MANUFACTURING INSIGHTS
Right-Sized Equipment

SCENE 1
CG: FBI Warning

Warning
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SCENE 2
ANI: SME Logo

SCENE 3
Standard Manufacturing Insights opening

SCENE 4
Opening Title
C.G.:
Right-Sized Equipment

NARRATOR(VO):

MANUFACTURING INSIGHTS, MANUFACTURING ENGINEERING MAGAZINE'S VIDEO SERIES FOR PROCESS IMPROVEMENT. THIS PROGRAM WILL EXPLAIN ANOTHER ASPECT OF LEAN MANUFACTURING, CALLED RIGHT-SIZED EQUIPMENT.

SCENE 5
b-roll of production lines

NARRATOR(VO):

COMPANIES SEEKING TO IMPROVE FLOW, QUALITY, AND TURNAROUND TIME WHILE MINIMIZING THE CAPITAL OUTPUT USE THE RIGHT-SIZED ALTERNATIVE.

SCENE 6
b-roll example of right size job

NARRATOR(VO):

RIGHT-SIZED EQUIPMENT USUALLY PERFORMS ONLY ONE JOB IN THE MANUFACTURING OF A PRODUCT.

SCENE 7
Ext. shot of boeing

NARRATOR(VO):

WE WILL TAKE AN IN-DEPTH LOOK AT BOEING'S

COMMERCIAL AIRPLANE PLANT IN WASHINGTON STATE. THEY HAVE BEEN APPLYING LEAN TECHNIQUES THROUGH A RIGHT SIZE EQUIPMENT APPROACH SINCE THE EARLY-NINETIES.

SCENE 8
w.s. tube & duct area

NARRATOR(VO):

ONE AREA WE WILL FOCUS ON IS THE MANUFACTURING OF TUBES AND DUCTS USED IN THE DE-ICING OF PLANE WINGS. THE COMPLEX ASSEMBLY OF THESE PARTS WAS BROKEN DOWN INTO SMALLER, SIMPLER CELLS WITH AN IMPROVED FLOW OF PRODUCTION.

NARRATOR(VO):

THE TUBE AND DUCT CENTER FOOT PRINT ON THE PLANT FLOOR IS REDUCED, SO MORE SPACE IS AVAILABLE FOR POSSIBLY NEW PRODUCTION. IN ADDITION, THE REDUCED OUT-PUT FOLLOWS THE LEAN PRINCIPLE OF "PULL" BASED ON CUSTOMER DEMAND.

SCENE 9
w.s. aero structure area

NARRATOR(VO):

WE WILL ALSO LOOK AT HOW THE RIGHT-SIZED EQUIPMENT DIVISION WITHIN BOEING'S INTEGRATED AERO STRUCTURE HAS IMPROVED PRODUCTION IN THE SHEET METAL EXTRUSION AREA.

NARRATOR(VO):

BY REDUCING FLOOR SPACE AND CHANGING FROM LARGE MACHINES TO SMALLER CELLS, BOEING HAS LOWERED THE COST OF SOME PARTS BY AS MUCH AS SEVENTY-FIVE PERCENT.

SCENE 10
t.c.: 4:05:00 woman loading part

NARRATOR(VO):

WE WILL EXPLAIN WHAT THE JAPANESE TERM CHAKU-CHALKU (CHALK KA – CHALK KA) MEANS AND HOW IT CHANGED BOEING'S WAY OF THINKING.

SCENE 11
b-roll production area (bad rt.size equipment possibly)

NARRATOR(VO):

TRAVELING ON THE LEAN JOURNEY HAS GIVEN THE PEOPLE AT BOEING AN INTERESTING PERSPECTIVE AS WELL AS SOME THOUGHTS FOR THOSE WHO MAY FOLLOW THEM. WE WILL HEAR HOW TO AVOID THE "WRONG SIZED EQUIPMENT" TRAP WHEN BEGINNING TO GO LEAN.

SCENE 12
Stock footage of planes flying

NARRATOR(VO):

BOEING IS THE LARGEST COMBINED MANUFACTURER OF COMMERCIAL JETLINERS AND MILITARY AIRCRAFTS IN THE WORLD. THE COMMERCIAL AIRPLANE DIVISION HAS ITS HEADQUARTERS IN RENTON, WASHINGTON.

SCENE 13
b-roll: Traditional production

AT THE BEGINNING OF THE LAST DECADE,

BOEING'S PRODUCTION AREA HAD THE SAME FOOT PRINT AS MOST LARGE AMERICAN MANUFACTURERS. A SINGLE, COMPLEX MACHINE CREATED HUGE BATCHES OF PRODUCT, REQUIRING STORAGE OF VAST AMOUNTS OF INVENTORY. IF A SPILL HAPPENED, THERE WERE THOUSANDS OF EXAMPLES. MACHINE MAINTENANCE WAS ALSO A COMPLEX ENDEAVOR AND FLEXIBILITY TO CHANGE THE PRODUCT LINE WAS SEVERELY LIMITED.

NARRATOR(VO):

BY THE EARLY NINETIES, BOEING BEGAN EXPLORING ALTERNATIVES MANUFACTURING APPROACHES. A GROUP OF BOEING EXECUTIVES WENT TO JAPAN TO STUDY THEIR QUALITY PROCESS.

SCENE 14
b-roll Toyota footage (if available)

NARRATOR(VO):

TOYOTA WAS USING THE LEAN MANUFACTURING PROCESS, INCLUDING THE CONCEPT OF RIGHT SIZED EQUIPMENT. THE IDEAS AND WAYS OF DOING BUSINESS THAT BOEING BROUGHT HOME, ACTUALLY GOT THERE START HERE.

SCENE 15
Suggested footage:
B&W shots of the ford production line.
(rag-time music would be a nice touch)

NARRATOR(VO):

IT SEEMS FORD, AS IN HENRY FORD, REALLY DID HAVE A BETTER IDEA. IN THE EARLY NINETEEN HUNDREDS, HENRY FORD DEVELOPED THE FAMILIAR

ASSEMBLY LINE. HIS APPROACH OF KEEPING PRODUCTION MOVING INCORPORATED ONE OF THE LEAN PRINCIPLES…FLOW.

Writer's note: I believe it would be helpful to periodically put up a graphic with the principles of Lean on it, i.e.,

Lean Principles

- *Value*
- *Value Stream*
- *Flow*
- *Pull*
- *Perfection*

NARRATOR(VO):

SINGLE-PURPOSE MACHINES LOCATED ALL ALONG THE ASSEMBLY LINE WERE USED TO CONSTRUCT COMPONENTS FOR THE VEHICLE. THE PARTS WERE BUILT AND READY FOR INSTALLATION JUST IN TIME.

SCENE 15a
b-roll: Model T on road

font;
Lean Principles

- *Value*
- *Value Stream*
- *Flow*
- *Pull*
- *Perfection*

NARRATOR(VO):

UNFORTUNATELY, THE FORD SYSTEM HAD ONE MAJOR FAULT…A LACK OF FLEXIBILITY. WITHOUT PRODUCT VARIETY, FORD SOON LOST THEIR HOLD ON THE MARKET. THE FIRST PRINCIPLE OF LEAN MANUFACTURING IS VALUE, AND IN THIS CASE THE CUSTOMER'S PERCEIVED VALUE OF THE PRODUCT WAS LESSENED.

SCENE 16
b-roll: Toyota plant

NARRATOR(VO):

TWENTY YEARS AFTER FORD TOOK THE FIRST STEP, THE JAPANESE BASED COMPANY TOYOTA

TOOK THE NEXT STEP AND KEPT ON RUNNING.

NARRATOR(VO):

THROUGH A SERIES OF SIMPLE INNOVATIONS, TOYOTA WAS ABLE TO ADD FLEXIBILITY WHILE MAINTAINING PRODUCTION FLOW.

THE BOEING EXECUTIVES OBSERVATIONS OF TOYOTA WERE TRANSLATED FIRST INTO WORKSHOPS AND THEN INTO LEAN TEAMS.

SCENE 17
(Herscher)
t.c.: 3:47:42, - 3:47:07
time: 17 seconds

font:
Michael Herscher
Lean Enterprise Office
Boeing Commercial Airplanes

Sot: (Herscher)

Yes, right-sized equipment is a tool in lean to help us improve our production system. Here in the Boeing Company, we look at the Boeing production system as our over-arching strategy for implementing lean, and there are multiple tools we can use. Right-sized equipment is one of them.

SCENE 18
(Herscher)t.c.: 3:39:59 – 3:40:23,
time: 23 seconds

Sot: (Herscher)

Right-sized equipment is an outgrowth of production preparation process. It's a process we use to design any kind of workflow. Trying to get the transformational steps of any process broken down to their simplest levels, and then building equipment or methods to perform that transformational step.

SCENE 19
Footage of right size equipment

NARRATOR(VO):

THE IDEA WAS TO SIMPLIFY THE PRODUCTION PROCESS BY BREAKING DOWN MULTI-TASK MACHINES TO SINGLE CELL OPERATIONS. THE CONCEPT IS SMALLER IS BETTER. LARGE MACHINES SITTING ON IMMOVABLE FOUNDATIONS

ARE REPLACED BY SMALL, ADAPTABLE MACHINERY

JUST THE RIGHT SIZE.

SCENE 20
(Herscher) t.c.: 3:40:32-
3:40:46, time: 12 seconds

Sot: (Herscher)

The purpose of the right-sized equipment is to enable us to do flow production. We want to create a tempo or a pace in our factory, in our work areas, so we don't have things starting and stopping.

SCENE 21
b-roll of inventory

NARRATOR(VO):

INSTEAD OF LARGE BATCHES OF PRODUCT THAT

MUST BE STORED AND QUEUED, THE RIGHT SIZE

EQUIPMENT PRODUCES JUST THE AMOUNT OF

PRODUCT NEEDED. IF THERE IS AN ERROR IN

THE PROCESS, IT CAN BE EXPOSED AND QUICKLY

ELIMINATED. DESIGN IMPROVEMENT CAN BE

INCORPORATED MUCH SOONER AS WELL.

SCENE 22
(Herscher) t.c.: 3:40:55 -
3:41:22,
time: 24 seconds

Sot: (Herscher)

When you manufacture in one-piece flow you improve quality, because you can't generate defects in more than one piece at a time. In batch production, if you had a batch of 100 and you performed a transformational step on those 100 pieces, you could in fact have 100 defects before you recognize it. So right-sized equipment allows us to let things flow one piece at a time through each process step.

SCENE 23
SCENE 24
(Herscher) t.c.: 3:43:44 -
3:44:46,
time: 1:02

Sot: (Herscher)

One of our principles when we developed the flow lines was "don't spend any money." When we say don't spend any money, what we mean is don't go out and purchase a solution, create the solutions yourself using materials you've got, and then harden it into production capable equipment. So cost is one issue. If we build something we know how to maintain it and repair it. The old way we would get equipment is we would write a specification, and it would

go to a tool designer or a machine designer, and they would put together a request for quote, and it would go out to a supplier, a machine tool builder, and they would build it. It usually would come back and not be what we wanted, and then we'd spend a fair amount of time reworking it into what we wanted. This way we know that we get exactly what we wanted, exactly the way we want it, and in a much shorter time frame and at less cost.

SCENE 25
(Herscher) t.c.: 3:41:29 - 3:41:57,
time: 28 seconds

Sot: (Herscher)

It started out kind of in a grass roots method, it wasn't a top down strategy. Our Shinigitzu consultants, which are ex Toyota production people, are the ones that brought us the method. It's called moonshining, and we created it as part of a workshop. Right-sized equipment comes from moonshining and allows one-piece flow.

SCENE 26
b-roll (if available)
Historical footage of moonshine stills, or examples of building right size equipment.

NARRATOR(VO):

THE CONCEPT OF USING THE MATERIALS ON HAND OR "MAKING DO" IS ACTUALLY A VERY AMERICAN TRADITION. WHEN THE JAPANESE BUSINESS PEOPLE WERE STUDYING AMERICAN INDUSTRY IN THE MID-NINETEEN HUNDREDS, THE MOONSHINE STILLS OPERATING IN THE APPALACHIAN HILLS CAUGHT THEIR ATTENTION. THE STILLS CONSTRUCTED OUT OF SPARE PARTS AND JUNK COST NOTHING TO MAKE AND THEN TURNED A PROFIT BY SELLING ALCOHOL.

AT BOEING, MOONSHINE SHOPS REFERS TO BUILDING A NEW OPERATION WITH AVAILABLE MATERIAL AND NO ADDITIONAL CAPITAL.

SCENE 27
(Herscher) t.c.: 3:42:11 - 3:42:44,
time: 35 seconds

b-roll: moonshine shops

Sot: (Herscher)

The moonshine shops really are a support group to people that are trying to improve the production facility. We'll hold a workshop in the facility, and as we try things we need to build prototypes, facsimiles, something we call tristorming. The moonshine shops are the ones that help us do that. They'll build things out of cardboard, plywood, foam, that will allow us to actually see how things could work. Then once we've proven the concepts we'll reverse engineer those and harden those into real production equipment.

SCENE 28
b-roll of stinger cell area, t.c.: 4:02:13 approx. woman loading part into bin

NARRATOR(VO):

LEAN MANUFACTURING UTILIZES PEOPLE TO IMPROVE THE PRODUCTION PROCESS RATHER THAN MACHINES. THIS IDEA IS ENCAPSULATED IN THE JAPANESE TERM OF CHAKU CHAKU (CHALK-A, CHALK-A).

SCENE 29
(Herscher) t.c.: 3:45:29 -,
time: 28 seconds

Sot: (Herscher)

Chaku Chaku was brought to us by our Shinigitzu consultants. Chaku Chaku means place-place or put-put. One of the principles we've learned from Toyota is that we want to use people to link our production system rather than highly complex computing systems. So a chaku chaku line allows an employee to put a workpiece into a machine. The machine will grab it, orient it, produce whatever function it's going to produce, and then eject it, or something called hanedashi. So all the operator has to do is move from machine to machine to perform the transformational steps.

SCENE 30
b-roll: machine operators

NARRATOR(VO):

TO DEVELOP RIGHT-SIZED EQUIPMENT REQUIRES A DIFFERENT MIND-SET BY THE PRODUCTION TEAM.

WORKERS ARE ENCOURAGED TO THINK OF THEIR

GROUP AS A BUSINESS WITHIN A BUSINESS.

SCENE 31
(Herscher) t.c.: 3:48:26 – 3:49:41
time: 1:23

Sot: (Herscher)

In our workshops, particularly in our production preparation process workshops, we really try to get people to get creative. When we lay out how work is performed, and we break things down into transformational steps, our solutions for those transformational steps, we require people to come up with seven different ways to do every transformational step. Coming up with one or two or three ways is pretty easy, but coming up with seven different ways to drill a hole, to machine a part, to form a piece of sheet metal, is really quite difficult. The other thing we do to try to tap into their creativity, is before we let them come up with a solution, we want them to describe how that same solution is performed in nature, so we continue to get them to be more creative. For example, clamping—an eagle, when he picks up salmon out of the water, clamps with his talons. An elephant, when he picks something up, clamps with his trunk. So trying to get them to really think very creatively by forcing them to think about nature and forcing them to come up with seven different solutions for each transformational step, and then down-select those solutions into the solutions you're going to use to build your production line.

Suggested b-roll
Stock footage of eagle or clamping action from a production line

SCENE 32
(Herscher) t.c.: 3:49:50 – 3:50:24
time: 34 seconds

Sot: (Herscher)

To use the creative side of their brain rather than the analytical side. We're really good, particularly as an engineering company, at jumping to what we think is the correct solution and only trying one solution. So by getting people to do what we call tri-storming, and to try multiple ways, we'll find ways we probably never would have thought of before, that are probably simpler and easier. We also know that, typically in nature, things are done more simply than the way we would design them.

SCENE 33
Tube & duct center footage

NARRATOR(VO):

IN THE MID-NINETIES, THE LEAN TEAM FOCUSED ON THE TUBE & DUCT CENTER TO BEGIN A DIRECT PULL SYSTEM WITH THEIR CUSTOMERS. WITHIN THE CENTER, THE THERMAL ANTI-ICING DUCT UNIT WAS IDENTIFIED AS A GOOD APPLICANT FOR THE NEW SYSTEM.

SCENE 25
(Hughey) t.c.: 3:41:29 - 3:41:57,
time: 28 seconds

Font:
Brian Hughey
Lean Manager
Auburn /Boeing Commercial Airplane
(check title)

Suggested b-roll: footage of old tube and duct equipment.

Sot: (Hughey)
It's a basic and stable product made up of 41 unique assemblies. At the time it was firing every day, so every day we needed to provide a ship set, so we thought it would be a great candidate for direct pull. So we implemented a pull system. With every great pull system, the thing they're really good at is identifying where the problems are.

Very quickly, it raised to the surface that the real problem in the production system was our own production processes within the tube and duct center. We were tremendously unreliable at our flows, at bringing together the complete kit, and we were always the ones creating the problem with the pull system. That in itself brought us to the realization that we needed to reinvent our production processes, and for these high value repeater products, we needed to pull them out of the job shop environment and create these right-sized production cells around that product. Since we've gone down that path and implemented this product cell, it has been in production for four years and we have not been late to the line once. It's a tremendous success story.

SCENE 35
b-roll of old tube and duct center

NARRATOR(VO):

BEFORE RIGHT SIZE, THE TUBES WERE SHAPED IN LARGE BEND MACHINES. TO CLEAN THE INTERIOR OF THE GUN SHAPED TUBES, HUGE VATS WERE USED. THEN THE TUBES WERE DIPPED IN

GIGANTIC BATHS FOR A FINAL CLEANING BEFORE THE NET TRIM. THE TUBES WERE NOW READY FOR THE ORBITAL WELD. ONCE COMPLETE, THE TUBES WERE STORED WHILE WAITING FOR THE NEXT STAGE IN PRODUCTION.

SCENE 36
FONT:
Capital Equipment Costs
$2,320,000

Lead Time
1,872 minutes

Parts/person
9 (weekly)

NARRATOR(VO):

THE COST TO BOEING COMMERCIAL AIRPLANE FACILITY WAS OVER TWO MILLION DOLLARS, LEAD TIME WAS OVER EIGHTEEN HUNDRED MINUTES AND PARTS PER PERSON PRODUCED ON A WEEKLY BASIS WAS NINE.

SCENE 37
(Hughey) t.c.: 1:03:10 – 1:03:48
time: 38 seconds

Sot: (Hughey)

It took us three or four years of really stubbing our toe and learning what lean was. When we initially went into it, we came out with the philosophy that we had to go into a machine, and we do a AIW type activity and aggressively work for a week to reduce setup reduction on a bend machine. In doing that, we'd have a lot of success, and we would be able to reduce the setup by 50 percent, but in hindsight, as we stepped back and looked at the efficiency of those activities, we learned that we really didn't affect the business plan, the bottom-line dollars of the business unit.

SCENE 37

SCENE 38
b-roll:
tube bend, t.c.: 3:01:06

NARRATOR(VO):

THE NEW RIGHT SIZED CELL NOW HAS AN OPERATOR BENDING THE TUBES WITH A SINGLE MACHINE, THEN THE GUN IS CLEANED USING A SHOT OF FORCED AIR.

SCENE 39
b-roll:
tube shower, t.c.: 3:03:10

NARRATOR(VO):

A BRIEF SHOWER CLEANS THE TUBE PREPARING IT FOR TRIMMING AND THE DEBUR PROCESS. AFTER THE ORBITAL WELD, THE PIECE IS PLACED IN THE COMPONENT KIT.

SCENE 40
b-roll: tube kit, t.c: .3:00:22

NARRATOR(VO):

THE COMMODITY KIT IS ON WHEELS AND PROVIDES A VISUAL COMPONENT VERIFICATION AND INSTALLATION GUIDE. WITH A GLANCE, AN OPERATOR HAS A SENSE OF PRODUCTION PACE. IT' S ALSO A PRACTICAL COMMODITY PACKAGING SOLUTION.

SCENE 41
Font:

Capital Equipment Costs	
$2,320,000	$280,000 (now)

Lead Time	
1,872 minutes	12 minutes (now)

Parts/person	(weekly)
9	110 (now)

NARRATOR(VO):

CAPITAL EQUIPMENT COST IS NOW DOWN TO TWO-HUNDRED-EIGHTY-THOUSAND DOLLARS. LEAD TIME IS NOW DOWN TO TWELVE MINUTES AND PARTS PER PERSON PER WEEK HAS RISEN TO ONE-HUNDRED-TEN.

SCENE 42
(Hughey) t.c.: 1:10:04 – 1:10:46
time: 42 seconds

Sot: (Hughey)
The creation of these lines has had a significant impact on the floor space associated with our facility. The first line we put in place, as we mapped out the product, the product flowed through about 12 different, unique work centers. We were able to consolidate all of that activity into a single footprint. In doing that we freed up a significant amount of floor space, and as we've continued in that process, we have freed up about 9,000 sq. ft. of manufacturing floor space, which was a direct contributor to our ability to consolidate our two facilities into one building.

SCENE 43
b-roll: c.u. anchor bracket

NARRATOR(VO):

IN THE TUBE AND DUCT CENTER, THE RIGHT-SIZED EQUIPMENT APPROACH HAS LEAD TO IMPROVED QUALITY. EVEN MORE IMPRESSIVELY, SOME AREAS, SUCH AS THE ANCHOR BRACKET PRODUCTION HAVE ACTUALLY BROUGHT ASSEMBLY IN HOUSE.

SCENE 44
(Hughey) t.c.: 1:05:59-1:07:58
time: 2:00

suggested b-roll:
traditional production line and lean line

Sot: (Hughey)

Traditionally, when we're building a product, we would take a product and dump it into a shared process center where our engineering folks would go out and procure very large, very complex do-all pieces of equipment. In the past, the Auburn facility took a lot of pride in being able to produce any unique configuration that engineering felt was necessary to produce an airplane. In doing that we have evolved our processes to be very complex and require very highly skilled labor to produce that product. As a result, there is a tremendous amount of batching and queuing of those products as they progress through the manufacturing process to transform that machine.
Through our learnings, we have learned we need to identify our high-value products, and instead of having those products fit to a do-all machine, we have reconstructed our production processes specifically around the key characteristics of those high value products. In doing so we have eliminated the craftsmanship involved with the setup, and enabled the product to flow very quickly and efficiently through our factory.

SCENE 43
b-roll: workers on the line

NARRATOR(VO):

WITH THE CHANGE TO RIGHT-SIZED EQUIPMENT, THE OPERATORS' JOB WAS REDEFINED. THE LARGE, SHARED, SET-UP INTENSIVE PROCESSES EVOLVED TO SIMPLE, SEPARATE OPERATIONS.

BOEING AND THE UNION WORKED TOGETHER TO

CONSOLIDATE UNION JOB CODES.

SCENE 46
(Hughey) t.c.: 1:14:31 - !:15:37
time: 1:06

suggest b-roll:
workers on rt. size line

Sot: (Hughey)

Initially when we were creating this cell, this concept, the general folks looked at it and had the feeling that we were designing away their craftsmanship, we were going to turn them into robots. We had a lot of resistance initially as we went down this path. However, as we implemented the cell and people worked in that environment, there was a change of behavior and a change in how they looked at the cell.
Traditionally, in a job shop type environment, I receive a product from somebody, I do a transformation, and I hand it off to somebody else to do the next step. Inherent with that there is a lot of bickering and finger pointing back and forth in terms of quality or in terms of how things come together.
The mechanics who worked in this environment very quickly learned to appreciate it and actually love this environment. Now they had complete control, from raw material to finished product, of every process and step associated with that. They really took a lot of pride in that. The second thing that we really didn't think about when we got there was that now they had very clear expectations on what they had to produce on a daily basis. I'm a mechanic working on this line, I need to produce 39 pieces, I have my raw material, my expectations are very clear.
In hindsight we have learned that people really do want to know what is expected of them, and we don't communicate that very well. But by creating this cellular environment around a product, we've created a system where the expectations are built in, and the mechanics can work to that environment very well, and they really took to it, and really like it. So, as we've continued down this path and created more and more cells, we're getting more and more mechanics that are clamoring to work in that environment.

SCENE 47
b-roll: aero structure storage area

NARRATOR(VO):

DURING THE NINETIES, BOEING ADOPTED MORE AND MORE LEAN MANUFACTURING APPROACHES. WHEN THE INTEGRATED AERO STRUCTURES DIVISION BEGAN TO IMPLEMENT JUST-IN-TIME FOR MATERIAL PART STORAGE, IT CREATED HAVOC WITH THE TRADITIONAL MANUFACTURING APPROACH.

SCENE 48
(bowman) 1:36:34 – 1:37:26, time: 52 seconds

Font:
Paul Bowman
Process Engineer
Integrated Aero Structures

Suggested b-roll
4x12 sheet metal

Sot: (bowman)

At that time we actually had auto-guided vehicles that picked up 4 ft x 12 ft sheets and carried them from machine to machine, but part of the difficulty was that we were getting progressively smaller lot sizes. With the JIT, the material part storage areas didn't want to stock 200 or 300 of something that was going to be a 5- or 10-year requirement, they wanted a couple of months. So lot sizes were dropping, and a lot of times we didn't have enough parts to use up an entire sheet of material. We would take a couple parts out of one corner and recycle the rest. So when "cow" came through, the material was the size of this table, and there would be two patterns out of this corner, and it would just be put into recycle. We were getting maybe five percent utilization in some cases.

SCENE 49
b-roll: backtime sot or footage of bowman in plant

NARRATOR(VO):

PAUL BOWMAN HAS BEEN WORKING AS A PROCESS ENGINEER WITH BOEING FOR TWENTY YEARS. IN 1997, THE LEAN JOURNEY BOWMAN SAYS BEGAN IN THE SHEET METAL AREA.

SCENE 50
(bowman), t.c.: 1:33:35 – 1:35:23

Sot: (bowman)
We heard that Boeing was using the Shingigitzu Consulting Group, which are ex-

time: 1:50 seconds

Toyota and other automobile manufacturer guys from Japan, to go around the company and look at ways to improve, this new thing, lean manufacturing. I had read a little about it, but we really hadn't started doing any of that in our factory at that point. So he came for a visit, and we showed him an overview of our factory and went out and did a 2-3 hour tour. We came back in and he said, before we went out there I thought we could just kind of rearrange things, because I guess that's what he had done at GE Aircraft Engines and some other places. But he slumps down in the chair and says we're going to have to start all over. And we said, What?? We're supposed to have one of the world-class sheet metal factories in the world, so that was a little discouraging. That's when he started to show us a little about how you look at the particular process you're doing. His guideline for right-sized equipment is, however big the part is, let's say it's 6 inches long, then the equipment to do one process should be 6 inches on either side of that, so you've got 18 inches to do one process to that part. Typically we were making all our parts on 4 ft x 12 ft routers, our deburr equipment was about 4 ft wide by 20 ft long. Everything was sized for the largest part. He was the first one to come in and encourage us to use, for small parts, small equipment.

SCENE 51
SCENE 52
(bateman) t.c.: 2:11:24 – 2:11:50,
time: 27 seconds

font:
Darren Bateman
Electrical Controls Engineer
Right Size Equipment Group
Boeing Integrated Aero Structures

Sot: (Bateman)
So it was like a different mindset to start thinking about right-sized equipment and the right way of doing it. When we look at the way we do stuff in industry today with giant equipment that can do everything, you have to take a look back and start looking at equipment that is customized and will do just the specific task you need it to do

SCENE 53
b-roll: back time sot or bateman at work.

NARRATOR(VO):

AN ELECTRICAL CONTROLS ENGINEER, DARREN

BATEMAN NOW WORKS IN THE RIGHT-SIZED

EQUIPMENT GROUP IN INTEGRATED AERO

STRUCTURES STRIVING FOR CONTINUOUS

IMPROVEMENT.

SCENE 54
t.c.: (bateman) 2:09:05,
time: 51 seconds

Suggested footage:
Right size equipment1

Sot: (Bateman)

That's the thing our sensei's always told us, we always have to continually improve. Reliability, able to keep the machines up and running all the time, continually improving, adding andon lights to warn if a condition is bad—there's always things we can do to make it more successful. That's one of the things you learn in a lean journey, you really have to continually work and work. I've heard it quoted before that a lot of times, the fifth or sixth time you go through and solve a problem is when you really solve the problem, because you really figure it out. That takes a lot of rehash and rework and refining to continually improve things.

SCENE 55
b-roll: old machine

NARRATOR(VO):

ON THE STRINGER CLIP LINE, THE EXISTING

MACHINE WHILE NINETY-SEVEN PERCENT

ACCURATE, TAKES AS MUCH FLOOR SPACE AS A

SMALL RANCH-STYLE HOUSE. THE CONVENTIONAL

I-E-M HAD A LONG SET UP TIME AND TOOK A

MINUTE AND A HALF TO PRODUCE A PART.

SCENE 56
(bowman)t.c.: 1:42:00 –
1:43:06, time: 1:08

Suggested b-roll:
Stringer clip line

Sot: (bowman)
So we were making these stringer clips, which are roughly 3.5 inches long, on these huge machines. So Sensei Makao thought that was inappropriate. So we began to investigate different ways of doing it. We had already been through our initial 4 in. x 4 in. line, so we used a lot of those same concepts and same equipment to do the smaller clips. Our total flow distance was approximately 7 or 8 feet, and as far as the footprint, we reduced it from about 700 sq. ft. to about 144 for the total line.

Then using load-load type concepts, we were able to make a load every 30 seconds vs. about 2 minutes for the machining process. And the material was also less expensive. The section we bought from another company had to be heat treated and stretch straightened and so forth, so the material cost was about a quarter of what it was when we started. So over all we reduced the cost of the product by about 75 percent.

SCENE 57

SCENE 58
b-roll of chaku-chaku line

NARRATOR(VO):

AS PART OF HIS LEAN APPROACH, BOWMAN DEVELOPED A FORMULA TO DETERMINE THE PAYBACK PERIOD FOR A PARTICULAR CHAKU-CHAKU LINE. IT IS ONLY AN ESTIMATE SINCE THE FORMULA MUST USE THE AVERAGE LENGTH OF SET-UP AND RUN TIME.

SCENE 59
font.:

Chaku-Chaku Line Payback Period

P/NS = Quantity Of Part Numbers That Used To Be Produced In Another Cell That Will Be Transferred To The Chaku-Chaku Line For Processing

NARRATOR(VO):

FIRST IT IS NECESSARY TO UNDERSTAND THE DIFFERENT FACTORS THAT NEED TO BE DETERMINED:

P/NS EQUALS THE QUANTITY OF PART NUMBERS USED TO BE PRODUCED IN ANOTHER CELL THAT WILL BE TRANSFERRED TO THE CHAKU-CHAKU LINE FOR PROCESSING

SCENE 60

Font:
Chaku-Chaku Line Payback Period

T-H = Average hours spent producing new tools, or

NARRATOR(VO):

T-H REPRESENTS THE AVERAGE HOURS PRODUCING NEW TOOLS, OR MODIFYING EXISTING NEW TOOLS FOR THE CHAKU-CHAKU LINE.

modifying existing tools per p/n so the part numbers identified can be processed on the chaku chaku line

SCENE 61

Font:
Chaku-Chaku Line Payback Period

EH = Total Hours Spent Designing & Building New Chaku-Chaku Equipment Needed To Process P/Ns

NARRATOR(VO):

E-H IS THE TOTAL HOURS SPENT DESIGNING AND BUILDING THE NEW CHAKU-CHAKU EQUIPMENT NEEDED TO PROCESS THE NUMBER OF PARTS.

SCENE 62

Font:
Chaku-Chaku Line Payback Period

OLDH = Average Time In Hours To Produce An Average Sized Order For The P/Ns In The Old Cell Where They Are Currently Processed.

NARRATOR(VO):

OLD H IS THE TIME TO PRODUCE AN AVERAGE ORDER THE CURRENT WAY.

SCENE 63

Font:
Chaku-Chaku Line Payback Period

CCH = Average Estimated Time In Hours To Produce An Average Sized Order For P/Ns In The Proposed Chaku-Chaku Cell.

NARRATOR(VO):

C-C-H IS THE ESTIMATED HOURS IT WILL TAKE TO PRODUCE AN ORDER ON THE PROPOSED CHAKU-CHAKU CELL.

SCENE 64

Font:
Chaku-Chaku Line Payback Period

ORDERS = Average Number Of Orders Processed Each Year For The

NARRATOR(VO):

ORDERS REFERS TO THE AVERAGE NUMBER OF ORDERS PROCESSED EACH YEAR.

P/Ns

SCENE 65

Font:
Chaku-Chaku Line Payback Period
(if possible, it would be helpful to highlight each letter as the narrator says it. I would also suggest keeping the definitions on the screen at the same time. I would expect the audience to pause at this point to study the quotient.

$$\frac{(P/NS \times TH) + EH}{(P/NS \times OLDH \times ORDERS) - (P/NS \times CCH \times ORDERS)} = \text{YEARS TO PAYBACK}$$

NARRATOR(VO):

WITH THOSE DEFINITIONS IN MIND, BOWMAN'S FORMULA IS:

P –N MULTIPLIED BY T-H, PLUS E-H, OVER P-N, TIMES OLD HOURS, TIMES ORDERS MINUS P-N TIMES C-C-H MULTIPLIED BY THE ORDERS AND THAT IS EQUAL TO THE NUMBER OF YEARS THE CHAKU-CHAKU LINE WILL TAKE TO PAY BACK THE INITIAL INVESTMENT.

SCENE 66

Font:
Chaku-Chaku Line Payback Period

$$\frac{(500 \times 8) + 500}{(500 \times 1 \times 3) - (500 \times 0.25 \times 3)} = 4 \text{ YEARS}$$

NARRATOR(VO):

HERE IS AN EXAMPLE OF HOW IT WORKS:

IF THE P-Ns EQUALS 500, T-H EQUALS 8 HOURS, E-H EQUALS 500 HOURS, OLD-H EQUALS 1 HOUR, C-C-H EQUALS A QUARTER OF AN HOUR, AND ORDERS ARE THREE PER YEAR, THE PAYBACK WOULD BE FOUR YEARS.

SCENE 67

Font:
Chaku-Chaku Line Payback Period

$$\frac{(500 \times 8) + 500}{(500 \times 1 \times 3) - (500 \times 0.25 \times 3)} = 4 \text{ YEARS}$$

NARRATOR(VO):

THIS SUM WOULD BE PAID BACK BY MANUFACTURING ON THE NEW CHAKU-CHAKU LINE FOR FOUR YEARS, IF IT TOOK FIFTEEN MINUTES TO PROCESS AN ORDER THAT TOOK ONE HOUR IN THE OLD CELL.

NARRATOR(VO):

WHILE STILL ONLY AN ESTIMATE, IT PROVIDES INFORMATION TO A TEAM TRYING TO MAKE A CHAKU-CHAKU IMPLEMENTATION DECISION. FOR THE BEST RESULTS, IT IS IMPORTANT TO REPORT THE AVERAGE HOURS TO PRODUCE AN ORDER FOR THE PART NUMBERS IN THE EXISTING CELL AS ACCURATELY AS POSSIBLE.

SCENE 68
Font:

Conventional IEM	Chaku-Chaku Line
Delivery time	
1 part/90 secs.	1 part/30 secs
Setup Time	
Long (?) IEM time	30 secs
Floor Space	
1,579 sq ft	108 sq ft
Rate of Accuracy	
97%	98.7%

Narrator (VO):

ON THE NEW CHAKU-CHAKU STRINGER CLIP LINE, THE RIGHT SIZE EQUIPMENT TEAM HAS SHAVED A MINUTE OFF PART DELIVERY TIME, BRINGING IT DOWN TO A PART EVERY THIRTY SECONDS. SET UP TIME IS NOW AT THIRTY SECONDS AS WELL. THE CELL FOOTPRINT IS A LITTLE OVER ONE HUNDRED SQUARE FEET AND PARTS COST HAVE BEEN SLASHED OVER FIFTY PERCENT. EVEN THE ACCURACY RATE HAS GONE UP.

SCENE 69
b-roll: stringer clip line

NARRATOR(VO):

NOW INSTEAD OF ONE LARGE MACHINE PLUS A FOUNDATION, THE STRINGER CLIP LINE HAS BEEN BROKEN INTO NINE RIGHT SIZED MACHINES ALL ON WHEELS.

ONE OF THE KEYS TO A SUCCESSFUL OUTCOME, BOWMAN SAYS IS TO EVALUATE THE ENTIRE SIZE

RANGE OF THE PRODUCT BEING MADE.

SCENE 70
(bowman)t.c.: 1:52:49 - 1:54:23, time: 1:39 seconds

Suggested b-roll:
Stringer clip area

Sot: (bowman)

Find out the variety you make. If you're making extremely small parts and extremely large parts and you only have one piece of equipment, there's definitely some potential to investigate separating the two and getting the longer stuff over in one area. With the smaller items you can group your machines more closely together and save space and have one operator run multiple machines. That's one of the bigger changes. In the past each machine was run by an individual operator. You can get quite a bit of efficiency by having one operator run four or five pieces of equipment in a kind of circular fashion than you do in a U-shaped type line. If their parts are all very consistent sizewise, then it could be that their equipment is right sized. We make body frames for the 747 on our 4 ft. x 12 ft. routers, and the parts are 12 ft. long, so in that case the equipment is right sized. At the same time, if you're making 3 inch parts on that piece of equipment, it's probably getting the way of making the 12-foot pieces. You have very different handling requirements, different quantities, and there are definitely some advantages to separating it. In the other case we used the Shingugitzu Consulting Group to come in and give us ideas and help us think outside the box.

SCENE 71
b-roll: right size equipment

NARRATOR(VO):

IN ADDITION TO THE MOONSHINE APPROACH OF USING EXISTING MATERIALS, BOWMAN SAYS IT IS HELPFUL TO VIEW ALL EQUIPMENT AS HAVING THE POTENTIAL TO PROVIDE MORE THAN ONE OPERATION.

SCENE 72

Sot: (bowman)

(bowman) t.c.: 2:00:13 – 2:01:06 (tight),
time: 55 seconds

Suggested b-roll:
Stringer clip area:

bowman) t.c.: 2:01:19 – 2:01:29,
time: 11 sec

We're going out and getting equipment that in some cases would not be considered industrial, not Boeing industrial. They would just be for a hobbyist, or woodshop, somebody who doesn't have the big bucks that Boeing has. We're grabbing that as the backbone and then, using our knowledge of the operation and what we're specifically trying to do, adding on the PLC and the appropriate air cylinders, pneumatic cylinders, hydraulics in some cases, and then getting everything timed with the logic controller, so the operator can just place the part, push a button and walk away. When he comes back the finished part is presented to him. It takes some smarts when it comes to PLC type programming and how to tie things together. [**EDIT HERE]**
So we have safety come in and look at all our equipment to make sure the adaptations we've made are safe and can be used safely in the shop.

SCENE 73
(bateman) t.c.: 2:10:22 – 2:11:23,
time: 1:05

suggested b-roll:
c.u. of Dave's hand in a vice

Sot: (Bateman)
One of my favorite stories from early on is, we had gone out and bought a press because it was a right-sized press. It was industrial and it was a right-sized press, compared to these multi-ton presses that had giant beds that we were currently blanking the parts in. A friend of mine actually got his hand put in a vise, and the sensei started tightening the vise up on his hand, and he said, how much pressure does it take to blank this part? How much force are you getting from this vise? And he kept cranking on it until it was kind of hurting. And he said, you're right, I could probably blank it with the vise. That was the lesson he was trying to teach him. So the next time the sensei came in we had built a right-sized blanking press that had the proper tonnage for the 4x4 tool we had in there that had a relatively small periphery we were blanking out.

SCENE 74
b-roll: workers in factory

NARRATOR(VO):

CHANGING FROM TRADITIONAL MANUFACTURING TO THE RIGHT SIZE EQUIPMENT APPROACH IS AN ADJUSTMENT IN THINKING FOR WORKERS. THE EMPLOYEES BUY-IN IS CRUCIAL FOR LEAN

SUCCESS.

SCENE 75
(bowman) t.c.: 1:46:58 – 1:47:56,
time:1:02

Suggested b-roll:
Workers on line

Sot: (bowman)
The ones that are more "up for change", I think it's been an advantage, because they came in and did the same old thing and things never changed, they never saw an improvement. So I think some of them have been positively influenced by it, it's kind of got their creative juices flowing. And some of them who are more set in their ways have sometimes gotten a little upset at some of the things. It's a team environment where you pull different people together and say we want to make this product a different way, what are we going to do? Some of them really take to it and start coming up with creative solutions and new ways. Other people come up with, "hey, the way we're doing it now is fine." It's a little emotional for some of them. But for the most part I think it's worked pretty well.

SCENE 76

SCENE 77

NARRATOR(VO):

THE CONCEPT OF GETTING THE RIGHT SIZE EQUIPMENT REQUIRES, A NEW WAY OF APPROACHING MANUFACTURING. FOR A COMPANY TO REALIZE SUCCESS, IT MUST PLAN FOR THE LONG TERM.

SCENE 78
(hughey) t.c.: 1:08:17 – 1:09:39, time: 1:23

Sot: (Hughey)

In terms of the overall factory and the affect we had on the factory, as we've gone down this path we have created product cells around our high value products, and been very efficient in that. But for the remainder of the factory, if you look at it from a short-term viewpoint, we've actually made the products that remain in that shared process more expensive. However, the MBU is taking the long-term approach and realized that as we continue down this path and continue to create more of these lines, eventually those shared processes will go away or be consolidated. The issue you need to think of when you're going down

this path is not necessarily looking at the immediate short-term impacts to the business unit, but think long term and what is the future goal. For the Tube and Duct Center, we feel we can capture about 70 to 80 percent of the volume running through that facility in these types of lines, and in doing so the shared processes will reduce. But the other net result of that is we'll be much more efficient at managing that emergent environment, because it will strictly be emergent as opposed to a combination of emergent and basic and stable production.

SCENE 79

NARRATOR(VO):

AS A LEAN TEAM PREPARES TO BUILD THE RIGHT SIZE EQUIPMENT, THEY HAVE TO GUARD AGAINST THINKING "MORE IS BETTER."

SCENE 80
(herscher) t.c.: 3:52:53 – 3:53:57,
time: 1:06

Sot (herscher):

One of the mistakes we made early on with right-sized equipment is we tried to put too many transformational steps in an individual machine. The problem with that is, you add complexity, because you have to add either computing systems or controllers to integrate the different transformational steps. What I mean by that is, we might put in trimming, drilling and routing on one machine. That's a lot of features on a machine to try to integrate. What we really should have is a machine that drills, a machine that routes, and a machine that cuts periphery or trims. We actually built some machines that were too complex, and they took us too long to build, 18 months to two years. We need to make machines in three to six months. The other things that happens when you put too many transformational steps in a machine is, when one of those breaks, the whole machine breaks down, you can't use any of the features on the machine. So one of the real pitfalls is, keep it simple, try to stay away from complex controllers, and only put a single transformational feature in a machine.

SCENE 81

Sot (herscher):

(herscher) t.c.:,3:51:17 - 3:52:07,
time: 59 sec

We've taken a very different tack than others. We're not investing in complex manufacturing technology, unless it's something we're trying to do from a safety standpoint where we want to take people completely out of the process. What we're really focusing on is simplification, versatility, and flow. We really can't afford, and we made this mistake several years ago, we really can't afford to invest in huge amounts of capital, because in ten years you've got to replace that capital or you've got to maintain it.
What we really need to do is have very simple manufacturing processes that we build, we can maintain and we can replace, without depending on others. The other good thing about this is, because we build the machines ourselves, we really understand the transformational steps that are taking place on the workpiece.

SCENE 82

NARRATOR(VO):

TO CONTINUE DOWN THE LEAN PATH, BOEING NOW REQUIRES NEW TOOLING AND EQUIPMENT TO BE PORTABLE, TASK SPECIFIC AND FLEXIBLE. THEY BELIEVE THAT APPROACH WILL KEEP THEM COMPETITIVE IN THE FUTURE.