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# Participative Versus Assigned Production Standard Setting in a Repetitive Industrial Task: A Strategy for Improving Worker Productivity

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The participative standard with feedback condition was superior to the assigned difficult (140% of normal) standard with feedback condition in terms of worker productivity. The percentage increase in worker productivity with the participative standard and feedback condition was 46%, whereas the increase in the assigned difficult standard with feedback was 23%, compared to the control group (no standard, no feedback). Worker productivity also improved significantly as a result of assigning a normal (100%) production standard with feedback, compared to the control group, and the increase was 12%. The participative standard with feedback condition emerges as the optimum strategy for improving worker productivity in a repetitive industrial production task.

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participative standard assigned standard performance feedback  
repetitive industrial task worker productivity

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## 1. INTRODUCTION

Repetitive production tasks are often considered boring, monotonous, fatiguing, and unmotivating. This in turn has detrimental effects on worker productivity, and is considered a major problem of worker

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productivity improvement in industry. Consequently, it is of utmost importance to apply suitable strategy to improve worker productivity especially in repetitive industrial tasks.

Goal or standard setting is believed to motivate operators in task performance through directing attention, mobilizing energy expenditure, and prolonging effort. The positive effects of goals on worker performance have been well established. Research studies have demonstrated that specific difficult goals lead to higher levels of performance than do-your-best or easy goals (Awdia, Brown, Kristof-Brown, & Locke, 1996; Locke, 1968; Locke & Latham, 1984; Locke, Shaw, Saari, & Latham, 1981; Phillips & Gully, 1997). However, some recent studies have indicated that the typical positive effect of a specific difficult goal assignment may not hold for performance of novel, complex tasks (Earley, Connally, & Ekergren, 1989; Gilliland & Landis, 1992; Knafer, Ackerman, Murtha, Dugdale, & Nelson, 1994). Feedback affects performance by motivating to adjust work output, reinforcing response pattern and direction towards goal. It has been found effective in learning situations and improving individual's motivation in performance (Ammons, 1956; Leamon, 1974; Wofford & Goodwin, 1990). For goal setting to be effective, feedback is a necessary condition. Studies had shown that specific goals with feedback were superior to goal setting or feedback alone (Becker, 1978; Das, 1982; Erez, 1977).

The goals could be either assigned or set participatively with the worker. Research studies have shown inconsistencies regarding the superiority of participative versus assigned goal setting (Ludwig & Geller, 1997). Some studies have shown that participatively set goals lead to better performance than assigned goals (Latham, Mitchel, & Dossett, 1978; Latham & Yulk, 1975; Locke et al., 1981), whereas some other studies have shown opposite results or effects (Dossett, Latham, & Mitchel, 1979; Latham & Saari, 1979; Latham & Steele, 1983). Worker participation in decision making is the primary means of obtaining commitment to productivity and lowering resistance to change (Latham, Winters, & Locke, 1994; Locke & Latham, 1984). There is a need to explore further the effects of participative versus assigned goal setting on worker productivity. Such a study can contribute towards developing a strategy for improving worker productivity especially in repetitive production tasks.

In the past, considerable amount of research had been performed in this area under laboratory settings, however, only a limited number of studies were performed under field or industrial settings (Becker, 1978;

Ivancevich & McMahon, 1982; Kim & Hamner, 1976; Latham & Kinne, 1974; Latham & Yulk, 1975). The characteristics of many of the past research were (a) the task used were relatively *simple or simulated*, (b) the goals or standards were set *arbitrarily* or based on operators' past performance, (c) *measured standards* based on work measurement techniques were seldom used, (d) *difficult goals* or standards were not established or assigned in a consistent manner across studies, and (e) participative goals were set by employing different methods or approaches. Consequently, it was difficult to make comparative analysis among studies. Systematic controlled experiments dealing with participative and assigned standards were seldom performed with repetitive production tasks using measured standards in an ergonomically designed work environment.

In order to deal with the problems just stated, a study was conducted on a realistic, repetitive production task employing measured standards under an ergonomic working situation in a university machine shop environment (Das & Shikdar, 1989, 1990). The research results revealed that worker productivity improved significantly as a consequence of the provision of participative standard with feedback and the assignment of a difficult standard of 140% of normal with feedback. However, operator performance under participative standard with feedback was found significantly less or inferior than the assigned difficult standard of 140% of normal with feedback. The limitations of the study or research results must be recognized. The participants of the study were university students and the task was performed for the duration of 1 hr only. Therefore, the study did not represent a real life or industrial work situation, where the employees are engaged for an 8-hr work day and working for a living or pay.

It is necessary to validate the aforementioned research results in industry, where workers are engaged in performing industrial tasks under real life working conditions. It is believed that the results from such a study will be meaningful and can be generalized or applied in a real world work situation. The objectives of this investigation were to (a) study the effect of participative versus assigned standards with feedback on worker productivity in a repetitive industrial production task, performed in an ergonomically designed work environment and using a measured standard, (b) develop a strategy based on the research results (a) to improve worker productivity especially in a repetitive industrial task, and (c) compare the results of the industrial study with the results of the laboratory study in a similar task situation.

## 2. EXPERIMENTAL METHOD USED IN INDUSTRY

A large fish processing plant was selected for the conduct of the experimental research. The experimental method was designed with a view to cause minimum disruption to the normal industrial production work and thus minimize economic or production difficulty to the company. The details of the experimental method were described elsewhere (Shikdar, 1991), only the essentials relevant to the present investigation are highlighted in this section.

### 2.1. Task

The repetitive production task was a fish trimming operation (Figure 1). It involved trimming and sorting fish fillets into different product sizes. Regular trimming knives were used for the trimming operation. The task method was standardized, so that all the operators would be able to perform the task following the same procedure. An operator instruction

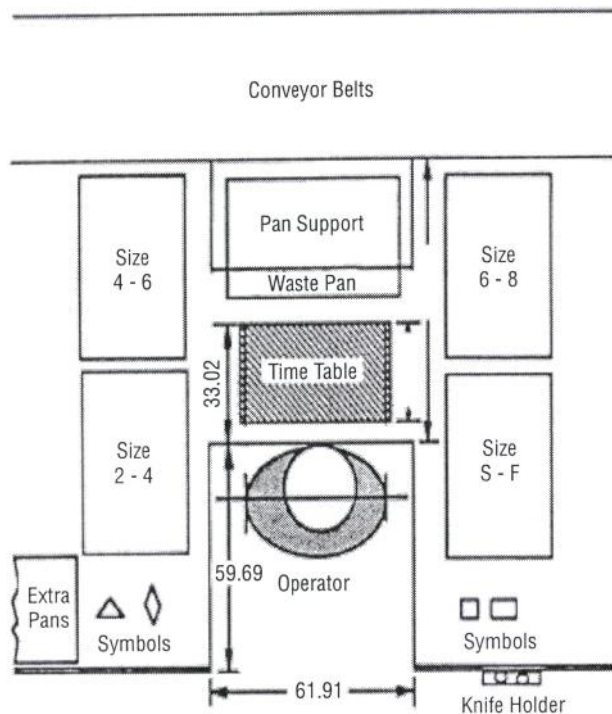


Figure 1. Fish trimming workplace layout. All dimensions are in centimeters.

sheet of the standardized task method that dealt with left hand and right hand operations was provided at each workstation.

## 2.2. Production Standards

The required motions to perform the task were determined through methods-time-measurement (MTM) and ergonomics analysis. The normal production time/standard to process a pan of fish fillets (20 lb [9 kg]), was determined through MTM, and a stopwatch time study was performed to check the accuracy of the MTM standard. The standard time was calculated using the formula:

$$\text{standard time} = \text{normal time} (1 + \text{allowance in percentage}) \quad (1)$$

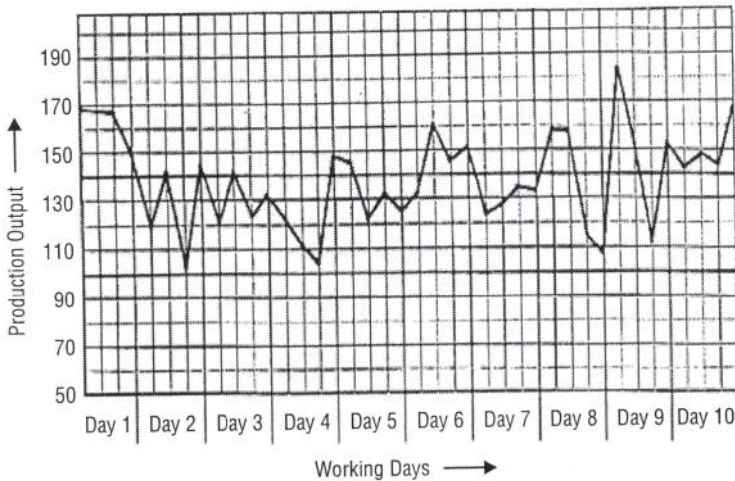
A 17% allowance, comprising of 7% for unavoidable delays, 5% for fatigue, and 5% for personal needs was added, taking due consideration of the wet working conditions.

The normal (100%) production was calculated in terms of the number of pounds (lbs) of fillets to be processed per hour. For example, normal time to process one pan of 20 lbs of fillets = 4.5 min, standard time =  $4.5 (1 + 0.17) = 5.27$  min, normal (100%) production standard =  $(20/5.27) \times 60 = 227.70$  lbs/hr (102.50 kg/hr). For the purpose of this study, the difficult or hard production standard was determined on the basis of 140% of the normal standard (normal standard  $\times 1.4$ ), as established earlier from a laboratory study (Das & Shikdar, 1990).

The participation standard was set by each individual operator in consultation with the experimenter. The operator was asked to set a standard above 100% of normal that he or she considered challenging and would like to attempt. Each standard was presented on a special feedback card for each individual operator in terms of pounds per hour (lbs/hr) against the standard.

## 2.3. Performance Feedback

A special feedback card was prepared for each operator who received feedback of performance results. Feedback was provided in terms of production output (lbs/hr) and performance (% of standard achieved every 2 hrs). The performance for each working day was recorded on the card in graphical form for easy visualization (Figure 2).



**Figure 2. Performance feedback card, showing percentage of production standard achieved by working day.**

## 2.4. Worker Productivity Measure

Worker productivity in terms of quality output (lbs/hr, fillet trimmed) and performance (% of normal standard achieved) was measured every 2 hrs. The full day's output was converted to performance in percentage for subsequent statistical analysis.

## 2.5. Work Environment

The physical work environment with regard to temperature, humidity, and illumination was considered within normal level (Sanders & McCormick, 1993). The temperature was 20 °C, relative humidity 50%, and lighting 2000 lx on the trim table. Due to wet conditions the participants wore full length aprons and special boots, covering up to the knees, and performed the task standing on a platform. The participants used ear plugs as the sound level was above 85 dBA. Continuous water supply was provided for washing hands or fillets, if required. Overall, the physical working conditions were satisfactory, given the nature of the work.

## 2.6. Participants

The participants of the study were regular employees of the plant. Thirty-two operators (trimmers) were selected on a voluntary basis for



the experimental research. The criteria of screening were based on the participants having at least 6 months on the job or work experience, at least seventh grade education, and did not plan to quit the job within one year. They were given training for one day to familiarize with the standardized method of task performance. The participants performed the same task in the experimental sessions under specific experimental conditions for 10 days within a 10-month period.

## 2.7. Experimental Design

The selected 32 participants were assigned randomly into four groups and the four experimental conditions were randomly assigned to the groups. The experimental conditions and assignment of groups to these conditions are presented in Table 1. The experimental conditions for each group were explained to its members. The participants of each group performed one training and 10 experimental sessions, each session being a full day's work, over a 10-month period. Only one session was held on one day for only one group and the sessions were assigned at random. In every session the participants of the group were reminded about their experimental condition. The participants of Group 1 (control group) were simply asked to do their best. All the participants were asked not to discuss their experiments and results with each other.

**TABLE 1. Characteristics of the Experimental Groups**

Group Number (Characteristics)	Production Standard (PS)	Performance Feedback (PF)
1 (Control)	No PS	No PF
2 (Assigned)	PS: 100% of normal	PF
3 (Assigned)	PS: 140% of normal	PF
4 (Participative)	PS: Participative	PF

## 3. RESULTS

The production output data were collected in terms of percentage of the normal standard for statistical analysis. The data were analysed through the use of the Statistical Analysis System (SAS) computer program (Ray, 1982). Analysis of variance (ANOVA), analysis of covariance (ANOCOVA), and Student Newman-Kuel's (SNK) range test were performed for the analysis.

The results of the ANOVA (Table 2) showed that differences among the four groups were highly significant ( $F = 4.61, p < .01$ ) in terms of production output. It was believed the initial or inherent ability of the participants might have conditioned the outcome of the experimental results. To equate this individual variation among the participants of the groups, an analysis of covariance was performed on the data using the training data as the covariate. Thus an attempt was made to achieve statistical control of the errors by the removal of the influence of the individual differences. The results of the ANOCOVA (Table 3) showed the differences between the groups were highly significant ( $F = 6.08, p < .01$ ), confirming the results of ANOVA.

**TABLE 2. Analysis of Variance (ANOVA) of Worker Production Output Data**

Source	df	MS	F	PR > F	r <sup>2</sup>
Groups	3	1592.30	4.61	.01	.33
Errors	28	345.54			
Total	31				

Notes. PR > F—probability that a random  $F$  value would be greater than or equal to the observed value;  $r^2$ —coefficient of determination.

**TABLE 3. Analysis of Covariance (ANOCOVA) of Worker Production Output Data**

Source	df	MS	F	PR > F	r <sup>2</sup>
Groups	3	4862.89	6.08	.01	
Covariate	1	2480.83	9.31	.01	.50
Errors	27	266.45			
Total	31				

Notes. PR > F—probability that a random  $F$  value would be greater than or equal to the observed value;  $r^2$ —coefficient of determination.

**TABLE 4. Percentage Increase or Decrease in Performance as a Consequence of the Experimental Conditions**

Comparison Between Groups	Increase in Performance (%)
2 (assigned normal) versus 1 (control)	12.07
3 (assigned hard) versus 1 (control)	23.06
3 (assigned hard) versus 2 (assigned normal)	9.80
4 (participative) versus 1 (control)	45.60
4 (participative) versus 3 (assigned hard)	18.52

The adjusted means of production output of each group were calculated on the basis of ANOCOVA. The percentage increase or decrease in performance is presented in Table 4. Figure 3 drawn with the adjusted means shows the production output of the groups by day. The trend in performance of each group can be visualised from this figure. The adjusted means were used for the subsequent SNK range

TABLE 5. Student Newman-Kuel's (SNK) Range Test for Worker Production Output Data

Groups and Differences in Adjusted Means Between Groups <sup>a</sup>				
Groups	1 (Control)	2 (PS: 100% + PF)	3 (PS: 140% + PF)	4 (PS: Participative + PF)
1	—	8.87**	16.94**	33.50**
2		—	8.07*	24.63**
3			—	15.56**
4				—

Notes. a—groups in the order of increasing differences in adjusted means (production output, % of normal), \*— $p < .05$  (significant), \*\*— $p < .01$  (highly significant); adjusted production output for Group 1 (Control) = 73.63% of normal production; PS—Production Standard, PF—Performance Feedback.

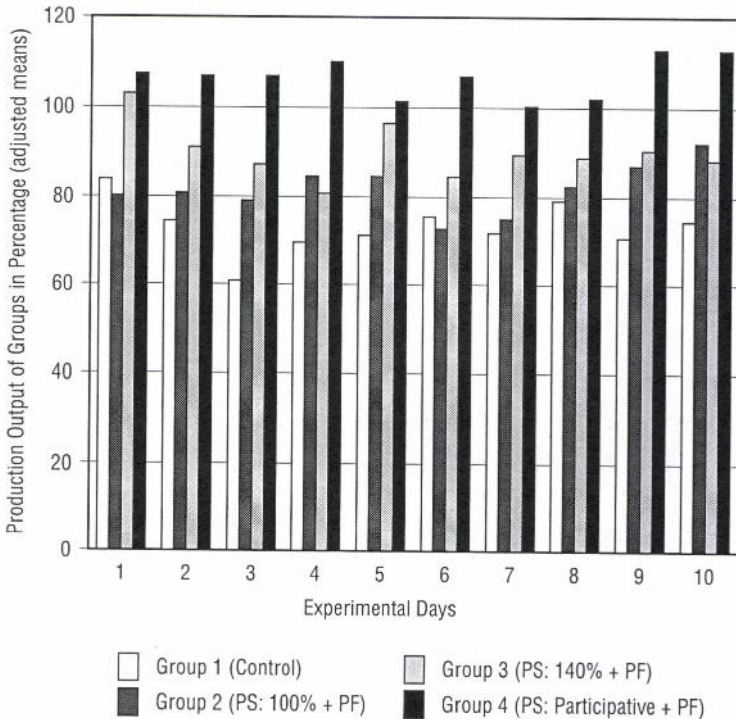


Figure 3. Production output in percentage of adjusted means of experimental groups by working day. Notes. PS—Production Standard, PF—Performance Feedback.

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test for comparative analysis of the groups. The results of the SNK range test are presented in Table 5.

### 3.1. Assigned Production Standards

The normal standard (100%) was used for comparison with the difficult standard (140%). A comparison between Groups 2 (100% of normal standard and feedback) and 1 (control) showed that the provision of an assigned normal standard improved worker performance significantly ( $p < .01$ ). In the laboratory study no significant difference was found between these conditions (Das & Shikdar, 1989, 1990). The provision of a normal production standard (100% of normal) along with feedback in industry was better than no standard and no feedback or, simply, a do-your-best standard.

A further improvement ( $p < .05$ ) in worker productivity was found when Group 3 (assigned 140% of normal standard and feedback) was compared with Group 2. The provision of an assigned difficult or hard standard and feedback had a significant positive effect on worker performance. This result was consistent with the result of the laboratory study (Das & Shikdar, 1989, 1990). All the participants accepted the difficult standard. Probably, they found the job challenging and were motivated by the specific difficult standard and feedback.

### 3.2. Participative Production Standard

The participants of the participative standard group had set a standard of about 120% of normal on the average. A comparison between Groups 4 (participative standard and feedback) and 1 (control) revealed that the provision of a participative standard with feedback significantly improved worker performance. A comparison between Groups 4 and 3 showed that the production output of the participative standard group was significantly better ( $p < .01$ ) than the assigned difficult standard group. Stated otherwise, the provision of a participative standard with feedback led to better performance than an assigned difficult standard of 140% of normal with feedback. The result was contrary to the laboratory study in which the assigned hard standard of 140% of normal with feedback was significantly better than the participative standard with feedback in terms of production output (Das & Shikdar, 1989, 1990). Although the participative standard was set at a much

lower level (on the average) than the assigned difficult standard, the worker production output was much higher. This indicated that in industry, a participative standard is preferred and the participant worked harder to reach his or her own standard. From this result it was evident that a participative standard with feedback was superior to assigned difficult standard (140%) with feedback in industry.

#### 4. DISCUSSION

It should be reiterated that this research was conducted in industry, as opposed to a university laboratory environment and the participants were industrial workers instead of college students. In the laboratory study, the participants performed the task for two one-hour work sessions (one-hour training and one-hour experimental work). In industry, the participants performed training for one day and experimental work sessions for ten days. The participants were industrial workers who were engaged for 8 hrs of work per day. Obviously, the results of the industrial study would be more realistic.

From the analysis it was evident that the results of the industrial study were different from the laboratory study in many aspects (Das & Shikdar, 1989, 1990). An assigned normal standard with feedback was considered as a substantial and meaningful change in the work situation to cause an improvement in worker productivity in industry. The finding was contradictory to the laboratory study where no improvement in worker productivity occurred. It could be stated that setting a specific production standard (provided with feedback) in industry is better than no standard and no feedback.

The standard of 140% of normal was considered *difficult* or hard as no further improvement in worker productivity was found as a result of assigning 150% of normal in the laboratory experiment (Das & Shikdar, 1990; Shikdar & Das, 1992). Worker productivity further improved beyond 100% of normal standard condition. This finding was consistent with the laboratory study. Many studies have reported that difficult goals lead to better performance than easy goals or do-your-best goals (Locke & Latham, 1984; Locke et al., 1981). The difficult goals in these studies were based on operators' past performance and not on a measured standard as determined by a work measurement.

Participation in decision making has been considered as a motivating factor in management (Latham et al., 1994). It has been recommended as

a means of obtaining employee commitment to organizational goal and reducing resistance to change (Locke et al., 1981). Although participative standard setting improved performance in the laboratory study, the performance was inferior to an assigned difficult standard of 130% of normal with feedback. Performance further improved with assigned difficult standard of 140% of normal with feedback in the laboratory setting (Das & Shikdar, 1990). In industry, the results were reversed. The performance of the difficult standard (140% of normal) group was significantly inferior to the performance of the participative standard group. The performance in participative condition was 46% higher, and in the assigned difficult standard condition was 23% higher compared to the control condition. It should be mentioned here that in the participative standard condition the workers had set a standard of about 120% of normal on the average, much below the hard standard of 140% of normal.

This finding clearly indicates the importance of participative standard setting in industry. The finding was also different from many goal setting studies that showed no difference or was inferior in performance with participative goal setting (Dossett et al., 1979; Ivancevich, 1982; Latham et al., 1978; Latham & Steele, 1983; Locke et al., 1981).

## 5. CONCLUSIONS

The following conclusions were drawn on the basis of the results obtained from the study performed in a field or industrial setting.

- Participative standard with feedback was superior to assigned hard standard of 140% of normal with feedback in terms of worker productivity in a repetitive industrial production task. The improvements were about 46% in the participative standard condition and about 23% in the assigned difficult standard condition compared to the control group. This was contrary to the result obtained in the laboratory study.
- The provision of an assigned normal production standard with feedback also improved worker productivity significantly compared to the control group. The improvement was about 12%. The result was contrary to the earlier laboratory study. In general, standard setting in industry improved worker productivity.
- Participation of workers in setting standards should be considered an important strategy to improve worker productivity in a repetitive production task in industry, especially in a unionized environment.

## 6. FUTURE RESEARCH

To realize maximum benefit from production standards and feedback as major components of a job design approach, research is needed as follows:

- Participative standard with feedback should be applied on a continuous basis for a longer period to determine if the positive effect on worker production would be sustainable in a repetitive production task in industry.
- The possibility of providing suitable monetary incentive to obtain full participation of the workers on a sustained basis for improving worker productivity in industry should be ascertained.
- Worker acceptance and satisfaction as well as attitudes under these circumstances need to be assessed.

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