

Notes:

Quick Changeovers

Key Learning Points

1. Describe the need for quick changeovers.
2. Describe the SMED process.
3. Identify best practices in implementing quick changeovers.

What are Quick Changeovers?

A changeover is the amount of time taken to change a piece of equipment from producing the last good piece of a production lot to the first good piece of the next production lot. For a hospital or office area, it is the amount of time to change from the last good unit of work to the next good unit of work. Focus is placed on the time between production because is a non-value added period.

Single Minute Exchange of Dies

Single Minute Exchange of Dies, or SMED, is a setup time reduction methodology developed for die processes in manufacturing, but the principle applies to all types of changeovers.

Rapid Changeover

Rapid changeover facilitates reduced production lot sizes which improves flow, reducing production loss and output variability.

Shingo

Quick Changeovers is based on work done by Shigeo Shingo at Toyota. He

- Processing
- Inspection
- Transportation
- Storage

Operations

- An operation is any “action” performed by workers or machines.
- Production = Process + Operations

Setup Operations

A setup operation is the preparation work or adjustments that are performed before or after a lot is processed. There are two types of Setup Operations:

- Internal Setups: Are done only when a process or machine is shut down.
- External Setups: Can be done when a process or machine is running.

Basic Steps in Setup Operation

Step	Percent of Time Before Implementing Quick Changeover
Preparation	30%
Mounting and Removing	5%
Measurements, Settings, and Calibrations	15%
Trial Runs and Adjustments	50%

Step 1: Preparation, After-Process Adjustment, Checking of Materials, Tools, etc.

Make sure that all parts and tools are where they should be and are functioning properly. Also, remove these items and return them to storage and clean machinery.

Step 2: Mounting and Removing Blades, Tools, Parts, etc.

Remove parts or tools after the processing is complete, or attach parts for the next lot.

Step 3: Measurements, Settings, and Calibration

Perform all of the measurements and calibration that must be made in order to perform a production operation. An example of this would be checking a dimension or measuring a temperature.

Step 4: Trial Runs and Adjustments

Make adjustments after a test piece is made. This is where you spend most of your time. The better you do in the previous step, the easier the adjustments will be. This

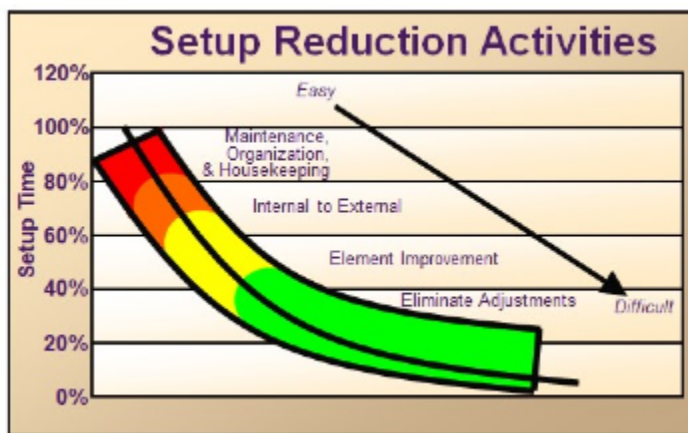
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step can vary considerably depending upon the skill level of the setup operator. Often the most difficult task for the operator is making accurate equipment adjustments.

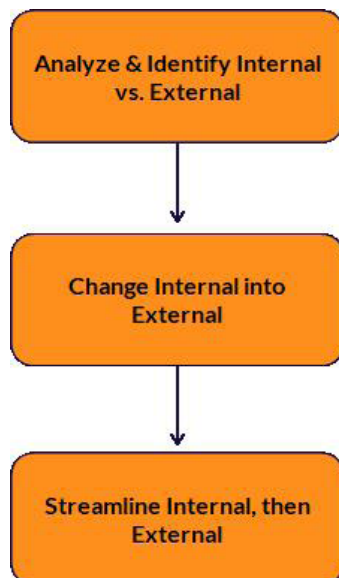
Setup Reduction Return on Effort

Some setup reduction activities are relatively easy to do, such as improving the housekeeping and storage of the tools used in the setup (really a part of 6S). These easier activities should be engaged first as detailed in the following steps so the improvement team can get maximum return (improvement) for the least effort and time invested.

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Phases of Setup Reduction



Setup reduction begins by understanding how setups are currently performed and what tasks are currently done as internal vs. external setup. Next, opportunities to change internal setup activities to external setup activities are identified and

implemented. Finally, the remaining setup activities are streamlined by identifying wasteful actions (NVA) and changing or removing them. Internal setup activities are streamlined first, then external.

Notes:

Phase 1: Setup Analysis

1. Examine the changeover process.
2. Make records of activities performed during setup.
3. Note movements of tools, fixtures, jigs, and process equipment.
4. Note steps taken by the setup operator.
5. Determine which actions are typical setup vs. special cause (such as repair).
6. Record time to perform operations.

Tips for Setup Analysis

- Analyzing your setup operations before you begin the improvement will help you plan. It will then be easier to define an approach to reducing the time of the setup.
Videotape the operation, focus on the person doing the setup. Using a video camera that has an on-screen timer will achieve two purposes—recording and timing the setup operation.
- Show the setup person the video, and ask them to describe what he or she is doing. Be sure to keep careful notes about each step, whether it is currently internal or external and whether or not it is adding value.
- Study the video, then note the length of time to do each operation and the steps involved. Break the steps down as finely as possible.

Example: Setup Analysis Worksheet

Setup Analysis Worksheet					
Machine/ setup name: Mold Press #123A					
Setup Step	Time hh:mm:ss	Currently Internal or External?	Convert to External?	Value added?	Comments
Shut down/ lockout press	0:05:22	Internal	No	Yes	
Loosen clamps	0:06:10	Internal	No	Partly	Could use quick clamps?
Get empty die cart	0:10:30	Internal	Yes	No	Stage empty cart at press.
Remove mold from press	0:01:35	Internal	No	Yes	
Transport mold to shop	0:15:20	Internal	Yes	No	Have mat'l handler do later
Get new mold from rack	0:10:25	Internal	Yes	No	Get while job still running

Phase 2: Change Internal Into External

1. Examine movement of interchangeable process components.
2. Minimize process-waiting time during the exchange of components.
3. Develop checklists of everything needed for the next setup.

4. Required tools and product specs are on the checklist.
5. Perform operation readiness checks (function checks).
6. Prepare operating conditions in advance.
7. Function standardization.
8. Intermediary Fixtures/jigs.

How to Change Internal Setup to External Setup

Develop Checklists for Next Steps

- Required tools
- Product Specifications
- Personnel
- Adjustments
- Process specifications

Perform Operation Readiness Checks

- Necessary repairs made

Examine Movement of Components

- Process-waiting time to be minimized during exchange of components

Prepare Operating Conditions in Advance

- Preheating dies
- Preheating material
- Staging materials at the process

Function Standardization

- Alignments (centering, leveling)
- Dimensioning
- Securing, gripping, clamping
- Expelling
- Separation of functions (cassettes)

Use Intermediary Fixtures/Jigs

- Multiple die applications

Minimize Waiting Time During Exchange of Components

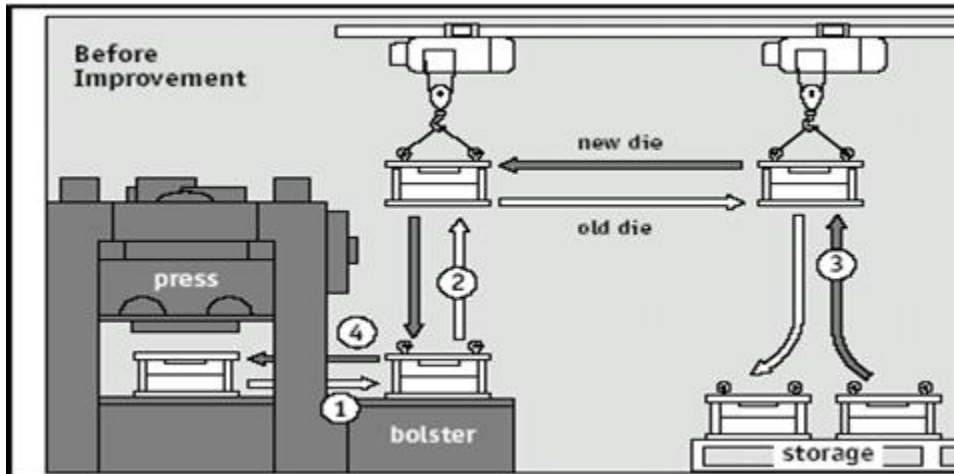
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To save setup time, any tools, components or equipment needed should be transported between the storage area and the machine before the machine is shut down for changeover.

Equipment should be labeled for easy identification and retrieval.

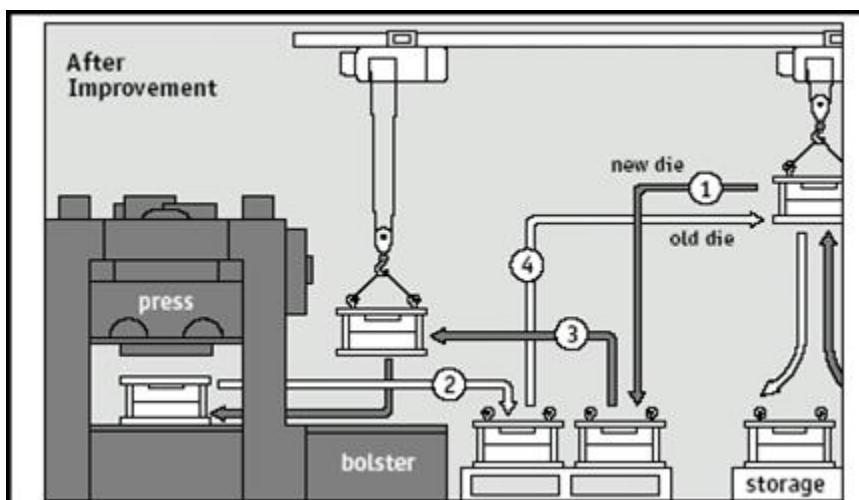
Example: Improved Transport

Before



The process waits until the next die is brought from storage. Depending on the distance of travel and speed of retrieval, this could be considerable lost time.

After



By staging the next die at the machine before changeover, transport time is minimized.

Notes:

- This changes internal setup to external.
- This streamlines external setup.

Internal to External Checklist

Make a checklist of all the parts and steps required to changeover. Include:

- Tools, specs, people
- Operating settings

Specifications required for all incoming parts and outgoing dimensions

Establish a specific checklist for every machine. These checklists help you avoid errors and multiple test runs later. They are useful for determining if all the parts are where they should be.

Perform Function Checks

A function check tells you whether the parts are in good working order.

Function checks should be done before setup begins so that repairs can be made if something does not work correctly.

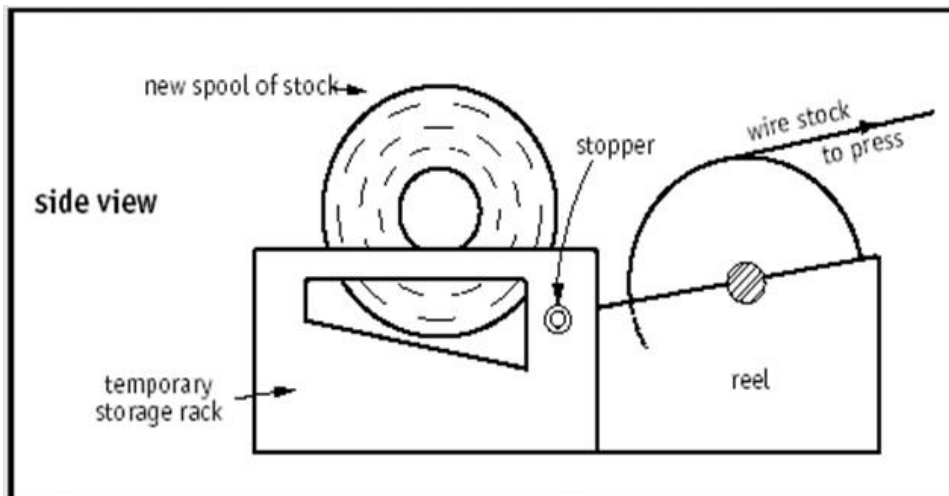
This is done to reduce delays after and during the first test run of the new batch because of defective parts or broken equipment.

Advance Preparation of Operating Conditions

Some operating conditions can be prepared externally for the necessary parts, tools, etc., before the internal setup begins.

Some examples include preheating of dies, parts or materials, temperature, pressure, or position of materials.

Example: Advance Preparation of Operating Conditions



Notes:

Function Standardization

Function standardization reduces waste by standardizing any possible elements whose functions are essential to the setup.

This is different than shape standardization where one would standardize the sizes and dimensions of all machine parts and tools—shape standardization can be very expensive and wasteful.

Function standardization breaks down each step in the process into its elemental step in order to determine commonalities. For example:

- Gripping a product
- Sending the object to the next process
- Returning the feed bar to its original position

Intermediary Fixtures and Jigs

Internal setup time can be reduced by using duplicate intermediary fixtures/jigs. Intermediary jigs help eliminate loading and centering during internal setup by allowing these to be done externally with an auxiliary jig or fixture—the intermediary jig needs not be a duplicate of the one currently in processing and can be setup externally so the next job can be rotated or slid into place when the current job finishes.

Examples:

While a work piece on one jig is being processed, the next work piece is attached to the duplicate jig. When the first is complete, it is removed from the machine and the second jig is mounted.

- A tool magazine on an NC machine where the tools for the next job can be set while the current job is running
- Shuttle presses where one mold or die is setup external to the process and shuttled into place when needed
- Cassette dies where standard sized functional portions of the larger tool are swapped rather than changing the whole tool

Phase 3: Streamlining All Aspects of the Setup Operation

In Phase 3 of Quick Changeover, all of the remaining internal and external setup operations are improved by reviewing the elemental functions, once again, of each step in the setup process in order to further improve them.

Implementing Phase 3 usually leads to single minute setups in most cases.

Phase 3 is broken down into two areas:

Notes:

Area 1: Internal Setup Improvements

- Implementing parallel operations
- Use of functional clamps
- Eliminating adjustments
- Mechanization

Area 2: External Setup Improvements

- Streamlining the storage and movement of parts and tools
- Organization of these items
- Maintenance of these items
- Quantities of these items to be kept in stock

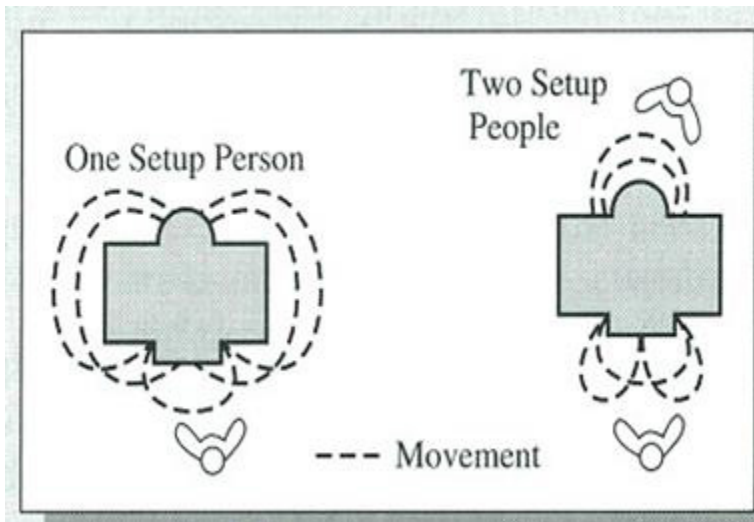
Streamlining Internal Setup

- Implement parallel operations.
- Eliminate bolts (screw connections), replace with functional clamps.
- Eliminate/minimize adjustments with functional standardization.
- Mechanize the final transport using forklifts, electric drives, automation.

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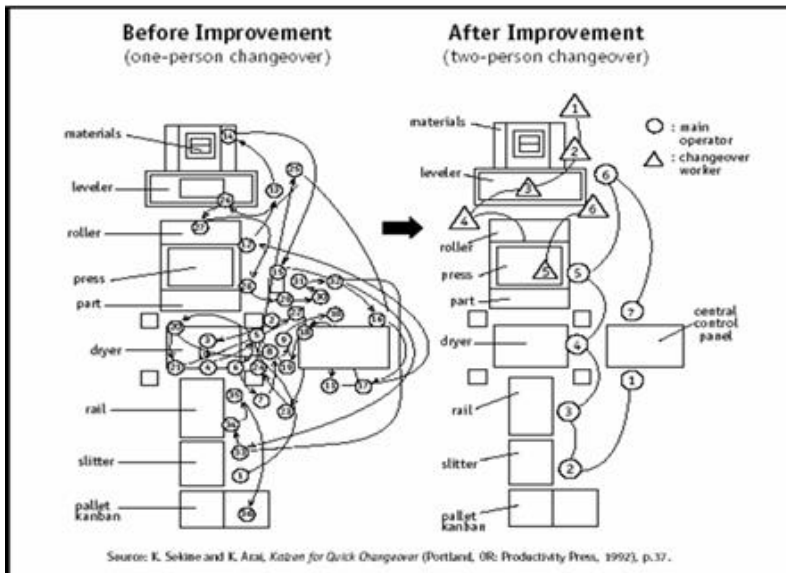
Parallel Operations

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Internal setups can sometimes be improved by having multiple workers doing setup tasks simultaneously. This is ideas for large machines where setup entails a lot of walking.

Example: Parallel Operations



Functional Clamps

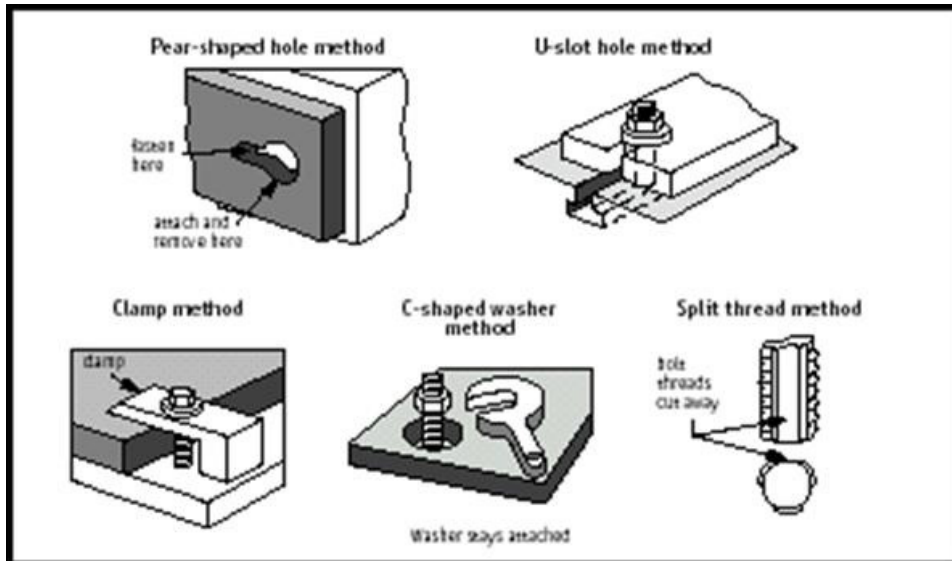
The following are examples of functional clamps. They also include one-motion methods such as:

- Cams and mechanical clamps
- Wedges and taper pins
- Spring stops (detents)

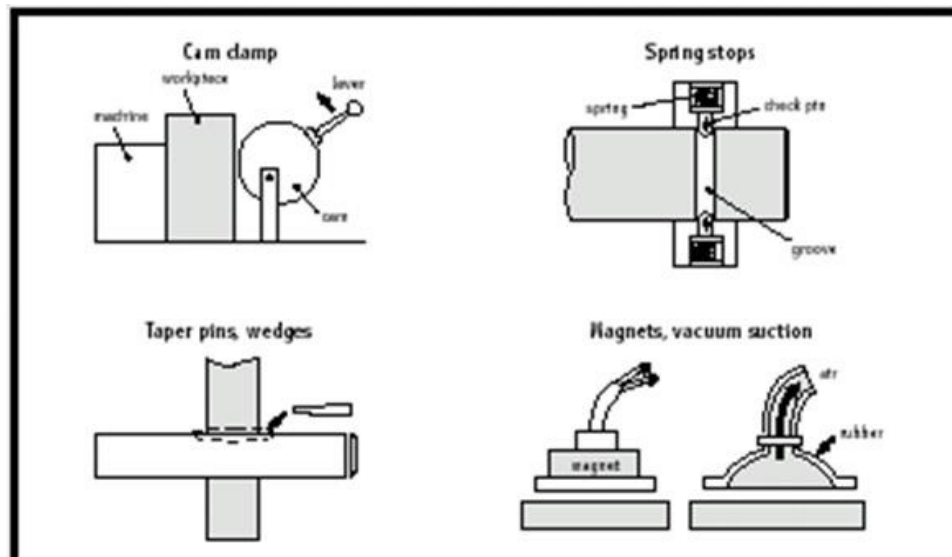
- Magnets or vacuum suction

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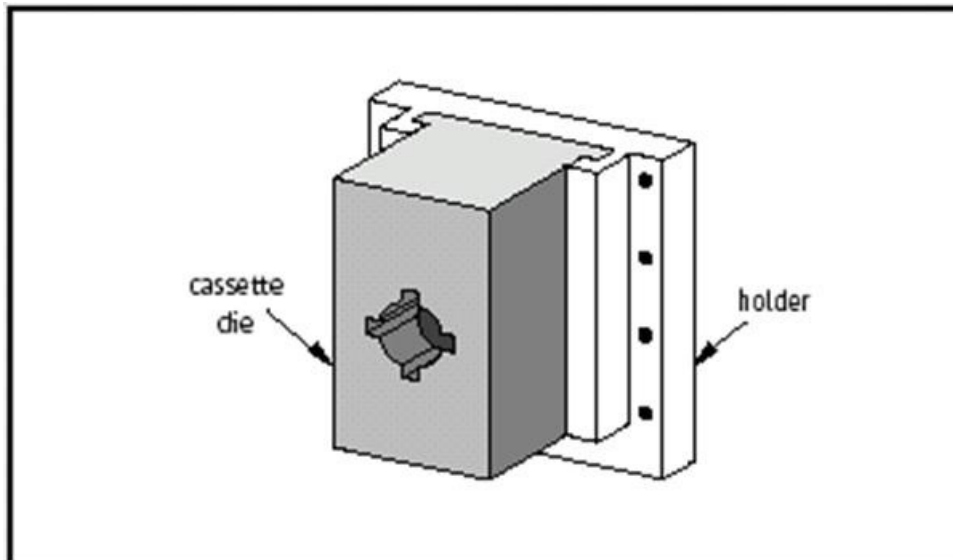
One-Turn Methods



One-Touch Methods



Interlocking Method



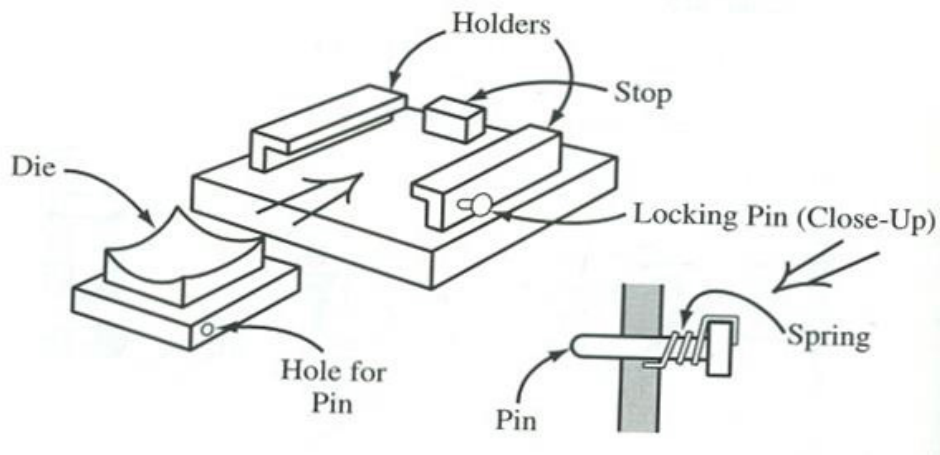
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Low-Torque Methods



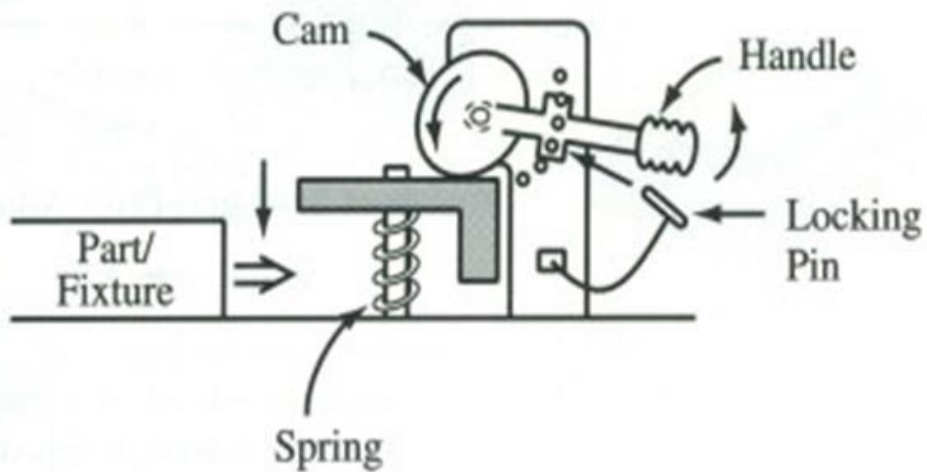
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Standard-Size Holders



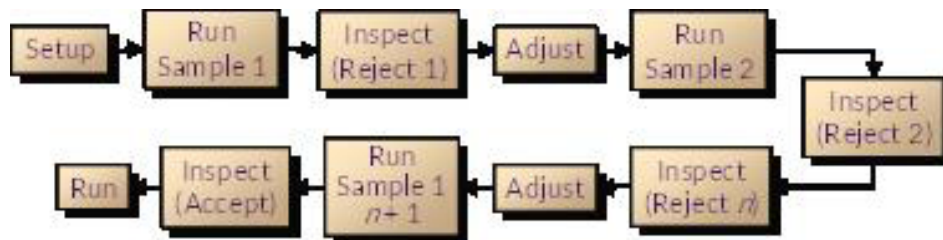
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Complex One Movement



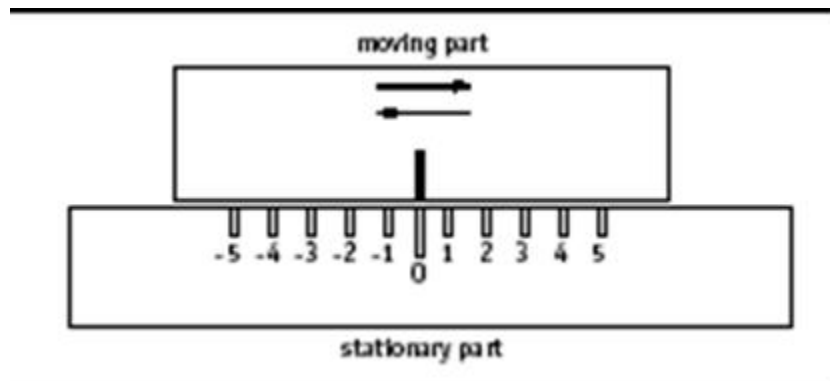
Eliminate Adjustments

Machine adjustment can be the hardest part of setup reduction to achieve. It requires an in-depth understanding of the process and its optimal settings. Often a designed experiment (or several) may be required to get to this level of process knowledge.



Many adjustment steps can be eliminated to reduce time

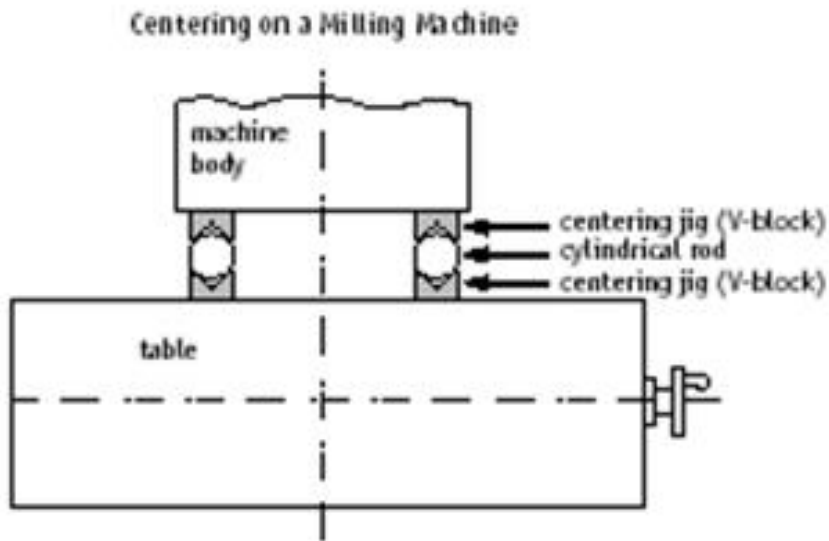
Fixed Numerical Settings



- Graduated Scale
- Alignment Scale
- Dial Gages
- Digital Numerical Controls
- Gages or Shims

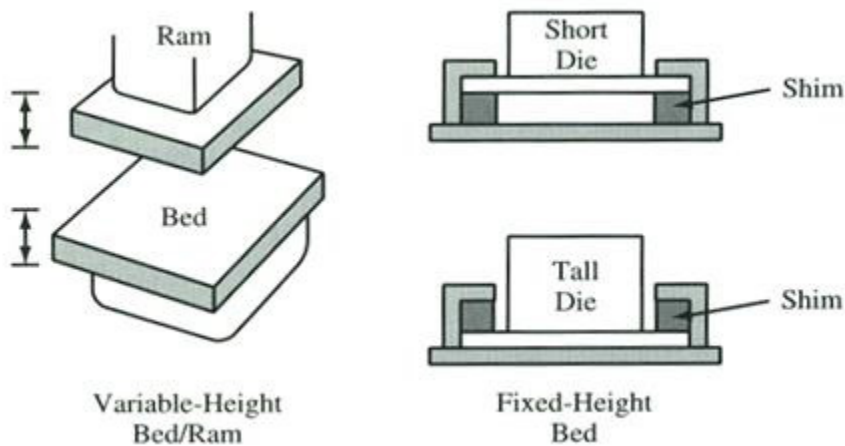
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Visible Center Lines



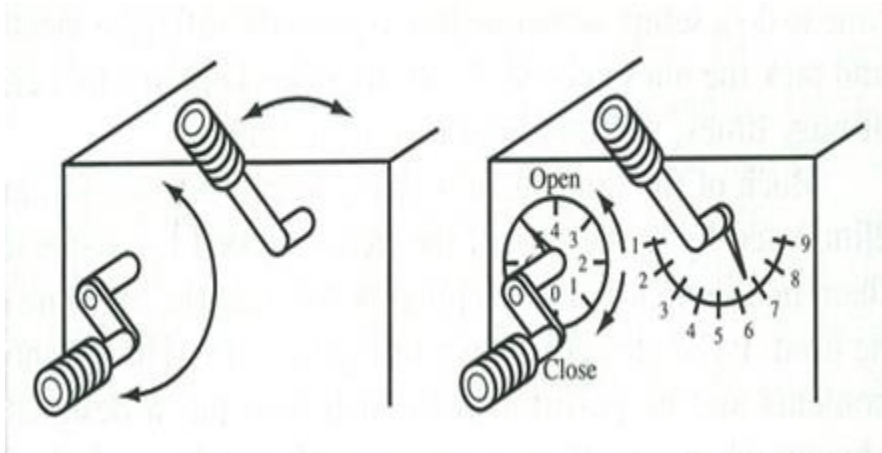
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Dies



Dies of varying heights are accommodated by shims.

Scales



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Scales provide a more precise setting without trial and error; making it easier to set to a specified value.

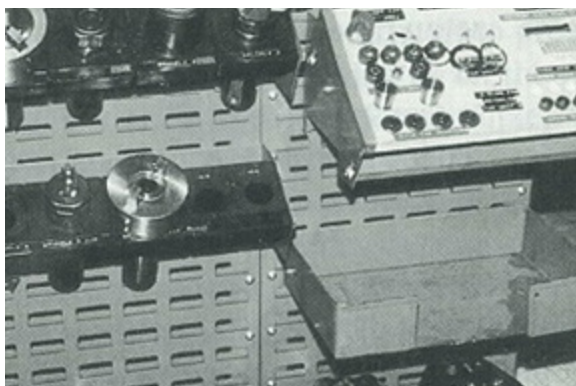
Streamlining External Setup

- Organize using S1 and S2 of 6S; make tool and component kits.
- Use racks and carts to store and move changeover components.
- Assign specific workers to changeover setups.
- Improve the transport of components.

Kitting

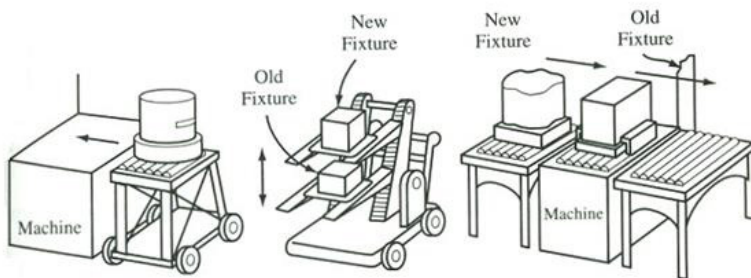
Kitting encompasses the following:

- All items needed for setup are in one place, with no time lost searching for them.
- Items are partitioned and visually differentiable.
- Items are stored close at hand.



Racks and Carts

- Material handling equipment correctly sized for the job can improve safety as well as setup time.
- Use of fork trucks, which require time to arrive on site and can be a safety concern, should be minimized if possible.



Notes:

Difficulties of Setup Simplification

- Setup reduction takes dedicated effort from people who know the equipment and operation the best, i.e. machine operators and setup people.
- There is often a preference toward the purchase of new equipment, rather than the improvement of existing equipment.
- Setup reduction cannot be achieved on all fronts simultaneously, and it takes time before benefits are global.

Benefits of Quick Changeover

Decreases Inventory

- The longer setup time you have, the more likely you are to store inventory! Shorter setup = shorter runs.
- Less scrap exists because of out of date inventory.

Improves capacity and Throughput

- Downtime is reduced.
- There is higher productivity, less clutter, and fewer tools to track and organize.

Improves On-Time Delivery to the Customer

- It permits implementation of planning and leveling of customer demand.
- Your customers perceive you as being more flexible.
- Delays are decreased.