MITOCW | Ses. 1-2: The Start of Your Lean Journey

EARLL MURMAN: OK, well, this is literally, for most of you, the start of your lean journey because we've seen the value of data, and we know that, for many of you, this whole subject matter is something you've hardly heard about. And that's perfect because that's what this course is designed for. So welcome.

So, at the end of this module, we hope you'll be able to explain the origins of Lean and Six Sigma, explain the lean 6S tool. You're going to learn your first lean tool here. You're going to be able to define what is lean, what's a lean enterprise, and who are stakeholders of the lean enterprise. You'll recognize why Lean Six Sigma principles are being implemented in aerospace, health care, and other sectors. We're going to talk about why these sectors are moving in this direction.

And you'll be able to explain that lean is a journey. It's not a state. You never are lean. You're always trying to become lean. And we'll talk a little bit about that.

So this subject matter comes out of the Japanese automotive industry. And, unlike aerospace engineering and structures and controls and aerodynamics where you can go to the laboratory and see what's happening and do experiments and things, in this field, you have to go to where it's actually being practiced because the body of knowledge comes from that field.

So this all kind of came to the surface in 1990 when MIT published a book called*The Machine That Changed the World.* It was a study of the Japanese, North American, and European automotive manufacturing. And this is a plot given then of production of cars. These are all the US car manufacturers, and here's Japan.

And what do you see in that chart? What jumps out at you? What's the first thing you see?

AUDIENCE: Japan is increasing a lot faster than US and passes us in--

EARLL MURMAN: Yeah, close to--

AUDIENCE: --1980.

EARLL MURMAN: It's now kept going.

AUDIENCE: Yeah.

EARLL MURMAN: So that's one thing. Japan has just steady growth. What's the next thing you see?

AUDIENCE: It's pretty consistent.

EARLL MURMAN: Inconsistent, right. This is the typical US thing. You kind of overproduce, underproduce, overproduce. And the Japanese are nice, smooth, and steady. There's a lot of data in *The Machine That Changed the World.* And we're not going to go through all this, but I want to make a couple of points.

First of all, the data in this chart is product development and manufacturing. Now, a big mistake a lot of US companies made when they read this book was that lean is a manufacturing paradigm. It's a manufacturing system.

In fact, most of my friends, when they talk to me say, oh, you're in lean manufacturing. The Japanese never saw it that way. They implement lean right back in engineering and product development.

So, in product development, for instance, the average engineering hours in a new car, 1.7 million for Japanese, 3.1 million for US, almost twice the number of engineering hours for the same car. Supplier share of engineering, how many of the suppliers are actually doing engineering compared to just supplying parts? 51% in Japan, 14% in US. So we're going to be talking about that tomorrow in the engineering section. That's design.

Here's production. Let's just get a couple of numbers. Quality defects per 100 vehicles, 60 for Japanese, 82 for US. Training hours of new workers, 380 for Japan, 46 for US. That's probably not because the Japanese need more training. It's probably because Japan invests more in training. So this is what started the whole lean activity around the world and in the US.

Now, how does lean compare-- what are the fundamental comparisons of lean with what we already know? Well, we have here lean thinking, mass production, and craft production as sort of three paradigms. Let's just-- we're going to spend a bit of time on this chart because this is going to set your thoughts for the whole course.

So let's look at these are different focus areas. So, in operations, in a craft thing, a person is working on a single item. In mass production, the idea is you make a lot of them, and you put them in a queue. You make more, and you put them in a queue.

In lean thinking, it's all flow. Everything is flowing very smoothly and synchronized. And we're going to talk a lot about flow.

What's the overall aim? In craft, it was the mastery of the craft. In mass production, it's reduced unit cost and increased efficiency. In lean, it's eliminating all waste and only doing value-added activities. You're going to be hearing a lot about this.

By the way, most of the things that we talk about today, we're going to come back and talk about tomorrow. And then we're going to come back and talk about on Wednesday. So, if something goes by you today and you go home and say I don't think I really got it, that's good because tomorrow you're going to get it again probably. So we're going to be talking about all these things.

Quality, in craft production, it was just part of how they did things. It was integrated into their whole system. In mass production, quality was treated as a second step. We inspect, and we correct.

In lean thinking, it's built-- the quality is built in at every step of the whole activity from engineering right through production. And one of the things that was so hard for Westerners to grasp was most Westerners thought I'll give you a quality output, but it's going to cost you more money. And what the Japanese found was I'll give you a quality output, and it costs less money.

Quality-- and this is really important in health care. This is really important in health care. Focusing on quality will drive down cost. It always has.

Business strategy here was customization. Here it's economies of scale and automation. Here it's being flexible and adaptable to the changing customer demands.

And I think this is really the heart of lean, this last one. In the craft, who does the improvement? In the craft world, it was the master-driven continuous improvement. In the mass production world, it was the expert-driven periodic improvement. We'd bring in the consulting company. They'd tell us how to improve.

Here it's the worker does the improvement in a continuous way. The worker is a continuous problem solver. So I spent a lot of time on that chart because this really sets up the whole course.

And, when we wrote a book on this, we struggled with how we define lean. And here's the term we came up with. Lean thinking is the dynamic, knowledge-driven, customer-focused process through which all people in an enterprise continuously eliminate waste and create value.

So you guys are actually little enterprises for this course. You guys are going to be airplane manufacturing enterprises. And you guys are going to be clinics. And tomorrow, when we do our LEGO simulations, you're going to be applying these principles in your enterprises.

OK, so what about Lean and Six Sigma? They're very interrelated. They came from somewhat different backgrounds. Six Sigma was developed by Motorola in the 1980s when they decided that the big problem they had was that all their processes had too much variation.

So, when they built something, they weren't sure what the output was going to be. And so they didn't have very good what you might call yield. They had a lot of scrap and not just in production, but in office processes and everything.

So Motorola focused on reducing the variation of every process so that every process would have a predictable output to deliver value to their customers. It was very problem focused, and the assumption is you've got a-- that a process isn't working. So you go, and you do a very kind of quantitative analysis and fix that process and get the variation down.

Lean has the same end objective of delivering value to the customer, but its focus is to reduce waste, to get all the waste out of the system. And we'll find out that most of the thing-- most of the inefficiency is not the people. It's the system in which the people are working is wasteful. And it's focused on keeping everything flowing.

And so the assumption is that waste removal will improve businesses and that many small improvements are better than a big, giant step. So lean is very much a process of starting where you are, taking whatever system you have, making it a little bit better or a lot better, and then making it a lot better and then making it a lot better and just continually trying to improve it. And that's why it's a journey.

Now, what's happened over the past 10, 15 years is that-- well, let me back up and say, 15 years ago, there were people saying, oh, I'm doing Six Sigma, or I'm doing lean. It was like there were two camps.

And, luckily, eventually we got past that, and most organizations now pick some portions of lean, some portions of Six Sigma, and bring them together. We think of lean as sort of optimizing flow and Six Sigma as reducing variation. And the body of knowledges have come together into something that's generally called Lean Six Sigma. There are books you can buy called *Lean Six Sigma.*

And what happens is an enterprise will look at these principles. They will tailor their own version of it. They will name it and brand it. And it becomes their operating strategy or their improvement strategy.

So Textron calls theirs Textron Six Sigma. Virginia Mason Medical Center calls it the Virginia Mason Production System. Some of you are either going to work or have been working at Boeing. They call theirs Lean+ now.

And I was talking with Susan a little earlier. Dartmouth, which is a real leader in this area, doesn't even call it lean at all. And that doesn't matter. It's that the organization understands their process improvement and identifies with it and takes ownership of it and doesn't get hung up on what the name is.

So our course is going to cover all the principles that underlie all these things. If you are going-- if you were in a company or a hospital in which they're training, they would give you specific training on their system because you're working for them. But you're all going to go somewhere else, different places. So what we give you are the fundamentals that apply to any of those systems.

Let's wind up the first part of this module with a slide that shows how important people are in implementing continuous improvement. I often hear that there are two jobs we all have. One job is the work we do, and the other job is improving how we do our work. And we're going to emphasize the importance of people in implementing lean thinking throughout the whole course. And we'll even get ahead of it in this exercise we're now going to do.

That's the background. Now, let's get some of these specifics. On the right-hand side of your folder is an exercise that looks like this. And take it out, and don't open it up yet. Just put it in front of you.

OK, this is called 6S. Now, there are two versions of this out there. There are multiple versions. There's 5S and 6S.

So 5S came from the Japanese. They were Japanese words, which I don't remember, but they've been translated into basically sort, straighten, scrub, standardize, and sustain. And this is a way of improving your work environment, very simple. And we'll talk a little bit about it.

Now, what happened when this came to the Western world? The Western world said, ah, safety, that starts with an S too. And safety is very important. So we'll make it 6S, and we'll add safety onto the list. And, when we put-- this is the only place in the course where we've actually taken something that we didn't observe in the field.

When we did this, we thought that's kind of an afterthought just to put safety at the end of a list. And safety is more important than that. So either leave it off, or, if you're going to integrate it, integrate it.

And so we put it as the second S. And we call it safe, which is an action verb. This is probably the only place you'll see this version of 6S, but that's OK. Don't worry about that.

So what we're going to do is we're going to do a little exercise. And this is your workplace for right now. This is your work environment. And we're going to try to improve it, applying the basic principles of 6S.

And we're going to do it in 20-second rounds. You can think of each 20-second round as maybe a work shift or something like that. And you have a bunch of supplies. And this is in the medical context, but we could do it otherwise. You have some instruments, some bandages, and some medications.

And you're going to-- each of your work shifts, you're going to be asked to fetch some of these supplies from your storeroom. And don't turn it over yet, but the first page represents your current work environment. And then each next slide will show you what you have to fetch in your first work shift. And, when you fetch it, so what you're going to do is just put an X through whatever you fetch. Or, if you want to circle it, you could do that too. I don't care.

OK, so here's what we're going to need to get on the first round. You're going to have to find five syringes, five of these Band-Aids, five scissors, and five of the medication II's. So don't do it yet, but, when I say go, you're going to flip the page, cross off five of each of these until I say stop. And that's the end of the shift. OK, any questions on the mechanics of it?

OK, so we'll do ready, set, go. Stop.

[LAUGHTER]

Shift is over. Time to go home. OK, so now count up the number of items, total number of items you got. I don't need to know items by category, just the total number of items. OK, super.

OK, how many are kind of around 8, 9, 10? OK, probably 10 is roughly about the middle. We don't have to be too careful. So this is kind of our workplace.

Well, what do we see? OK, we didn't get the job done. And there's high variability, OK? We have about-- let's see. We have about 25, 28 workers here in our plant. And we get quite a variable outcome. This is the kind of thing Six Sigma was worried about, high variability.

OK, so that's where we're starting. Now, our first S is to sort. And you probably saw, in your workplace, there's a lot of stuff there that you don't have to go collect. There's some old equipment that's in your storeroom. There may be some medications that have been there.

When this first started, a lot of these companies go into the storeroom, and they find out that somebody in purchasing got a good deal some time on some piece of some equipment or supply. They got a volume discount. They bought 10 years worth of it. And, a year later, they stopped using that stuff. And then another nine years are still in the storeroom. That's waste, OK?

So what we're going to do is we're just going to go through and clean up, get everything out of the workplace that we're not looking for. And then we're going to redo this. So it's the same thing, but now we've gotten rid of all the clutter, but we're going to get-- just so we take the learning out, we're going to get now five tape rolls, five Band-Aids, five tweezers, and five medication III's. OK, ready, set, go. Stop.

OK, now, we count them up again. And then we'll see where we're at. OK, anybody get all 20? 19? 19, OK. OK, how many are around 15, 15? OK, that's good enough. OK.

AUDIENCE: 25.

EARLL MURMAN: 25?

AUDIENCE: [INAUDIBLE]

[LAUGHTER]

EARLL MURMAN: So you've made a-- you've made a-- we're going to talk a lot.

AUDIENCE: [INAUDIBLE]

EARLL MURMAN: So, just a heads up, one of the things about lean is you're trying to meet your customer's demand. And you exceeded customer demand. OK, sometimes, the customer won't pay you for it, but, this time, it's probably OK. How many got-- look at your medications. Did anybody get a medication I or a medication II?

AUDIENCE: Oh.

AUDIENCE: Yeah, that one is right. That one is right.

AUDIENCE: I did.

AUDIENCE: Oh, yeah.

[INTERPOSING VOICES]

EARLL MURMAN: Ah, OK. OK, so now we're going to safe. Getting the wrong medications is a big problem. So that's an example of why we set it up-- that's why we put safe here. So safe is just making the workplace safe.

If your workers get injured or if the customers get injured or suppliers get injured, that's pure waste. That's lost time that they can't contribute to your enterprise. So safety is not good-- safety is important for many reasons, but it's very much a lean principle. You don't want anything that-- well, I've always said accidents are waste.

So we've gone in, and we've made our workplace a little safe now. We've put sheaths on our syringes. We've made the medications different shapes. We've closed the scissors. And so we're going to do the same thing, get 20 items. And ready, set, go. Stop.

I think everybody has got the mechanics down. OK, anybody get 10 or less than 10? 12? 11? 11?

AUDIENCE: 12.

EARLL MURMAN: 11, 11, 12. OK, we had a little bit of improvement here. Anybody get all 20? 18? 19? 19, OK. OK, how about 16, 17, 18, 15, 14? OK, it's kind of hard to see. I think we're maybe a little bit better than before, but about the same.

So we've closed down the variation a little bit. We didn't expect to get too much improvement in productivity because all we did was we made the environment safe. We didn't really do any reorganization.

OK, now we're going to straighten. Now, that we've gotten all the clutter out and we've made things safe, now, let's get our workplace a little bit better organized so it's not so helter-skelter. So we're going to straighten things.

So we've installed some racks in our storeroom. Because management has seen this great increase in productivity, they're going to ask for more now on the shift. They want 25. They want 25 things found. OK, so you can see the list up there. OK, ready, set, go. Stop.

OK, anybody 15 or less? How many?

AUDIENCE: 14.

EARLL MURMAN: 14.

AUDIENCE: 14.

EARLL MURMAN: 14. OK, 14. OK.

AUDIENCE: 15.

EARLL MURMAN: Yeah, you got 15, but she got 14. What did you?

AUDIENCE: I got 15.

EARLL MURMAN: 15, OK. Anybody get 25? 24? 23? 23, OK. And how many are 19, 20, 21? OK, that looks like we're about in the middle here. OK, well, we see the increase in productivity there.

OK, now the next S is to basically clean things up, to scrub. By the way, in these charts, there are multiple translations of the Japanese word. And we've given them all here. So, for scrub, it's scrub, shine, or sweep you might find in a particular 5 or 6S incarnation.

And that's pretty important. Of course, in a health care environment, it's critical for all sorts of reasons. But, in an aerospace environment or a production environment, you can walk-- a lean factory, you can walk into, and you can eat off the floor.

I mean, we'll see. We're going to have a video of New Balance shoe. And you'll see, when we get into that factory, how clean it is and well lit. Everything is clean. It's just a way of thinking.

So keeping your workplace tidy and neat is just part of it. We can't find a good way to do that exercise here. So we're going to skip this S and move on to standardize.

So now we want to make it-- now, we've got everything straightened up. Now, we make it really easy to find things. So we've got three clinics here. It'd be nice if each clinic had its own way of storing things. OK, and we're going to talk about that tomorrow in our simulation.

Or we've got two production facilities here. It'd be nice that, in the two production facilities maybe of the same company, you'd have the same way of storing things so you can go from one to the other and not have to be trained.

So we're now going to-- we've done a good job of that. We've standardized. This as an example. It's hard to see, but these are a bunch of binders. And they just put little tags on them so you can immediately see which binder is missing because it's out of sequence.

OK, well, now we're up to 30. OK, we want to get 30 items on this round. This is the last shift of the week. You're going to have the weekend off after this. Ready, set, go. Stop. OK, anybody get 30?

AUDIENCE: I got 30.

EARLL MURMAN: Look at that. Wow. Anybody get 25 or less? How many?

AUDIENCE: 25.

EARLL MURMAN: 25. OK, and how many got 30? Let's see your hands again. 29? I mean, it's like this.

OK, well, let's look at this chart. So we've gone from a system that has high variability and low productivity to a system that has high productivity and low variability. How many of you would-- how many of you found this environment where you produced so much more to be more stressful to work in than this environment? Nobody, right?

That's what lean is about. OK, lean is about doing simple things to improve your workplace. When I toured the Sikorsky plant where they make the Black Hawk helicopter, the plant manager said, Earll, lean is the focused application of common sense. This is not complicated stuff.

And lean is not about making the worker work harder. Lean is about putting the worker in an environment where they can be more productive and happier. OK, so this is what lean is about.

Most organizations start with 5S as their first thing. And let me just share-- just to underline it, I'll share you an example. So I live in the small town of 9,000 people. The whole county only has 30,000 people. It's a rural community. Our hospital started adopting lean.

The very first thing they did was they went into the hospital laundry and applied 5S. The laundry was so dysfunctional. They had high turnover of employees. The linens and gowns were not on the floors when they needed to be. The laundry bin, they didn't get to the bottom of it each day, the dirty laundry. So, the next day, more laundry was on top and so on.

In one week, the women in the laundry who operate the laundry took 5S with a facilitator and a coach. They reorganized their laundry. And it went from that to now they get all the laundry done every day.

I've been in this laundry. The women are so happy. They just can't-- they just want to tell you about their workplace. They've had no turnover since they did this.

And everybody in the hospital is affected by the laundry. And they all knew it was a success. So, if you want to start in a hospital, start in the laundry with 5S.

The last S is to sustain, often the hardest part. I like the Virginia Mason version of it, self-discipline. Sustainment should be-- the trap as you do this one-week event like I mentioned in the laundry, and then you drift back into old habits. So the hard part is keeping this as a mindset. Sometimes, you have to have a chart, but usually you should just be able to do it.

OK, so that's your first lean experience. Let's now talk about why lean is being applied in these areas. OK, we're going to look at aerospace, health here. And we're to look also at New Balance shoes just for three comparisons.

So aerospace is a really interesting industry. It's a flagship industry of the United States. It's one of these things that goes with the image of the country. It enables the movement of people and goods. It enables communication. It's critical to national security. And it's a source of inspiration for many people for exploration.

Now, why did aerospace turn to adopting lean? Here's an industry where we think we're the world's leader. And I pause because we may not be, but we think we are. But why did we turn to lean?

Well, here's why. This is a study that came out of the Sloan School by Jim Utterback that shows the natural progression of many different industries plotted by the number of companies in a particular industry.

So this is the typewriter industry. So it started in the late 1870s, and companies came in. They reached a peak of about 80 companies. And then somewhere they reached a peak around 1910. And then the number of companies started declining. And, of course, there's probably no typewriter companies now.

What happens? Well, this phase, this is where the product architecture and product characteristics are not set. So many inventors come up with new ways of doing things.

Eventually, somehow, the best design emerges. And that's where the market consolidates around. And then, instead, there's not really real opportunities for new companies. What happens is companies buy up other companies that emerge.

And, at this point, it's very hard to change the product architecture. This keyboard we all use came out of this era. It's pretty well known that there's more efficient keyboard layouts, but it's impossible to change that now. It's impossible to change it because it's the standard.

OK, here's the automobile industry, same kind of thing here. The main product architecture was the enclosed steel body. Here's aerospace. Now, this is representative aerospace. So it's probably-- it's just some of the major companies, but, throughout the 1900s up to about 1960, we had a growth of the number of companies.

Then along came something that looks like a 747, 707, and other things. And we sort of reached the product architecture. And then we would have gone on this decline just as companies.

But we get to this point here, and there's a plateau. We're in the Cold War. And the government, for strategic reasons, wanted to keep a big industrial base. So they invested in that industrial base.

When the Cold War was over, the Secretary of Defense invited all the CEOs of the major aerospace companies to dinner. It's called "The Last Supper." And he said, we don't need this many companies. And so we're not going to have as many, but it's up to you to sort it out. We'll let the marketplace sort it out.

So Boeing buys McDonnell Douglas, so on, and so forth. And we have now consolidation and fewer aerospace companies. Had we not had the Cold War, we probably would have done this.

But here's where aerospace-- here's where LAI started. We had an industry, which was inefficient and couldn't survive in the new world. And so they turned to lean.

So we had a company with-- companies that have mature products can't survive on a business strategy that's designed for early growth. Here's one of the things that happens. In an early phase, when there's not-- when the competition really hasn't developed, you can charge what you want. You can charge what you want for a new device. And then you subtract your costs, and you get whatever profit.

Competition builds up, or the government says we're not going to pay as much for airplanes anymore. OK, the customer sets the price. The only way for you to make a profit is to reduce your costs. So you have to become more efficient. It's just the way it is, or you don't survive.

Here's an example of some of the problems in the aerospace industry. Here are three programs-- the second block of the GPS satellites, the Joint Strike Fighter, Boeing 787. These are new airplanes, years behind schedule, one, two, three, four, billion dollars overrun, $12 billion beyond the development costs. The price per unit, they're going to buy a lot of F-35's. The price has doubled, and it's still in trouble.

Other programs where their costs and schedule is overrun is the F-22 and so on, the A340-- A380, so on. This is what's called the burning platform. The paradigm here is people adopt lean when the platform they're staying on is burning. And, if they don't do something, they're going to disappear.

Now, there are so many aerospace programs which are executed very well. And we've learned a lot from studying those. So I don't want to say the aerospace can't do anything, but there are a lot of problems with the aerospace programs.

Health care, there was a book published in 2003 called*Crossing the Quality Chasm.* It was published by the Institute of Medicine. And the paradigm here was this is the health care we're delivering. This is the health care we know how to deliver. And there's such a wide gap in quality of health care that we have a big chasm between what we're doing and what we should be doing.

And they outlined what the objectives of health care are and that these are not new aims. These are aims that have been there for many years. And most people go into health care because they want to do this.

Probably, all of you guys are going into health care because you don't want-- you probably didn't say I picked health care because it's an inefficient system that I can work in. You picked health care because you want to help people and do things. So we need to do that.

OK, but what are some signs? Well, I think we've all heard about the cost of health care. There are different metrics here. I don't think we have to go through those in detail. There are quality issues.

This is the one that was staggering to me, the study done in 1999 that between about 50,000 and 100,000 people a year in our country die from perfectly preventable medical mistakes. OK, that's more people than die on the highway. And, by the way, that number still has not changed too much. It's gotten a little bit better maybe, but not changed.

Many people don't have access to health care. This slide is a little bit out of date because of the Affordable Health Care Act. And 60% of the doctors in the survey said they wouldn't recommend going into health care to their children. Here we've got Bo is an emergency doctor, emergency medicine doctor. Is 50% of your time spent on paperwork?

AUDIENCE: On waste on a good day.

EARLL MURMAN: On a good day, 50% is wasted. And Susan is a nurse. Many studies have shown we have a big shortage of nurses coming up here. OK, so we've got some problems, as you all know about.

So, basically, what we say in health care is there's a value crisis. Value is defined as what you deliver and divided by what you pay for. And roughly about half the health care we know how to deliver to the patient gets delivered.

And the cost, this is of GDP. In 2007, we were spending 16% of our gross domestic product on health care. In 2050, it's supposed to be 37%. That's just unsustainable and the same with Medicare.

So we hope that lean thinking can be one piece of a puzzle of improving health care. It's a complicated-- it's a complicated field. And there's no simple solution, but lean can help.

OK, so those are two industries as to why they're applying lean. Now, let's talk a little bit about what is an enterprise because, in this course, we very much focus on applying lean across an enterprise, not just a manufacturing or a clinic thing. So an enterprise is broadly defined as one or more organizations having related activities, a unified operation, and a common business purpose.

And so you might have, in an engineering enterprise, customers, engineering products, product development or engineering, manufacturing, suppliers, finance, and so on and support. And enterprises can be pretty complex. So it's hard to define the boundaries in an enterprise. It's somewhat contextual.

You might draw it around your table here as an enterprise, but most enterprises have partners that they have close operating agreements with. And so we call the core enterprise the organization plus its most closely related partners that work with them.

And then, beyond that, there's an extended enterprise, which is all their suppliers and actually their customers too. And also their community and regulatory agencies and things like that all can affect their enterprise. So a company like Boeing has maybe 2,000 suppliers. And, by the way, those 2,000 suppliers are suppliers to Airbus and Embraer. And so this gets very complicated.

OK, so who are the stakeholders of an enterprise? They're any group or individual who can affect or is affected by the organizational objective. So you have your employees, partners, suppliers, unions, customers, shareholders. These are all stakeholders who can affect or are affected by your enterprise.

Jennifer, at Boston Medical Center, do you have any-- I don't know how long you've been at Boston Medical Center and whether you-- do any of these kind of things resonate with you in terms of who your stakeholders are there? What department? You're in radiology?

AUDIENCE: Radiology. I've been there for five years. So hopefully I know a little bit about--

EARLL MURMAN: So you have some suppliers of CAT scans and all this kind of stuff?

AUDIENCE: Oh, sure. Sure, I mean, I was actually thinking about the broader sense in terms of how the community health centers [INAUDIBLE]. So we, for instance, serve the emergency room. We serve the inpatients. We serve our own BMC outpatients. Then we also serve a very large network of community health centers who send all of their patients to us for imaging that they can't provide.

Then there's the technical arena of all of the-- GE provides most of our equipment, but we have different suppliers for our MRIs and our CTs and our ultrasounds. Those are all different corporations. And then they all have their own technical support services.

EARLL MURMAN: I think you've made the point.

AUDIENCE: Yeah.

[LAUGHTER]

EARLL MURMAN: So there are a lot of stakeholders. And each of these stakeholders-- this is a very high-level definition of value. We're going to come in the next module to a much more specific definition of value. This is a very high level, but every one of these stakeholders expects some value from the enterprise just like Jennifer just outlined.

And, in return, they're supposed to contribute some value to that enterprise. So there's kind of a value proposition here. A value is how various stakeholders find worth, utility, or a benefit or reward in exchange for their respective contribution to the enterprise. So there's this kind of value relationship going on here in an enterprise.

And now what's a lean enterprise? When we started this work, we said this is a lean enterprise course or a lean enterprise initiative. People said, well, what is a lean enterprise?

It turns out that's a good question. And here's our definition. It's an enterprise of-- it's an integrated entity that officially creates value for its multiple stakeholders by employing the principles and practices we're going to cover in this course.

Now, these principles apply across the entire enterprise. So, in an engineering enterprise, you have generally what's called the product lifecycle from the initial concept of a product like this through the design, definition, design, getting the supply chain lined up, production, and distribution of support. That's what generates money for the enterprise, selling this product.

But it also has finance, information technology, human resources, various support functions which are needed, and the leadership processes. And the point is lean applies to all these. It doesn't apply just to manufacturing. It applies across the whole enterprise. And we'll show you an example of that in a minute.

In health care, it's very much the same. Instead of having the product life cycle, you have the patient life cycle. So lean doesn't apply just to treatment. It applies from preventive monitoring through long-term care management. We should really be thinking-- in fact, there are people who feel that the health care system should be reorganized along-- let's call them disease pathways or something like that, instead of segmented into imaging and so on.

And again you have the same supporting functions. And I'm really glad that a couple of our students here in health care are administrative fellows, looking into health care administration. That's really important.

OK, so does it work? Well, I told you how LAI got started in 1992. And it took us 10 years to respond to the general with a book we wrote. And we said-- after 10 years, we said to the general-- by then, we'd been through three or four generals. And we said, yes, lean does apply to aerospace if we take it at the enterprise level. If it's applied to all the functions of aerospace, not just to manufacturing.

OK, here's a really good example of the F-18 aircraft. This is a fighter aircraft for the Navy. They were going through an upgrade to the model E/F. It was an upgrade, but it was actually a completely new aircraft. It was 25% bigger, but it was sold to Congress as an upgrade, $5 billion budget, 8 and 1/2 years to do the engineering and design.

The program performed on schedule within cost, met all its technical requirements, very unusual compared to those burning platform programs I showed you. And, when we went in and studied it and looked at what they'd done with what the lean principles are, they were a lean enterprise. They didn't call themselves a lean enterprise, but they had done this.

And, in fact, we went and gave them this briefing. And we said to them, we've concluded your lean enterprise. And they said, whoa, no, we're not. We have so much more to do. Don't tell us we're a lean enterprise. That's the attitude you want, wonderful program.

Here's a completely different area, electronics, Rockwell Collins. We're going to come back to them on Thursday with a case study of Rockwell Collins, but they applied lean thinking across their whole company in the office environment, as well as in the factory, and the great results. And we'll see data from them on their operating performance tomorrow.

Health care, many examples in health care, Susan will give you a lot more when she talks on Thursday, but just hear a few. There's a number of books out now. ThedaCare in Wisconsin, waiting time from when you first call to when you get scheduled for orthopedic surgery went from 14 weeks to 31 hours. Here's a hospital in Pennsylvania where they reduced the readmission rate for COPD patients.

Children's Hospital in Seattle reduced its capital expenditures by $180 million by using lean improvements. And Susan mentioned about architecture. That's becoming a big area for saving in capital improvements. And here's a hospital in Nebraska where it reduced the time it took to turn around the lab results over a six-year period by 72% by using the same people and the same facilities.

OK, here's the New Balance story. We're going to see a video on this shortly, but they're a shoe company. They're the only company that manufactures athletic shoes in the United States. OK, it used to take them eight days to make a pair of shoes. Now, it takes three hours.

They're actually doing the same amount of work. So here they were only-- of the eight days, only 2/10 of a percent of the time were they doing anything useful on the shoe. The number of items they have to have in inventory went from-- well, inventory turn is the number of times you turn over the inventory. Here it took from 3.5 to 13.

They can make a pair of shoes. They get a call saying we need some more shoes. They can ship it in three days. Floor space reduced. Production went up and so on.

Let's just talk about this. Kanban, Japanese word, who's ever heard the word kanban? One, Catherine has heard kanban.

Kind of a strange word, isn't it? How many of you at home keep a shopping list? OK, so tell me. How do you make your shopping list, Whitney?

AUDIENCE: Like in terms of which ones? Well, now, I use an app for everything. So I don't [INAUDIBLE]. On the weekends, we'll kind of pick what things I'm going to do. And it forms a list for me. So I carry it around with me everywhere.

EARLL MURMAN: So how do you make that list of things you-- well, let's say grocery shopping, just to take an example. So grocery shopping, what do you put on your list?

AUDIENCE: I pick the recipes, and it creates a list for me.

EARLL MURMAN: OK, so you pick what you need.

AUDIENCE: Yeah.

EARLL MURMAN: OK, anybody else? How do you do your shopping list, Tony?

AUDIENCE: I go to my fridge. And I look at what is missing I go to my cupboard and see if there are things that are missing that I need to replace. And I write down the list.

EARLL MURMAN: So he's got 5S working. He can look at his cupboard and see he's missing something, right? OK, you have some kind of standardized way of storing things in your cupboard.

AUDIENCE: Yeah.

EARLL MURMAN: OK, and you spot what you're missing, and you put it on your list again. Those are kanbans. OK, kanban is nothing more than a queuing system, a visual system, to indicate what material parts or other information you need to keep going.

In a factory environment, typically, it's a card, a barcoded card of some kind. And, at some station where they're manufacturing something or, in a health care environment, where they need some supplies, they need more of that. And so they make a little system. And then someone delivers it.

OK, now, the opposite is, instead of deciding what recipes you have and what you're going to buy, you go to the store, and you say, oh, this is on special. I'm going to load up on whatever, hamburger or toilet paper or ketchup. OK, what you're doing is you're buying because you're getting volume discount, but you may not need it.

So a kanban system is one where you only deliver what's needed to whoever is doing the work. And there's some cue, usually a visual cue. It can be a barcoded card. It could be a bin that's empty, some space on the floor that I need a new delivery there. In an engineering environment or a work office environment, it might be an empty inbox.

Also, an interesting kanban I saw, this was a factory at McDonnell Douglas in East St. Louis. And they have supplies, something coming from a company in California. They make a packaging container that this product went into.

And so the company is in California. The factory is in East St. Louis. And on the ceiling is a camera looking down at the number of these boxes that are there. And, when the company in California sees they need more boxes, they ship them. That's a kanban.

So Toyota implemented kanban in their production system. It took them 20 years. You wouldn't think it would take that long.

When they first started doing it, they actually came to the United States and saw the supermarkets. And, in the supermarket, the potato chips, you buy potato chips, and the shelf looks empty. So the potato chip guy comes and sees you need more potato chips. That's where it came from, supermarkets.

So they introduced it. It took them 10 years after they did the experiments to make it across the whole company and another 10 years to make it across their suppliers. OK, and they continued to work on it. So now think a little bit about whatever enterprise you might think about. Get out your colored cards here.

Think about where you've had some experiences. How long do you think it would take to implement lean in some environment? You can think about your company or your department at MIT. Think about lean thinking in your department.

Think about your parents' work environment. Just pick some work environment, knowing that all the we could teach you in three days, how long do you think it might take to implement lean in whatever work environment you're thinking about? And then hold up the colored card when you make up your mind.

OK, I don't see any blues. I see a lot of yellows, a lot of greens. That's good, some reds. OK, so it's going to take a little while. Maybe it looks like, I'd say, the bulk of the numbers I have up here are five years.

Susan, you work with a lot of health care organizations. You said you've been doing this for five years. What kind of-- how long are you seeing that a typical health care organization--

SUSAN SHEEHY: Most of the hospitals we've worked with take at least five years if not more because you really have to spread it throughout the organization. And it takes that long. You can't just teach five people and say, OK, we're lean. So it's at least five years if not more. And that's with an all-out effort.

EARLL MURMAN: At least five years with an all-out effort, not a half-hearted effort. OK, so this is a big commitment for an organization to implement lean. OK, they're not going to see quarterly bottom-line profit changes, which their shareholders may be looking for.

What are some questions that this introductory module kind of brings up in your mind? Or do you have comments you'd like to make or suggestions? Yeah, Jennifer.

AUDIENCE: For the 6S activity, if you had asked me to sort that stuff from the very beginning, I probably would have ended up on the end page first with everything in-- if you just said sort these things, it would have been super subselected, which might just be my own personality when somebody says sort. So I'm a little unclear what the difference between sort, standard, straighten, and standardize are in that respect.

EARLL MURMAN: That's a good question. You know, I think the sort one is, first of all, just get rid of stuff that shouldn't be there. And I have slides from a lot of different examples of storerooms that had totally obsolete equipment in them. And people were spending lots of time looking for something that was not all that obsolete equipment.

So I think the sort part is pretty quick. Now, the straighten and standardize I think might be done as a single step. But I'm not going to-- I think you're fine. It's a good comment.

But what's amazing to me is how often an organization starts with 5S. I mean, you would think, why isn't anybody doing it this way?

SUSAN SHEEHY: It's because-- and we hear this term all the time. It's the way we've always done it. That's what we always hear. Because it's the way we've always-- and workarounds and do-overs have been built into the system. So nobody even recognizes that they're doing it. It just becomes part of the daily work.

EARLL MURMAN: Do you have a question, Monica?

AUDIENCE: Yeah, I was just wondering. You said that the average time was five years. So I was just wondering, in our culture of immediate response time and response to crisis, how do you sustain an organization's interest--

EARLL MURMAN: That's a--

AUDIENCE: --for five years?

EARLL MURMAN: --really good question I'll answer what I can. And Bo and Sue and others can pipe in. First of all, you have to have this so-called burning platform. That is there's sort of no other option. Either we do it, or we go out of business. So it's very hard for an organization that's doing extremely well to adopt something like this.

Secondly, it takes leadership. It has to be that the organizational leadership says, this is important, and we're going to have constancy of purpose and sustain this. We're going to start this and do it and stay with it.

And then, third, it has to align with the strategy of the organization. That is it has to be built into what the organization is trying to do. It can't be something separate. We're trying to do this, and, meanwhile, we're going to do lean. The two have to be together. And, frankly, many organizations can't do it.

SUSAN SHEEHY: I could answer that too. It's also a series of incremental changes. So, if something happens, like a medication error that's disastrous, you can certainly start with that.

And, as you have improvements, you celebrate those improvements and distribute that information so that it's a continuous improvement. And it can happen over time with really good things happening along the way. But to roll it out to an entire organization takes a long time.

But we tell people we have to start somewhere. And it's not like it's going to alter your whole organization overnight. It's celebrating those incremental things that you do, looking at your data, looking at your outcomes, looking at your staff turnover, and using that to build your lean program. So it takes time, but you can celebrate things along the way.

EARLL MURMAN: The biggest-- I think the biggest barrier to this is if there's a change in the leadership at the top, and the new person doesn't really understand it. And then the whole thing can crash. Bo?

BO MADSEN: I think, as well, it's important that you have a vision, that your organization has a vision, and that everybody knows what that vision is. And then the beginning is the hardest, but, in reality, we all want to do value-added work. We want to do the work that we're actually employed to do.

People, they enjoy that. When they can see with the first steps that the waste that we're sucked into every day, that that goes away and you're more productive, that's nice. People, they enjoy that.

EARLL MURMAN: Good, what are some questions that come from the engineering folks here? Yeah?

AUDIENCE: So, at some point, you pointed out a disparity between how many hours of training both United States and Japanese companies, exactly, give to their workers. And this might be silly, but it seems that the people are what pretty much makes the company run. So, if they're spending so much time training their workers and getting so much profit off of it, how are we not doing the same thing?

EARLL MURMAN: So is the question-- is the question, does the training detract from the productive [INAUDIBLE].

AUDIENCE: No, my question is, why aren't we investing more into training our workers?

EARLL MURMAN: Oh yeah, so that's been a real change in the US companies as they've adopted these is they've come to realize the importance of training. And they do invest a lot in training. A typical company that I know of in the US will invest at least 40 hours a week for every employee to be trained during the year. And training can be broad. It can be specific to that particular job, but it could be much broader, just communication skills or sometimes even just awareness about their culture of the customers in other countries.

AUDIENCE: So do you think that the difference is not in training hours anymore, but in the workers themselves?

EARLL MURMAN: I really don't know. I'm not sure I can answer that. I can say that they are investing more in training hours. Whether it's because the workers are different, I don't know. Yeah. There may be a chicken and egg situation there. One question here, and then we'll come back.

AUDIENCE: OK, so you mentioned that a lean enterprise creates value to multiple stakeholders.

EARLL MURMAN: Yeah.

AUDIENCE: But what happens if those values are not necessarily aligned?

EARLL MURMAN: Aligned. Good question.

AUDIENCE: I'm thinking, sometimes, you have the shareholders. And they might be willing to move the enterprise-- transform the enterprise in one direction. And you can have the employees. They don't want change because they're comfortable in that situation. I don't know.

EARLL MURMAN: No, it's a great question. Is it Matthias?

AUDIENCE: Yeah.

EARLL MURMAN: Matthias asked is the shareholders values are not always-- will normally not be aligned completely. OK, so you have to do the best you can. OK, I mean, you have to find something.

I mean, the ideal is if you could find something where every stakeholder gains something. Maybe they don't gain everything they want, but they gain something. Something is better than before.

OK, so let me take the employee thing. I think one of the-- I think the question Monica asked relates to that too. One of the things that-- one of the things that successful organizations do that implement lean is they make it known to their employees that nobody is going to lose their job because of increase in productivity.

So it's very hard if you go into an organization and say, Emily, I want you to help improve us. And, by the way, we probably won't need you when we're finished. Your heart is not going to be in that.

So instead, you say, Emily, we want to have a better organization. And you're going to be part of it. You may not be doing the same thing you were doing before. We may have to train you to do something else, or we may have to do something. But you're valuable to us, and we want you here. And we want you to help us improve.

So Emily is going to come out. She'll probably be happier when she's done because she's probably not completely satisfied with her job. And they'll be more productive. And maybe they'll end up outsourcing stuff, but they'll find a place for Emily in the organization. So you want to make sure it's as much of a win-win as you can.

And that's the challenge. I mean, sometimes, it's hard. And, unfortunately, the short-term focus of our financial system is a barrier for some of these long-term commitments. So it takes a lot of strong leadership to overcome that. And I think Susan-- good. You want to show incremental improvement. You want to try to get better and better and better, not [INAUDIBLE].

SUSAN SHEEHY: But I also think that the equation in health care traditionally has been that employees were on the expense side of the equation. And so, when they needed to cut costs, they cut positions.

And what Toyota does is their employees are on the value side of the equation. And so they value those employees. And that makes the difference in the expense side as well.

And I think that makes a difference because Toyota expects their employees to make suggestions. And they implement their suggestions where, in health care, we haven't done a good job at doing that. Employees were just employees. And now we're starting to see that employees are the experts at what they do. And so we need to start listening to them.

And I have an example. I was doing work at a small rural hospital in northern New England, a 50-bed hospital. And this class, I did two classes of 16 people. And they were working on some productivity kinds of issues. And they came up with $3 million in savings from the delayed OR start times and canceled imaging tests and all those kinds of things. And they really did a beautiful job with their projects.

And the last day at report out, the CEO was there. He didn't hire us. It was a grant through the state. So they did this report out and talked about what they found.

And, at the end, he said, this really makes me look bad. And I said, excuse me. And he said, I should have fixed these things. [INAUDIBLE]

It was just-- it was the old, traditional model of the hierarchy. I tell you what to do, and you do it. If I tell you to cut 10% off your budget, you do it, not show me how you can increase throughput and revenue.

So we need to just change our thinking in health care. And it's happening, but very slowly. And valuing the employee is the most important thing we need to do. And, unfortunately, the term lean gives people the absolute fear that we're going to cut positions. That's what they immediately think when you say we're coming in to do lean, that word.

EARLL MURMAN: Do that, and lean became the word. It's like the--

SUSAN SHEEHY: Exactly.

EARLL MURMAN: It's like the evolution of industry I showed you. We can't change the word now. It's just become part of it.

SUSAN SHEEHY: It's just what it is.

EARLL MURMAN: It came actually from a MIT graduate student in a research seminar one day when they were talking about the things they were learning about the Japanese automotive industry. And they said, what are we going to call this? And he said, well, let's call it lean because we're doing more with less, and it stuck. But it unfortunately has a negative sound to it, lean and mean and all that kind of stuff. So we have time for one more question. Did you have a question?

AUDIENCE: Yeah, so I'm going to play the skeptical a bit. How do you establish causation between these methods and the outcome? How is it not just an improvement in employee mentality? I want to have this company that won't just sit back and--

EARLL MURMAN: That's a really good question. How can we show that the kind of results we showed here come from lean? Because there are a lot of confounding factors going on. There's a changing business environment. There may be other things going on.

And I guess, in a scientific sense, it might be very hard to do that. But, when you go and look at organization after organization after organization that adopts this and sees improvement, there's a correlation there that adopting lean thinking and the way we teach it here-- one of the pitfalls in adopting lean thinking is-- and let's take the 5S or 6S.

A lot of people think lean is a tool. Oh OK, now, I know how to do 5S. I can fix it. That's not what lean is. Lean is this change in culture and the way of thinking that Susan mentioned. And that takes some time.