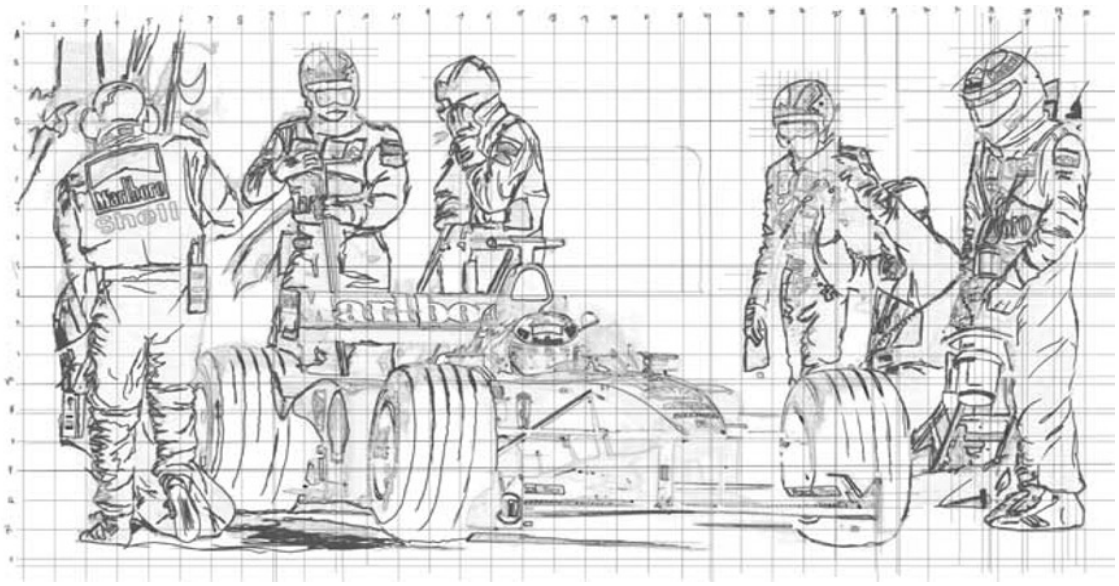
SMED
Quick Changeover
Setup Time Reduction
Turnaround Time Reduction



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Quick Changeover: The Winner's Edge

When an auto racer stops in the pits for fuel, tires, water, and whatever else they need, they do not stop racing. In the pits, they are racing the clock because to stop means they are giving up their place to the competitors still on the track. Typically they are in and out of the pit in approximately 10 to 15 seconds. At racing speeds of 200 miles/hr, an extra second in the pits represents over 200 feet on the racetrack. The margin of victory in many races is often in inches.

This same philosophy can apply to all manufacturing facilities in all industries. Once a production run has finished, it is important to get the production line changed over and up and running on the next product. Failure to do so will result in costs from lost capacity, wasted labor, lost production and the lost opportunity for a revenue stream. The cost of downtime in the typical consumer packaged goods plant can run from $10,000 to $25,000 per hour.

How does that racecar get in and out of the pit so quickly? While it may not be obvious or easy, the concepts and methods used are fairly simple. First, the specific pit stop process is formally defined. Everybody on the pit crew knows their job and everybody focuses and steps up to achieve the overall objective of short pit times. They have all parts and materials pre-staged before the pit stop begins. They have eliminated the use of tools where possible (i.e.; tear away windshields) and use the proper tool where they cannot be eliminated. Standardization of tools is done as much as possible.

These same concepts will work in any manufacturing plant for changeover. These concepts and methods are called SMED, Quick Changeover, Setup Time Reduction, and or Turnaround Time Reduction.

What Is SMED?

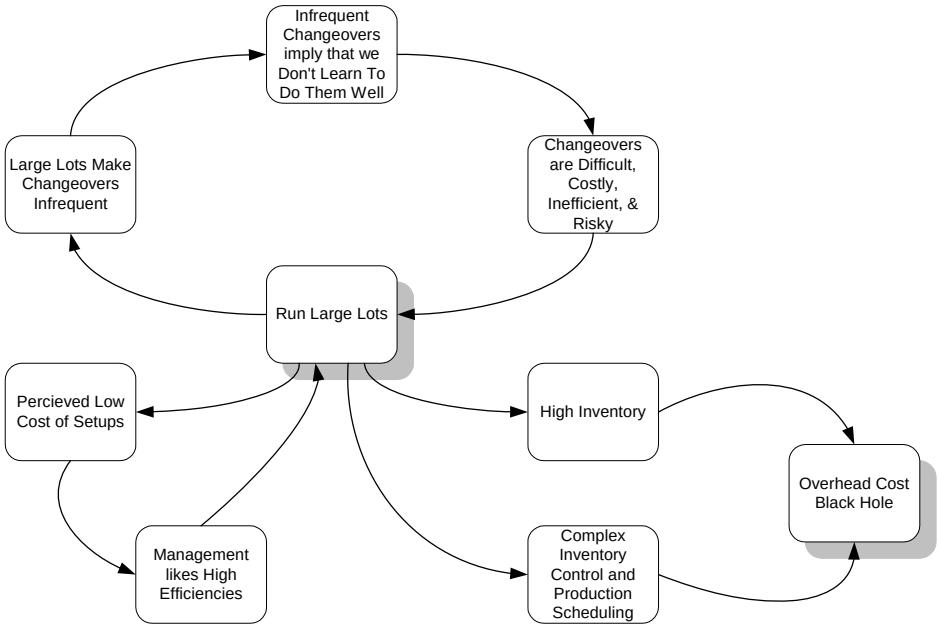
SMED, Single-Minute Exchange of Die, is a set of techniques for performing setup operations in under ten minutes (in a number of minutes expressed in a single digit.) The SMED method was formally practiced and originally written about by Mr. Shingo in the 1950's. The concept has revolutionized Japanese manufacturing since that time. The concepts and techniques became available around 1974 in West Germany and Switzerland and in 1976 in other parts of Europe and United States. However, not until the 1980s did the SMED technique begin to gain acceptance with companies outside Japan.

Why Is SMED Needed?

A production plant and its processes sit in place 24 hours a day, 7 days a week, year round. In an ideal world, it would be nice if we could utilize those assets 24 x 7 year round as well. However, 24 x 7 year round is not feasible. Even if the plant runs only one product and never has to changeover, even if no unplanned downtime occurs, even if the plant is able to produce yields of raw material to product of 100%, planned downtime is necessary to provide the kind of repair, maintenance, installations that creates a state of repair in which unplanned downtime and poor yields don't occur.

However, our ideal world does not exist for most operational plants. Multiple products are often run on the same process and therefore downtime is needed to change from one product to another. Some pieces of equipment within a process need to be cleaned or have planned but frequent maintenance done to them. Unplanned downtime does occur. Yield, well some plants are lucky to have 80% yield. Inefficiency is the norm more than the exception to the rule.

One way to gain efficiencies in the mind of many plant managers is to call for and insist on long runs of the same product so that downtime needed for changeovers can be avoided. Obviously making long runs or large lots of a product is good for process efficiency. But the consequences of large runs, when they exceed the customer's order size or when they make late the delivery of other products that come from the same production line, cost the organization money.



Inventory, especially finished goods inventory, which is created for the sake of process efficiency in lieu of sales, is in reality a form of cash. Money, real dollars, invested into the conversion of ingredients, packaging, labor, energy, equipment, etc. results in products and services that has a monetary valuation based on conversion costs and a monetary valuation based on competitive price. This investment of dollars makes cash less liquid, reduces cash flow, and puts margin at risk as the product sits in a warehouse and if the competitive price of the product drops unexpectantly.

SMED can help management avoid unnecessary buildup of inventory due to the desire to have process efficiency by providing the process capability to change over, clean, or maintain the process in a quick non obtrusive, and efficient fashion.

Components of Lead Time

In manufacturing, lead-time was started with design and ended with the deliver of the products or services to the customers. Thus, lead-time consists of the following time elements:

- Product Development (Design) Lead Time.
- Sourcing (Purchasing) Lead Time.
- Manufacturing (Production) Lead Time.
- Order Processing Lead Time.
- Distribution Lead Time.
- Other (e.g. decision making, coordination) Lead Time.

Clearly, Production lead-time is only a small portion of the whole lead-time, but it is the only component, which is controllable by the production function. The production lead-time can be further divided into:

- Queue Time Before Processing.
- Setup Time.
- Run (Processing) Time.
- Waiting Time after Processing.
- Move Time.

Among these time elements, run time is the only portion that adds values to the products. Others elements can be considered and are a waste. Therefore, if we strive to become more competitive and profitable, eliminating waste in the system makes a lot sense, including any time during the Production lead-time that is non-run time.

Effects of Setup Reduction

As we eliminate waste through changeover time reductions, these reductions may bring the following impacts to the shop floor:

- Lot-size can be reduced.
- Help to reduce inventory.
- Reduce the cost of setup labor.
- Increase the capacity on bottleneck equipment.
- Help to eliminate the setup scrap.
- Reduce the potential for Quality problems.
- Reduce the probability of product obsolescence from being in inventory too long.

Alternatives for Setup Reduction

However, before we make SMED the great wonderful only way kind of tool, let's not forget that SMED is not the only approach for reducing setup time. Some other alternatives are:

- Production Planning - reduce the number of setups with good planning and inventory management.
- Group Technology / cell formation - reduce the number of setups.
- Design Standardization - reduce the number of setups.
- Use Standard Module - reduce the number of setups.
- Work Simplification.
- Mechanization or automation - an expensive option.

SMED Basic How To

If we have actually done all that we can do to avoid non-productive time due to product changes, cleaning, or maintenance, SMED can be helpful in finding ways to minimize this downtime. The basic concept of SMED follows the following basic steps:

1) Maintenance, Organization, and Housekeeping

It often happens that setup problems are related to poor maintenance such as worn parts, worn tooling, dirt, or damaged threads. Disorganization and poor housekeeping are also contributors to setup problems. These are easy to fix and should be a first step.

2) Identify the Current Setup Process

If we do not know what the current setup process is, it cannot be improved. Knowledge of the current situation allows us to see the opportunities for improvement and the keys to the new process' ability to reduce setup time.

2) Internal Elements to External Elements

Internal elements occur when the machine is down. Examine each internal element and see if it cannot be done externally. For example, the pre-heating of an injection-molding die could be done before it goes into the machine.

3) Improve Elements

Here we examine every element to see how we can eliminate it, simplify it, reduce the time required or improve it in some other way.

4) Eliminate Adjustments

Adjustments are often the most time consuming, frustrating and error prone parts of a setup. There are many ways to eliminate them entirely and this is the ultimate goal.

Basic Guidelines for Setup Reduction

Each setup reduction event begins setting the objective – reducing setup times – with the group that is involved in the improvement initiative. After the group has been oriented to the project, the first task is to identify the current process(s) of setup or changeover. This can be done by drawing a flow diagram of each step and then noting how long each step takes.

Another method of defining the current situation is by videotaping one or two complete setups; recording every action the operator performs in a changeover. A time-marker on the video camera allows reviewers to construct a detailed sequence of setup activities, which is recorded in a computerized spreadsheet. How long each step takes is derived from the time-marker readings.

After the flowcharting or videotaping and the identification of each element of the process are complete, a team comes back together to conduct a brainstorming session. Its purpose is to

come up with all of the ways setup can be reduced and to sort out the best of these ideas. The team includes the operator from each shift and at least one manufacturing engineer. Representatives from other departments are designated to be on standby if their input is needed. These representatives include someone from design engineering, purchasing, production planning, and inventory control.

Brainstorming sessions follow a standard agenda shared with the group before the session starts. The six steps are:

- Review the flowchart with times or the video and element breakdown.
- Review what steps of the changeover process are external, internal, or just plain a waste of time.
- Sort the steps by how long they take.
- Brainstorm and discuss ideas to improve the longest duration step first, then move on to the next longest item, etc.
    - Start the improvement by planning to eliminate a "waste" step.
    - Then attempt to convert internal steps to external steps.
    - Finally look for ways to simplify and cut time from the remaining internal steps.
- List action items, assign responsibilities, and determine a timeline by creating an action plan.
- Implement the plan.

When reviewing the element breakdown – the process steps of the changeover, the team immediately determines which setup elements are a complete waste of time, which are external, and which are internal as was noted above. External steps, those that can be done while the machine is running, can be pulled out of setup right away, but procedures must be developed to ensure that these steps are completed before a current run is finished. External steps include getting parts, fixtures, gauges and cutting tools ready for the next run.

Internal steps, those that must take place when the machine is not running, must be streamlined. This is usually a matter of organizing the workspace and standardizing parts, fasteners, or equipment. Having all tools ready and within reach is an example.

Steps that are just plain waste often exist as well. These steps add no value, do not contribute to the changeover, and are not necessary. Spending time to retrieve a needed tool from the shop is an example of this form of waste.

The list on this page helps team members think about ways to reduce setup. Ideas from the brainstorming session are collected and organized.

Things to consider when brainstorming

✔**Workplace layout**
✔**Tooling and equipment organization**

- Make things easy to locate
- A place for everything and everything in its place

✔**Additional tools, equipment, gages**
✔**Machine repair**
✔**Things that can be done to prepare for next job while the current job is running**

- Setup tooling for next job
- Get collets or jaws for next job
- Get material
- Get inspection equipment

✔**Additional information on setup sheets**
✔**Visual aids—color code items, mark with numbers or letters, and so on**
✔**Is more information needed?**
✔**Is more training needed?**

The SMED Methodology Steps

SMED or Quick Changeovers can be conducted according to the following steps:

1. Considering the process and its constraints identify a process area that is a constraint and consider how beneficial SMED might be for the whole system's performance.

2. Select a certain machine area or work area for setup or changeover time reduction activities.

3. Form the setup reduction team.

4. Conduct training and education if needed.

5. Study and document the activity and duration of the current changeover or setup process (e.g., use video tape). Use this as the starting benchmark

6. Classify setup operations into waste, internal setups, and external setups.
   a. Waste – Operations or actions, which do not add values to the setup.

   b. Internal Setups - Operations that can only be performed while the machine is shut down.

   c. External Setups - Operations that can be performed without shutting down the machine.

7. Eliminate the waste.

8. Convert as many internal setups as possible to external setups.

9. Improve internal setups (include adjustment).
    a. Use specially designed cart to organize tools.

    b. Use quick-release fasteners instead of bolts and nuts.

    c. Use stoppers to quickly position the jigs.

    d. Use rolling bolsters instead of cranes.

    e. Use overhang mechanisms to handle heavy jigs.

    f. Use locating pins and holes (socket) to eliminate the adjustment.

    g. Use standardized die height.

    h. Standardize bolt types and sizes, screw types and sizes, etc.

10. Improve external setups.
    a. Apply visual control principles.

    b. Use checklist to avoid omission.

    c. Use specially designed cart to help organize tools.

    d. Organize workplace (5S) to reduce search.

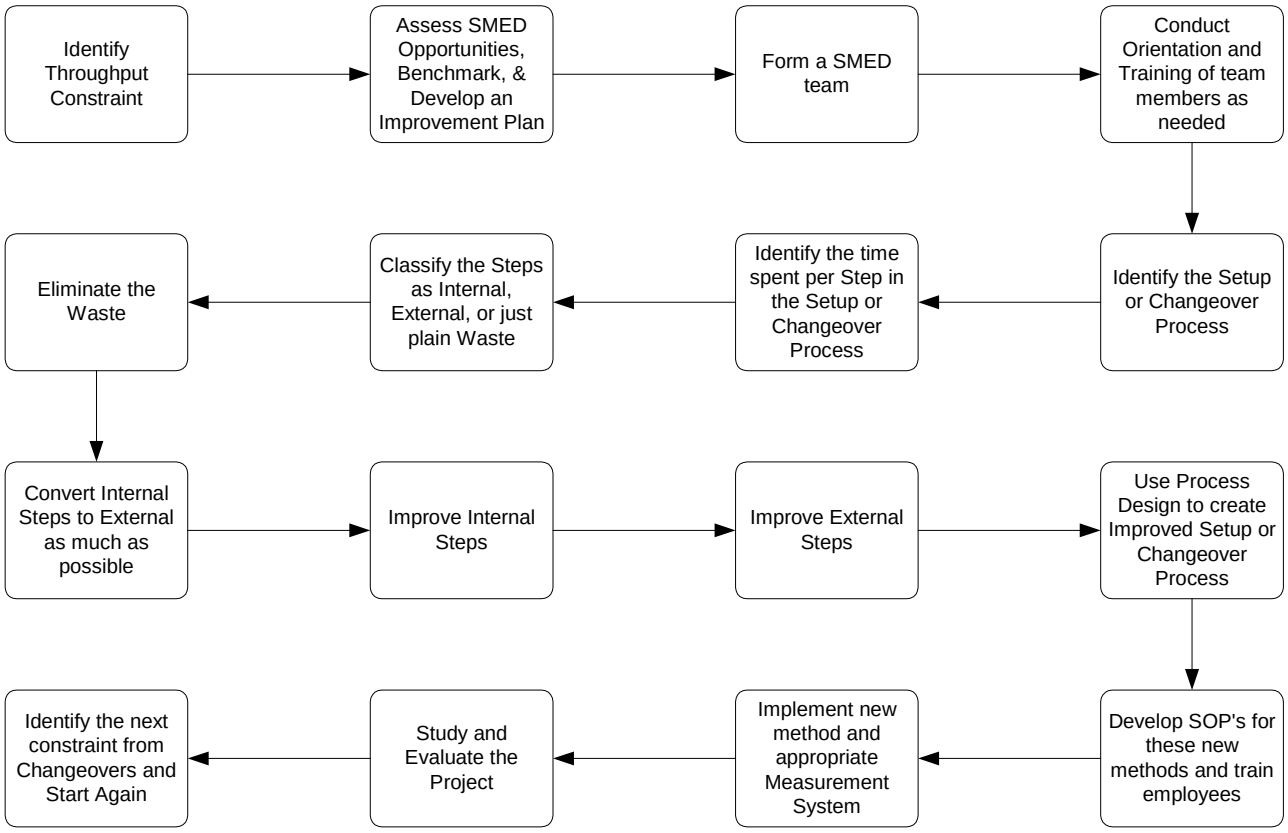
11. Develop the standard operating procedure (SOP).

12. Conduct training and education if needed.

13. Study and evaluate the performance of the new setup or changeover process.

14. Prepare for the next setup reduction project.

SMED Process Flow



Pitfall!

Whatever your success is on a specific setup or changeover time reduction effort using SMED techniques, there in one big "pitfall".

In an industrial environment, the potential improvement points are numerous. One could even improve indefinitely. However time, technical, financial, and human resources are always limited. In addition, some projects are more significant in their contribution to improved organizational performance than are others. To rush into SMED and to want to apply it everywhere, without preliminary planning, is dangerous. It is indeed advisable to distinguish within the process the stations or machines that really deserve setup or changeover time reduction attention.

The theory of constraints (TOC) distinguishes two types of resources: bottlenecks and non-bottlenecks. Let me briefly explain that bottlenecks are resources whose capacity is limited and who therefore limit the total capacity of the entire process, whereas the non-bottlenecks are resources with excess capacities. Usually bottlenecks are saturated while the non-bottlenecks are often idle.

SMED methods applied to the non-bottlenecks is a double nonsense insofar as these resources, having excess capacities, should already have the possibility of changing tools or series

without significantly affecting production flow. Applying SMED techniques to bottlenecks, on the other hand, can have a significant impact on increased productivity and higher profitability.

Therefore, before engaging in SMED methods, it is advised that one analyze the process with a TOC point of view, redefine resource planning and management according to theory of the constraints rules, and then lastly define the targeted resources for the application of SMED.