Learning From Toyota:

Some key points from history and implementation

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TPS/Lean is a widely accepted improvement program

- Starting from simple roots in Toyota in the 1950's TPS has spread around the world to become a dominant improvement methodology
- Annually for the several years Toyota has earned in excess of $10 Billion in profits
- Toyota will overtake GM in a year or two as the automotive industry leader in volume and add this to their already dominant positions in quality and profitability – "Triple Crown"
- TPS has been "discovered" by multiple people over the years and identified as various different items such as:
  - QC circles
  - Kanban system
  - Kaizen events
  - Value stream mapping
  - What's next?

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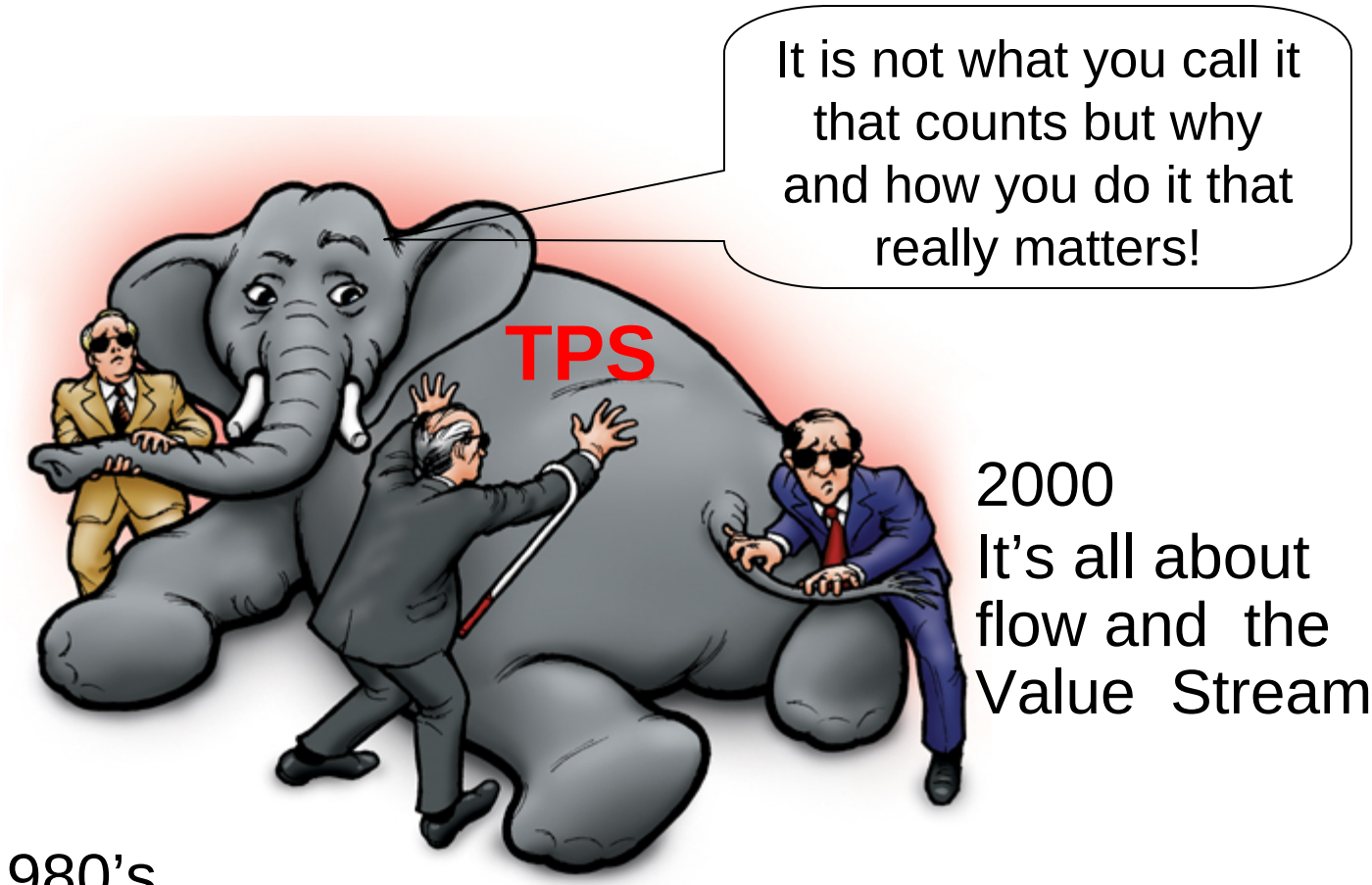
The parable of the elephant and the blind men…



1970's QC circles!

2000 It's all about flow and the Value Stream!

1980's It's Kanban!

1990's It's Kaizen!

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However…

- Despite all this “discovery” and wealth of information no one has been able to consistently copy this elusive system and produce the same type of results…
- Additionally as Lean/TPS spreads I am starting to see more implementation instances with either limited or poor results to show for all the hard work…in several cases it has even somehow added cost.
- Why is this proving so difficult?

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Multiple possible explanations exist…

- Toyota took about 20 years or so between 1950-1970 to build up the system and implement it across several plants. Most practitioners are in about year five or less…
- TPS in Toyota is fairly different from Lean programs I observe in North America (I don't know as much about here!)
- There is a shortage of talented TPS implementation leaders…Most of us don't have Taiichi Ohno for example (and for the record Toyota struggles sometimes overseas as well).
- Perhaps creating this new system in companies with an established culture and old way of doing things is just inherently very difficult…(i.e. we are fighting some form of invisible law of change / gravity?)
- Other reasons as well

Note: With today's time limit I can only touch briefly on these two items as time allows

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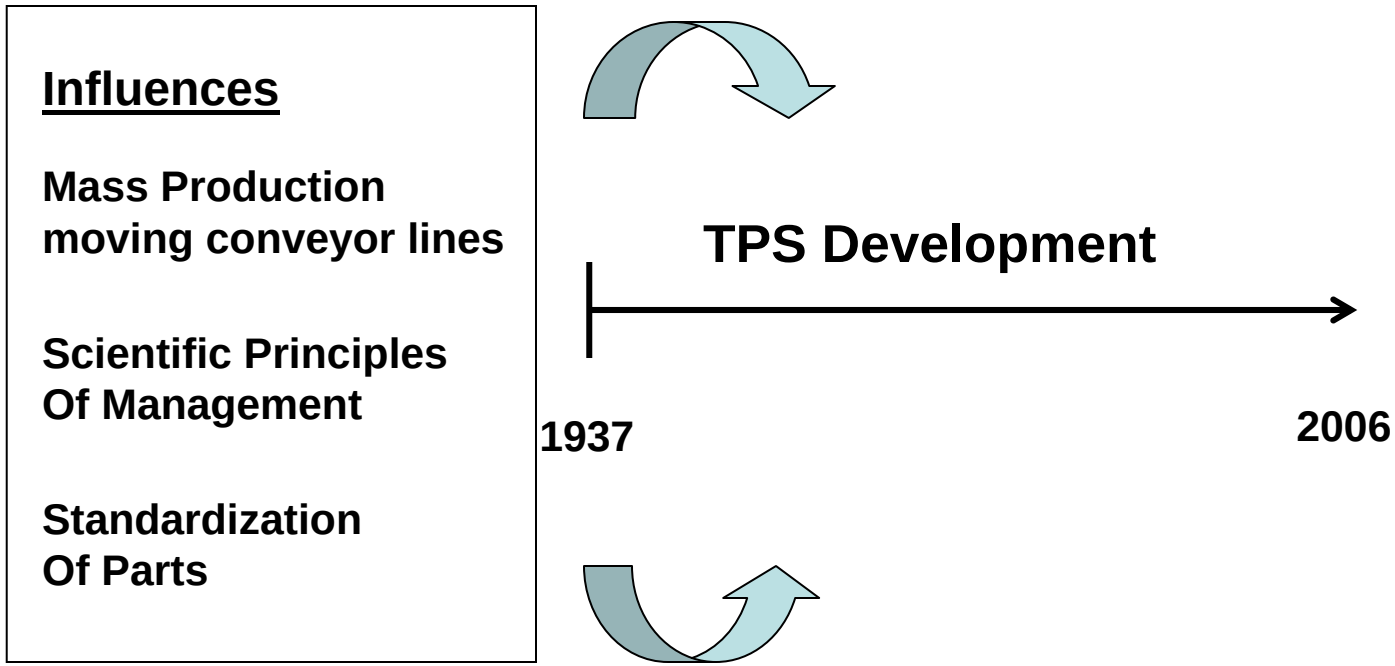
1) TPS development timeline



Guess what – it did not just happen overnight!

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Before “Toyota” there was “Toyoda”

Sakichi Toyoda “Inventor”

- **Low capital cost**
- **Automated machine**
- **Jidoka stoppage features**
- **1 person ran 24-36 machines**
- **Zero shuttle change over time**
- **24 technical patents**
- **“Magic loom”**

1890 Wooden Loom

1896 Auto Loom

1924 Type G Auto Loom

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Sakichi provided the original spirit of Toyota

“Managers, staff, and employees must all work together”

“Let’s give it a try”

“Don’t be afraid of mistakes”

5 Main Principles of Toyoda

1. Always be faithful to your duties, thereby contributing to the Company and to the overall good.
2. Always be studious and creative, striving to stay ahead of the times.
3. Always be practical and avoid frivolousness.
4. Always strive to build a homelike atmosphere at work that is warm and friendly.
5. Always have respect for God, and remember to be grateful at all times.

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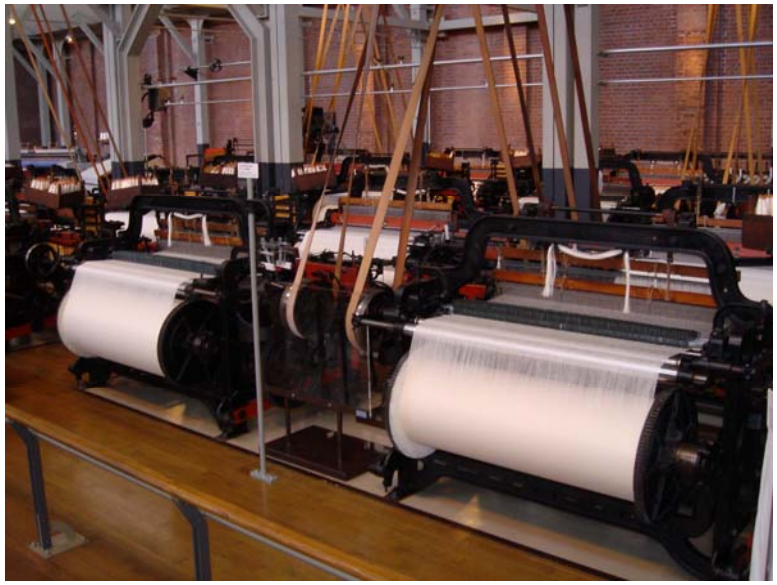
TAL* Factory and Type G Auto Loom's Influence

Flow concept

Toyoda Looms were built in a factory designed by Sakichi's son Kiichiro in 1927 using the basic principles of Henry Ford.

- -Flow production in assembly (moving conveyor line)
- -Scientific principles of management (Taylor)

Jidoka concept



Sample layout of the 1924 Type G Loom in usage by customers.

- -One employee tended 24-36 machines (separate man from machine)
- -They also automatically stop when a thread breaks (defect occurs)

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*Toyoda Auto Loom Works

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1933 to 1945 - The Start Up of Toyota

Founder
Kiichiro Toyoda

1933 Early Auto Department in TAL*

1935 A Type Vehicle built as a prototype

1937 Started the Toyota Motor Corporation
Open Koromo (Honsha) Plant for vehicle mass production of vehicles
Organized new factory production for flow and eliminated intermediate storage
10 centimeter thick document regarding operations and flow production
Decreed that production and procurement but be done JIT in 1937

Unfortunately World War II disrupted operations
The Japanese economy weakened in 1950 and sales sagged
One third of the company (2,146 employees) were let go
Kiichiro stepped down to take accountability

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***Toyota Auto Loom**

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1945 to 1955 – Mr. Ohno's Line

Eiji Toyoda

Taiichi Ohno

1945-1955 Machine Shop Experiments by Mr. Ohno and his staff

- One person operates two machines, three machines and then four, etc.
- Re-organize processes from process to product flow (Grinders to Cam Shafts)
- Pace production to an average (i.e. takt time)
- Level production volume of time and mix of items
- Standardized work routines and methods
- Implement replenishment style production and kanban
- Invent simple "Jidoka" devices to stop the line when there is a problem
- Utilize visual control and other workplace organization methods
- Observe processes to find problems and then make improvements

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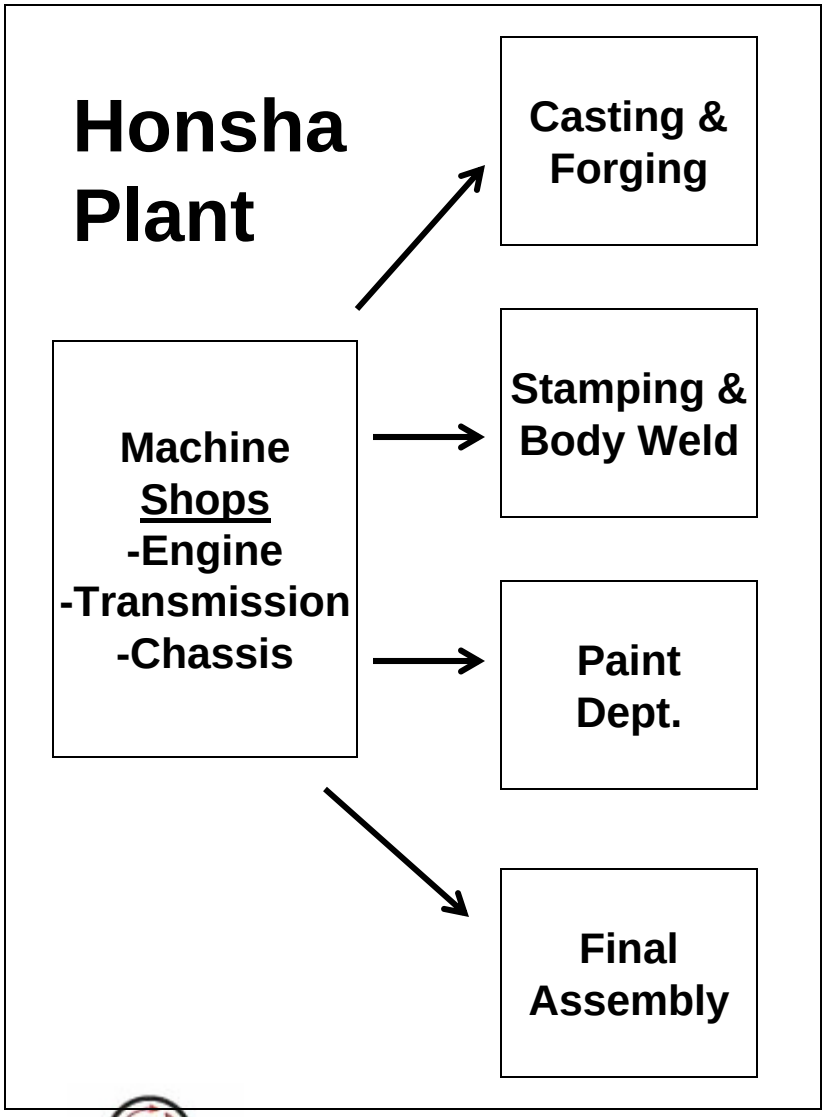
1955 to 1960 – Beyond the Machine Shops



- 1950 Production volume of 10,000 units
- 1960 Production volume of 100,000 units

- 1950 Mr. Ohno was a 38 year old manager of the machine shop
- 1955 The machine shop had 500 employees and 3,500 machine tools

- 1955 Mr. Ohno had about 5 main disciples in the machine shops (and Eiji Toyoda covering his back)
  - -Yukio Arima
  - -Itsuo Mamiya
  - -Kikuo Suzumura
  - -Takeo Watanabe
  - -Masanobu Morita

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1960 to 1970 – Beyond Honsha Plant

Exec VP
Manufacturing

Honsha Plant

Motomachi Plant	1960
Kamigo Plant	1965
Takaoka Plant	1966
Miyoshi Plant	1968
Tsutsumi Plant	1970

President
Chairman

Manufacturing

Quality

Product Development

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1970 to 1980 – TPS External Spread to Supply Base

OMCD*

-Kikuo Suzumura
-Fujio Cho
-Others

Jisshuken Activities

1. Flow production
2. Standardized work
3. SMED
4. JIT/Pull/Kanban
5. Kaizen

Aishin

Denso

Kanto Auto

Central Auto

Koito Seisaku

Toyoda Gosei

Toyoda Boshoku

Tokai Rika

Aisan Kogyo

Taihou Kogyo

*Operations Management Consulting Division (Seicho-bu)

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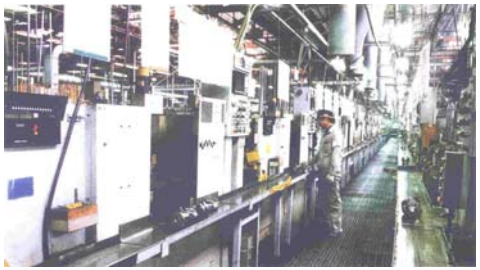
1980 to 2000 – Exporting TPS Beyond Japan



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Long period of consistent profitable growth…

Ranking by Sales (Million units sold)

Rank	1950	1970	2003/4		Market cap (April 2002) (USD billions)
1	GM	GM	GM	(8.60)	34
2	Ford	Ford	**Toyota**	(7.20)	101
3	Chrysler	Chrysler	Ford	(6.72)	27
4	Studebaker	VW	VW	(5.11)	18
5	Nash	Fiat	Renault*	(4.98)	14
6	Kaiser	**Toyota**	Daimler**	(4.50)	44
7	Morris	Nissan	Honda	(2.88)	20
8	Hudson	Renault	Hyundai	(2.65)	
9	Austin	BL	Fiat	(2.37)	7
10	Renault	Peugeot	Mitsubishi	(1.44)	

Aspiration:
By 2010
Global
No. 1 with
Market share
Of 15%

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* Renault/Nissan
** DaimlerChrysler
Source: finance.yahoo.com

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TPS Summary* 1945-1965

	Topic / Dates	1945-55	1955-65
JIT	Process flow	’50 Machining and Assembly Line Flow ’50 Machine Shop Flow	’55 Engine to Vehicle Plant Flow ’60 Intra Plant Flow
JIT	Conveyance	’53 1-4 Material Handling Call System	’60 Intra Plant Time Delivery ’55 Fixed quantity unfixed time based system
JIT	Set up Reduction	’50 1-4 Hour Set Up Time	’62 15 Minute Average C/O (New Technology – Danly Stamping Presses)
JIT	Kanban	’48 Replenishment pull pilot	’62 Company wide pull established ’53 Machine shops implement pull & level scheduling
JIT	Purchase Parts Management	’55 Fixed quantity delivery control system	’65 Adoption of supplier kanban
JIT	Ordering System	’55 Monthly Production Plans	
JIT	Production Instruction	’57 Adoption of Sequence List	’63 JIT Production Instruction Signals
Jidoka	Multi-Process Handling & Standardized Work	’47 1 Man 2 Machines ’49 1 Man 4 Machines	’53 Standardized Work ’55 1 Man 7 Machines (average in machine shop)
Jidoka	Visual Control & In Process Control	’50 Andon lights on engine assembly line	’62 Full work control system / Pokayoke

*Source: 創造限りなくトヨタ自動車50年史. Toyota 50 Year History Published 1987

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TPS Summary* 1965-1985

	Topic / Dates	1965-75	1975-85
JIT	Process flow	'75 Synchronization of Flow Between Plants '75 Development of Equipment for Flow Production	
	Conveyance	'70 All Plants on Call Conveyance Method '77 Cross Docking Methods	'83 Review from Sales to Manufacturing
	Set up Reduction	'71 3 Minute Average C/O Press Machines	'75 Single Minute C/O Machines at Suppliers
	Kanban		'77 Kanban Auto Sorting and Reading
	Purchase Parts Management		'77 Bar Code Reader for Supplier Kanban
	Ordering System	'65 10 Day Order Entry System '70 Daily Order Entry System	'74 New Order System '85 Lead Time Reduction Project
	Production Instruction	'71 Development Plant Production Instruction Signals '80 Adoption of Automatic Signals	'86 New Technology System
Jidoka	Multi-Process Handling & Standardized Work	'75 Company Wide Standardized Work	
	Visual Control & In Process Control	'66 Full Automated Machining Lines (JIT & Jidoka Fulfilled Kamigo Model Plant)	

*Source: 創造限りなくトヨタ自動車50年史. Toyota 50 Year History Published 1987

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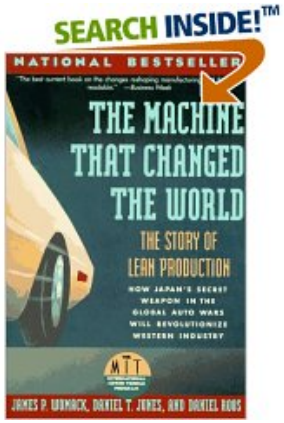
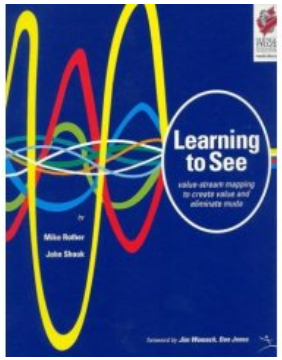
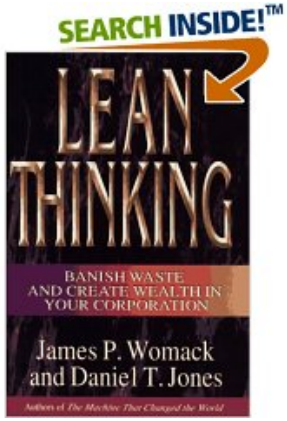
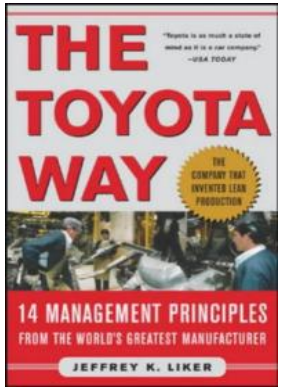
2) TPS in Toyota versus Lean in most companies…









Typical Questions for a Value Steam

1. What is takt time?
2. Where can you use continuous flow?
3. What is the pacemaker?
4. Where will you need a supermarket pull system?
5. Will you build to a finished goods supermarket or to customer order?
6. How will you level production mix at the pacemaker?
7. What increment of work will you consistently release and take away at the pacemaker?
8. What process improvements will be necessary for the value stream to flow as your future state design specifies?

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Any lens affects how well and what you see…

Eye Glasses

Blurred image

Clear image

Microscope

Small image

Magnified image

Telescope

Distant image

Closer image

But no one lens can do everything!

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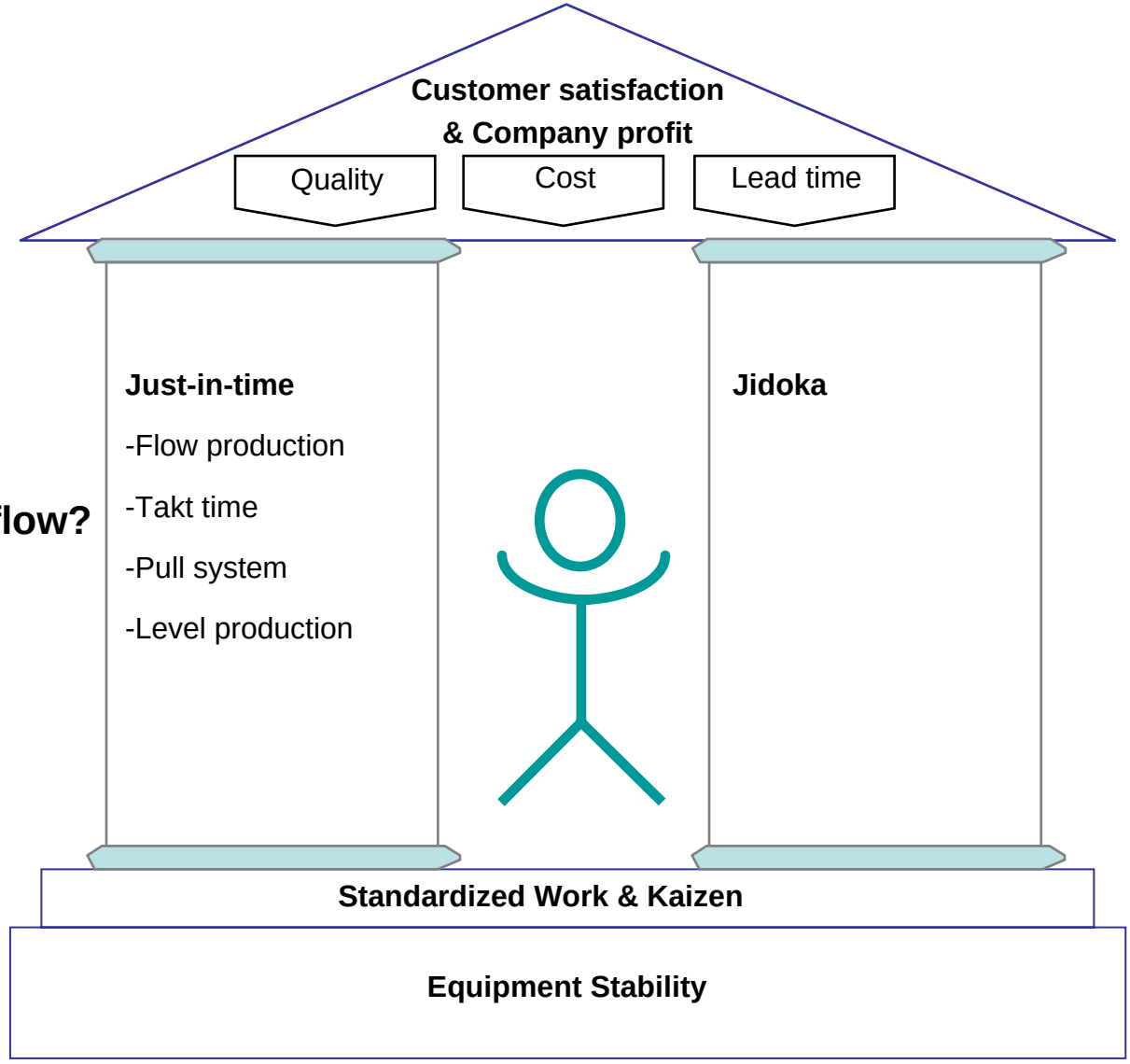
TPS Framework

LTS* - Map the value stream

1. **Takt time?**
2. **Continuous flow?**
3. **Pacemaker?**
4. **Supermarket pull system?**
5. **MTO/MTS?**
6. **Level production?**
7. **Pitch increment?**
8. **Process improvements for flow?**

(Add in CCF, MMF, CLP, etc.)

Where is the focus?



*LTS - Learning to See, followed by CCF - Creating Continuous Flow, MMF - Making Materials Flow, & CLP – Creating Level Pull

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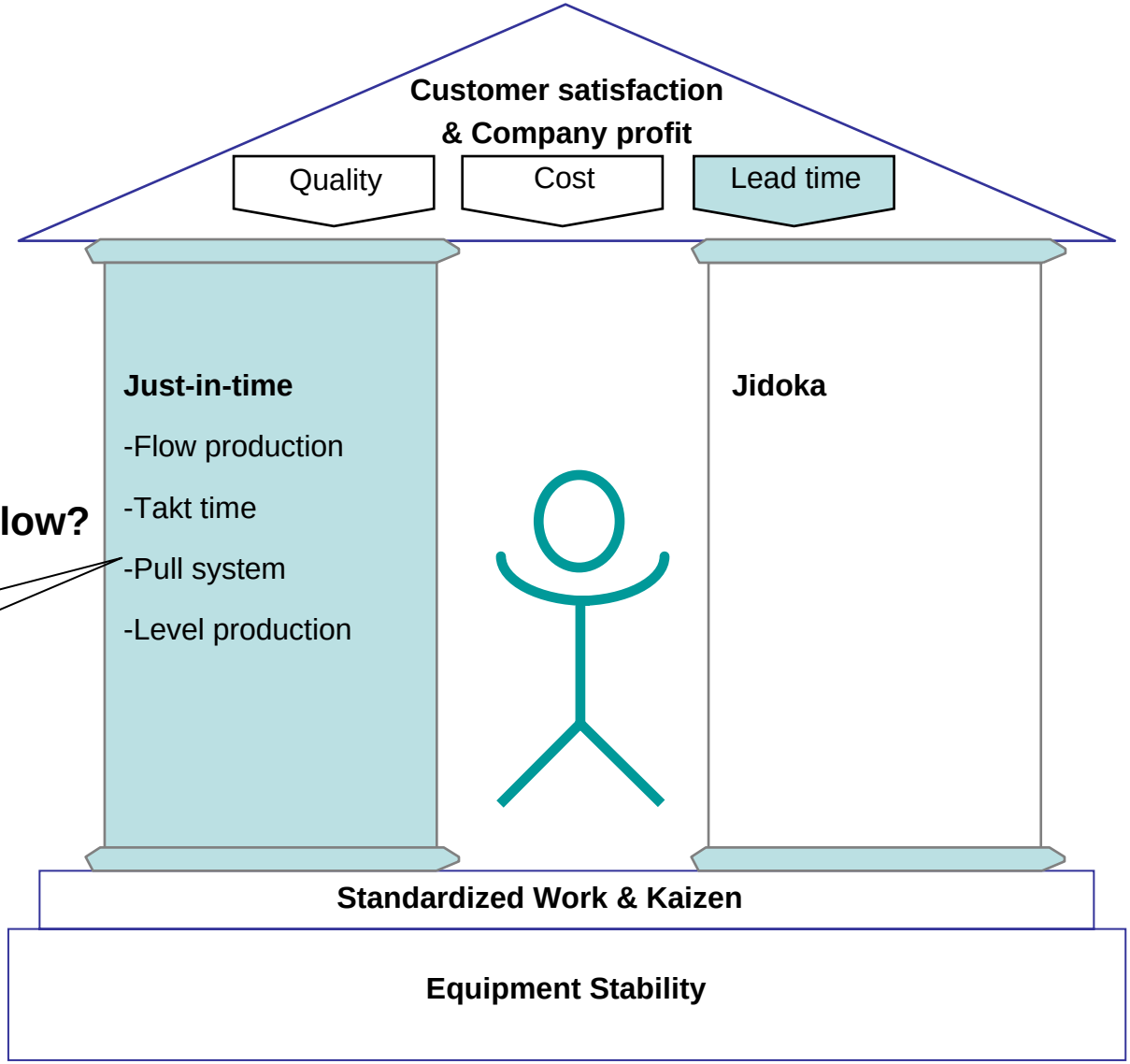
TPS Framework

LTS* - Map the value stream

1. **Takt time?**
2. **Continuous flow?**
3. **Pacemaker?**
4. **Supermarket pull system?**
5. **MTO/MTS?**
6. **Level production?**
7. **Pitch increment?**
8. **Process improvements for flow?**

Most of the Lean focus in the U.S. today is on just a part of overall TPS – mainly JIT, inventory and lead-time reduction



*LTS - Learning to See, followed by CCF - Creating Continuous Flow, MMF - Making Materials Flow, & CLP – Creating Level Pull

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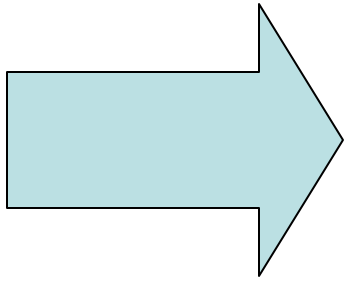
JIT/VSM focus is “necessary”…but not “sufficient”

“Process A”
Availability = 65%
Capability = .8 Cpk
Flexibility = 1 Hr. C/O

+ Supervisors inundated with other “problems”

(First 20 years of TPS)



Sometimes the “process” is what needs to be fixed and not just the “JIT flow” across the process…

In other words truly “learning to see” certain problems involves crawling under the hood and getting the 1 foot view and not the 10,000 foot VSM view…

Companies won’t improve quality, cost, and delivery significantly until all these types of problems are addressed better than today.

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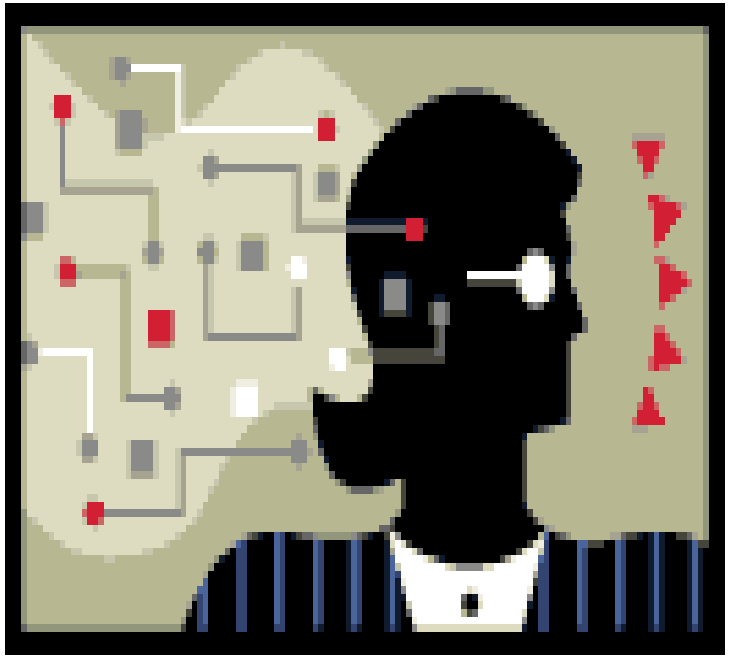
TPS is built on the scientific way of thinking…



General Scientific Method

1. Define the question / make observations
2. Gather information and facts
3. Form Hypothesis
4. Perform experiment and collect data
5. Analyze data
6. Interpret data and draw conclusions
7. Summarize results

TPS Basic Thinking Pattern

1. Define the problem
2. Analyze the causes
3. Set a goal
4. Implement the action items
5. Verify the results
6. Follow up / Standardize

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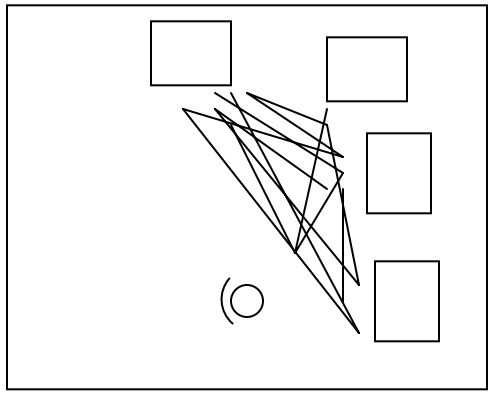
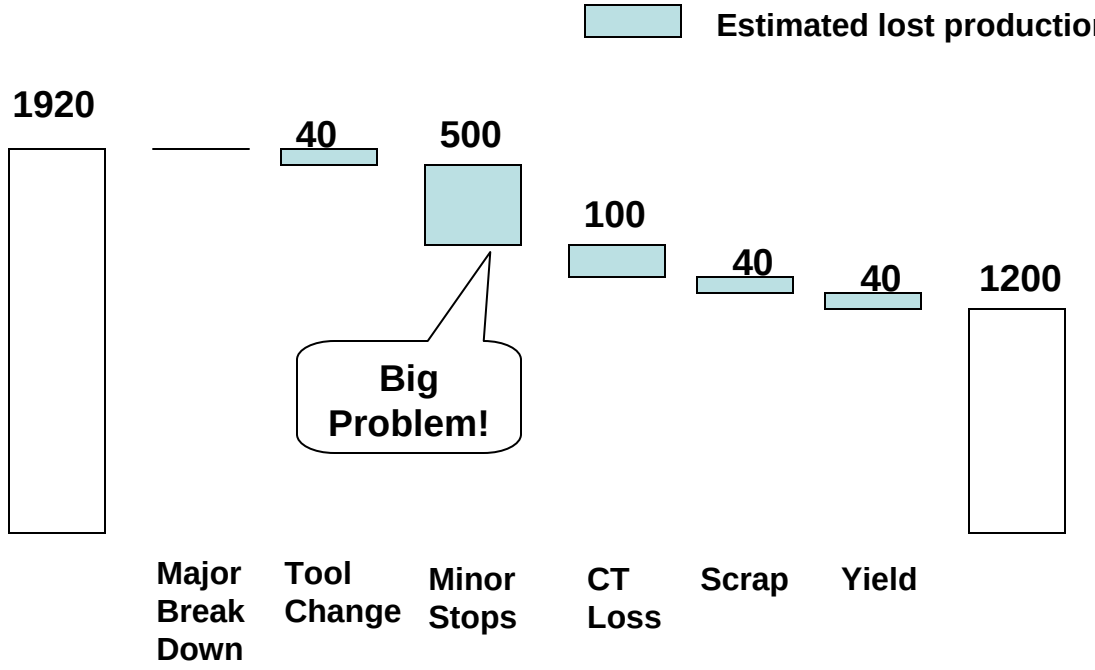
Observation of actual situation (facts not opinions!)

Lathe area





1 hour observation

Results extrapolated to 1 machine 8 hours

Problem: Machine not producing 1580 parts per shift to meet takt time
Goal: We must improve 380 parts (1200 to 1580) per shift.

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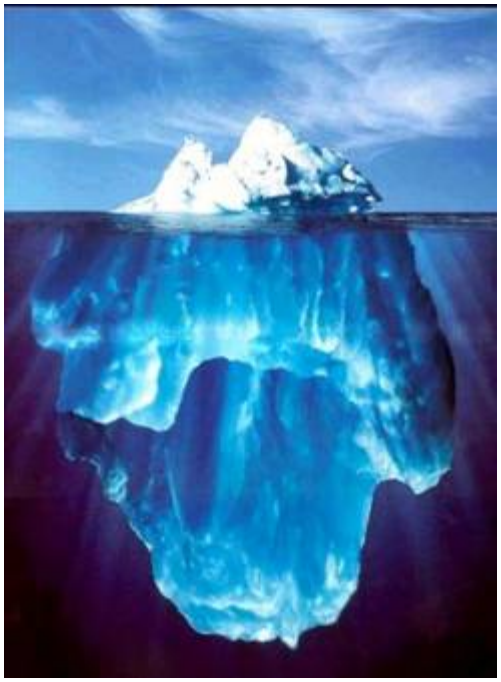
Why all the minor stops? (Invisible problems)



1) Operator's point of view: This is my daily grind – it is entirely normal…(abnormal has become normal).
2) I have to clean the machine constantly as there are cutting chips that accumulate everywhere. The chips stop the parts from rolling down the chute and auto loading time and time again so I have to un-jam the machine. I know that I am told not to break standardized work but unless I do the area will not run.
3) Also I have to gauge parts carefully even more that the quality check interval calls for…otherwise bad parts are found down stream and I get in trouble.
4) And I have to constantly adjust the tooling offsets at the control panel of the machine as this helps me keep the parts within specification (0.1mm tolerance)
5) No one will help me out on this sort of stuff…they are too busy doing lean or chasing other problems.

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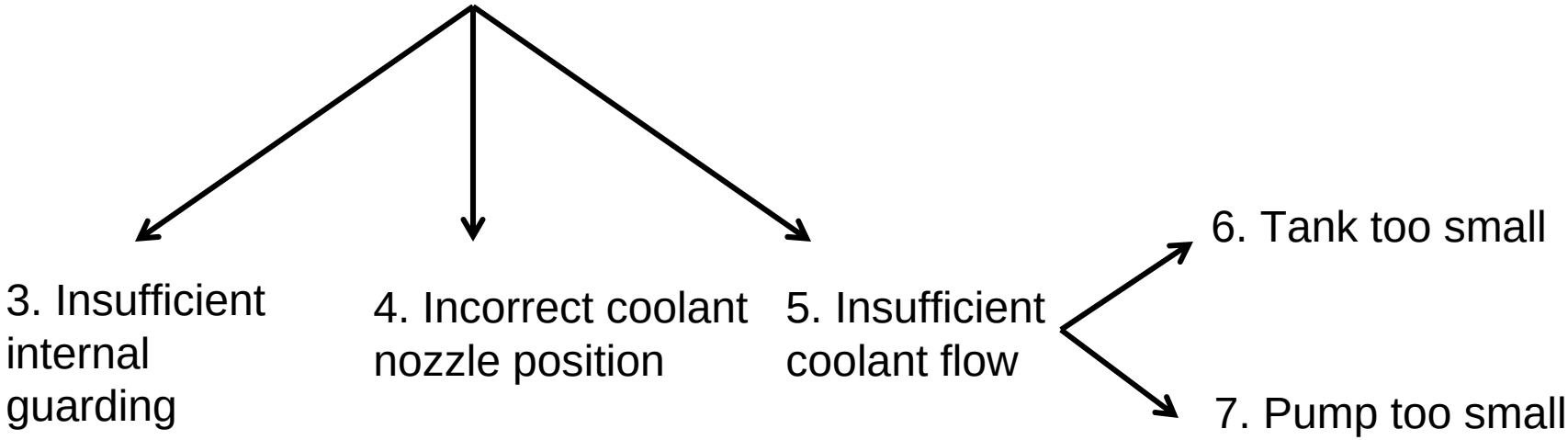
What are the root causes? (1/2)

Parts jamming problem (minor stops)

1. Why do the parts jam in the loader?

2. The cutting chips fly up in the auto loading chute inside the machine



None of this was adequately considered in design and procurement of the machine. Long term this is what must be standardized and fixed…

Action Items: #3, 4, 5, and 7, must be fixed tonight…no exceptions.

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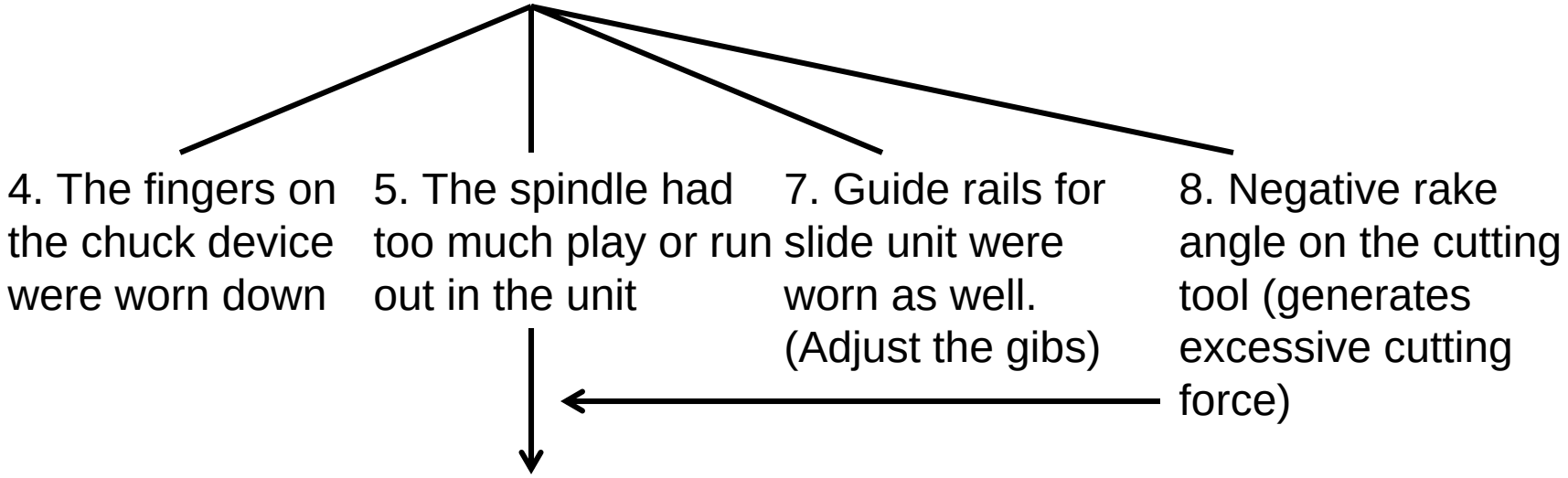
What are the root causes? (2/2)

Operator adjusting offsets (quality problem & minor stops)

1. Why does the operator adjust the offsets?

2. He was compensating for “something” wrong in the machine

3. What is the process capability? (It was .8 Cpk) Why?



Action Items: #4, 6, 7, must be fixed tonight…no exceptions. #7, #8 investigate further…

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Check Results and Follow Up: Good News

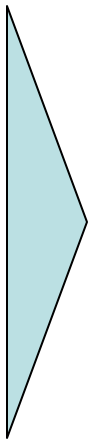
Test Results (1 machine)

Capacity = 1920

Demand = 1580

Actual = 1680

Remain = 240



The process averaged closer to 87.5% uptime during the shift

Only one minor stop for cutting chips blocking auto loader was reported

The quality of the parts was 100% right the first time

Spread to other machines ASAP

Still more room to improve. Further study required.

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Check Results and Follow Up: Bad News

2-3 Year Superficial Effort:	1 Week "TPS" Effort Uncovered:
Heavy VS Mapping and material flow emphasis	$500K in wasted capital identified on two lathes
8 Kaizen events conducted but mainly flow or assembly related	6 lathes at 85% uptime possible (saved $4-500K of overtime in 2 departments)
Good visual impact. At least things were cleaner.	Scrap will be reduced as well ($150-200K estimate)
No real impact on quality and cost however for all the effort that was put into the project	Probable annual savings in the area of $6-800K just by looking in more detail the lathe department. Other areas?
Operators dismayed with lean – seen as a burden	Operators thought this was the greatest thing ever – their job got easier, and someone finally listened.

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Reflection Points: Learning from Toyota

Some companies just seem have the wrong “framework” for doing lean (multiple examples)

When the emphasis is to “apply the tools” then rigorous thinking is not required. Law of least mental effort is followed…

In TPS leaders must see that practitioners “solve the real problem” and apply the scientific method. This will won’t happen naturally.

TPS at its essence is developing a way to surface problems right now, and respond right away, not just building a tool kit.

The real issues in this case were 1) up front mistakes in engineering, 2) inability in the lean group to even see the problem, and 3) abnormal situations had become normal. No one took action.

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Let's revisit some basic TPS questions

= Enough done already?

Key TPS Questions	Typical Problems	Countermeasures or analysis tools
1. How will you satisfy the customer and obtain a profit? 2. What are your main problems in production?		
3. How will you achieve 100% JIT?	•On-time delivery •Inventory •Lead-time	•VS Mapping •Flow of product •Pull system / kanban
4. How will you build in 100% quality?	•Customer defects •Scrap •Rework	•Abnormality detection •Stop the machine •Process Cpk
5. How will you stabilize the availability to 100%?	•Capacity losses •Downtime •Scrap & Rework	•6 losses •OA / Maintenance •Problem solving
6. How will you standardized work 100?	•Labor productivity •Scrap & rework •Safety	•Job Instruction •Standardized work •Motion analysis
7. How will you develop natural work team leaders?	•Team morale •Skills development •Small improvements	•TWI/JR •TWI/JI •TWI/JM
8. How will you sustain and improve?	•Recurring problems •Firefighting •Poor problem solving	•PDCA •Root cause analysis •Recurrence prevention

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TPS Vision of Ideal State: True North

Customer Satisfaction
- **0 defects**
- **100% value added**
- **1x1, in sequence, on demand**

+

Human Development
- **Physical & Mental Safety**
- **Job Security**
- **Professional Challenge**

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Thank you for your kind attention!

- **Questions?**
- **Comments?**
- **Ideas?**

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Appendix

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Early training courses in Toyota

- **Training Within Industry (TWI) Courses - Started in 1951 continues today**
  1. **Job Instruction**
  2. **Job Relations**
  3. **Job Methods -- Replaced in 1955 by the P-course training**
  4. **Job Safety -- Added by Toyota to the above courses**
- **P-Courses taught by Mr. Shingo – Started in 1955 and continued until 1980**
  1. **Motion analysis**
  2. **Time study analysis**
  3. **Operational analysis**
  4. **Process analysis**
- **TQC related courses (Starting around 1962 with the TQC program)**
  1. **QC Circle activity**
  2. **Basic problem solving**
  3. **Statistical quality control**
- **Standardized work – established in the early 1950's and refined up until1978**
- **Kaizen training course – formalized in 1978 and replaced the P-course**
- **Role of a Supervisor – formalized in 1970 and continues today**
  1. **Role of a Team Leader**
  2. **Role of a Group Leader**

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