

SET-UP IMPLEMENTATION



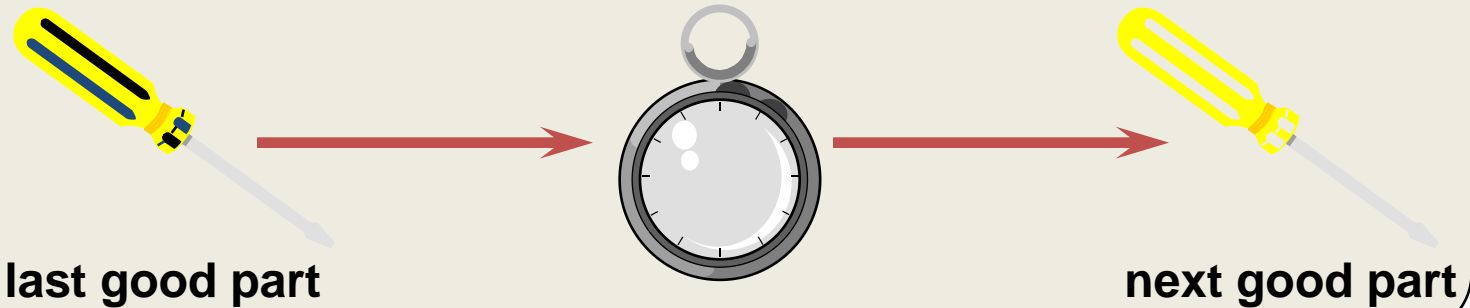
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Definition of Set-up

By set-up we mean the length of time from the last piece produced to the first good piece produced.

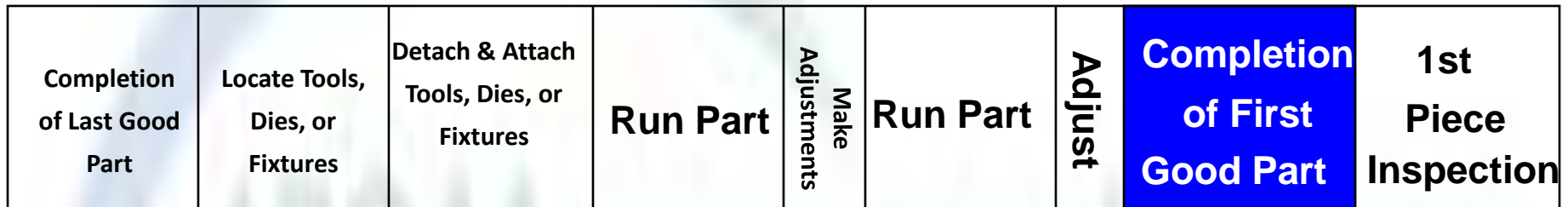


Focus is placed on the time between parts because it is a period of non-value added time. In other words, the equipment is idle and not producing parts.

Definition of Set-up

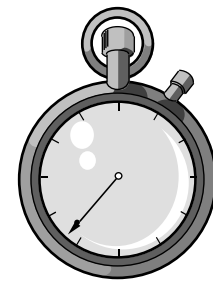
The time required to remove the old tools, dies, or fixtures; attach new tools, dies, or fixtures; and run the machine until a new part, without defects, is produced.

→| Changeover|←



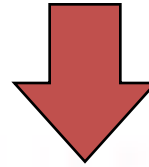
Set-up time includes all run time and adjustment time until a good part is produced. If good part is produced with no adjustments, run time is not part of the setup time.

Internal vs. External



Internal:

Internal time is the time when set-up activities are performed while the machine is shutdown.



External:

External time is the time when set-up activities are performed while the equipment is running.

Objective: Move internal to external, improve both.

Batch Processing

Past Practices

- Setup time was fixed
- Lot sizes were variable
- Lower per unit cost by increasing lot size
- Economic Order Quantity formula

$$\mathbf{EOQ} = \text{SQRT} (2AD / h) \quad \text{Ford W. Harris (1913)}$$

where :

D = Demand Rate (units / year)

A = Setup Cost (fixed)

h = Holding Cost (dollars per unit per year)

also $h = IC$ where (*I*) in the annual interest rate and *C* is the Unit Production Cost

Batch Processing

Key Insight of the EOQ (The Harris Model) :

Given a constant setup time, there is a tradeoff between lot size and on-hand inventory.

Under the EOQ Model : Increasing the lot size increases the average amount of inventory on hand, but reduces the frequency of setups. On the other hand, more frequent setups will lead to smaller inventory but are penalized by setup costs.

Harris' Solution : An optimum Quantity that strikes the balance..EOQ

Harris's Solution: An optimum Quantity that strikes the balance. . EOQ.

Set-up Example

Part number: ABC

Labor rate: €12 per hr.

Overhead rate: 500%

Machine number: XYZ

Set-up time: 4 hours

Process time: 2 min.

Unit cost calculation: Lot size 100 units *

$240 \text{ min.} / 100 \text{ units} + 2 \text{ min. process} = 4.4 \text{ min.}$

$4.4 \text{ min.} / 60 \text{ min.} \times €12 + 500\% = €5.28 \text{ per part}$

** 100 units = one month requirement*

Set-up Example

Part number: ABC

Machine number: XYZ

Labor rate: €12 per hr.

Set-up time: 4 hours

Overhead rate: 500%

Process time: 2 min.

Unit cost calculation: Lot size 1000 units *

$240 \text{ min.}/1000 \text{ units} + 2 \text{ min. process} = 2.24 \text{ min.}$

$2.24 \text{ min.}/60 \text{ min.} \times €12 + 500\% = \text{€2.69 per part}$

** 1000 units = ten month requirement*

Set-up Example

Part number: ABC

Labor rate: €12 per hr.

Overhead rate: 500%

Machine number: XYZ

Set-up time: 4 hours

Process time: 2 min.

Theoretical Savings

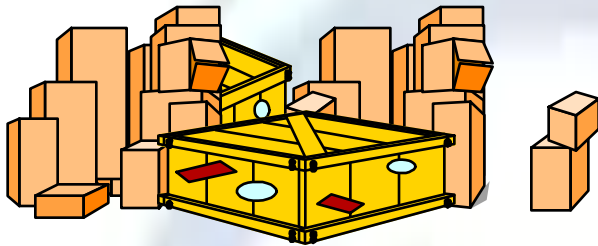
Original cost (lot size 100 units) €5.28

Revised cost (lot size 1000 units) €2.69

Theoretical Savings €2.59

Savings Are Theoretical

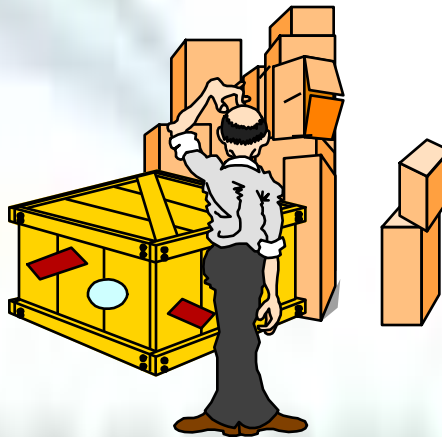
Traditional cost practices encourage the production of more parts to reduce fixed costs per unit. In reality the following fixed costs increase:



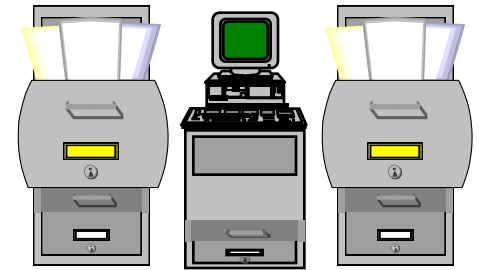
Inventory Carrying Costs (9 Months)



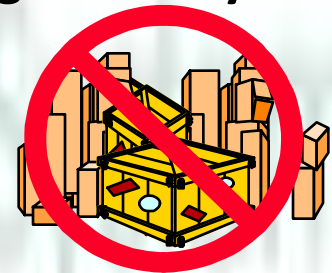
Additional Stockroom Space



Additional Inventory Management Personnel

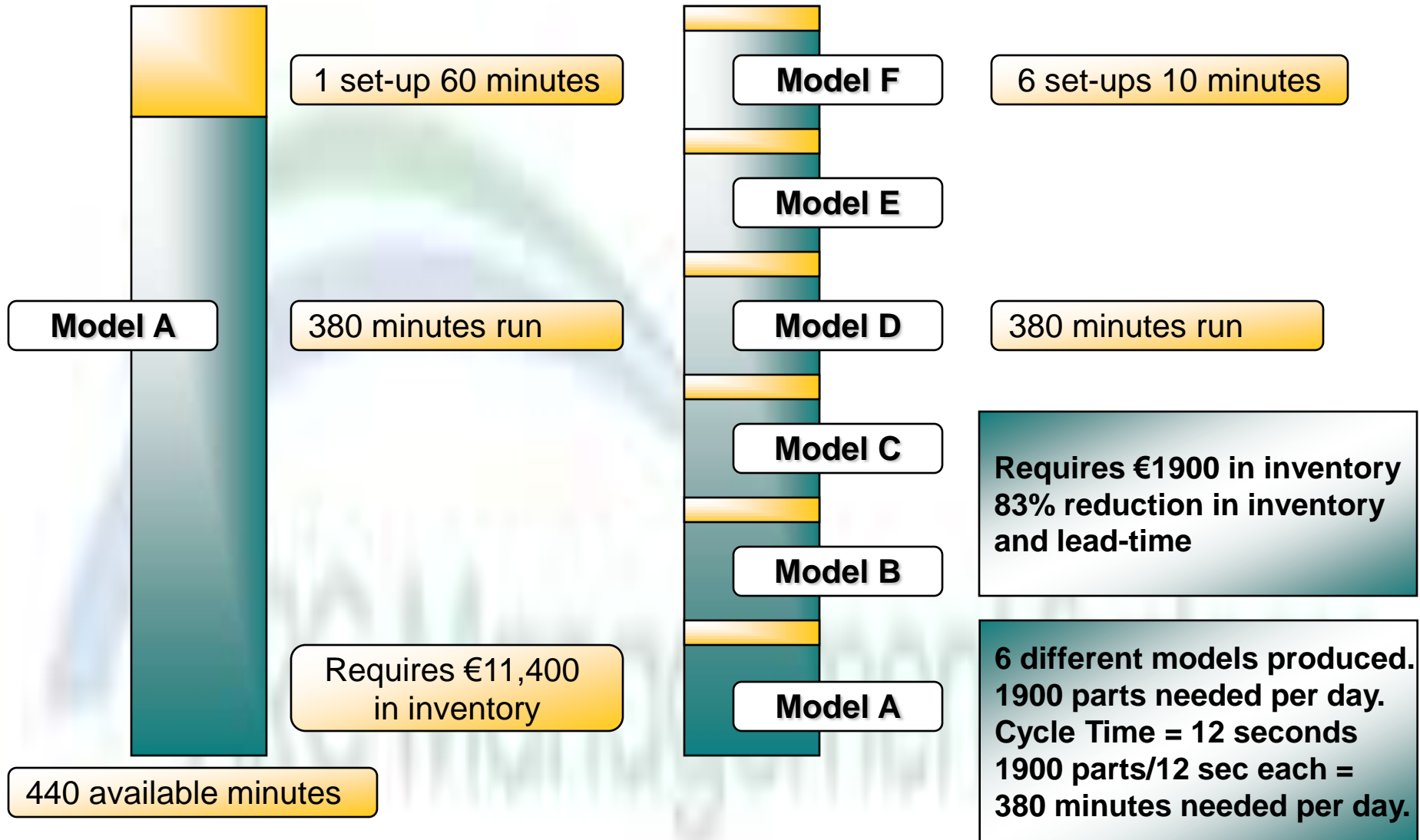


Additional Inventory Management Systems



Potential Obsolescence of Inventory

Set-Up Reduction Goals



It will take 6 days to cycle through all models requiring inventory of at least 6 days of each model. That is 11,400 total pieces. If each costs €1 there is €11,400 in inventory because of set-up.



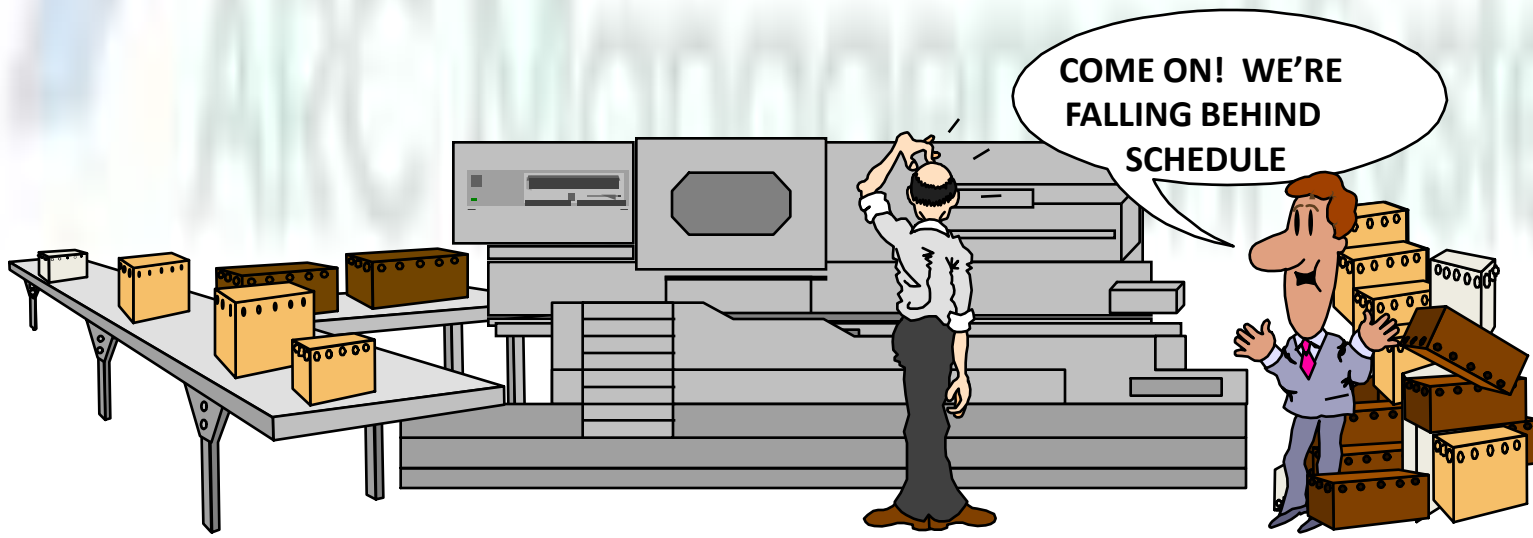
Frequently Asked Questions

- **What is the benefit of having two people set up a machine?**
 - If the helper shut down his/her machine then there is no benefit. But if another operator can leave his/her machine running then we can reduce set-up time.
- **Why do we want to set-up more often?**
 - By setting up more often we reduce the amount of inventory in the plant, the amount of management needed to control inventory, and the potential for large amounts of scrap.

When Is It A Problem?

Set-up becomes a problem when we try to balance production to a daily rate in a mixed model environment.

- Equipment utilization can be 30% or lower.
- There is a perceived need for additional equipment.
- Plants become crowded.
- Profit is lost because machine is not producing.
- No time available for product development.



Traditional Setup Approach



- **Individual operators did the setups their own way, based on their own experiences.**
- **No one setup the same way.**
- **Each shift was not comfortable with setup done on previous shift. Often the setup was done over.**
- **Some thought the longer the setup, the better the quality.**

Set-up

- **When is it a problem?**

- **How to identify**

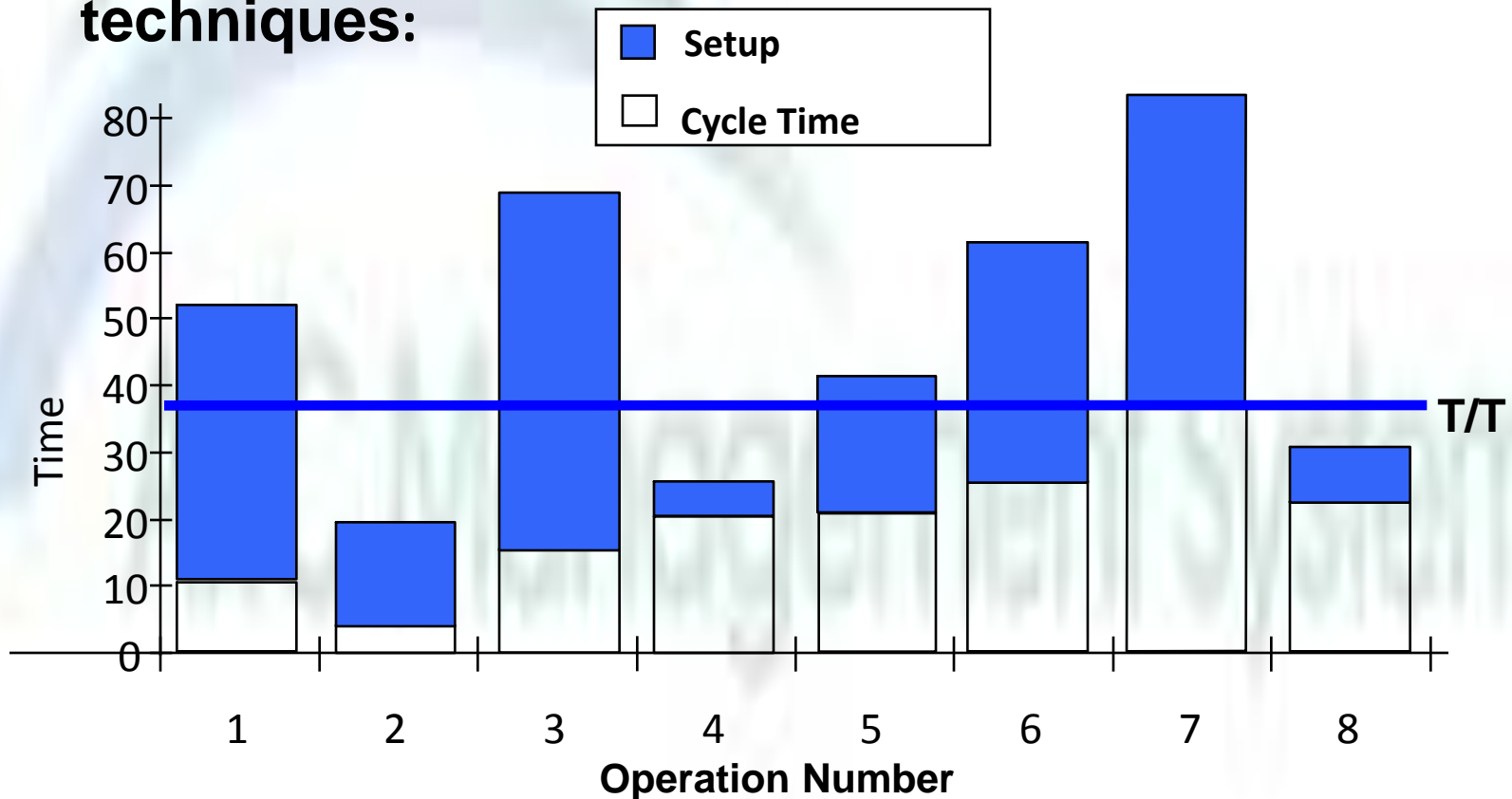
- **Common causes**

- **World Class status**

- **How to reduce**

Identifying Set-up Problems Using Standard Work

By using a Percentage Loading Chart, you can quickly identify areas to apply set-up reduction techniques:



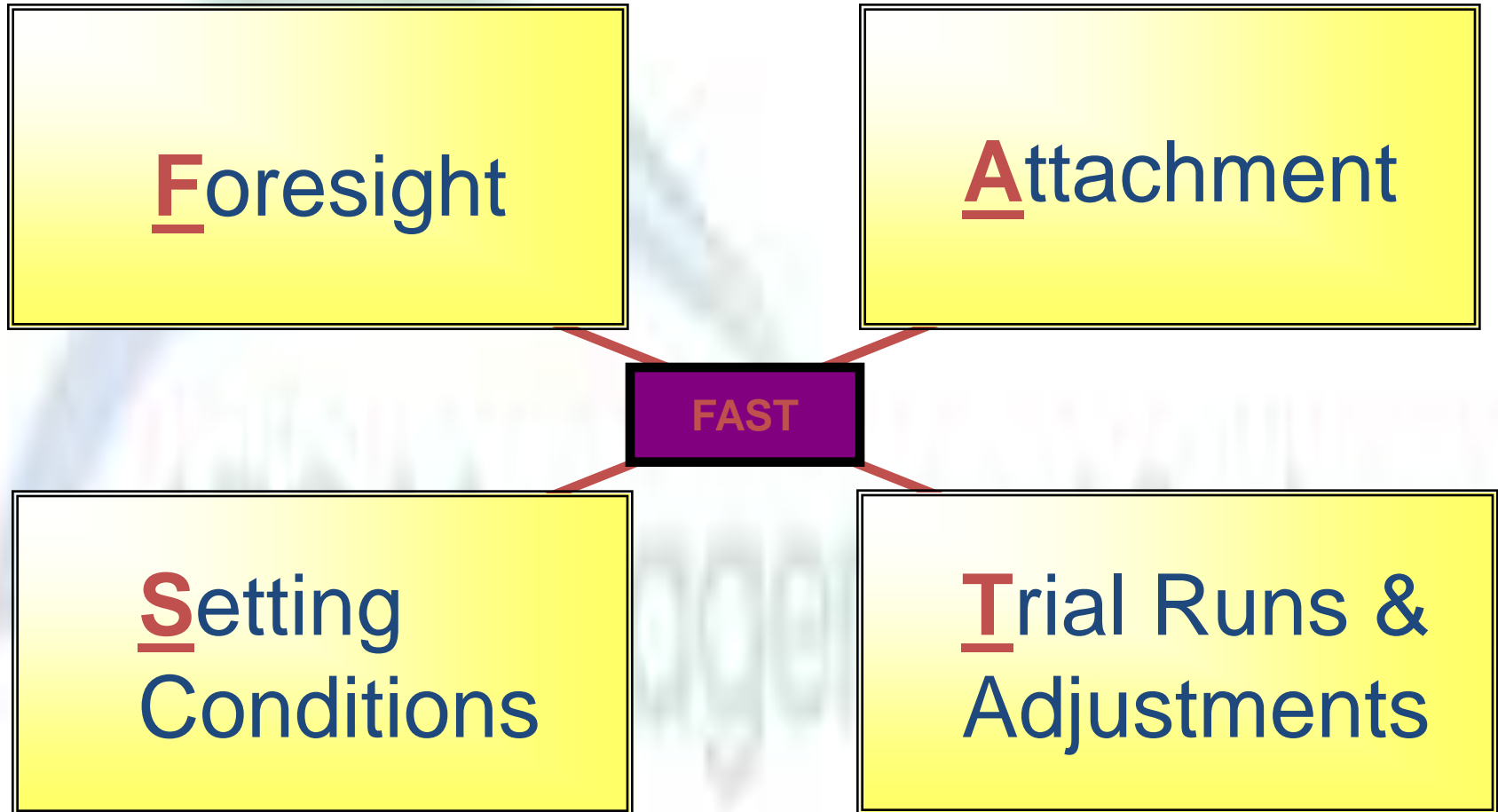
Set-Up

FAST - TRAC

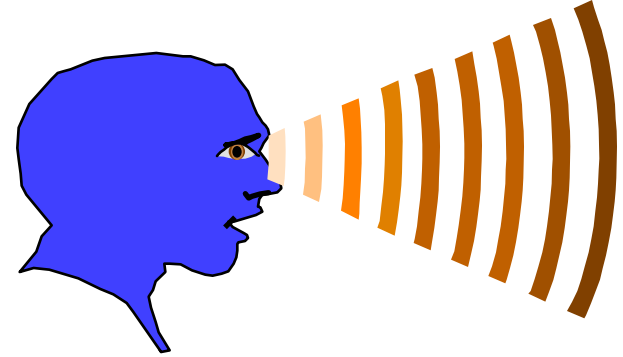
The Tool For Set-up Reduction



Set-up Time is Classified into Four Categories



Foresight



Planning / Preparation



Pre-kitting

- * Tools
- * Gages
- * Material



Point of use storage

*** WALKING**



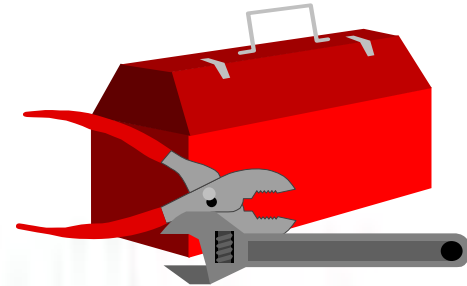
*** WAITING**



*** SEARCHING**

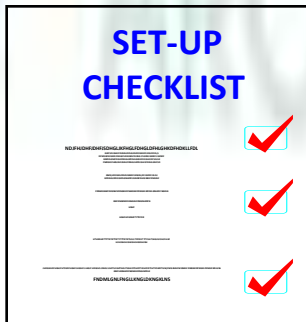


*** MISSING TOOLING**

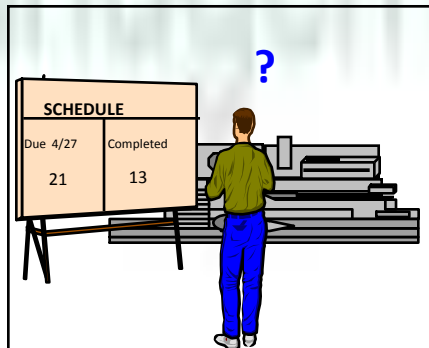


Typical Causes Of Set-up Delays

*** NO CHECKLIST**

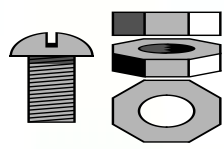


*** POOR SCHEDULE INFORMATION**



*** LACK OF CALIBRATION**

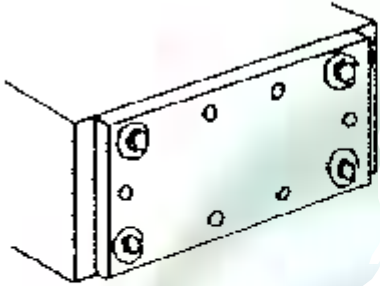




Attachment

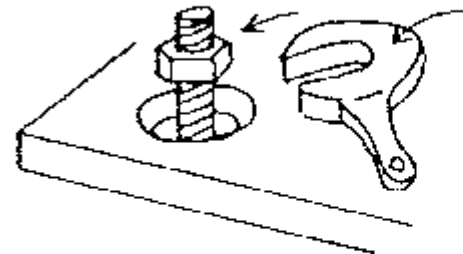
- How are fixtures and tooling currently attached?
- What other type of attachment devices can be used?
 - Toggle clamps
 - Cam action clamps
 - Auto clamps (include mistake-proofing devices)
 - Hook clamps
 - Swing clamps
 - Quick Acting Clamps
 - Swing “C” washers
 - Swing bolts
 - Quarter turn screws
 - Wedges
 - Pear shaped / tear drop slots

1) Reduce # of screws



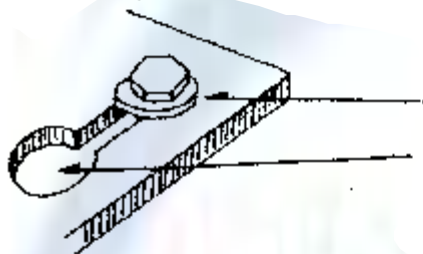
10 > 4 fixed screw sights
Give thorough
consideration to the
magnitude and direction
of forces undergone

2) C-washer method



Don't remove
the C- washer

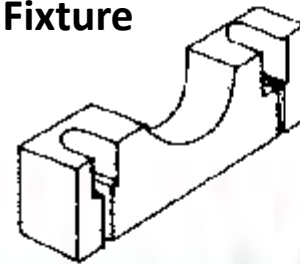
3) Pear-shaped hole method



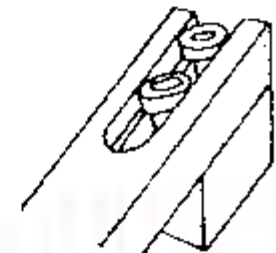
Tighten here
Attach and
remove here

4) U-slot method

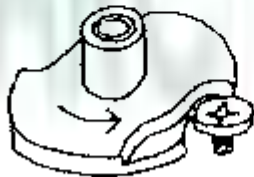
Fixture



Clamp

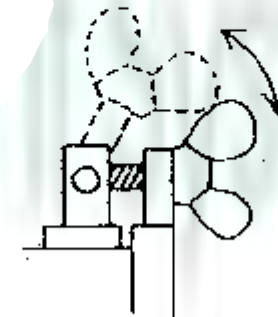


5) Variation of pear-shaped hole method

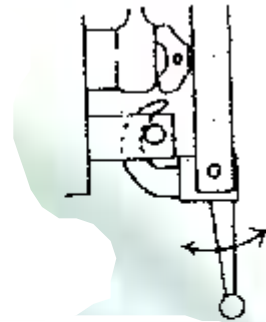
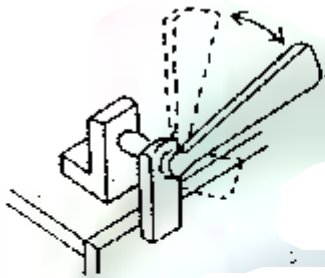


Bushing cap

6) Wing nut method

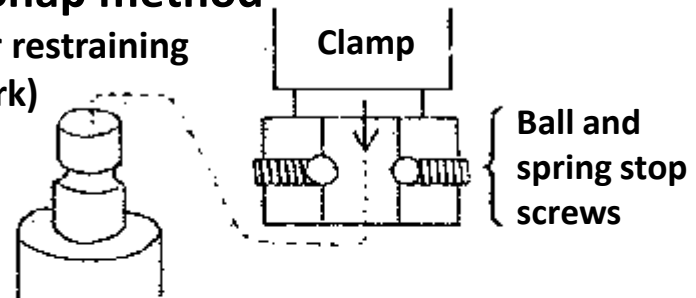


7)Cam method

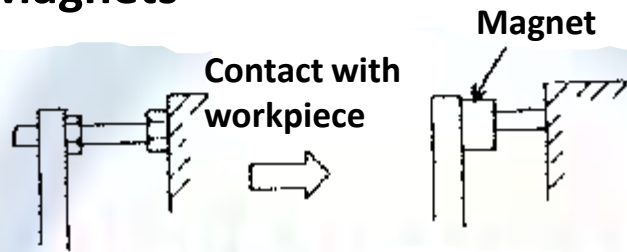


8)Snap method

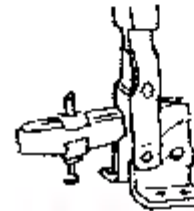
(for restraining work)



9)Magnets

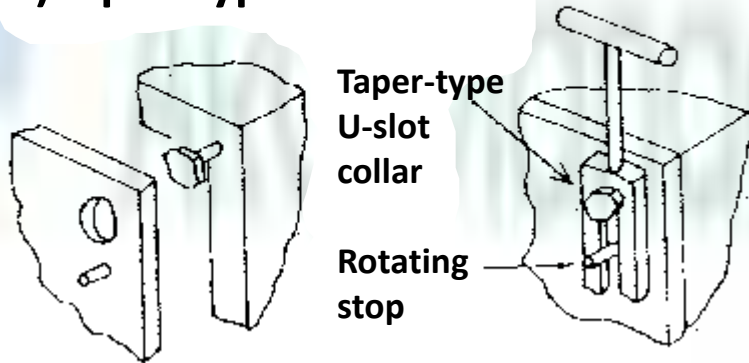


10)Toggle clamp



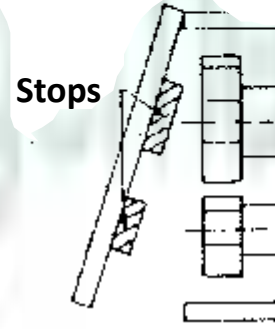
Can apply pressures of over 500kg

11)Taper-type U-slot collar

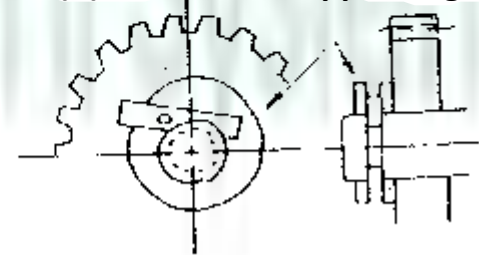


12)Gear slippage prevention

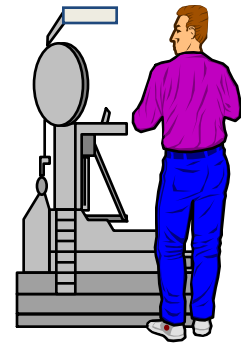
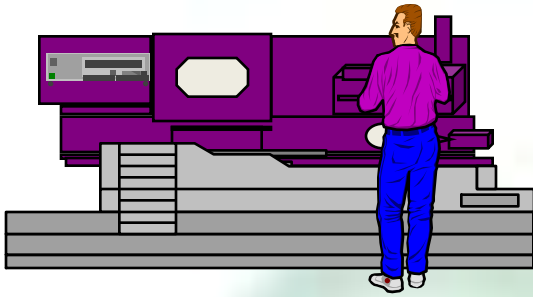
(A)using gear box cover



(B)One-touch stopper ring

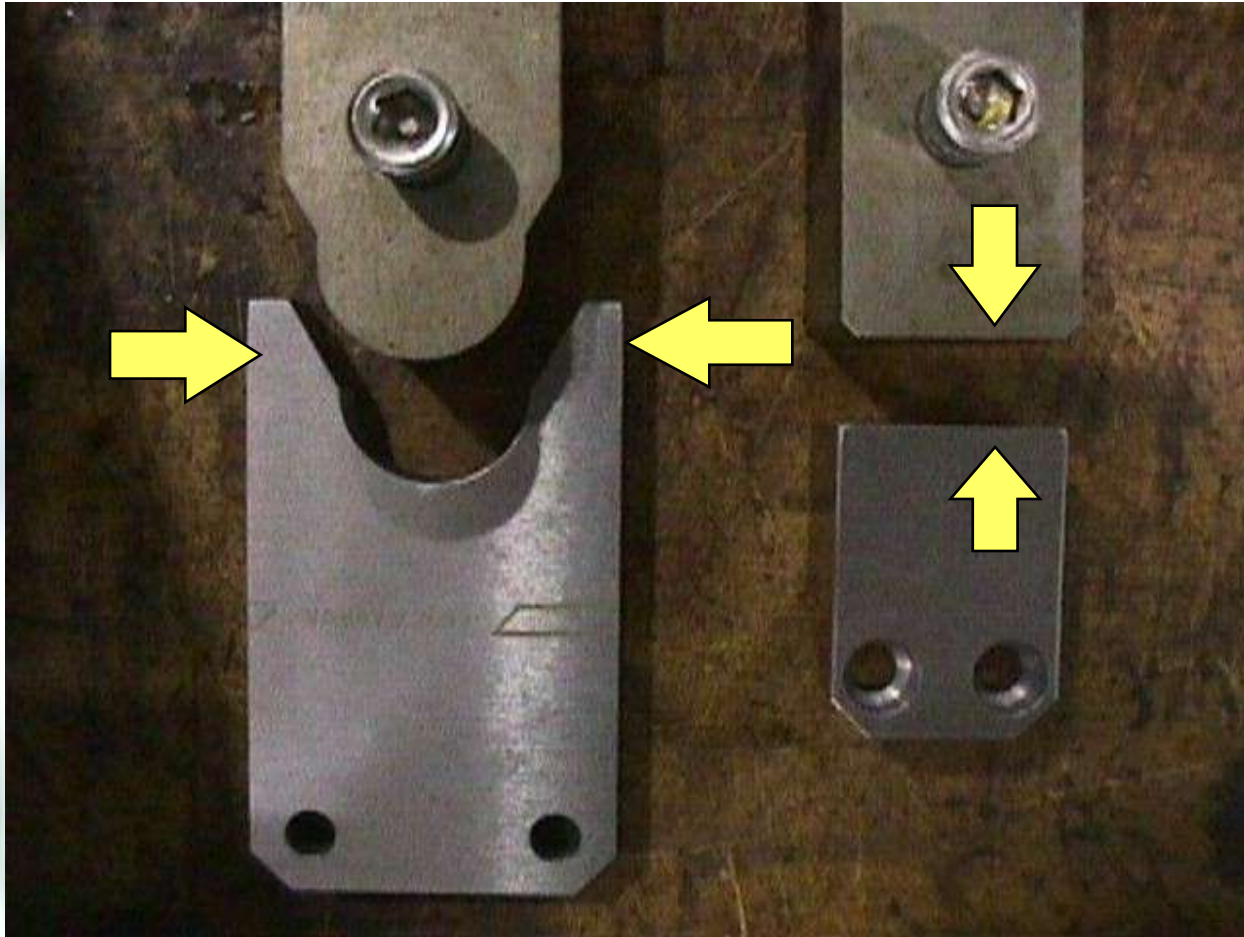


Setting Conditions



- **How is the fixture or tooling positioned?**
- **What can be used to eliminate setting conditions?**
 - **Locating adapters**
 - **Pins**
 - **Rails**
 - **Notches**

Locating Blocks



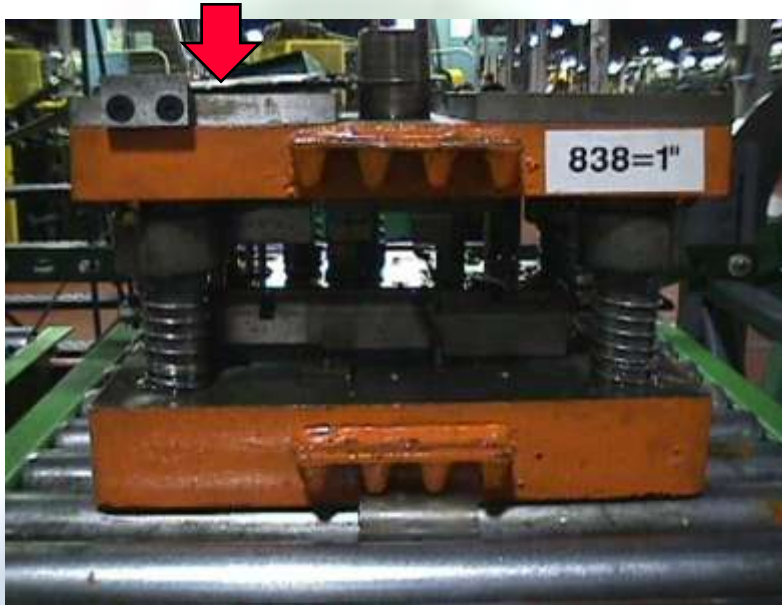
The blocks on the left are used to locate the tool from left to right and the blocks on the right are for up and down location.

Trial Runs and Adjustments

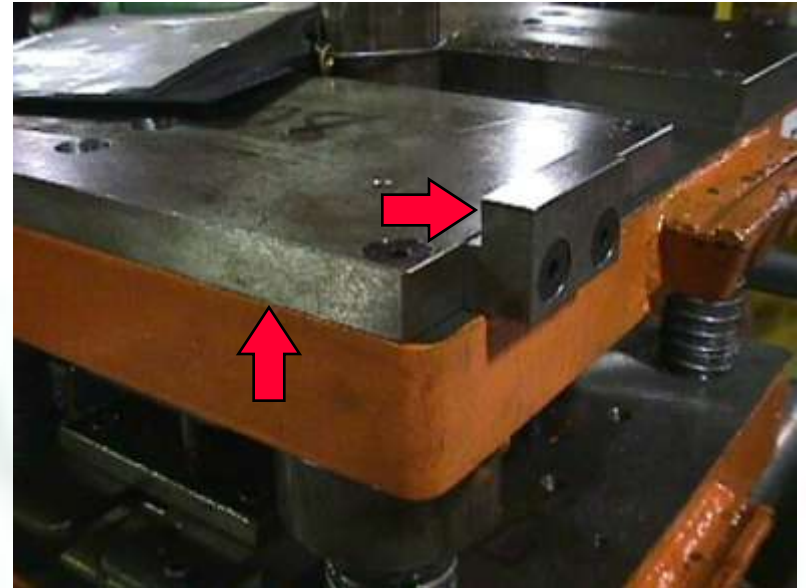
- How do we establish the starting point today?
- What can be done to eliminate trial runs & adjustments?
 - Standardized fixturing
 - Standardized tooling
 - Guide block
 - Template
 - Alignment marks



STANDARDIZED DIE HEIGHTS & LOCATION BLOCKS

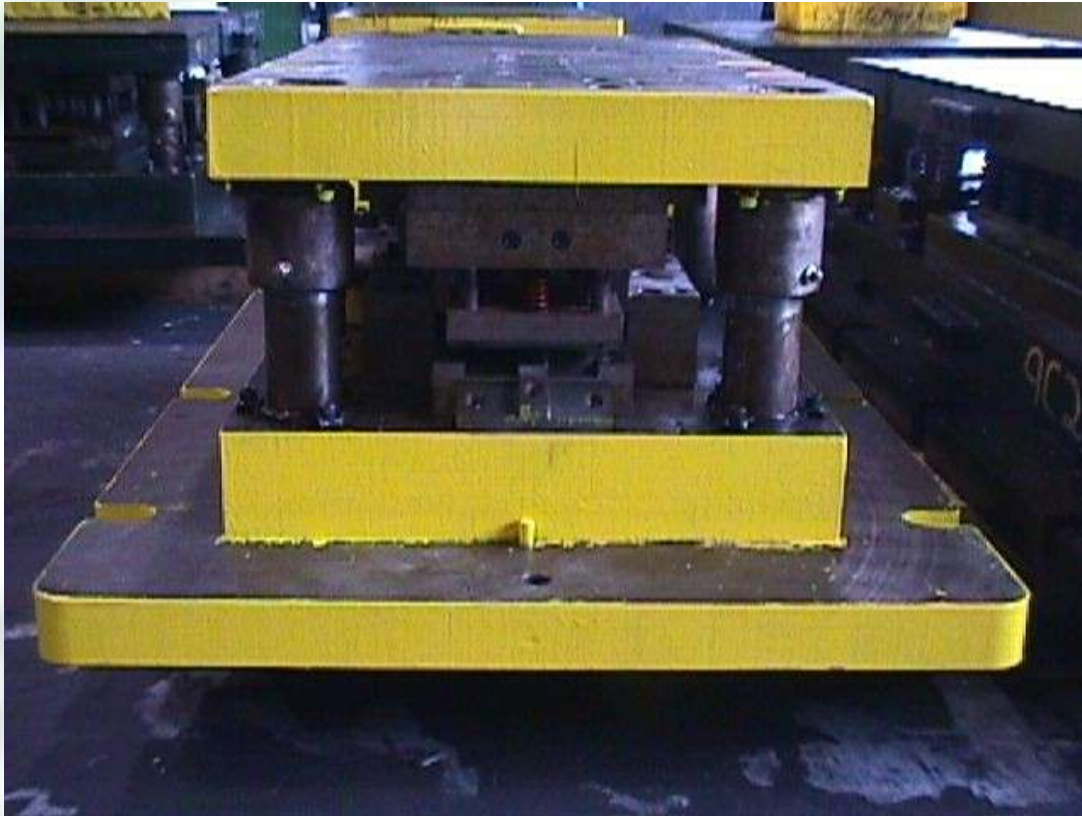


Additional plates have been added to this die to standardized the height.



Close-up view of added plate and locator block on front of tool.

COLOR CODING



Color coding can be used to identify all tools required in a certain area or to a specific job.

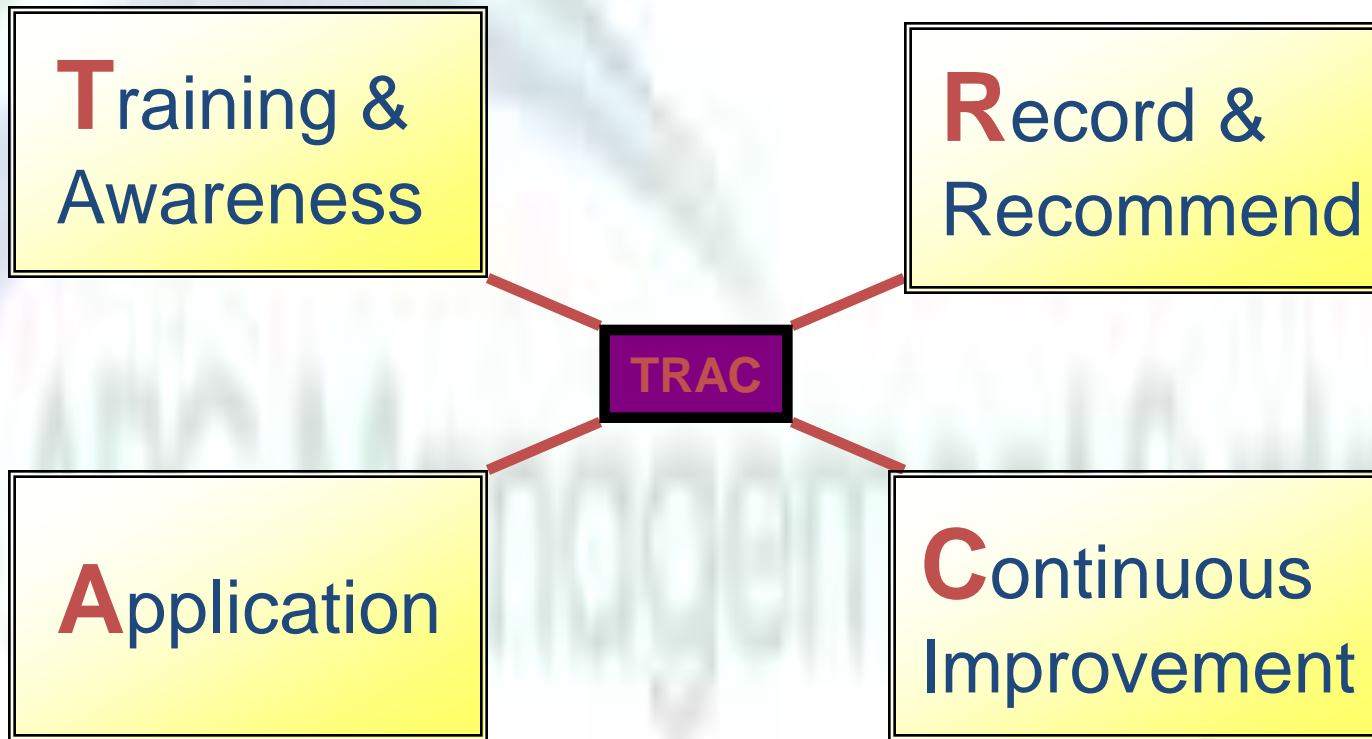
FAST TRAC

- Internal set-up time can be compared to a race car pit crew. The longer the car is idle, the less the chance of winning the race.



What is the ideal pit crew size?

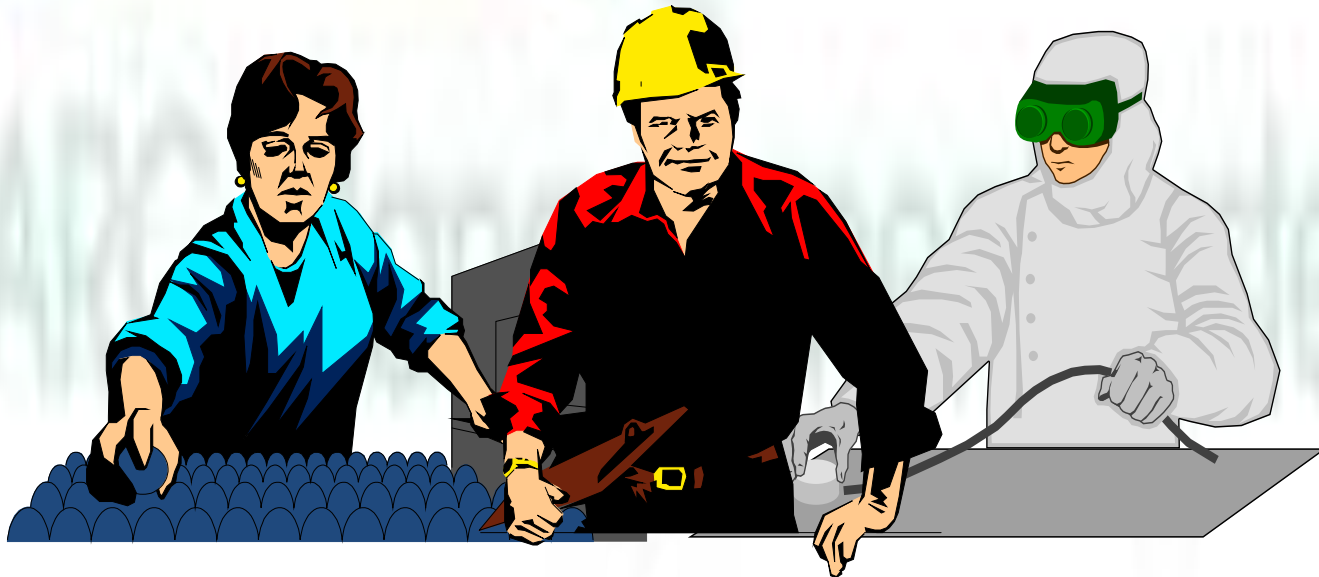
Improvement Methodology



Phase 1: Training & Awareness



In this phase, we assemble a cross-functional team of employees.



Phase 1: Training & Awareness (Cont.)



Training is completed in three areas:

 Importance of set-up improvements to increase speed, improve quality, reduce cost, and lower inventory.

 Conceptual stages underlying a typical set-up operation & the four phase implementation approach.

 Actual examples from manufacturing using video tape and slides demonstrating these concepts and approaches.

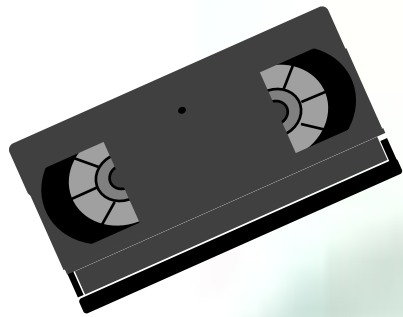
During this phase, equipment is usually selected for analysis.

Phase 2: Record & Recommend

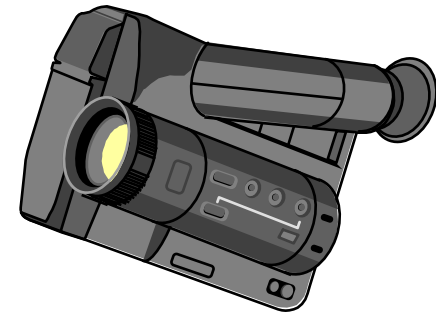
In this phase..

- ⌘ We observe and document existing set-up procedures using a video camera.
- ⌘ We Analyze all work efforts.
- ⌘ We Identify short-term solutions that could be realized with procedural changes, modifications to existing fixtures, and minor investments in tooling.





Video Tape



COLLECT BACKGROUND DATA

- * ANALYZE PERCENT LOADING CHART.
- * SELECT PART AND OPERATION TO TAPE.

PREPARE - EVALUATE SITE

- * WHERE DOES OPERATOR STAND?
- * WHERE IS THE BEST POSITION FOR THE CAMERA?
- * IS THERE ADEQUATE LIGHTING?

VIDEO TAPE SET-UP ELEMENTS

NARRATE

- * DESCRIBE WHAT IS HAPPENING WHEN THE OPERATOR BLOCKS THE CAMERA OR LEAVES THE AREA.

Analyze Video Tape

- Review with team.
- Break down into elements.
- Review areas containing waste.
- Solicit improvement ideas.

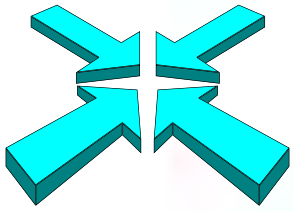


Phase 2: Record & Recommend (CONT.)

Our goals:



- 1) Move as much internal to external time by arrangement of activities and fixtures.
- 2) Minimize internal and external time by: pre-kitting tooling and fixtures, improving attachment operations, reducing or eliminating adjustments, and organizing the work place.
- 3) Document improvements and develop procedures & checklists describing proposed activities.



Phase 3: **Application**

In Phase 3,

- 1) Make minor modifications to the existing fixtures.
- 2) Additional tooling to remove attachment from internal to external.
- 3) Standardize tooling.
- 4) Document time savings.

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Phase 3: **Application** (Cont.)

For example:

- Slots in fixture and T-Bolts reduce attachment time.
- A new part holder reduced the time required to load and unload parts to fixture. Swing hook eliminated the need to remove nut from bolt.
- Extra set of slides allow detach & attach to be completed on external time.

⇒ Move internal time to external time

Internal:

Internal time is the time when set-up activities are performed while the machine is shutdown.



External:

External time is the time when set-up activities are performed while the equipment is running.

⇒ Eliminate unnecessary movement



Set-up Reduction Techniques

⇒ Eliminate nuts and bolts



⇒ Turn nuts and bolts no more than one turn



Search time

- Looking for fixtures, tools, gages, hardware



Waiting time

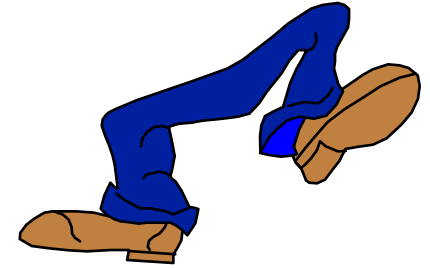
- Hoist
- Pallet or container
- Cart or truck



**Move Internal
To External**

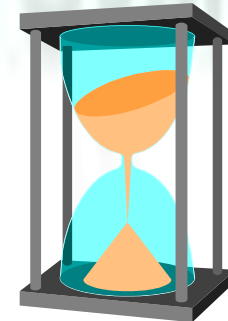
Walking time

- Know where tools are, must walk to get them

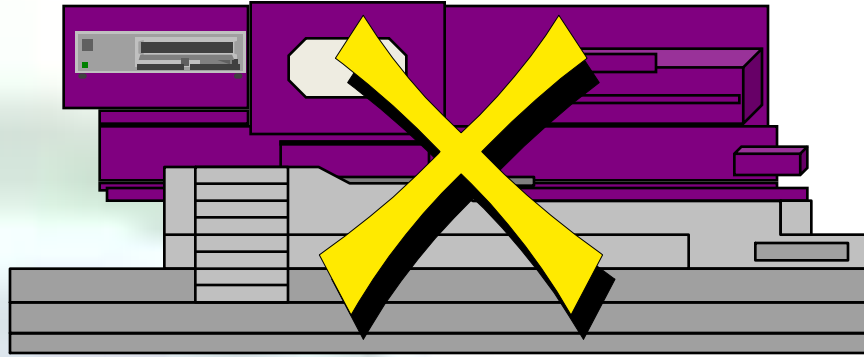


Setting time

- Fixtures
- Tools / gages

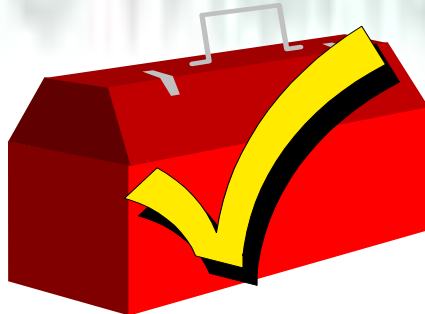


≡ **Eliminate machine base adjustments**



Set-up Reduction Techniques

≡ **Standardize fixtures, tools and fasteners**



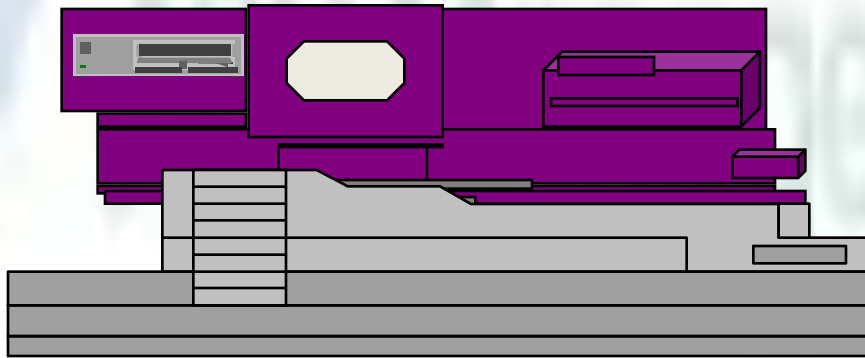
≡ **Eliminate trial and error**



Phase 4: **Continuous Improvement**

In this Phase we consider:

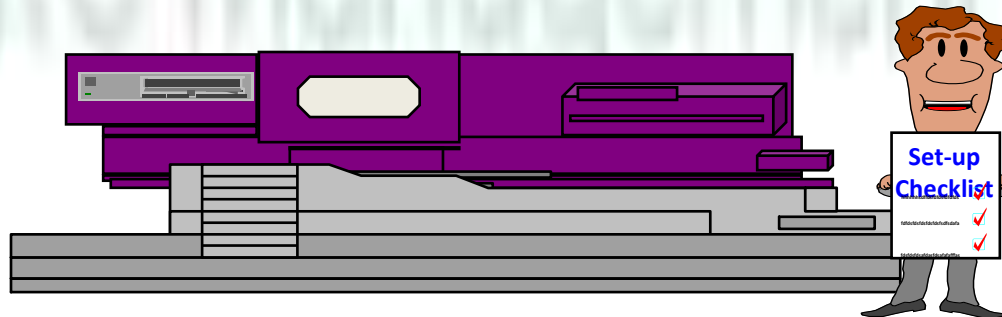
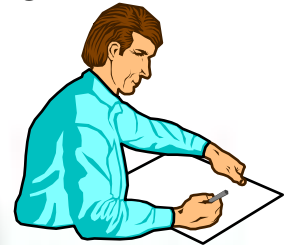
- **Longer term suggestions**
- **Modifications which may require more investment (money and time)**
- **More complicated improvements**



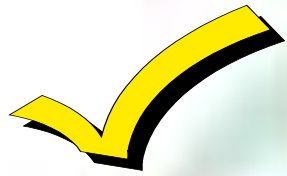
Phase 4: Continuous Improvement (Cont.)

Examples include:

- ⇒ Design and fabricate new work holding devices that incorporate cassette type inserts.
- ⇒ Design and fabricate a cart for quick removal & loading of fixture.
- ⇒ Develop checklist that describes all tools, holders, and gages required. Create kits for all machines and train all people.



Set-up Reduction Benefits



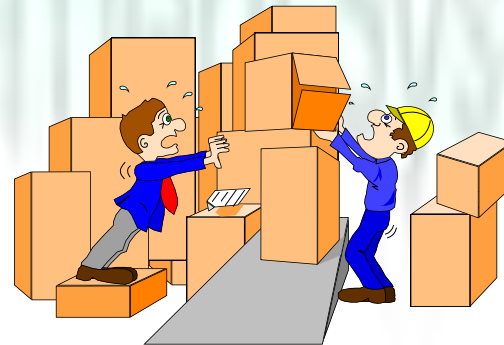
Lower throughput time

- Ability to satisfy customer demand



- Greater Flexibility

- Reduction in Inventory

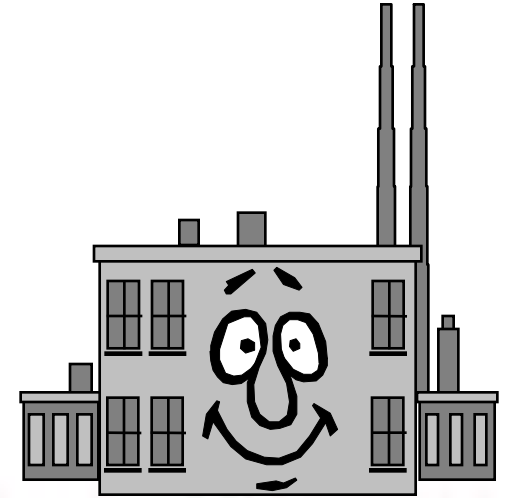


Set-up Reduction Benefits (Cont.)



- **Increased throughput**

- Greater capacity
- Less resources



- **Reduced complexity**

- Reduced operator dependency
- Improved quality
- Reduced tooling costs

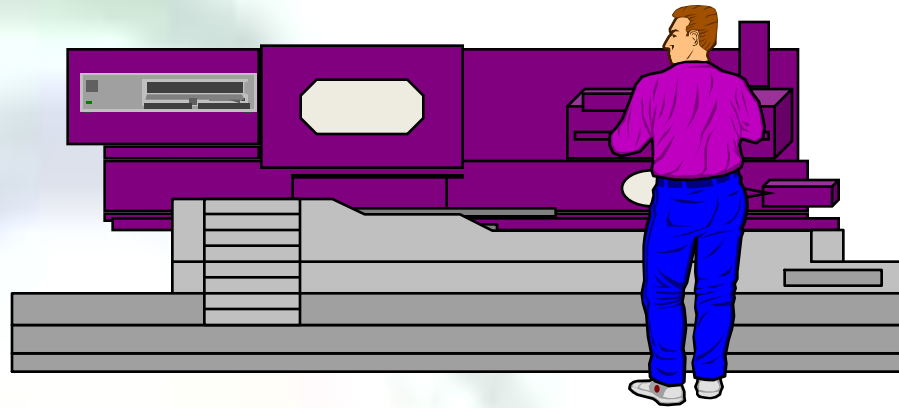
Set-up Reduction Benefits (Cont.)



- **Build to requirements not stock**

- Synchronize assembly to fabrication
- Shorter production cycle
- Quicker response to demand changes
- Reduced floor space

Set-up Reduction Benefits (Cont.)



- 
- **Equipment utilization improves**
 - Reduced need for outsourcing
 - Greater sales possible