a problem in terms of the output from how you've done this work. And these are ways in which people get trained into following those four rules. So the four rules are not codified anywhere in Toyota. Although it seems to be omnipresent when you look at how their work is done.



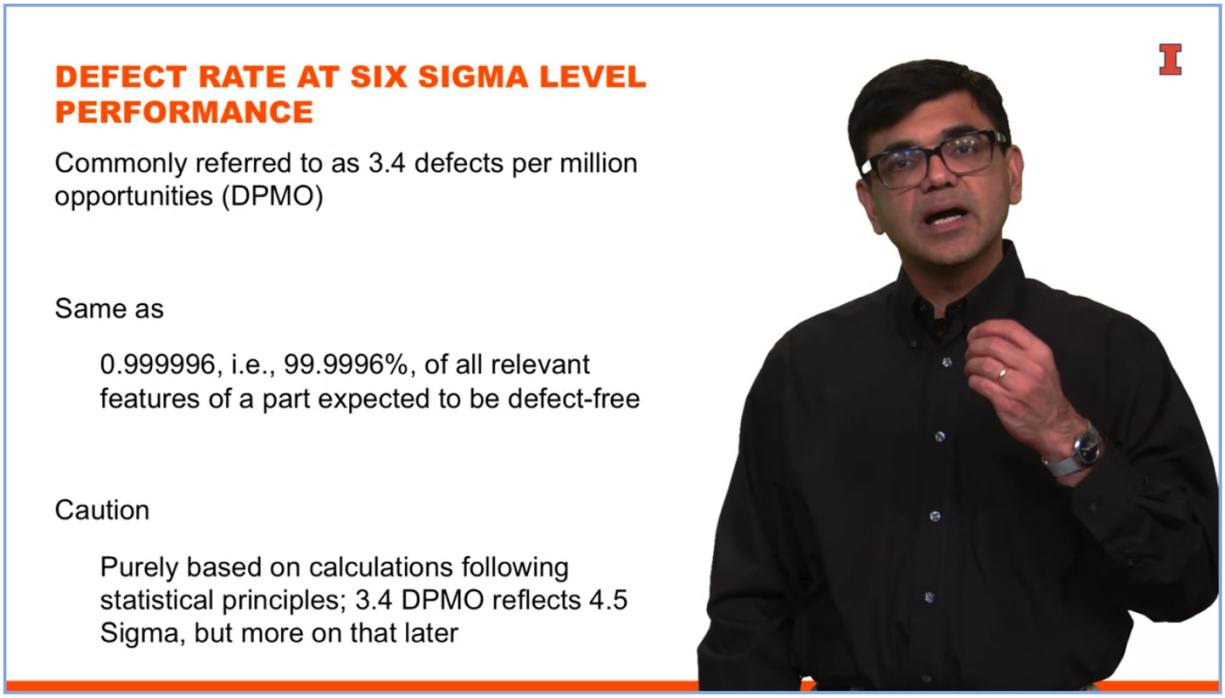
So, the article talks about the ideal that Toyota is trying to achieve and the ideal is that every product should be defect free, that all of the production should be defect free. It should be made in batch sizes of one if possible. So it should be delivered one request at a time, batch size of one. It should only be available when it's needed, so it should appear exactly when it's needed and it shouldn't be available earlier than is needed. And of course it shouldn't be later because it's going to stop the assembly line.
It should be delivered immediately without wasting any resources. And so it should be produced in an environment that is safe for all the employees. So you can see here that last point is also getting at some of the principles that you may know from from Deming. The idea that you should not only be thinking about making your product cheaper, better quality, less defects, but also thinking about whether employees can do this in a sustainable way over time without there being any harmful effects on them. So this is an ideal that Toyota tries to get to, a batch size of one being produced exactly when it's needed.



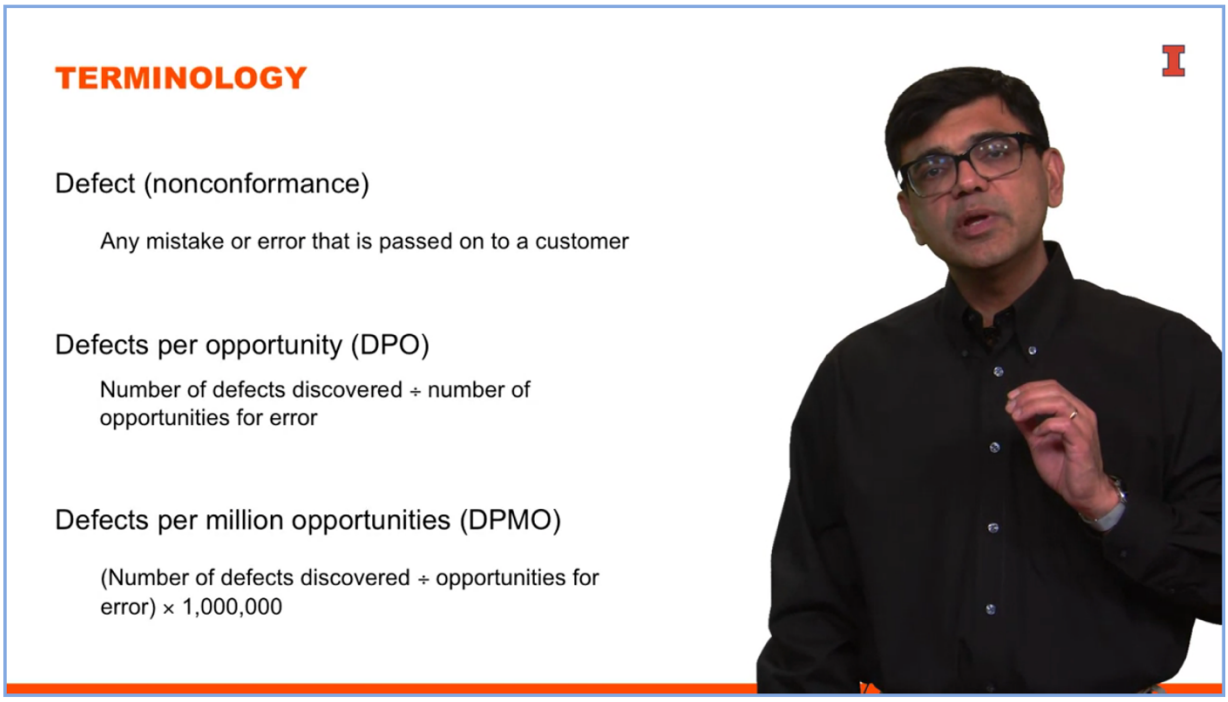
Now, Toyota itself admits that or the article talks about Toyota is itself admitting that this is not something that they are able to achieve right away or that they are even able to achieve after a long time. So, the ideal of one unit at a time, no inventory, zero waste, no buffers is something that they are aspiring to, but while they can get there, there are countermeasures in place. So when they plan for inventory, and when they plan for compound containers for inventory, there's going to be some buffer at this point because they haven't been able to achieve full stability. So they're constantly studying these things. So what does this tell us about the total production system? This tells us that when companies are trying to implement the total production system, first, they shouldn't just be focusing on the tools and the techniques. They shouldn't be just focusing on the compound container and on pull cord for stopping work when there's a problem. They shouldn't just be focusing on those tools and techniques. Rather, they should be focusing on the principles that underlie those tools and techniques. So don't go about using those tools and techniques just because you've learned them, but instead think about how they are getting towards the principles of the total production system. And that is going to be beneficial for any company that is trying to implement the total production system.

Lesson 6-1: Philosophy of Six Sigma

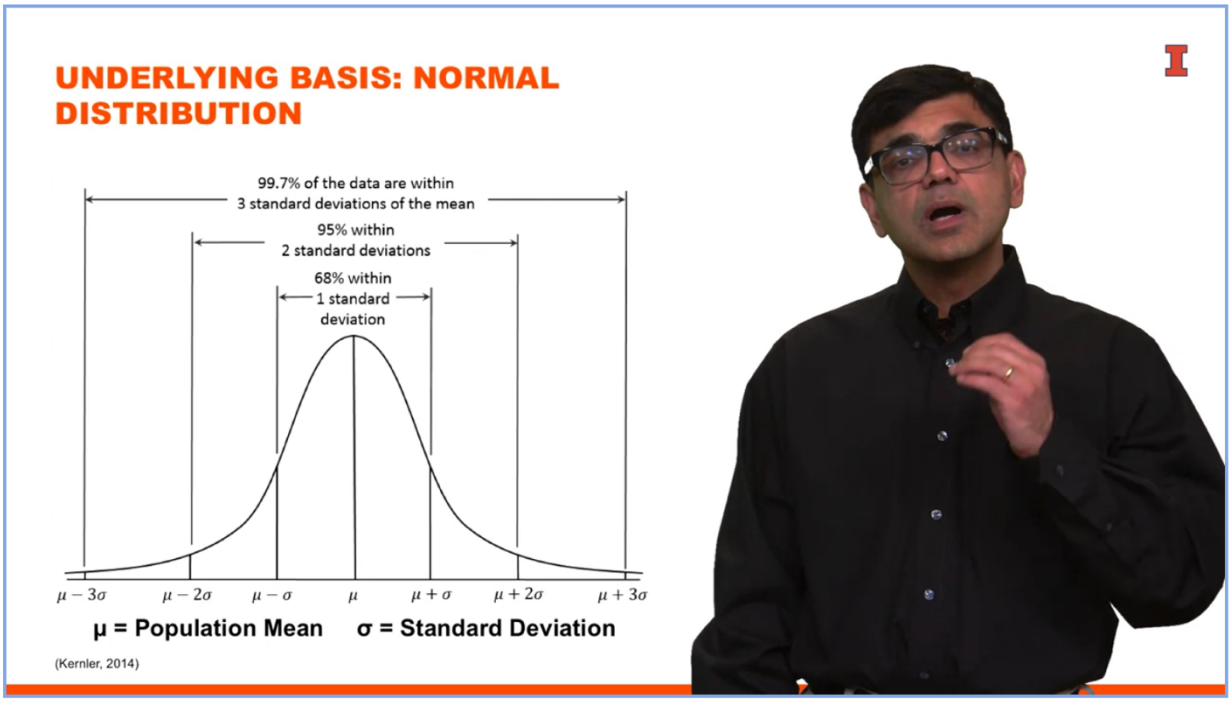
Module 6.1.1. Quality Standard of Six Sigma



What is this idea of Six Sigma and what does this mean. In terms of statistics, in terms of defects per million opportunities, what does this mean and where did it come from? Six Sigma is commonly referred to as a very high standard of quality that is talking about 3.4 defects per million opportunities, so this is per million, not a percentage. It's much more stringent than it being 3.4 percent. When you think about 3.4 defects per million opportunities, you're talking about a process that is 99.996 percent defect-free, we're talking about again, a very high standard. Now, although if you do put in 3.4 defects per million opportunities and you know the statistics to go back and look at the number of defects, let me warn you up front that you're not going to find it as being Six Sigma because there's some adjustment that we need to do for that and we'll talk about that a little bit. But for now, let's just think of Six Sigma as being 3.4 defects per million opportunities and the point being that it's talking about a very high-quality standard, a very low number of defects.



Before we start looking at some of the actual calculations for Six Sigma, let's get some terminology straight. We said defects per million opportunities, so you must be wondering what does that mean. Well, a defect is a non-conformance. Traditionally, we think about defects as being something that is a defect in a physical part, but it could be generalized to anything that a customer puts value on, anything that a customer cares about and we can have a defect in that if the customer thinks it's a defect. Defect per opportunity, when we think about defect per opportunity, you could take this clicker that I have in my hand and the button that I have to go forward, maybe referred to as a single opportunity for a defect. If there's a button that takes slides forward and there's a button that takes slides back, there are two buttons, those are, two opportunities for defects. What are we saying in a sense? We're saying that a product can have multiple opportunities for defects, and how do you define opportunities for defects? Well, that comes from, what does the customer care about in that product? I care about these two aspects. These are what are going to be opportunities for defects for me. Then what is this idea of defects per million opportunities? Defects per million opportunities is simply taking defects per opportunity and scaling it up to a million. Instead of calling it a proportion, or instead of calling it a percentage, we're going to say it's going to be out of a million and that's why we're saying defects per million opportunities. That's the idea that we're going to use when we calculate something like DPMO, we're going to have the idea of opportunities and then scaling it up to defects per million opportunities.



The underlying idea for Six Sigma comes from what we know as the standard normal distribution. What you already may know from statistics or from taking other classes. You would know that when you look at a standard normal distribution, we know that there's a certain area that is under the curve of the standard normal distribution when you think about plus or minus three standard deviations. Conventionally, we talk about this. Traditionally, we talk about this from the point of view of a plus or minus three standard deviations. Commonly we say plus or minus three standard deviations covers 99.7 percent of the area under the curve, so 99 percent of the area will be covered within plus or minus three standard deviations. When we talk about Six Sigma, what we're essentially saying is that if you go six standard deviations from the mean, we're getting a little statistical here, we're getting a little bit technical here, but what we're saying is essentially that you have the mean in the center and you go all the way to the right up to six standard deviations, not just three that we commonly talk about, but six standard deviations and whatever area is left after that, that little small area that's left after you've gone six standard deviations from the mean, represents the area of defects. That is what we are referring to when we're referring to a Six Sigma process. The defects are only to the extent of that small portion of the tail under the standard normal distribution that is beyond plus six standard deviations from the mean.

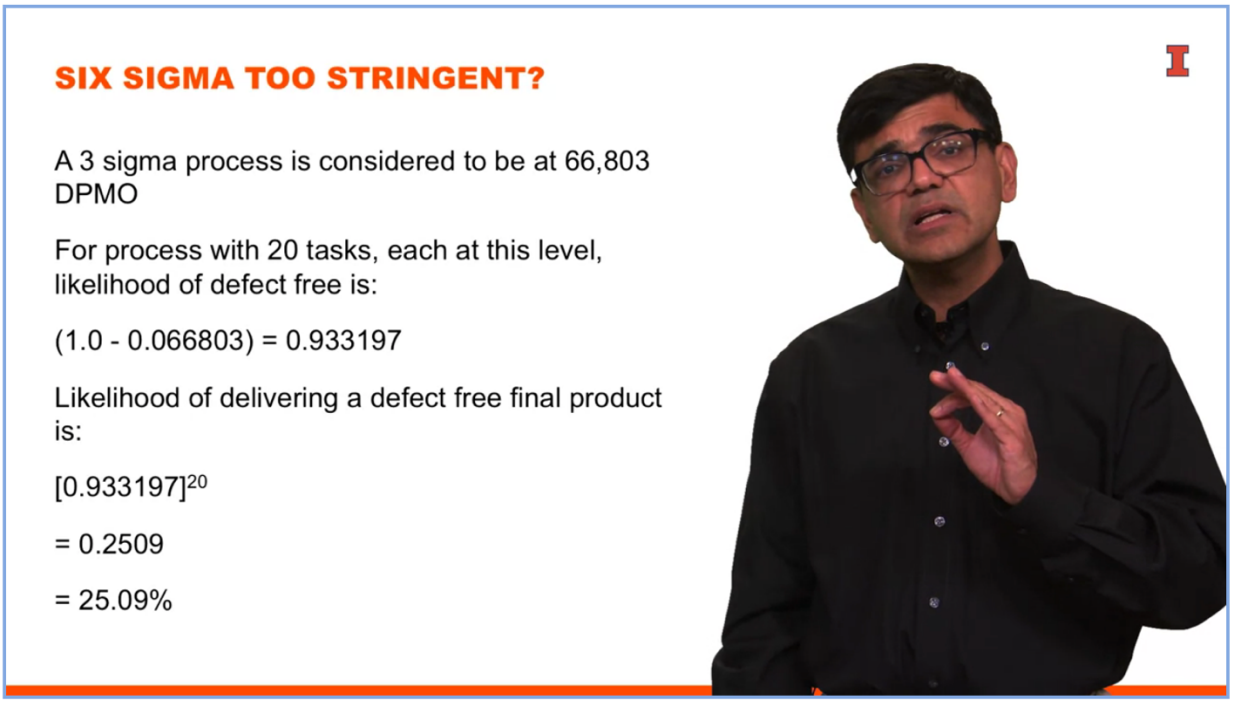
IN-VIDEO QUESTION

Is such a stringent quality standard needed?

(flickr.com/taymazvalley, 2010)

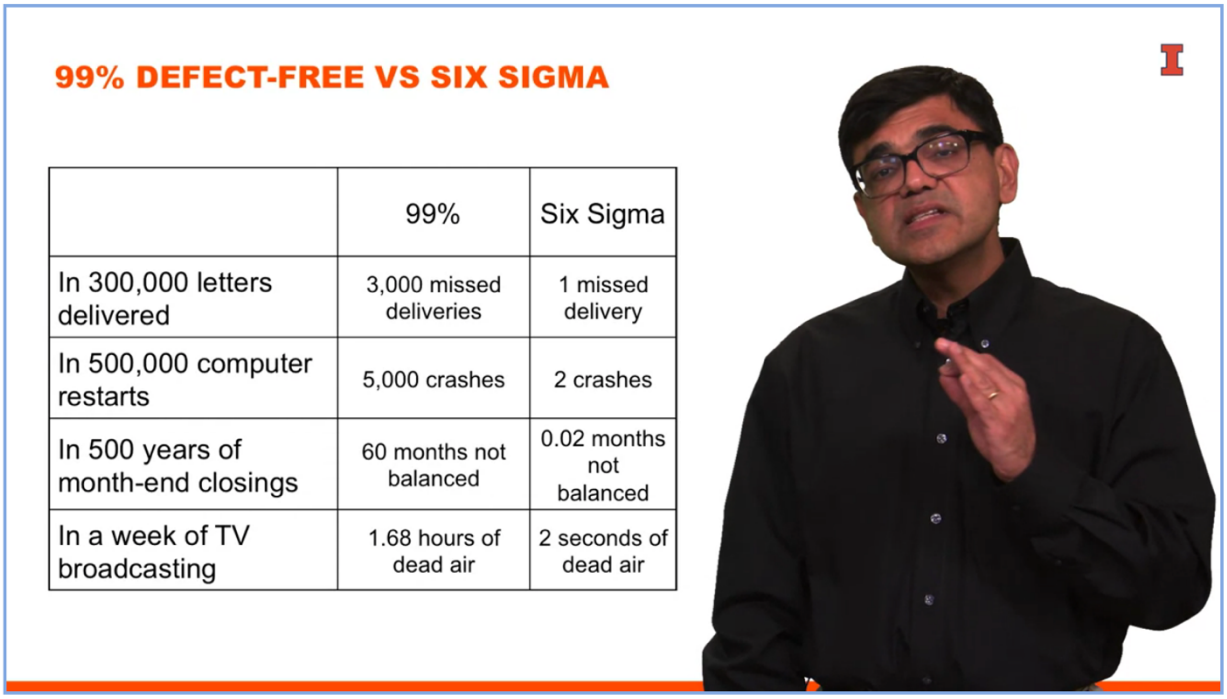
First of all, you should be thinking, why is this stringent standard needed? Why do we need a standard that is so strict that we're talking about 3.4 defects per million opportunities? Take a minute to think about that as to whether such a standard would be needed, when would it be needed? What are the implications? Then we'll come back and see why Motorola started using this standard. First, if you are trying to answer the question of, is such a stringent quality standard needed? You would say, well, it depends. That's the standard idea. That's the standard answer that we like to use in MBA schools. It depends. Well, it depends on what? It depends on if you're talking about a process where having such a high standard is important. If you're talking about a nuclear power plant, if you're talking about space exploration, if you're talking about airline flights, there, we're talking about a standard that is needed to be at 3.4 defects per million opportunities or even better, it probably needs to be even beyond Six Sigma and you need to achieve an even lower level of defects than even 3.4 defects per million. You may say that, well, it depends. It may be a process where you actually need such a stringent quality standard. The other perspective that you can take is, well, it depends on what's the cost for us to get to that standard. In some situations, in some contexts, you may say, well, there may be a cost-benefit analysis for us to get to such a high standard. Another perspective that you might take is that, you may have a process that is made up of many different steps, many different opportunities for error and the process is going to be a combination of all those opportunities for error and how is that going to play into the total output quality of that whole process? What are we going to get from that process? That's another perspective that you want to take when you're thinking about, is 3.4 defects per million opportunities too stringent a standard? Let's

take the storage perspective and study it from a numerical perspective.

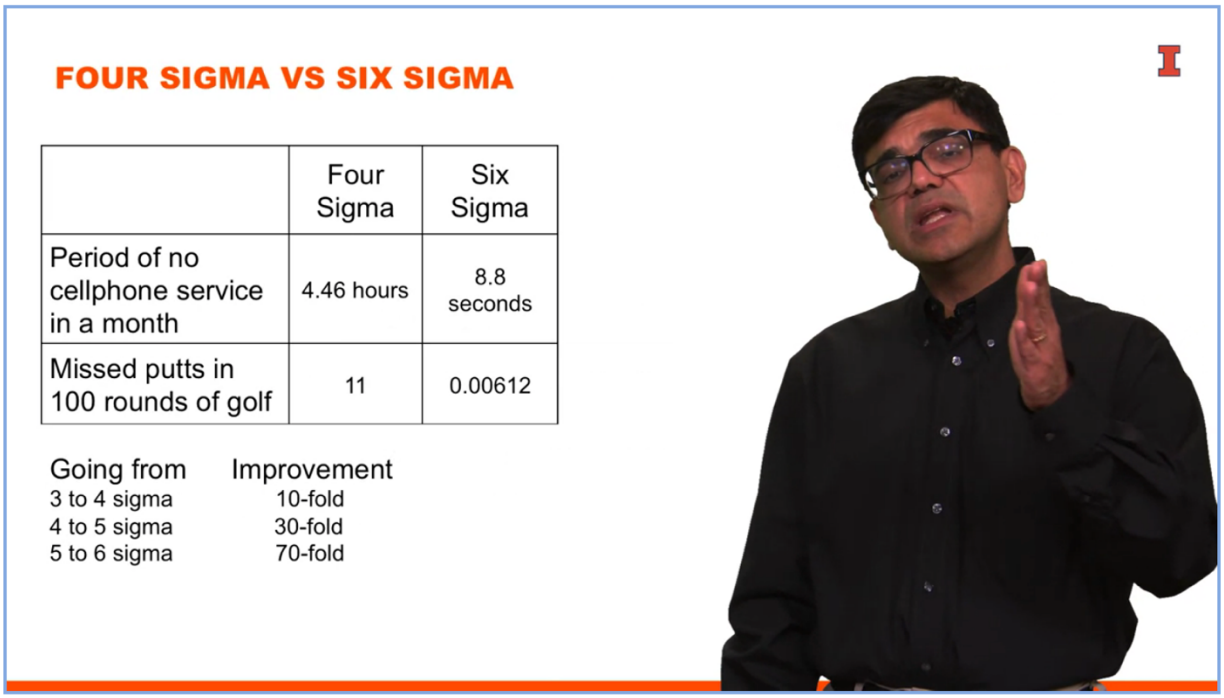


You have a three sigma process. Now, we're moving from six sigma to three sigma process, and a three sigma process, without getting into the details of it, three sigma represents 66,803 defects per million opportunities. Six sigma represents 3.4, three sigma represents 66,803 defects per million opportunities. If we have a process that has a 20 tasks in it, all you can think of, a physical product that is made up of 20 different parts that are going into that particular product, and each of the steps in a process are being run at a rate of three sigma. Each one is giving a 66,803 defects per million opportunities output. If there are 20 steps, what will happen to the output rate from the whole process that has 20 steps? Or if there are 20 parts, what will happen to the product quality for the product that is made from putting those 20 parts, those 20 sub-assemblies together? If you take a look at the calculation, it's basically saying you take 0.933197, you multiply it by 0.33197 when you're talking two steps, you multiply it again when you're talking three steps, and you keep doing that until you get to 20 steps. It's raising it to the power of 20, which gives you a likelihood of finding a defect free product at the end of 20 steps or 20 parts of only 25.09 percent. This should give you some appreciation of when there are many different parts. If there's a complex product like a car, or a cell phone even, and you're talking about many different parts going into that particular product, each part being at a three sigma level performance would mean that you're going to get a product that's going to be 25 percent defect free, 75 percent chance of having a defect, which no customer would be willing to accept, no company would be willing to accept. From that perspective, a stringent standards such as six sigma is required when you have highly complex products, when you have highly

complex services, highly complex physical goods that are being produced. That's why six sigma is something that Motorola went after.

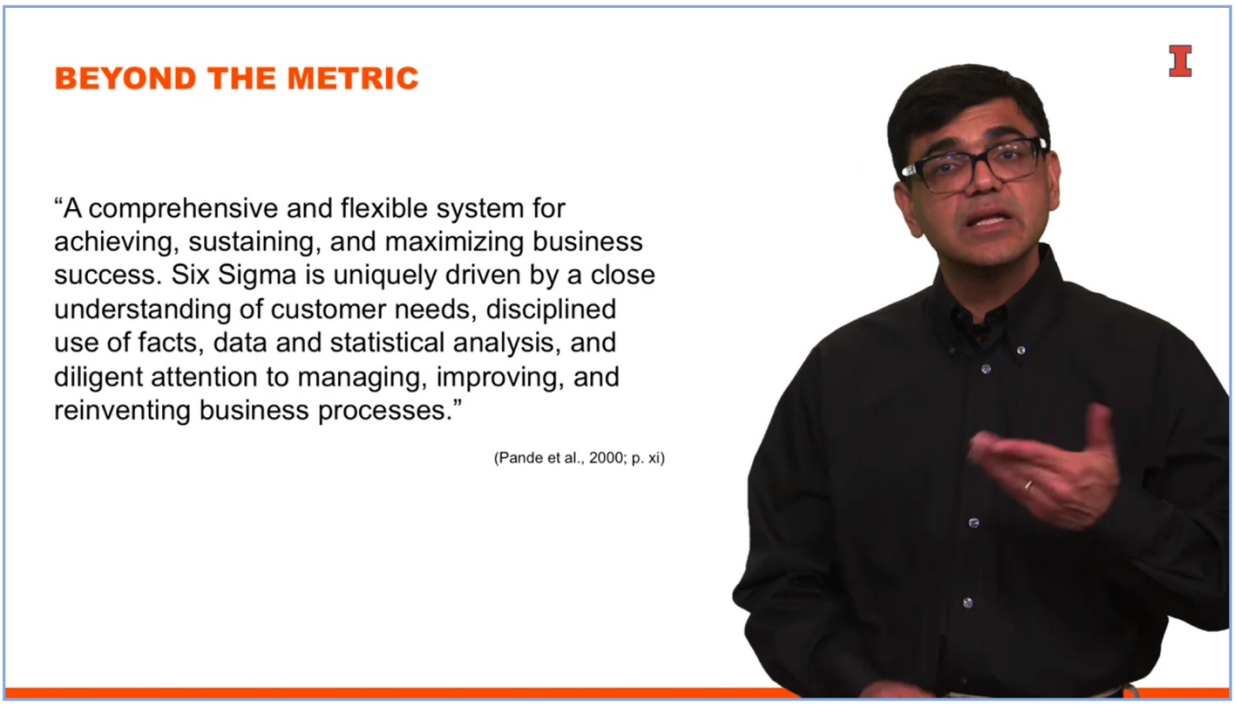


Now, what does this mean from things that we know from our daily experiences? In terms of comparing a six sigma performance with a 99 percent good performance, so one percent level of errors, in 300,000 letters delivered, 3,000 missed deliveries versus one missed delivery when you're talking a six sigma performance. In 500,000 computer restarts, 5,000 crashes when you're talking about 99 percent good versus two crashes when you're talking about six sigma good, or 3.4 defects per million opportunities bad, 3.4 defects per million opportunities, good. In 500 years of month-end closings, you were talking about 16 months being not balanced versus 0.02 months not being balanced when you're talking about six sigma good. Week of TV broadcasting, 99 percent good, one percent defect. You're talking about 1.68 hours of dead air, and when you're talking about 3.4 defects per million opportunities, when you're talking about 3.4 being the bad part of it and the rest being good, you're saying only two seconds of dead air in a week of TV broadcasting. Here, you can also see that the idea of measuring a process based on its DPMO, it's sigma level, is something that can be translated into any process. That's one attraction of this metric of six sigma, that you can use it for different processes and have a conversation about at what level of sigma that process is. These could be many different processes of many different contexts, and this gives you a common metric.

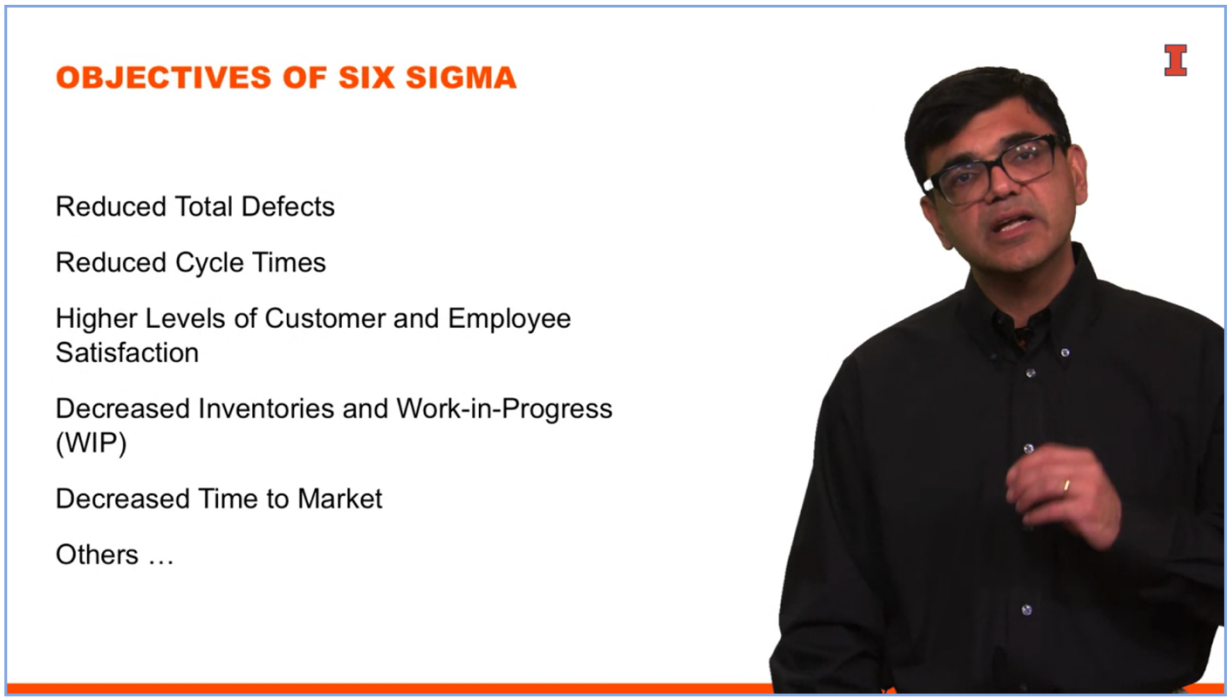


Comparing, on the other hand, between a four sigma versus a six sigma level of performance. If you're talking about cell phone service, a four sigma is 4.46 hours of no service, a six sigma is 8.8 seconds of no service. Missed putts in100 rounds of golf, we're talking about a 100 parts that are being missed in the 1,800 putts that you're going to make based on a 100 rounds of calls and 18 holds, versus in six sigma, you're talking about a miniscule number of putts, 0.06 putts being missed in the 1,800 opportunities that you're getting from a 100 rounds of calls. What you can also see from this comparison is that going from four to six sigma is a quantum leap. It's a huge jump. This is exactly what Motorola was going after. They were going after a 10-fold improvement in quality, a 10-fold reduction in defects when they were trying to improve their quality from what it used to be before they started implementing six sigma. Going from a three to four sigma level, to be more specific, is a 10-fold improvement, four to five is a 30-fold improvement, five to six is a 70-fold improvement. That's the quantum improvement that you can get when you're going from a small sigma level to a high sigma level. Now, why six, why not seven, why not 4.5? That's something that has been popularized by Motorola. You may have heard this earlier, six sigma is actually a registered trademark of Motorola. They stuck with six sigma, but there's no reason for you to have that as being a magic target. It could be higher or lower based on where your process is, where your companies is trying to achieve quality performance at.

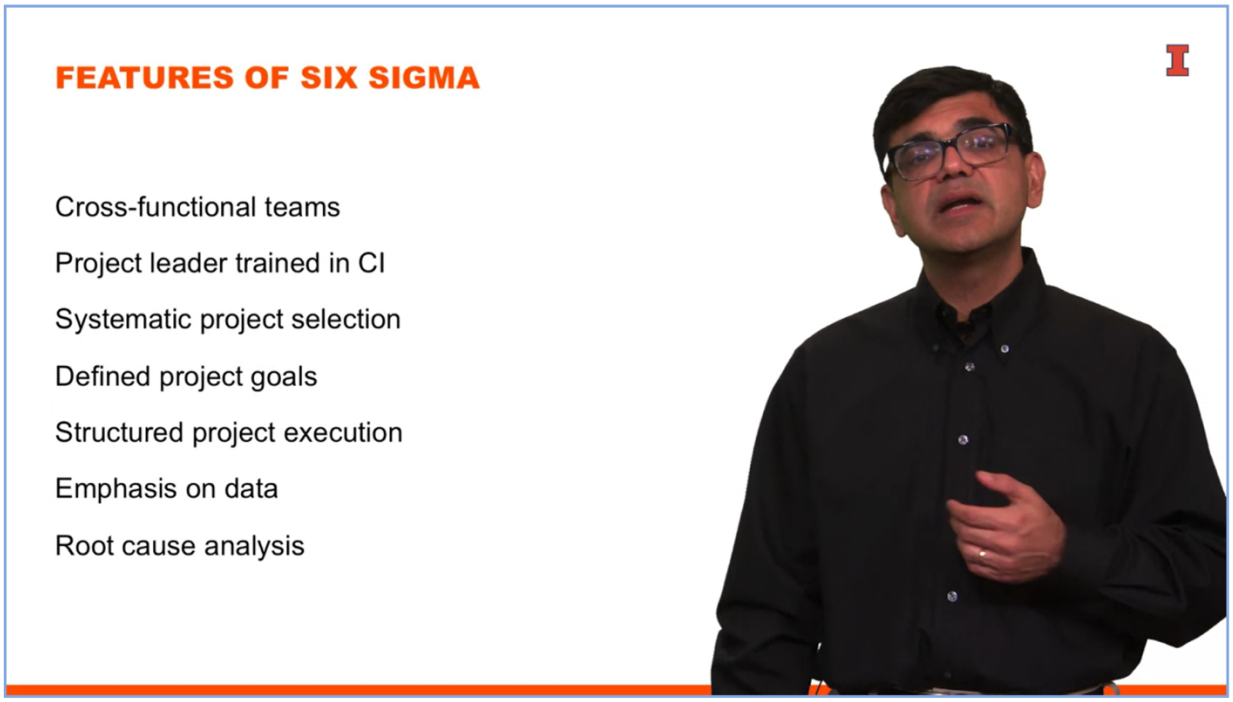
Module 6.1.2. Features of Six Sigma Programs



Six Sigma as a process improvement initiative. Six Sigma as a continuous improvement initiative is much more than simply the metric. It's a methodology. It's a methodology that is used by companies to implement continuous improvement. So here you have a definition of Six Sigma which takes all of that into account. So going partially into this definition, Six Sigma is uniquely driven by understanding of customer needs, disciplined use of facts, data and statistical analysis. So what are we talking about here? We're talking about taking some problem, taking some improvement opportunity based on customer needs and that could be a process customer. Facts using metrics as much as possible using numbers and trying to use statistical analysis to improving that process. Going back to the first line of the definition, it's a comprehensive and flexible system for achieving, sustaining and maximizing business success. So it's a system for putting continuous improvement in place. It's a system for having the idea of continuous improvement in place. So what is it beyond 3.4 defects per million opportunity.



What is it beyond the metric? So Six Sigma is not only about reducing defects, it's also about reducing cycle times. We could be talking about a project that not only focuses on defects in the conventional sense, in terms of a product not working or a service having a defect, but in terms of saying, we want to reduce the cycle times, we have a certain cycle time in mind. We want to reduce the cycle time, we want to reduce the lead time for when somebody places an order and receives the product. We want to target higher levels of customer satisfaction or even employee satisfaction. We want to target higher levels of that. So that could be an objective. So it's not just about looking at defects in the very common sense of looking at defect in a product. It could be about reducing working process inventory, it could be a longer process in talking about decreasing time to market from conceptualization of a product idea to actual production and bringing it into the market for customers. So it could be many of these things.



Different elements of Six Sigma that go beyond the metric, different aspects of six sigma that go beyond the metric are cross functional teams. So we're talking about teams that are made up of people from different parts Six Sigma of the process. You have people that are related to the actual process that is being improved or they could be support staff or support employees. If you're talking about a process for reducing cycle time you may have somebody from information systems because if there's an IT Solution to that you want them involved although they are not directly in the process. There's somebody that can help with the improvement. So it's cross functional teams. Six Sigma relies a lot on the idea of project leaders. It has this concept of of black belts and green belts and these are some full time project leaders, some part time project leaders that lead continuous improvement projects that are trained in the methodology for conducting a process improvement project using Six Sigma methodology. So there's a specific methodology for for using Six Sigma in a project systematic project selection. It's about getting projects that are going after organizational objectives and making sure that we prioritize projects based on how much they're going towards particular organizational objectives. Which ones should be focusing our attention on more and how does that translate into something that the organization will be able to achieve? Six Sigma has this idea of having very specified project goals. So the notion that even before you start a project there should be specific goals and to the extent possible enumerated in terms of money in terms of dollars, euros, rupees whatever the case may be but in terms of what is this project going to get us in terms of top line and bottom line? That's what there should be some specification of that before you start the project. It's about structured project execution using the DMAIC a way of executing a project,

define measure, analyze, improve control, that's the most popular framework under Six Sigma. It has emphasis on data and measurement and the idea of we're focusing on making improvements based on root cause analysis. We're trying to find the causes for the effect. We're trying to find the Xs that have an impact on the Y. If Y is the outcome we should be looking at what are the different Xs that are affecting that Y and focusing on those to make improvements. So here we can see that Six Sigma is much more than simply the idea of 3.4 defects per million opportunities.