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Full Length Research Paper

Productivity development of computer numerical control (CNC) set up in manufacturing company

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Most manufacturing operations require periodic setups for product changes, process-control verifications or engineering evaluations. Setups performed in-line-on the tool in lieu of running product take away from production time and may be classified as waste. This paper focuses that, setup procedures should be analyzed to see if they can be done in parallel, off line, to allow production to continue. Alternatively, process checks might be accomplished with product parts instead of monitors, eliminating what is effectively downtime (waste) for a tool or sector. In this paper data was also calculated and collected after implementing of Set up Reduction Single Minute Exchange of Dies (SMED) technique. By implementing Set up Reduction (SMED), waste time is reduced from 113.75 h in June 2008 to 59.75 h in May 2009 with 585.00 h available time for machining. Productivity of machine also increases from 19 platens in June 2008 to 44 platens in May 2009.

Key words: Set up reduction, single minute exchange of dies (SMED), productivity, world class manufacturing, down time.

INTRODUCTION

Nowadays, a productivity improvement is the important requirement for all manufacturing companies. Productivity refers to measures of output from production processes per unit of input. Any manufacturing company reaches to higher profit level only by improving productivity of its product. For an organisation to be relevant in the dynamic and changing environment, according to (Elliott, 2007) productivity improvement effort must focus on:

1) Doing the „right things" (know „what" to produce and distribute) by continuously reviewing and identifying changing customer and societal needs and expectations (economic, social and ecological) as well as developing and designing products and services to best satisfy the needs, while it meets the expectations of the customers. Creating of more customer values.

2) Doing „things right" (know „how") by constantly improving production and distribution processes to produce and deliver the goods and services in the most efficient way, while at the same time minimizing their negative social and ecological impacts (Elliott, 2007).

In this paper, productivity improvement will be achieved by using Set up Reduction (SMED). It is one of the world class manufacturing techniques. By implementing the Set up Reduction, we can reduce waste time during machining and hence we can improve our production rate on that machine. This paper focuses on productivity improvement of Computer Numerical Control (CNC) set up

(Horizontal machining centre).

SET UP REDUCTION

Set-up reduction builds on the principles of the Single Minute Exchange of Dies (SMED) system, developed by Shingo (1985) to dramatically reduce or eliminate changeover time. The four-step changeover improvement process is used to help companies design no/low cost solutions to reduce changeover time. Companies that used SMED tools to ensure that changeovers are quick and relatively simple are typically much more agile: they can quickly change production operations to satisfy changing customer requirements. Increased responsive-ness, in turn, allows the firm to meet customer demands for high quality, low-cost products, delivered quickly without holding expensive excess inventory. The SMED process focuses on reduction of setup and changeover time as a way of improving utilization, increasing capacity and more volume. Changeover of rooms or equipment can be accomplished in less time and serves as a goal for change (Kayis and Kara, 2007).

The need for short set-up times

Globalization of the market has changed the way organizations have to do business nowadays. There are multiple manufacturers for the same products and there is excess capacity worldwide. However, not all customers are the same; different needs call for different products and product variants. On the other hand, most of the machines and machine lines in manufacturing plants are "shared resources". Indeed, given that the output capacity of machines has been much improved over the last decades due to technological improvements – machines have become larger and faster - the required volume of each product or product variant is in most cases lower than this available capacity. Hence, machines are used to produce different product types or different product variants within one product family and there will be changeovers when production is switched from producing a product A to a product B. Traditionally, the time needed for this changeover - the set-up time - has always been considered as a given, necessary evil. Since the publication of Narasimhan and Melnyck (1990), there has been a shift in thinking as Shingo proved that set-up times can be reduced drastically. Nowadays, set-up times are no longer considered as fixed (Narasimhan and Melnyck, 1990; Spence and Porteus, 1987).

Reducing downtimes due to set-ups results in additional available time on a production resource which can be used in two different ways: to effectively boost capacity (to be able to produce more) or to produce a greater range of products without increasing the total set-up (that is, producing smaller batches and increasing the set-up frequency) (Spence and Porteus, 1987). A third benefit of shortening set-up times is the reduction of production costs as is demonstrated by Van Goubergen (2000).

Procedure for set up reduction

According to Kais and Kara (2007), the implementation of Set up Reduction (SUR) initiatives were carried out in a packaging firm which experienced difficulties in dealing with inefficiencies caused by extended delays between production runs leading to increased lead times, extended production runs and high levels of inventory. It designs and manufactures a range of specialty closures, mainly for the food and beverage industry, and is a market leader in the development of innovative solutions for the Australasian market. It comprises three main manufacturing areas, one of which is climate controlled, and two large warehouses.

There are twenty-two injection molding machines ranging in age from just a few weeks right up to more than fifteen years. Raw materials are delivered to the machines through either a vacuum delivery system from bulk storage, or from large containers located next to the machine. The vacuum delivery system feeds from three large silos at the front of the plant, and is the primary material supply system. These machines are highly automated, and are either custom built assembly lines, or in a number of cases completely robotic. While these machines have their own problems associated with lengthy setup procedures, they were not considered in Kais and Kara (2007) paper.

The following steps are covered to identify the mechanical, organizational and procedural bottlenecks followed by suggestions for SUR initiatives:

1. Formation of a SUR team
2. Data collection and analysis

One of the most important steps towards reduced setup times is the analysis of the steps employees complete to physically change the mold towards maintaining a Single Minute Exchange of Dies (SMED) philosophy and it is vital to any SUR program. A form was produced with columns for Type of Process and Target Time. The tasks which could have taken place before the setup began were labeled „External", and were given a Target Time Value of zero. Internal processes were analyzed and revised to reflect the amount of time the task would be expected to take once SUR measures had taken place (Kais and Kara, 2007).

Alternatives for set up reduction

SMED is not the only approach for reducing setup time. Some other alternatives are:

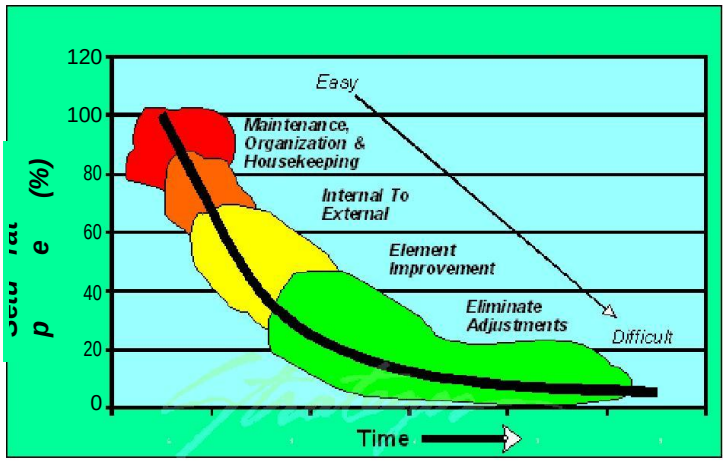

Figure 1. Phases of Set up Reduction.

1) Production planning - reduce the number of setups.
2) Group technology / cell formation - reduce the number of setups.
3) Design standardization - reduce the number of setups.
4) Use standard module - reduce the number of setups.
5) Work simplification.
6) Mechanization or automation - an expensive option.

Toolkits for set up reduction

Many toolkits can be applied to help set up reductions, for instance:

1) Visual control.
2) Checklist.
3) Specially designed setup cart.
4) Workplace organization (5S).
5) Railed cart.
6) Standardized base plate and socket.
7) Attachment plate.
8) Overhang tools.
9) Quick fasteners -- clamping cam, crank, clamping (lock) lever.
10) Standardized die height.
11) Locating pins.
12) Stopper.

Effects of set up reduction

Set up reduction may bring the following impacts to the shop floor:

1) Lot-size can be reduced.
2 Help to reduce inventory.
3) Reduce the cost of setup labor.
4) Increase the capacity on bottleneck equipment.
5) Help to eliminate the setup scrap.
6) Reduce the potential quality problems and obsolescence.
7) Respond to customer needs and schedules with more flexibility.
8) Improve on-time delivery.
9) Decrease costs due to excess inventory.
10) Increase line and machine capacity levels.
11) Increase changeover accuracy.
12) Reduce startup defects.

Phases of set up reduction

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) Internal elements to external: 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 (Figure 1).

RESULTS

After the implementing of Set up Reduction, data were collected and analyzed. Waste time is so much reduced for machining and because of that more time was available for only machining; hence finally rate of production is increased. The following tables and chart gives all the information about machine"s down-time (waste-time) from June 2008 to May 2009.

Table 1 represents value of down time of CNC machine from June 2008 to May 2009. It indicates that down time is highest in the month of December 2008, with a value of 149.25 h. This down time is also high in the month of June 2008, with a value of 113.75. It is reduced to 59.75 h in the month of May 2009. A graphical representation of these results is given in Figure 2.

By reducing the waste in machine, more available time for machining and finally high production rate was achieved. In June 2008, only 19 platens machined on that machine while in May 2009 44 platens machined on same machine. Table 2 gives all information about platens machined every month from June 2008 to May 2009 on that machine.

Table 2 and Figure 3 indicates that platen production

Table 1. Down time of CNC machine from June 2008 to May 2009.

Year	Month	Down time (Hours)	Available time (Hours)
	June	113.75	585
	July	123	585
	August	148.5	563
2008	September	104.25	585
	October	102	518
	November	56. 25	594.25
	December	149.25	607.5
	January	45	540
	February	75.25	540
2009	March	150.75	570
	April	73.5	547.5
	May	59.	

Table 2. Produced platens on CNC machine from June 2008 to May 2009.

Year	Month	Produced platen
	June	17
	July	19
	August	10
2008	Sep.	25
	Oct.	19
	Nov.	17
	Dec.	22
	Jan.	24
	Feb.	26
2009	March	19
	April	29
	May	44
	June	38

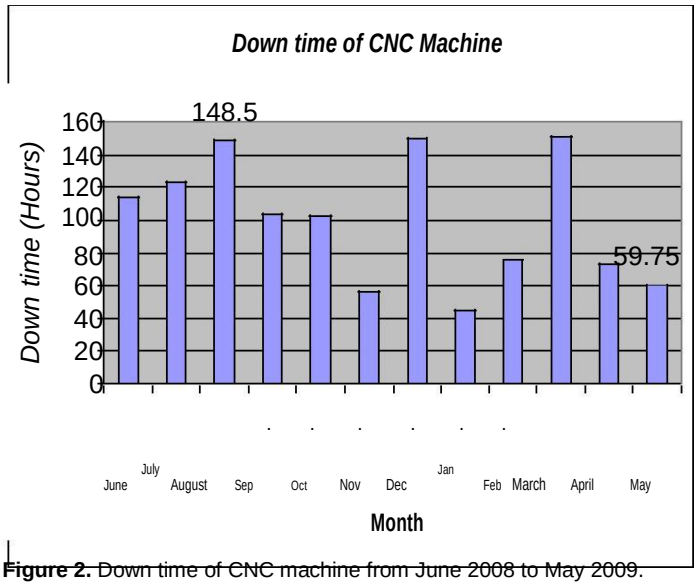

Figure 2. Down time of CNC machine from June 2008 to May 2009.

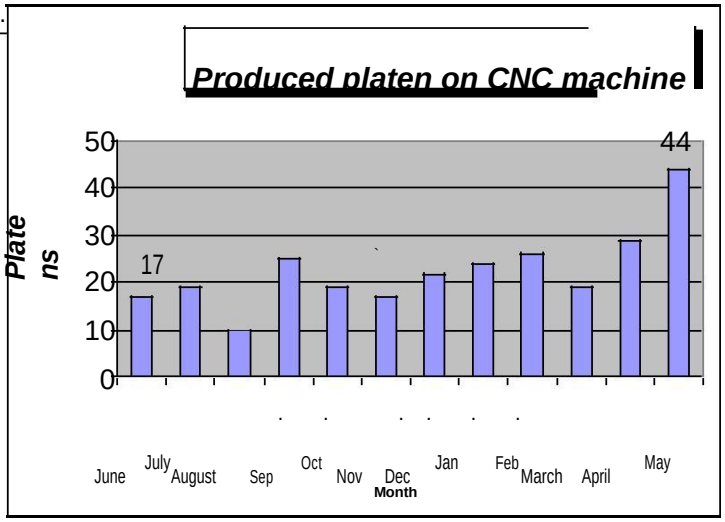

Figure 3. Platens produced on CNC machine from June 2008 to May 2009.

rate, in short productivity of CNC machine increased from 17 platens in June 2008 to 44 platens in May 2009.

Conclusion

By implementing the Set up Reduction, change in waste time and change in production rate can be observed. Waste time is reduced from 113.75 in June 2008 to 59.75 in May 2009 and productivity increased from 17 platens in June 2008 to 44 platens in May 2009. So our target of productivity improvement is achieved. Similarly this type of Set up Reduction technique also applies to other machines of all manufacturing companies for achieving higher productivity. Any manufacturing company can use this methodology for improving its productivity.

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