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New Things (?) from Old Guys

John Bicheno

Lean Enterprise Research Centre



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2009

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A Prophet in his Own Land...

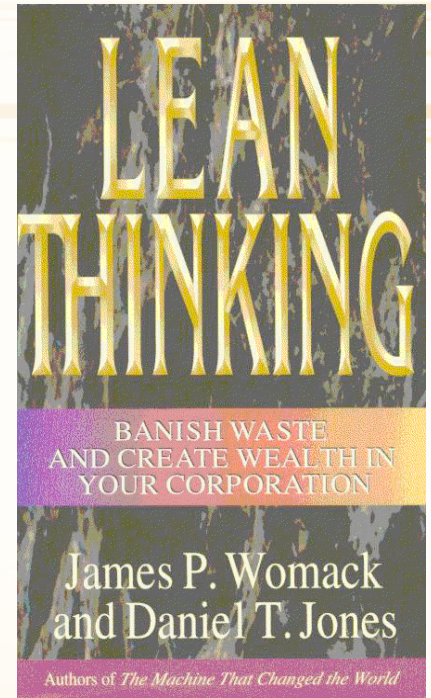
- Why a Deming Prize in Japan and a Shingo Prize in USA?
- The top selling book on Toyota in Japan is by an American – Jeffrey Liker’s ‘Toyota Way’



Five Lean Principles

....have served us well

- Specify what creates **value** from the customers perspective
- Identify all steps across the whole **value stream**
- Make those actions that create value **flow**
- Only make what is **pulled** by the customer just-in-time
- Strive for **perfection** by continually removing successive layers of waste



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But now: 5 Revised Principles (?)

- Value
 - ➔ for Customers, Stakeholders, and Environment
 - ➔ Waste (Muda)
 - ➔ Value demand vs Failure Demand
- System
 - ➔ end-to-end value streams
 - ➔ holistic, integrated, with feedback
- Flow
 - ➔ Add value without interruption
 - ➔ Muri (overburden and capacity overload), Mura (unevenness, variation, amplification.)
- Perfection
- People



The word 'Lean'

- Although the English word Lean was first used in the MIT studies, the idea was based on the Japanese word 'genryou' meaning 'reduced weight, 'dieting', slim down'



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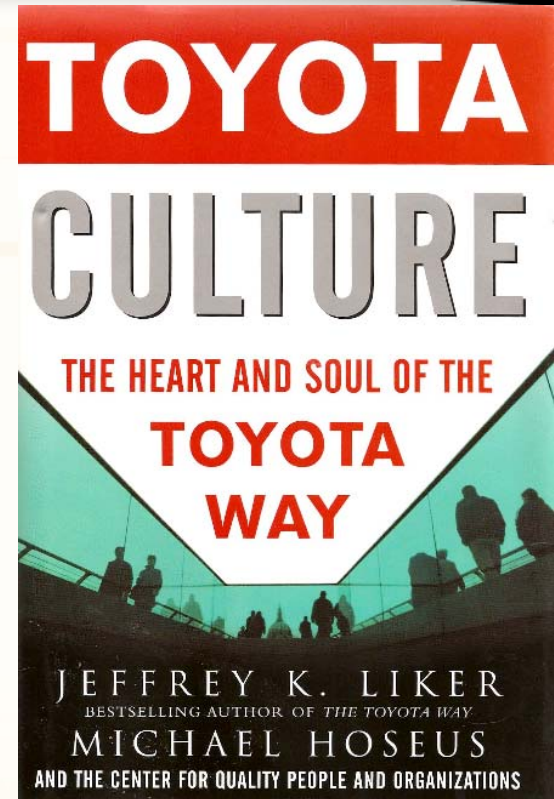
Myths and Truths about Toyota

- Ohno's 'supermarket system' (also known as the Ohno System) was the idea of making the customer go to the 'store' to buy. He built this and other concepts on the work of predecessors, particularly Kiichiro Toyoda.
- Kiichiro Toyoda developed the concept to 'everyday make the necessary items in the necessary quantity' in 1937. He wrote the first manual on what was to become TPS.
- TWI was Toyota's first management and supervisor development program.
- Ohno's original phrase for what became TPS was "Profit Based Industrial Engineering"
- Ohno battled for years to get his ideas accepted. For instance changeover reduction failed and was brought in only after a successful implementation in Brazil
- Ohno was a big shouter, particularly with supervisors. He did NOT use 'Socratic' methods.
- Shop floor TPS was essentially developed during the 1950's and early 60's. Work in other areas took place after this.
- Shingo did not invent SMED

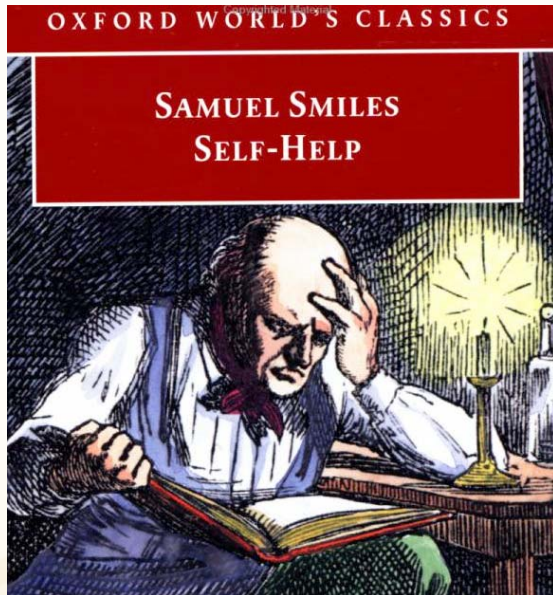


Culture..

- Today, 'culture is a big thing..
- But where did Toyota Culture come from?

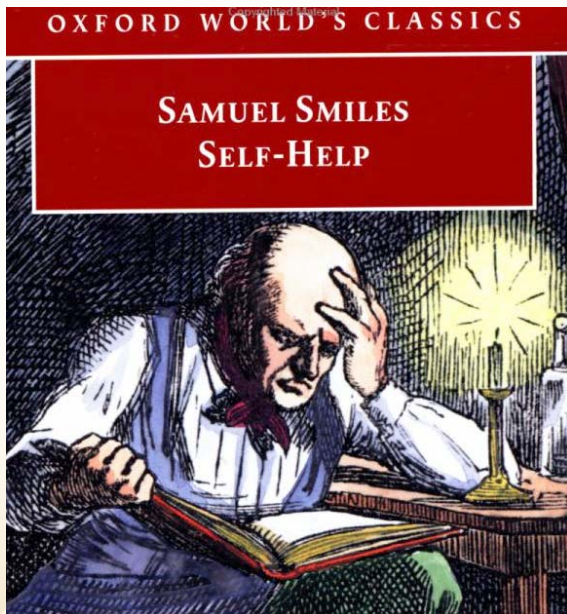


Toyota Founding Concepts...



- **First published in 1859**
- 'The spirit of self help is the root of all genuine growth in the individual; and, exhibited in the lives of many, it constitutes the true source of national vigor and strength'
- By learning to be more efficient, employees could improve the quality of their own lives and those of co-workers. They could also improve the quality of life for the people who used the products they made, which were consequently of more use and value.
- 'The greatest results in life are usually attained by the exercise of ordinary qualities... they who are the most persistent, and work with the truest spirit, will usually be the most successful.'
- **It is the only book on display at Sakichi Toyoda's birthplace**

The Influence of Smiles...



Some Chapters

- Self Help - many great men of humble origins, and self taught
- Leaders and inventors - who learned by doing and observation
- The Potters - searching for the secrets
- Application and perseverance - 'genius is patience'
- Helps and opportunities - Watt, Brunel, Newton, Priestly - observing with intelligence (at Gernsey)
- Artists - wealth not the ruling motive
- Energy and courage - the force of purpose, and promptitude of action - Wellington, Napoleon, Dr Livingstone
- Men of Business - attention to detail, economy of time, accuracy, punctuality - Wordsworth, Shakespeare, Walter Scott, Dr Johnson
- Money - living within means, frugality, riches no proof of wealth, independence attainable



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'Innovations are rarely dramatic breakthroughs...but

- ..rather small improvements in a new process or product in which genuine novelty and imitation-with-a-difference shade imperceptibly into one another' (from Mark Blaug)

and

- 'Generally, inventions come from the operatives' (from House of Lords, Select Committee, 1851)

and

- 'every invention we have made and patented has been the invention of overlookers, or ordinary working men, or skilled working mechanics, in every instance' (from A.J. Mundella, a Nottingham manufacturer, 1850's)

All quoted in Terence Kealey
Sex, Science and Profits, Heinemann, 2008

...developing the steam engine...

- Newcomen, an ironmonger but with knowledge of the needs of Devon mines, developed his ideas through 10 years of exhaustive experimentation (NOT using the theories of academics or scientists e.g. Boyle)
- ..Watt followed, repairing Newcomen engines, whilst working as a lab technician at Glasgow University, and hence away from the restrictions of the Guilds (NOT using Black's theories)
- ..Trevithick, with a primary education only, improved and lightened Watt's engine, and built the world's first steam locomotive
- ..and Stephenson, also unschooled, built the *Rocket* which was lighter than Trevithick's, enabling it to run on cast iron rails....

Quoted from Terence Kealey
Sex, Science and Profits, Heinemann, 2008



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But now: 5 Revised Principles (?)

● Value

- ➔ for Customers, Stakeholders, and Environment
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- ➔ Value demand vs Failure Demand

● System

- ➔ end-to-end value streams
- ➔ holistic, integrated, with feedback

● Flow

- ➔ Add value without interruption
- ➔ Muri (overburden and capacity overload), Mura (unevenness, variation, amplification.)

● Perfection

● People



Customer Responsiveness

- The customer, and the supply chain!



Peter Drucker



1909-2005

**“The purpose of a
company is to create
customers”**



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Henry Ford



“If I had asked people what they wanted, they would have said **faster horses”**



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Levitt on Ford

What came First?



- 'Ford was both the most brilliant and the most senseless marketer in American history. He was senseless because he refused to give the customer anything but a black car. He was brilliant because he fashioned a production system designed to fit market needs. We habitually celebrate him for the wrong reason: for his production genius. His real genius was marketing. We think he was able to cut his selling price and therefore sell millions of \$500 cars because his invention of the assembly line had reduced the costs. Actually, he invented the assembly line because he had concluded that at \$500 he could sell millions of cars. Mass production was the *result*, not the cause, of his low prices....'

Theodore Levitt, 'Marketing Myopia',
Harvard Business Review, July / Aug 1960



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Value: Features v Benefits

- Customers do not buy products or services: they buy the benefits they provide

Charles Revlon:

In the factories we make perfume, but in the stores we sell hope."



**Selling drills...
or selling
holes..?**

Value

Free, Perfect, Now

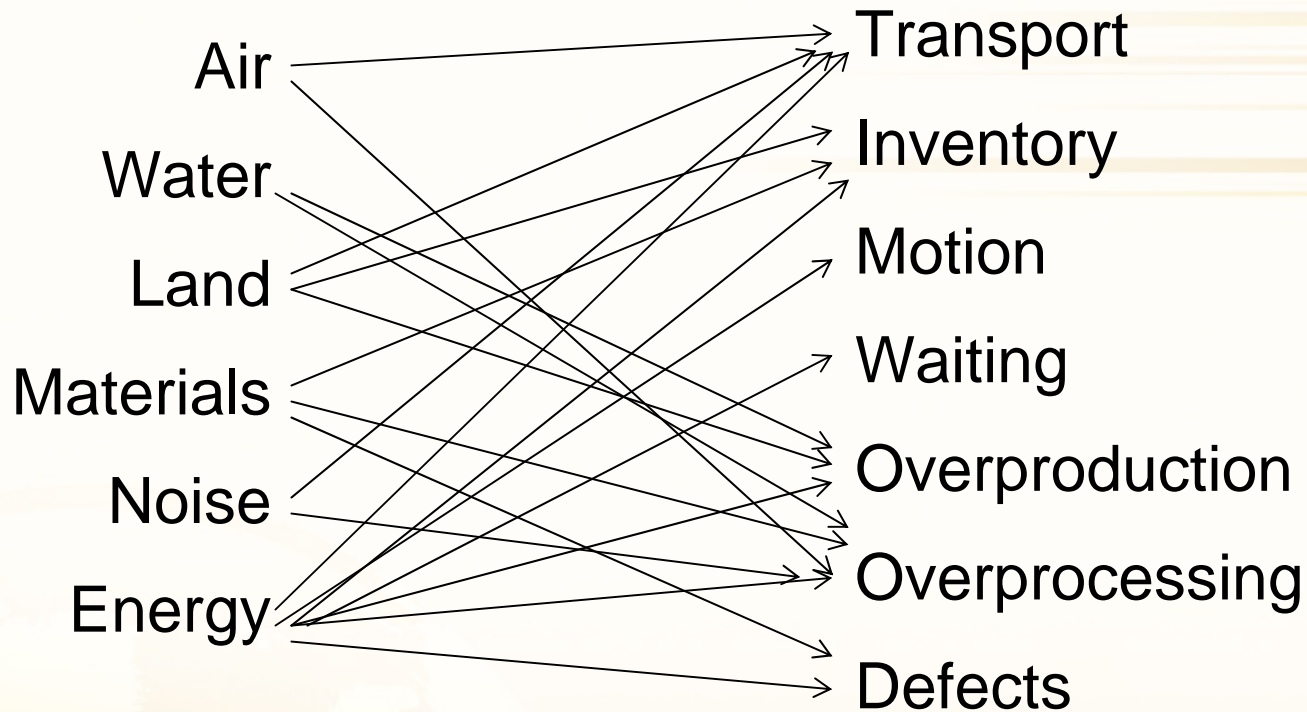


The Fundamental Waste ?

- Michael Porter (1985) said 'Pollution is the Greatest Waste'
- Hunter Lovins has echoed this (AME, 2007) saying that 'had Ohno been around in 2007...'
- As has Robert 'Doc' Hall, calling for 'No-growth Lean'
- The six categories of Pollution:
 - ➔ Air – including CO₂
 - ➔ Water – 'the greatest constraint facing mankind'
 - ➔ Land – and landfill disposal; forests, agriculture
 - ➔ Materials – 90% end up in landfill within 6 weeks
 - ➔ Noise
 - ➔ Energy – facing blackouts



6 Pollution Wastes and The 7 Wastes



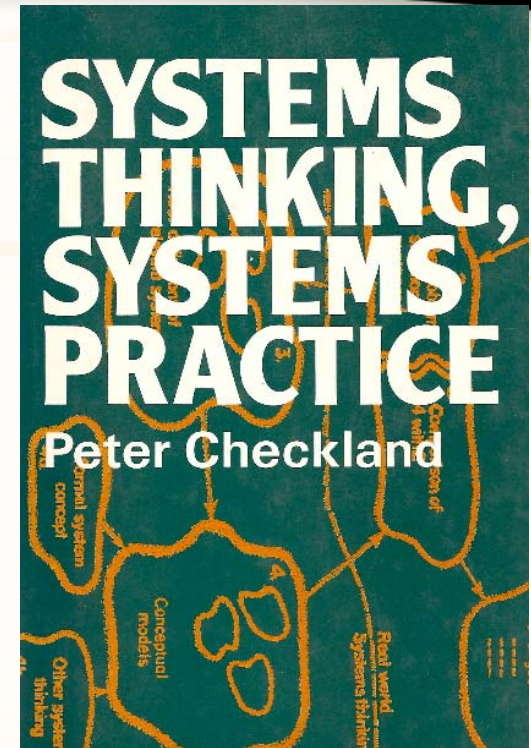
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Checkland

- Ohno or Checkland
- 'The Systems Approach seeks not to be reductionist'
- Relevant Systems
- CATWOE (Clients, Actors, Transformation, Weltanschauung (Beliefs, Filters), Owners, Environment (Wider Systems))

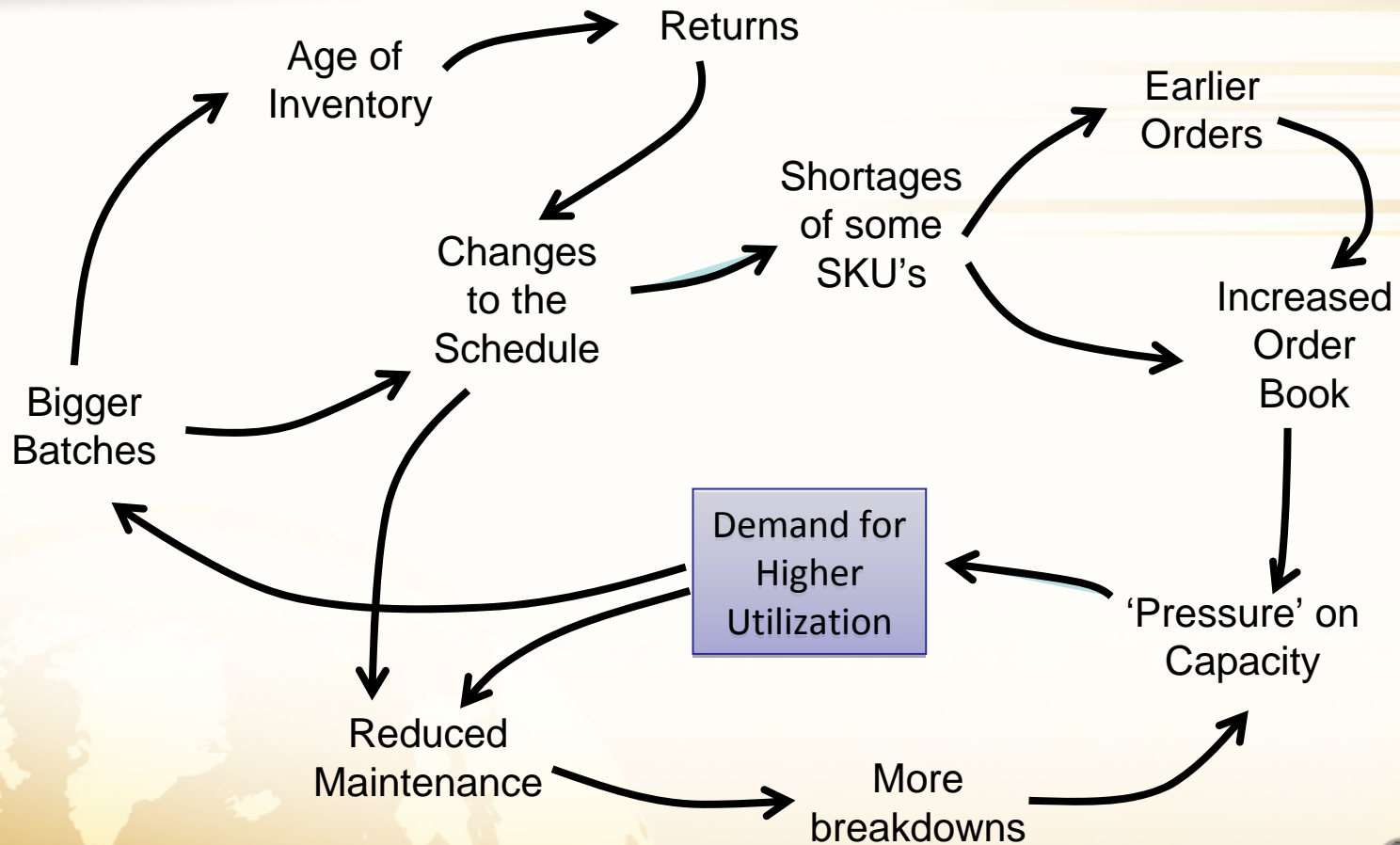


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Feedback in Systems - Example



See 'Industrial Dynamics'
Forrester, MIT, 1960's – 1970's

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Woollard

Frank G. Woollard
M.B.E. M.I.Mech.E. M.I.Prod.E. M.S.A.E.

PRINCIPLES
OF
MASS AND FLOW
PRODUCTION

55th Anniversary
Special Reprint Edition

INCLUDING

"Some Notes on British Methods of Continuous Production"
1925

With Commentary and Analysis
by Bob Emiliani, Ph.D.



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Woollard's Principles, 1925

1. Mass production demands mass consumption, but Flow production requires continuity of demand
2. The products of the system must be specialized.
3. The products of the system must be standardized.
4. The products of the system must be simplified in general and in detail
5. All material supplies must conform to specification.
6. All supplies must be delivered to strict timetable.
7. The machines must be continually fed with sound material.



Woollard's Principles (continued)

8. Processing must be progressive and continuous.
9. A time cycle must be set and maintained.
10. Operations must be based on motion study and time study
11. Accuracy of work must be strictly maintained.
12. Long-term planning, based on precise knowledge, is essential
13. Maintenance must be by anticipation – never by default



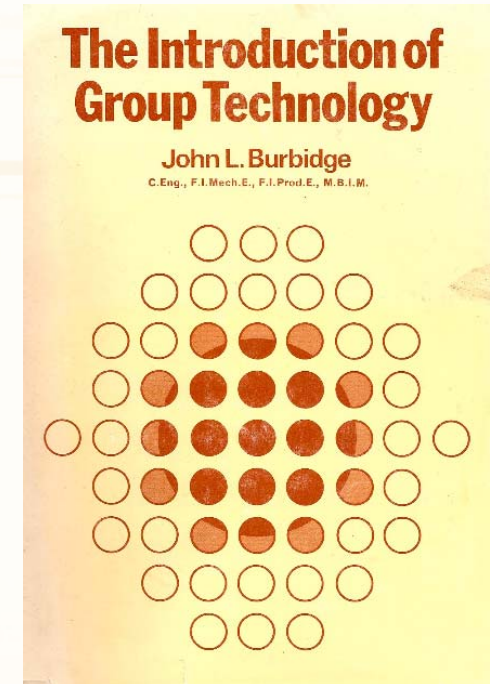
Woollard's Principles

14. Every mechanical aid must be adopted for man and machine
15. Every activity must be studied for the economic application of power
16. Information on costs must be promptly available
17. Machines should be designed to suit the task they perform – not oversized.
18. The system of production must benefit everyone – consumers, workers and owners.



Burbidge, 1975

- Incorporating
 - ➔ Quick Change (note: Shingo's SMED book published 1985)
 - ➔ Flow in Cells
 - ➔ Cell analysis ('Production Flow Analysis') and design
 - ➔ Flow control
 - ➔ Loading sequence
 - ➔ Capacity analysis of shared resources.

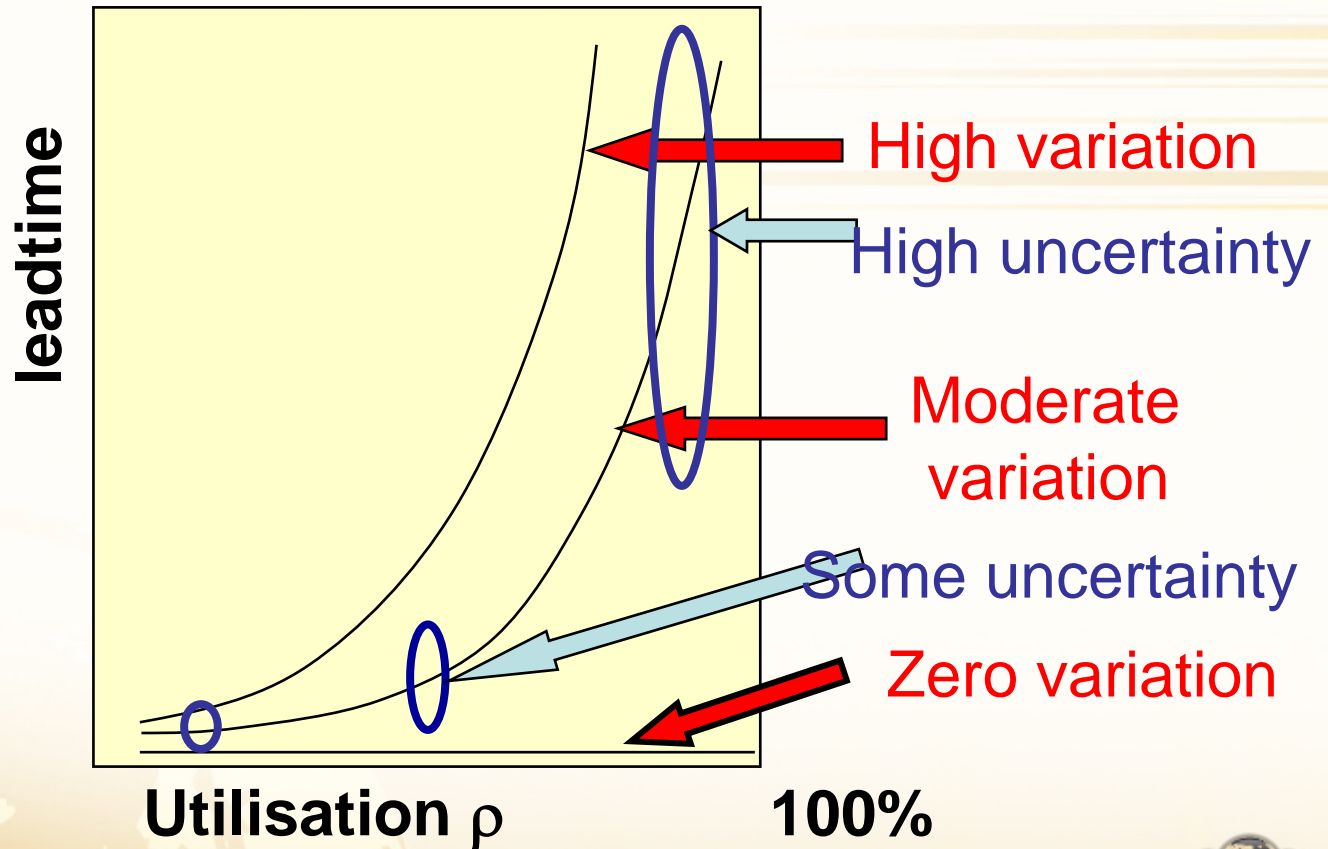


Queuing, Waiting, Capacity, Flow

- Original work of Queuing done by Erlang in 1909, but developed by Oxbridge professors David Kendall in 1953, and Kingman in the late 1950's.



Queue Time, Variation and Utilization



Expected Lead Time (Kingman's (1961) Equation)

$$L = (C_a^2 + C_e^2)/2 \times (\rho / (1 - \rho)) \times t_e + t_e$$

MURA MURI Ave Process Leadtime

C_a^2 is arrival variance; C_e^2 is process variance

ρ is utilization (load / capacity or arrival rate / service rate)

The Equation of Lean (?)

$$\text{Lead Time} = 1/2 \cdot (C_a^2 + C_e^2) \cdot (\rho / (1 - \rho)) \times t_e + t_e$$

Relates to
smoothing the
flow of work
(Heijunka)

Relates to
reducing
the variation
of the process
(Mura)

Relates to
Utilization
(Where high =
Overload)
(Muri)

Kingman's Equation

$$L = TUV$$

Lead Time = f (Process Time, Variation, Utilization)

**(now a central feature of “Factory Physics” –
Hopp and Spearman)**

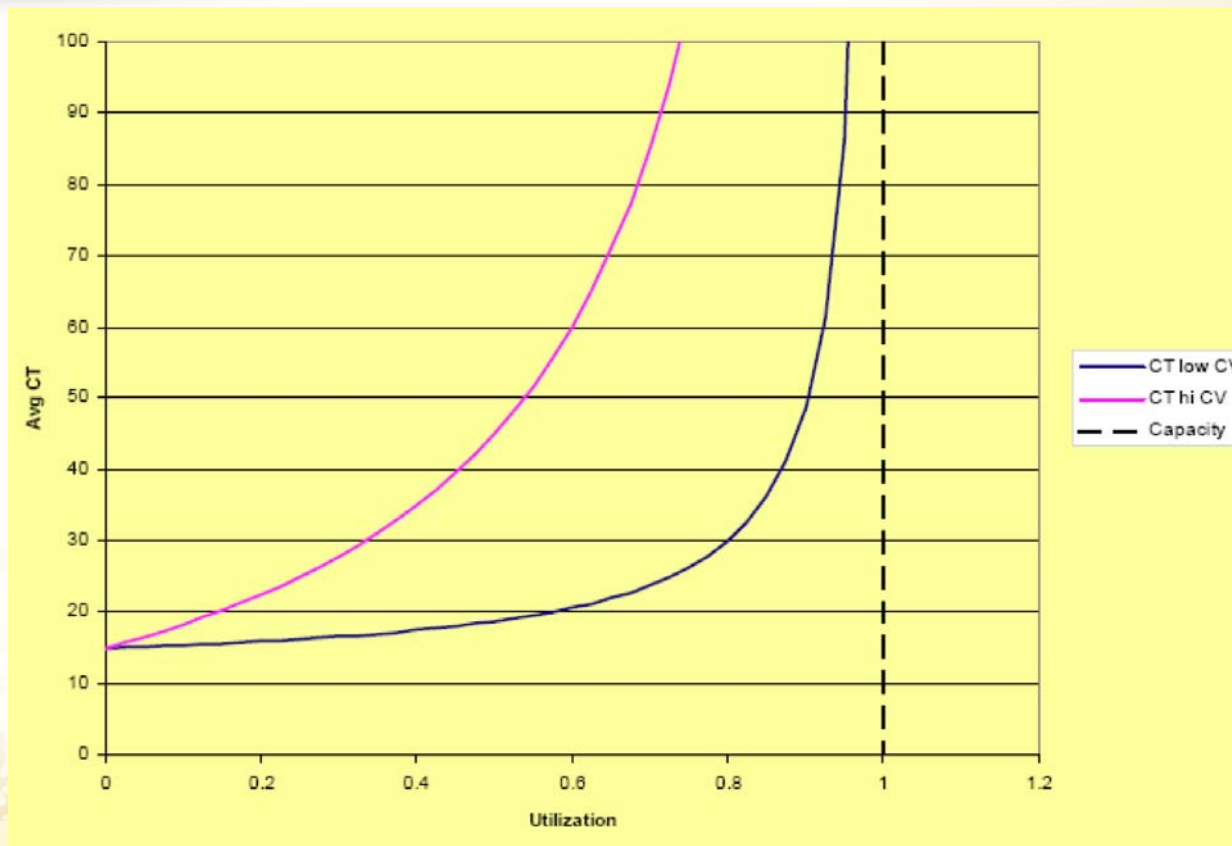


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Or, Showing this another way..



From Hopp and Spearman, *Factory Physics*.



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Value Demand and Failure Demand

- Seddon (2003)
- A variant of Cost of Poor Quality ? (Crosby, 1979)

John Seddon, *Freedom from Command and Control*, Vanguard, 2003

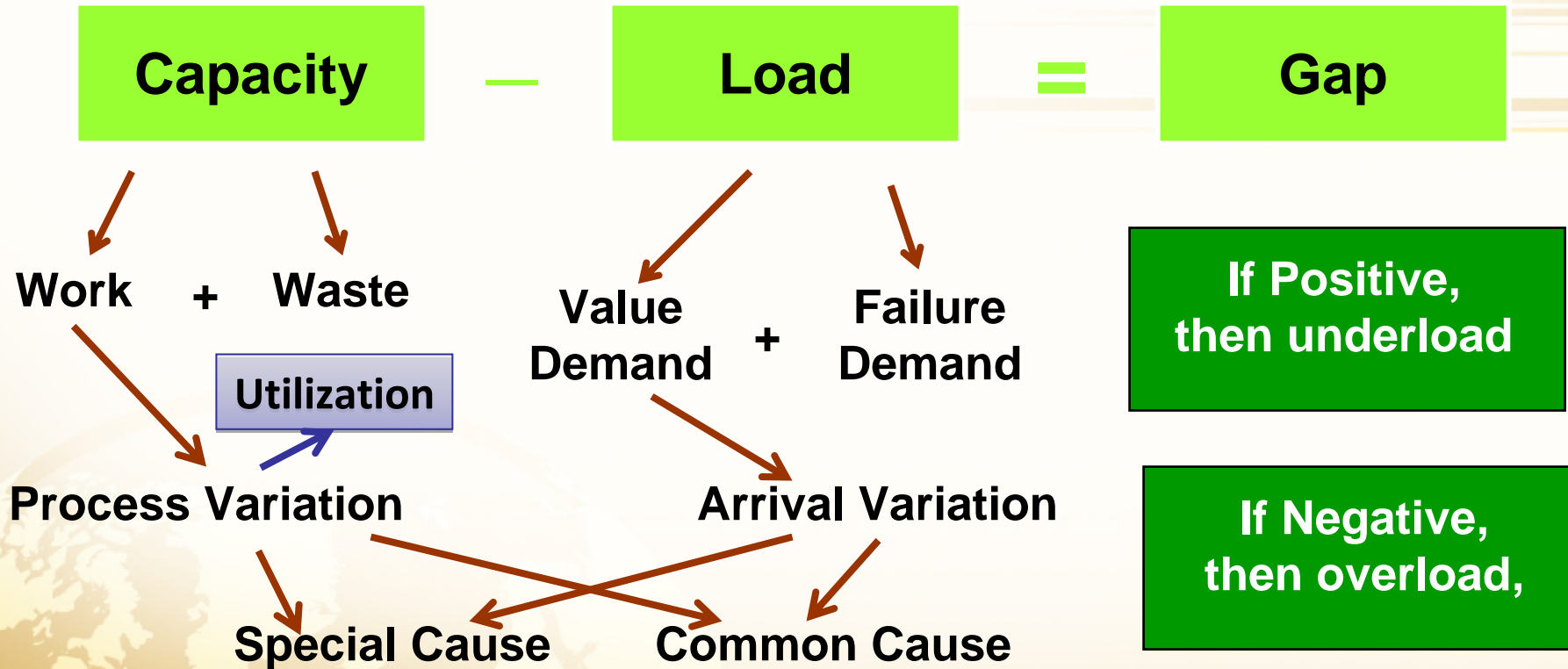
Philip Crosby, *Quality is Free*, McGraw Hill, 1979



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The Fundamental Formula



Forgotten? 'Not Toyota' (?)

- Goldratt
- Hopp and Spearman
- But 5000 copies of *The Goal* distributed to Toyota executives in 2000

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- **Perfection**
- People



Spear...

- 4 Rules:
- All work shall be highly standardised
- Every communication path shall be clear and unambiguous
- Every flow path shall be as simple as possible
- All improvement shall be by the scientific method, under the guidance of a mentor



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The Changeover Story

- The Management was satisfied, even delighted
- But Lionel Aldworth was not!
- Not so much what was achieved, but HOW it was achieved
- Using (mental?) models to surface your knowledge deficiencies
- PDCA is Win, Win
- Putting in place a Learning System, not just solving problems, or making 'savings'
- "If you want to understand TPS then you must first understand the scientific method and thinking behind the system" (Dr. Shingo)



Words from Charles Handy

- ‘To learn anything other than the stuff you find in books, you need to be able to experiment, to make mistakes, to accept feedback and to try again. It doesn’t matter whether you are learning to ride a bike or starting a new career, the cycle of experiment, feedback and new experiment, is always there.’



OEE or MTBF / MTTR?

Machine	MTTF (hr)	MTTR (hr)	Defect %	OEE %
1	90	10	10	81%
2	9	1	10	81%
3	85	15	5	81%
4	8.5	1.5	5	81%



Quotes

- 'To my amazement, the program that Toyota was going to great expense to transfer to NUMMI, was exactly that which the Americans had taught the Japanese decades before' (Shook)
- 'You will not become Lean by doing TWI, but you will not become Lean without doing TWI' (Huntzinger)

Quoted in
Jim Huntzinger, 'TWI Case Study: Ohno's
Vehicle to TPS', TWI Summit, 2008

Jim Huntzinger – The Roots of Lean

TWI and Toyota Today

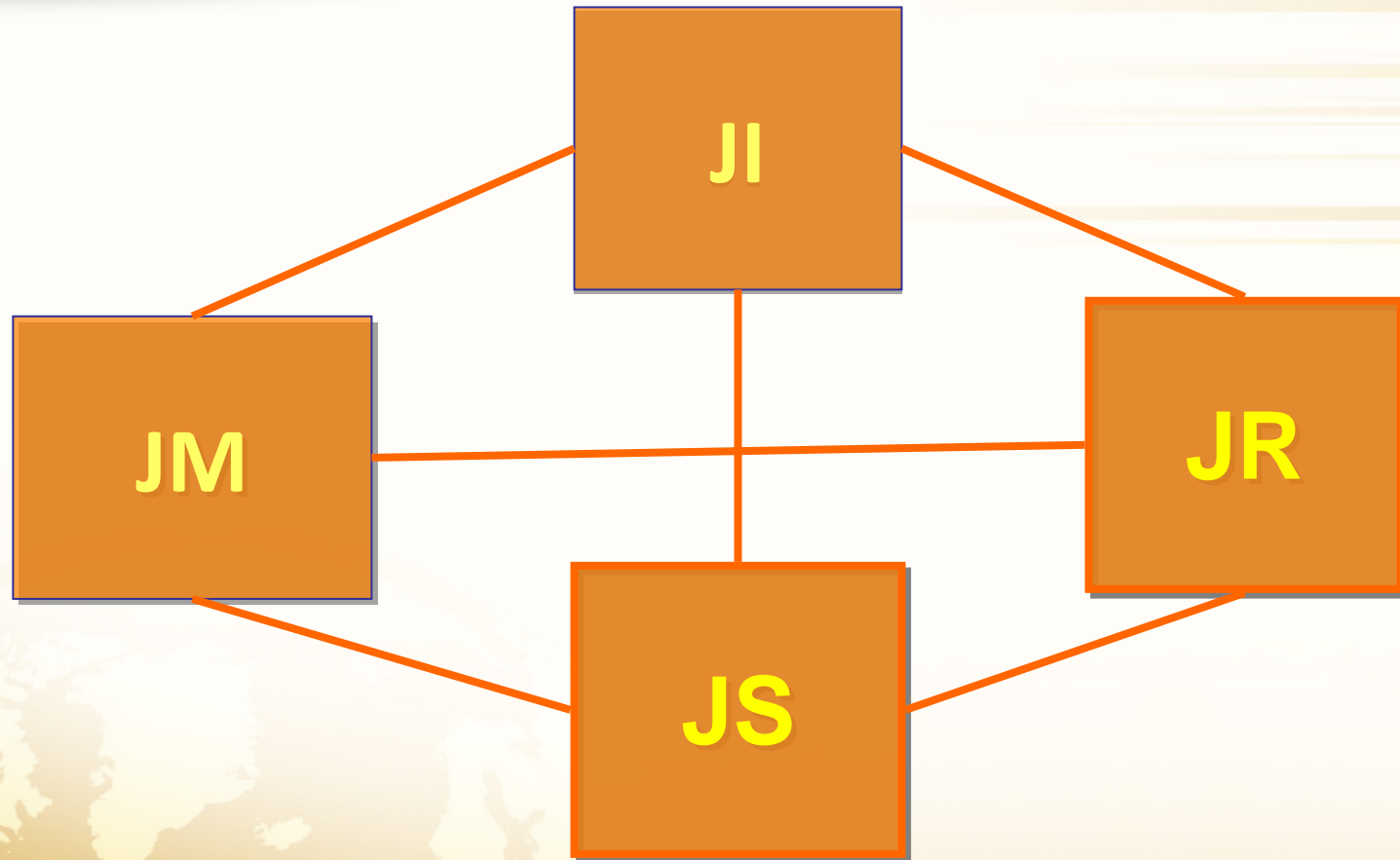
Isao “Ike” Kato – Retired from Toyota after 35 years and known as the *father of standardized work and kaizen courses*.



I don't think you can do a good job of implementing standardized work or several other elements of TPS without the JI skill set in place. I have observed quite a few companies struggle with implementing standardized work, kaizen, and other items. *Often the short term gains companies obtain fall away over time.* [emphasis added] One direct reason why is that no proper plan was ever put in place to train people to the new method and the JI technique provides the exact skill set required to do this work. I can't see how standardized work can function without JI in place underneath to support it in the long run.

Source: http://artoflean.com/documents/pdfs/Mr_Kato_Interview_on_TWI_and_TPS.pdf

TWI is a System!



From Jim Huntzinger, 'TWI Case Study: Ohno's Vehicle to TPS', TWI Summit, 2008

TWI and Toyota Today

- Job Instruction has not changed at Toyota in 60 years!
- An example of TWI's robustness

TWI, 1944

HOW TO GET READY TO INSTRUCT

Have a Time Table—
How much skill you expect him to have, by what date.

Break Down the Job—
list important steps, pick out the key points. (Safety is always a key point)

Have Everything Ready—
the right equipment, materials, and supplies.

Have the Workplace Properly Arranged—
just as the worker will be expected to keep it.

Job Instruction Training

TRAINING WITHIN INDUSTRY
Bureau of Training
War Relocation Commission

KEEP THIS CARD HANDY
470 10-3124-1

Toyota, 2003

Job Instruction
How to get ready to instruct

1. Have a Planning Time Table
 - How much skill you expect him/her to have by what date
2. Break down the job
 - List major steps
 - Pick out the key points (Safety is always a key point)
3. Have Everything ready
 - The right equipment, materials and supplies
4. Have the workplace properly arranged
 - Just as the team member will be expected to keep it

TOYOTA

TWI, 1944

HOW TO INSTRUCT

Step 1—Prepare the Worker
Put him at ease. State the job and find out what he already knows about it. Get him interested in learning job. Place in correct position.

Step 2—Present the Operation
Tell, show, and illustrate one **IMPORTANT STEP** at a time. Stress such **KEY POINT**. Instruct clearly, completely, and patiently, but no more than he can master.

Step 3—Try Out Performance
Have him do the job—correct errors. Have him explain each **KEY POINT** to you as he does the job again. Make sure he understands. Continue until YOU know HE knows.

Step 4—Follow Up
Put him on his own. Delegate to whom he goes for help. Check frequently. Encourage questions. Type off extra coaching and close follow-up.

If Worker Doesn't Learn, the Instructor Hasn't Taught

Toyota, 2003

How To Instruct

STEP 1: PREPARE TEAM MEMBER

STEP 2: PRESENT OPERATION

STEP 3: TRY OUT PERFORMANCE

STEP 4: FOLLOW UP

If the MEMBER hasn't learned, the INSTRUCTOR hasn't taught.

Front Side of the Cards

Front Side of the Cards

SOURCE: The Original Job Instruction card is from 1944 Job Instruction training manual. The Toyota Job Instruction card is courtesy of the Toyota Motor Corporation, Toyota Motors Manufacturing, Kentucky, TMM-K.

What TWI Learned about sustainability (1940-1945)

- A set plan needs to be agreed beforehand
- Training is useless without participation
- Managers need to be involved ('only when senior management understands, sponsors, participates, and demands results..')
- Supervisors are key
- Results and problems need to be recorded
- 5 x 2hr is much, much better than 1x10hr

From Donald Dinero, *Training within Industry: The Foundation of Lean, Productivity*, 2005



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What TWI taught Toyota (or reinforced)

- Job Methods have an important role in developing Kaizen
- Going to the source, observing in detail, learning by doing
- TWI 'taught the scientific, rational approach to the Japanese'
- Taylor > TWI > Toyota > The West
- W & J quote teamwork as 'the heart of the Lean Factory' and TWI taught the importance of Team Leaders and Supervisors. Hence Toyota's small span of control



Lean Accounting.....

- A man found that his cost on a certain article was 30 cents. When he found that he could buy it for 26 cents, he gave orders to stop manufacturing and to buy it, saying he did not understand how his competitor could sell at that price. He seemed to realise that there was a flaw somewhere but he could not locate it. I then asked him what his expense consisted of. His reply was labour 10 cents, material 8 cents, and over-head 12 cents.
- The next question that suggested itself was how the 12-cent overhead would be paid if the article was bought. The obvious answer was that it would have to be distributed over the product still being made, and thereby increase its cost. In such a case it would probably be found that some other article was costing more than it could be bought for; and, if the same policy were pursued the second article should be bought, which would cause remaining product to bear a still higher operating expense rate.
- If this policy were carried to its logical conclusion, the manufacturer would be buying everything before long, and be obliged to give up manufacturing entirely. Fortunately..... people as a whole will finally discard theories which conflict with common sense and, when their cost figures indicate an absurd conclusion, most of them will repudiate the figures. A cost system which fails us when we need it most, is of but little value and it is imperative for us to devise a theory of costs that will not fail in use"
Gantt (1861-1919) presentation to The American Society of Mechanical Engineers,
Buffalo, New York. **1915**



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- **People**



Improvement and People: The Gemba



Hawthorne

- Landsberger (1955)
- Based on
- The Hawthorne Studies 1924-1932



Pygmalion

- Rosenthal (1968) and many subsequent



Conclusions

- Continual rediscovery
 - ➔ Building on the best we have found thus far
- Critical adaptation
 - ➔ Ohno's reservations about adopting TPS
- Not dogmatic or arrogant
 - ➔ Remember Smiles
- Look back to look forward
 - ➔ Don't reinvent, build



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