The application of 7 Zeroes in improvement of Lean and Agility manufacture

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Abstract

Hopp and Spearman (2000) introduce two statements on the waste-free state that were given as early as 1983. The first statement used the term “zero inventories” to describe the ideally lean state. Another statement described the ideal goal by “seven zeros” corresponding to the different types of wastes. These are: Zero accidents, Zero defects, Zero delays, Zero inventory, Zero breakdowns, Zero changeovers, Zero waste (i.e. smooth flow). Hopp and Spearman pointed out that these “zeros” are physically unachievable in practice, but the goals inspire an environment of continual improvement. Nevertheless, the vision of the idea goals played an important role in developing the measure of leanness.

The purpose of implementing lean manufacturing is to become leaner. Ultimately, the goal of a leanness manufacturing system is to become totally “waste-free.” Also we can use these in agility manufacturing, where lean and agility mix together and corporate a new concept that call Leagility.

Key words: 7 zeroes, Lean manufacture, Agility manufacture

Introduction

There are different histories for every zero that will mention a number of them in its turn. I couldn’t find all of 7 zeroes in an article. Also there is another similar concept that calls 7 wastes. They are so similar, but not same. This essay created by sites and diverse articles.

Discussion and research findings:

Seven zeroes are include:

1) Zero accidents:

The philosophy of the Zero-accident is to respect human life. Specific safety methods developed so that workplaces can take steps on preemptive action for safety include hazard prediction training and pointing and calling. Activities incorporating these methods in a unified manner are called hazard prediction activities.
A. Hazard prediction training (KYT)

*KYT (K: kiken (hazard), Y: yochi (prediction), T: (training))

Using illustrations showing the workplace and work conditions, or while supervising or demonstrating work in real situations on site, discuss in small groups hazardous factors in the workplace and in work conditions (unsafe conditions and unsafe behavior that may lead to industrial accidents or accidents). Discuss, think about, and understand (or ask yourself about) the phenomena (type of accidents) that may arise from such factors, and determine the danger points and the kind of action to take, confirming these with pointing and calling, and pointing and saying out louder together. Conduct this training so that you can take steps on preemptive action for safety before you act.

The hazard prediction training based on the KYT Basic 4-Round Method and short meetings includes the following elements: Operational Direction STK Training on a supervisory level; Individual KY; KY by asking questions; One-point KY on a team level; SKYT; Individual KYT; KYT by answering a self-questioning and answering card; One-person 4R-KYT; Traffic KYT; KYT through meetings; and KYT by studying past disasters.

*STK (S: sagyo (work), T: team, K: kiken-yochi (hazard prediction))

*SKYT (Short-time KYT)

The KYT Basic 4-Round Method forms the foundation for all these elements. Workers openly discuss the hidden hazards depicted in the illustrations of the workplace and work conditions and solve problems by proceeding through the four rounds step by step.

- **Round 1**: What are the hidden hazards? (Understanding the actual situation)
- **Round 2**: These are the danger points. (Investigating the reality)
- **Round 3**: What would you do? (Establishing countermeasures)
- **Round 4**: These are the danger points. (Setting targets)

The KYT method increases the motivation of workers to practice in teams. It uses meetings to sharpen awareness of what constitutes danger. Workers share information on hazards and improve their problem solving capabilities by working on finding
solutions in meetings. And they improve their powers of concentration by practicing pointing and calling activities in all of the important points in the work.

B. Pointing and calling

This activity involves pointing at target objects by stretching your arm and stating out loud, “Such and such is OK” at important points in the work in order to proceed with work safely and correctly.

Pointing and calling are methods for raising the consciousness level of workers and confirming that conditions are regular and clear, increasing the accuracy and safety of work. This method for ensuring safety is based on the philosophy of respecting human life and can be achieved only with the full participation of the workforce in practice activities across the whole of the workplace.

The results of proof testing conducted by the Railway Technical Research Institute in 1994 showed that the rate of work-related errors decreased to less than one-sixth when conducting pointing and calling as compared with doing nothing.

C. Pointing and saying out loud together

Pointing and calling conducted by more than two people is referred to as “pointing and saying out loud together,” while “pointing and calling” is performed, in principle, by one person. The aim of this method is to join forces and to enhance a sense of oneness and community within a team by confirming the object through pointing and saying out loud together.

The “pointing and saying out loud together” method includes “touch and call” (touching, overlapping hands, forming a circle) with physical contact among all workers.

Other practice methods

- Health KY (hazard prediction), training for active listening, one-minute meditation, and hachidankin (traditional Chinese physical exercises that include eight types of physical movement to increase your physical strength)
- The 4-Round Method for problem solving, meetings to discuss near-miss accidents, and KYT on near-miss accidents
Complete management of safety and health system by line managers and supervisors

2. To prevent accidents caused by human error

The most common cause of accidents or industrial accidents is often attributed to human error such as operational error, judgmental error, and job-related error, all of which are caused by human characteristics. Most of these errors are said to be associated with psychological factors affecting human behavior. The mechanism of the occurrence of industrial accidents shows that unsafe situations, i.e., machinery failure or deficiency of work method, account for 80% of the total accidents. Work is always accompanied by issues related to human error, and unsafe behavior accounts for about 90% of all accidents, including those caused by inexperienced and unskilled workers. Human behavioral characteristics, such as mistakes and carelessness, are called “human characteristics,” and errors caused by human characteristics are called “human errors.

Safety first must be a way of life and not just a slogan. Without serious workplace-centered and people-centered daily attention to safety, there is no credibility to other aspects of lean management.
In order to tackle accidents caused by human error:

A. Hardware (equipment, facilities, and other tools)

It is important to push ahead with safety and health measures in terms of hardware (facilities, machinery, working environment, and raw materials) for the prevention of accidents caused by human error.

B. Software (human beings as well as hardware)

In addition to the above measures, it is necessary to improve the working environment including the relationship between workers and hardware as well as work from the perspective of a man-machine system.

C. Humanware

Humanware incorporates the safety and health management of both hardware and software. Effective humanware hazard prediction activities incorporate countermeasures against human error and include the Zero-accident Campaign, the hazard prediction training (KYT), and pointing and calling.

The Zero-accident builds on the three principles of zero accidents, preemptive action, and participation.

These are called the three basic principles.

A. The principle of zero accidents

“Zero accidents” means to achieve an accident free workplace (not only no fatal accidents or accidents causing absent from work, but also no accidents, including industrial accidents, occupational illness, and traffic labor accidents) by detecting, understanding, and solving all hazards (problems) in everybody’s daily life as well as potential hazards existing in workplaces and work.

B. The principle of preemptive action

“Preemptive action” means to prevent all accidents and industrial accidents by detecting, understanding, and solving all hazards (problems) in everybody’s daily life as well as potential hazards existing in workplaces and work in order to create a brighter and more vigorous workplace with zero accidents and zero diseases as an ultimate goal.
C. The principle of participation

“Participation” means to make a concerted effort by managers, supervisors, staff, and workers to detect, understand, and solve potential hazards (problems) existing in workplaces and work. It requires the voluntary effort and commitment of all those involved in actions for problem-solving.

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2) Zero defects.

"Zero Defects" is one of the postulates from Philip Crosby's "Absolutes of Quality Management". Although applicable to any type of enterprise, it has been primarily adopted within industry supply chains wherever large volumes of components are being purchased (common items such as nuts and bolts are good examples).

Zero Defects was a quality control program originated by the Denver Division of the Martin Marietta Corporation (now Lockheed Martin) on the Titan Missile program, which carried the Project Gemini astronauts into space in the middle to late 1960s. It was then incorporated into the Orlando Division, which built the mobile Pershing Missile System, deployed in Europe; the Sprint antiballistic missile, never deployed; and a number of air to ground missiles for the Vietnam War.

Zero defect is a way of thinking and doing that reinforces the notion that defects are not acceptable, and that everyone should "do things right the first time". The idea here is that with a philosophy of zero defects, you can increase profits both by eliminating the cost of failure and increasing revenues through increased customer satisfaction.

This is a much longer road than zero accidents and requires an early start and long-term commitment. Fundamental behavior and attitude changes come first, followed by the more technical aspects of problem solving and prevention. Without safety, you don't have a workplace and without quality you don't have a product.

**Principles of Zero Defects**

The principles of the methodology are four-fold:
A. Quality is conformance to requirements

Every product or service has a requirement: a description of what the customer needs. When a particular product meets that requirement, it has achieved quality, provided that the requirement accurately describes what the enterprise and the customer actually need. This technical sense should not be confused with more common usages that indicate weight or goodness or precious materials or some absolute idealized standard.

In common parlance, an inexpensive disposable pen is a lower-quality item than a gold-plated fountain pen. In the technical sense of Zero Defects, the inexpensive disposable pen is a quality product if it meets requirements: it writes, does not skip or clog under normal use, and lasts the time specified.

B. Defect prevention is preferable to quality inspection and correction

The second principle is based on the observation that it is nearly always less troublesome, more certain and less expensive to prevent defects than to discover and correct them.

C. Zero Defects is the quality standard

The third is based on the normative nature of requirements: if a requirement expresses what is genuinely needed, then any unit that does not meet requirements will not satisfy the need and is no good. If units that do not meet requirements actually do satisfy the need, then the requirement should be changed to reflect reality.

Further, the idea that mistakes are inevitable is rejected out of hand. Just as the CEO wouldn't accept 'mistakenly' not getting paid occasionally, his/her chauffeur 'mistakenly' driving them to the wrong business, or their spouse 'mistakenly' sleeping with someone else, so the company shouldn't take the attitude that they'll 'inevitably' fail to deliver what was promised from time to time. Aiming at an "acceptable" defect level encourages and causes defects.

D. Quality is measured in monetary terms – the Price of Nonconformance (PONC)

The fourth principle is key to the methodology. Phil Crosby believes that every defect represents a cost, which is often hidden. These costs include inspection time, rework, wasted material and labor, lost revenue and the cost of customer dissatisfaction. When properly identified and accounted for, the magnitude of these costs can be made
apparent, which has three advantages. First, it provides a cost-justification for steps to improve quality. The title of the book, "Quality is free," expresses the belief that improvements in quality will return savings more than equal to the costs. Second, it provides a way to measure progress, which is essential to maintaining management commitment and to rewarding employees. Third, by making the goal measurable, actions can be made concrete and decisions can be made on the basis of relative return.

**Criticisms**

Criticism of "Zero Defects" frequently centers around allegations of extreme cost in meeting the standard. Proponents say that it is an entirely reachable ideal and that claims of extreme cost result from misapplication of the principles. Technical author David slusburg claims that W. Edwards Deming was critical of this approach and terms it a fad.

Another criticism was that Zero Defects was a motivational program aimed at encouraging employees to do better (Wikipedia site).

Zero defects can be so effective, because it means it's adaptable to any situation, business, profession or industry.

3) **Zero delays.**

The decomposition of “Meet customer expected lead time” and “Mean throughput time reduction,” focuses on identifying predictable sources of delays and prescribing general solutions for elimination. A delay is defined as time that a part spends in the manufacturing system when it is not being processed. Throughput time is defined as the total time that a part spends in the manufacturing system, from the time it enters as raw material to the time it leaves as a finished product. A relationship exists between the time a part spends in the manufacturing system and the total number of parts in the system. This relationship, known as Little’s Law (Little, 1961), can be expressed as follows:

\[ L = \lambda W \]  

(1)
Where the variables and their units are the following:

L: Average quantity of parts in the system (i.e. total inventory) [parts]

λ: Average rate parts enter and leave the system [parts / time]

W: Average time spent in system (i.e. throughput time) [time]

This relationship assumes that the manufacturing system is operating at a steady state, so that the rate parts enter the system is, on average, equal to the rate at which parts leave the system. If these rates are not equal, parts will either accumulate in the system (arrival rate > departure rate) or the number of parts in the system will go to zero (arrival rate < departure rate). Little’s Law has been used to develop quantitative relationships between inventory and throughput time for the delays mentioned in this decomposition branch.

The delays identified in the MSDD include: lot delay, process delay, run size delay, transportation delay, and systematic operational delays.

Continuous flow of material and information results in finishing the work you started as quickly as possible. This has the benefit of helping you get paid quicker for the work you have put in, avoiding spoilage of your work, as well as getting feedback from your customer sooner. Questioning delays forces us to look at the reasons why we put things down rather than finish them, and then to connect and balance processes so that work moves along smoothly. Much of the time this is due to problems in planning and information flow.

4) Zero inventory.

It includes excess stock in the form of raw materials, work-in-progress, and finished goods.

We place inventory in the middle of the list because we shift into looking at material and information flow from a systematic level when we aim for zero inventory. Lowering inventory exposes previously hidden problems throughout the entire process from placing orders through delivery. In simple terms, to compromise on the zero inventory philosophy
is to compromise on making problems visible. Zero thinking is a practical philosophy of not compromising the pursuit of these ideals.

Maintaining a minimum level of inventory as part of a goal to reduce costs and increase profitability. Although an actual level of zero inventory is unlikely, a strategy to reduce inventory should result in lower expenses associated with warehousing, spoilage, and so forth. The term is sometimes used synonymously with just-in-time inventory.

5) Zero breakdowns.

We might think of breakdowns as accidents that happen to machines and equipment. We need to take care of our valuable physical assets and hardware as well as we take care of our people. People and machines process material and information to make us money. Zero breakdowns come in at step 5 so that we can prioritize breakdown prevention in ways that support safety, defects, delay and inventory improvement objectives.

There are two types of breakdowns: the function loss and function reduction breakdown. Function loss breakdowns occur when all the equipment functioning stops. This is the type of breakdown that most people are familiar with. However, setups and adjustments also stop all equipment functioning. Idling and minor stoppages also stop all equipment functioning even if just for a brief time period. Therefore, any loss that is created when all equipment functioning stops can be considered a function loss breakdown. Of the six major losses, breakdowns, setups and adjustments, and idling and minor stoppage losses would be considered function loss breakdowns.

The second type of breakdown would be a function reduction breakdown. This breakdown is when efficiency losses occur. The equipment may be operating, but it is not achieving design specifications.

Zero breakdown strategies can be categorized into five activities:

- Maintaining basic conditions
- Maintaining operating standards
- Restoring or preventing deterioration
- Improving or eliminating design weaknesses
- Preventing human error
6) **Zero changeovers.**

Increase uptime, production volume, security, flexibility, and produce small batches profitably. Reduce Standard Operating Procedures, supply chain sequences and checkpoints. Eliminate reconciliation. Where could Zero boost your processes?

The ideal process is available to produce whatever is needed whenever it is needed. This level flexibility is only possible when there is no artificial economy of scale driven by the desire to avoid time lost to changeovers. Equipment and processes must be designed to make zero changeovers a reality (changeover activity may happen but do not result in lost capacity).

7) **Zero waste.**

Zero Waste is a goal that is ethical, economical, efficient and visionary, to guide people in changing their lifestyles and practices to emulate sustainable natural cycles, where all discarded materials are designed to become resources for others to use. Zero Waste means designing and managing products and processes to systematically avoid and eliminate the volume and toxicity of waste and materials, conserve and recover all resources, and not burn or bury them. Implementing Zero Waste will eliminate all discharges to land, water or air that are a threat to planetary, human, animal or plant health.

Are you surprised to find waste placed last? Since we are addressing some of the 7 types of waste directly in the list above such as inventory, defects and delay, we must think of waste in broader terms here to include wasted space, energy, polluting the environment and even the waste of existing talent or the potential for people to learn and achieve excellence.
Agility manufacture

The figure 1: Sharp model

The figure 2: Gunasekaran model

Case study

Our client was an antifreeze factory that provide its’ PE & PT bottles from another factory. This factory had to pay the transportation costs of these bottles. We were asked that made decision between the strategy of buying trucks and rent them. We regardless of their determined strategies started to identify issue and we found a better solution.

We calculated cost-benefit and realized if the factory can produce the bottles their needs is more beneficial for them. Thus by redesigning the layout of machines and devices and use of
unused space in the factory could create the space needed to produce the bottles interruption of material delaying to factory. Therefore could reduce wastes of delay, inventory, transportation and motions.

**Conclusion**

None of these are discrete steps that start and end prior to the next step beginning. Think of them as a series of parallel activities that have staggered starting points but go on forever. The purpose of placing the starting point for each of the zero thinking steps in sequence is twofold: you can't focus effectively on seven areas at once, and you need to know where to start and what to do next. The timing at which you start the next step (while continuing efforts with the previous step) will be different with each organization. You will know if you started the next step too early, take a half a step back and firm up the foundation before moving forward.

One can always argue that inventory is a must-have for warehousing and distribution businesses, or that zero breakdowns do not apply to a pure service organization that has no physical assets to speak of, such as a psychiatrist. The seven steps to zero thinking were organized in that way based on our experiences in manufacturing-type processes so it is very possible that other arrangements are possible.

7 zeroes had applied in JIT and Lean production. We can achieve to agility manufacture from Lean manufacture by Sharp model. So, the organizations which have problem to achieve Agile manufacture. So these organizations can use a method which corporate by both of Lean and Agility manufactures that called Leagility.
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