LEAN MANUFACTURING

DEVELOPMENT TIMELINE

Inception

Early developments in lean manufacturing center around automation, standardization of work and developments in manufacturing theory.

Lean manufacturing begins with advancements in automation and interchangeability, dating back as far as the 1700s.

1913 YEAR — HENRY FORD
first turns on his assembly line, signaling a new era in manufacturing

1921 YEAR — KIICHIRO TOYODA
visits U.S. textile factories to observe methods

1923 YEAR — ALFRED P. SLOAN
becomes president of General Motors, institutes organizational changes

1925 YEAR — FORD
begins assembly in Japan, under their subsidiary company,

1927 YEAR — GM
begins assembly in Japan, at their subsidiary company, GM-Japan

Coninuous flow
production leads to 15 million units of the Ford Model T over 15 years

Kiichiro Toyoda
owned a textile company, and actively sought ways to improve the manufacturing process

1924: Jidoka
Sakichi Toyoda perfects his automatic loom and coins the term "Jidoka," meaning "machine with a human touch," referring to the automatic loom's ability to detect errors and prevent defects.

Global competition

The rise of global competition begins with American domination of the internation auto market. Toyota Motor Corporation is developetd in Japan, largely in response to low domestic sales of Japanese automobiles.

In the late 1920s and 1930s, American automaking dominates the global market, including the Japanese market. Ford and GM expand operations

1927 YEAR — TOYODA COMPANY
adapts assembly line to loom production

1937 YEAR — TOYOTA MOTORS
Toyota Motor Corporation established, with Kiichiro Toyoda as President

Flow production in practice
Factory laid out according to a plan authored by Kiichiro Toyoda, optimized for early **flow production**

1937 - 1945 — WORLD WAR II
leads to rationing, materials shortages and other challenges to manufacturing

1937 YEAR — WORLD WAR II
begins in the Pacific, with the Japanese invasion of China

1939 YEAR — WORLD WAR II
begins in Europe, with the German invasion of Poland

1941 YEAR — UNITED STATES
joins World War II, declaring war on Japan

1945 YEAR — WORLD WAR II ENDS
Germany formally surrenders, followed months later by Japan

"A Bomber an Hour"
Ford-run, government-funded Willow Run Bomber plant mass produces the B-24

During World War II, both Ford and Toyota are forced to divert resources into military manufacturing. Scarcity of materials slows some progress, but encourages greater efficiency

Economic strains and wartime policies present unique challenges to the manufacturing industry, along with opportunities to test new, efficient methods of production.

Wartime shortages

1950 YEAR — MANAGING DIRECTORS
of the Toyota Motor Corporation train with the Ford Motor Company

1954 YEAR — SUPERMARKET SYSTEM
of supplying parts in the Toyota plant is first implemented

Just in Time
manufacturing systems still modeled after this process

Following the conclusion of World War II, the United States and Japan begin collaborating to further develop manufacturing efficiency, especially in the automotive industry.

Peacetime cooperation

1979 YEAR — NORMAN BODEK
begins transcribing Japanese literature on manufacturing efficiency

1988 YEAR — JOHN KRAFCIK
A student at MIT, coins the phrase "lean production" in a paper

1990 YEAR — JAMES WOMACK
publishes "The Machine that Changed the World"

In recent decades, lean manufacturing has continued to expand through industries around the world, both in practice and theory.

"Lean manufacturing" enters the industrial and academic lexicon, and both manufacturers and researchers work to adapt the theory and practices developed in the auto industry to apply to a wide range of industries.

Translation and Expansion

EAGLE Group
AN EMPLOYEE OWNED COMPANY

TOOLS

OF LEAN MANUFACTURING

Developed over decades, the following tools can be used individually or in combination to improve efficiency and make manufacturing "leaner." When embarking on a journey towards lean manufacturing, each company must decide which tools to implement, and how to customize each one to fit their particular needs.

5S

5S is often the launching point for businesses just starting with lean manufacturing. Much of 5S seems intuitive, but implementing each step can result in significant improvements in efficiency and quality.

Sort - Organize every workspace by separating the necessary (materials, tools) from the unnecessary (waste, scrap, redundancies) and remove anything unnecessary from the production area

Set In Order - lay out the necessary inputs of production (tools and materials) in an easy, intuitive manner

Shine - Clean the workspace and remove any clutter

Standardize - Make a list of instructions for repeating the first three steps, so that any employee who arrives in the workspace knows exactly how to proceed

Sustain - Rinse and repeat. Sort, Set In Order and Shine on a regular basis, so that the workspace stays clean and clutter-free at all times.

BOTTLENECK ANALYSIS

Bottleneck analysis is the practice of finding bottlenecks and reducing them, or eliminating them entirely.

Evaluate the manufacturing chain, and look for the slowest or least stable aspect of the process.

Consider this "weakest link." How can it be strengthened, replaced or eliminated?

CELLULAR MANUFACTURING

Cellular manufacturing is the practice of grouping equipment and processes around specific parts, rather than grouping them based on equipment type or process type. Traditionally, manufacturing environments are organized so that all parts go through one process, and are then transported to another area to undergo another process. In cellular manufacturing, a part stays inside a single "cell" to undergo several processes. In setting up manufacturing cells, manufacturers must plan and execute the following:

Product grouping: combine parts based on key production similarities (size, equipment used, common processes)

Cell design: organize equipment within the cell, taking into account movement of personnel and production flows

Shop floor layout: organize cells on the shop floor, maximizing efficiency of storage and transportation

Schedule: starting and carrying out jobs in each cell

The primary goal of cellular manufacturing is to reduce a part's movement around the shop floor, which can be highly effective in reducing lead times, inventory buildup and production errors.

CONTINUOUS FLOW

Also known as one-piece flow, continuous flow is closely related to cellular manufacturing. In contrast to traditional "batch" manufacturing, continuous flow focuses on processing limited numbers of parts, one after another.
For example, in a well established manufacturing cell, a part may go through three or four different processes. As soon as the part has completely moved through the cell, the next part is taken and the processes repeated. As continuous flow is perfected, any downtime or extraneous processes are removed from production.

One of the major benefits of continuous flow production is that parts can be produced to match customer demand, and production can stop whenever demand is met. This way, standing inventory can be kept to a minimum.

GEMBA

Gemba is more of a philosophy than a concrete set of steps. Translating roughly to "the real place," gemba encourages executives and upper management to spend as much time as possible on the shop floor, interacting with employees and witnessing the production process firsthand.
By adopting a culture of gemba, companies can improve in several ways, including:

Building communication chains between the shop floor and the executive offices

Promoting a more thorough understanding of issues that affect production

Cultivating a more harmonious work environment

KAIZEN

One of the cornerstones of lean manufacturing, Kaizen focuses on continuous improvement in the manufacturing process. It's obvious that any business would want to improve their processes as much as possible, but Kaizen is more about creating an environment that allows continuous, incremental improvement. To use Kaizen, companies should:

Promote communication between shop-floor employees and management

Regularly request feedback from employees at all levels

Separate, record and quantify all aspects of production

Continually stay abreast of technological advancements

KPIS (KEY PERFORMANCE INDICATORS)

KPIs are performance indicators that align closely with broad company goals. When developed correctly, they offer a roadmap to all employees, and a way to self-evaluate success and improvement while on the job. Ideal KPIs should:

Involve measurement of waste

Be directly affected by shop-floor employees.

While not everyone at the company attends the board meetings, KPIs can get everyone on the same page and drive the company toward success.

MUDA

Muda simply means "waste." In manufacturing, muda is anything in the process that fails to add value to the customer's purchase. Muda could be excessive packaging, or unnecessary finishing processes, or even vending machines in the break room stocked with unpopular snacks.

Muda comes in almost infinite shapes and sizes, and its elimination is the basic tenet of lean manufacturing.

OEE (OVERALL EQUIPMENT EFFECTIVENESS)

Expressed as a percentage, OEE allows businesses to evaluate the productivity of their manufacturing resources. OEE measures three aspects of equipment:

Availability: how often a machine is broken or not functional

Performance: how slowly a machine produces parts, compared to its optimal speed

Quality: how often a machine produces rejects instead of perfect parts

100% OEE is a theoretical benchmark where a process is performing perfectly at its capacity, with no errors or defects. By evaluating each process and pushing toward 100% OEE, companies can eliminate waste and improve maintenance practices.

PDCA (PLAN, DO, CHECK, ACT)

PDCA is a simple acronym for the process surrounding any improvement that a company implements. Based on the scientific process, PDCA stands for Plan, Do, Check, Act:

Plan - decide how to implement the change, and record the expected results
Do - implement the change as planned
Check - evaluate the results based on the expected results
Act - adjust the strategy if needed, or induct the change into the standard process

ROOT CAUSE ANALYSIS (FIVE WHYS)

Root Cause Analysis is a problem-solving methodology that helps uncover the actual cause of a problem. Too often, part defects and equipment failures are treated with band-aid measures, dealing with the aesthetic problem but doing nothing to prevent the problem from occurring again.

Root Cause Analysis is often called "Five Whys," because a common way to implement the methodology is to ask "why?" five times, each time getting closer to the root of the problem.

SMART GOALS

SMART goals are another example of a highly flexible lean tool, widely applicable in just about any industry. SMART is an acronym to help decision-makers design company goals. Using SMART, all goals should be:

Specific: expressed as an exact number or percentage

Measurable: attached to monitorable metrics

Attainable: grounded in realistic expectations

Relevant: related to company success

Time-bound: attached to a specific timeline for completion

TAKT TIME

Takt time is the average time allowed to manufacture a product in order to match customer demand.

Takt time can be calculated with a simple formula: Takt time = Time available (per period)/ Customer demand (per period). The resulting value gives manufacturers an idea of how often they should schedule the start of production for each part.

Implementation of takt time motivates manufacturers to eliminate waste in the production system, to zero in on bottlenecks, and to remove non-value-adding work from the process.

TPM (TOTAL PRODUCTIVE MAINTENANCE)

Total productive maintenance is an equipment-focused tool that aims to eliminate four things: breakdowns, slow operation, defects and accidents. Training and scheduling are two important aspects of TPM, which focuses equally on equipment operators and on management.

The following are "pillars" of TPM:

Autonomous Maintenance: making operators responsible for cleaning and maintaining equipment

Planned Maintenance: scheduling maintenance tasks based on likely periods between failures

Quality Maintenance: adding error detection into the production process and using root-cause analysis to solve any problems

Focused Improvement: encourage collaboration to regularly achieve small process improvements

Early Equipment Management: apply knowledge of failures and issues to improve installation or production of new equipment

Training and Education: make sure everyone, from headquarters to the shop floor, is equipped with the knowledge to implement TPM principles

Safe and Healthy Environment: minimize hazards and risks to all employees

TPM in Administration: apply the same set of guidelines listed above to company administration

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LEAN MANUFACTURING

INTRODUCTION

Lean manufacturing helps manufacturers improve efficiency by eliminating waste in the production process–but what exactly is lean manufacturing? Is it a product, a procedure, a religion?

In short, it's none of the above. Lean manufacturing is an adaptable set of "tools" that can be applied to any system of manufacturing--whether that system produces spring coils, jet engines or blog posts. It starts with identifying waste in a production process, and then focuses on eliminating that waste bit by bit until production is as streamlined and efficient as possible.

If you're curious about lean manufacturing, chances are you work in the manufacturing industry and you're wondering if lean could work for you. Many different businesses have a proven track record of using lean to improve their processes and increase profitability. However, lean is not a quick fix or a time-saving product you can buy; it's a set of tools that need to be applied consistently and rigorously in order to produce benefits.

LEAN MANUFACTURING BACKGROUND AND HISTORY

Lean manufacturing has roots in Henry Ford's assembly line, but Japanese entrepreneurial scientists–namely those working at Toyota–are directly credited with developing the lean manufacturing tools we use today. While the term, "lean manufacturing," wasn't coined until 1988, Toyota started developing its "tools" as early as the 1930s.

While Ford's manufacturing process was certainly revolutionary, it was anything but perfect. By implementing what he called "flow production," characterized most visually by the assembly line, Ford's automotive fabrication plant was able to churn out car after car with a high degree of quality and precision. If Model T's were the only car Ford ever made, they could have stopped right there. The problem, however, was variety. While flow production all but eliminated human error, bottlenecks and manufacturing defects, it was nearly impossible to adapt the Ford plant to manufacture anything but that beautiful, black Model T.

Starting with Ford's system, engineers at Japanese automaker, Toyota, began the process of perfecting flow production. The system they developed, called the Toyota Production System (TPS) formed the basis for modern lean manufacturing.

Since TPS emerged, lean manufacturing has become as academic as it is practical. In fact, the term, "lean manufacturing," was coined in an MIT Master's thesis. A wide variety of approaches now present manufacturers with different sets of tools, and these approaches themselves are constantly in flux. Lean manufacturing can be seen as the intersection of science and practice in manufacturing.

While quite a lot has changed over the decades--both in manufacturing technology and products themselves--the basic goals of lean manufacturing remain the same: eliminate waste, increase throughput speed and improve quality.