The Effects of Intergroup Competition and Intragroup Cooperation on Slack and Output in a Manufacturing Setting

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SYNOPSIS AND INTRODUCTION: Firms are redesigning operations to reduce slack and waste and improve performance (Hoerr 1989; Safizadeh 1991; Walton 1987) and this often involves reorganizing production workers into workgroups to foster cooperation and group participation in setting standards (Hayes et al. 1988; Schonberger 1986). In addition to employing incentive schemes linked to meeting standards, many firms are using bonuses tied to relative performance among groups to develop a spirit of intergroup competition.

Over the past two years, we made several visits to three Fortune 500 manufacturing firms involved in such changes. The site visits suggested several hypotheses that merited further investigation. Thus, we designed a laboratory experiment to study more systematically what we had observed.

1 Since the firms that we visited were all experimenting with the workgroup form of reorganization, they asked that we reveal neither their names nor details about their businesses in any research projects. The firms produce consumer goods such as electronic instruments, leather goods, and small data storage devices. The hypotheses were formulated and the experiment designed according to a combination of insights gained from the firms, rather than on what any particular firm had implemented.

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in the field. This study extends previous research on determinants of slack and performance (e.g., Chow 1983; Chow et al. 1988; Waller and Chow 1985; Young 1985) by: (1) incorporating our observations and the literature on intragroup cooperation and competitive feedback to develop hypotheses, (2) studying workgroups rather than individuals, and (3) using a multi-period rather than single-period setting.

Results of the experiment show that the type of competitive feedback received by groups affected both their output and slack. Interestingly, when individuals were allowed to cooperate rather than work in isolation, performance actually declined. This latter result was unexpected and was likely the consequence of the particular experimental task.

Key Words: Manufacturing performance, Slack, Cooperation, Competitive feedback.

Data Availability: Inquiries about the data collection materials and data may be addressed to the first author.

In section I of the article, we review the relevant literature and develop hypotheses about the effects of intragroup cooperation and competitive feedback. We describe the experimental procedures in section II, report the results of the experiment in section III, and discuss our findings in the final section.

I. Background and Literature Review

Cooperation, Competition, and Task Interdependence

There is an extensive literature on the effects of individual inputs on group outcomes and compensation (Deutsch 1949; Goldman et al. 1977; Okun and DiVesta 1975; Schmitt 1981). Group goals and performance have been studied in intra- and intergroup cooperative and competitive settings (Johnson et al. 1981) with various types of incentive systems (Miller and Hamblin 1963; Steiner 1972). The degree of interdependence among tasks performed by individuals also affects both cooperation and competition (Schmitt 1981). With low interdependence, it is feasible and economical for a single individual to perform the entire task, but highly interdependent tasks involve the efforts of more than one person in creating a final product or outcome.

In the firms that we visited, workgroups were involved with intragroup cooperation, but were also faced with intergroup competition in highly interdependent tasks (assembly line production). All three firms had chosen this particular configuration as they believed it to be the most motivating. The idea was to develop a work culture in which individuals no longer competed against others on the line, but rather cooperated as a group through joint problem solving and team building. To promote even higher performance, each firm (with slight variations) had developed a competitive system in which workgroups were pitted against each other for rewards. The configuration chosen by these firms is quite consistent with the findings of previous experimental studies.

2 Young et al. (1988) studied performance in groups but did not manipulate group level variables; Chow et al. (1991) conducted a study over several periods but with a focus on individual performance.
research that the greatest level of performance for highly task-interdependent groups occurs when a group is internally cooperative but faces intergroup competition (Okun and Divesta 1975; Schmitt 1981; Tjosvold 1984).

Intragroup Cooperation

Our field sites had not systematically evaluated improvements in performance, but management mentioned instances in which they observed changes in the behavior of workers. For instance, workers were quite willing to suggest solutions to problems encountered in their workgroups, and management sensed that workers' attitudes toward their jobs were better and that tardiness and the number of sick days taken had decreased.

Our discussions with workers and managers reflected the evidence on the benefits of intragroup cooperation in Japanese, Swedish, and American manufacturing organizations (Aguren et al. 1976; Rohlen 1975; Safizadeh 1991). These benefits include better communication and assistance among group members (Schmitt 1984), sharing information to solve problems (Walton 1987), and greater commitment to the organization (Pinto and Pinto 1990; Tjosvold 1984). Although there have been a number of studies on changes in attitudes when firms adopt the intragroup cooperative form of organization, we are not aware of any research on the effects of intragroup cooperation on manufacturing performance. We test this relationship in hypothesis H1:

H1: Cooperative groups will outperform noncooperative groups.

Intergroup Competitive Feedback

Many firms attempt to motivate work groups by having them compete for bonuses or other types of rewards (Doyle 1983; Schmitt 1981; Walton 1987). Our sites were no different. In two of the firms, the rewards were financial bonuses; in the other firm winning groups received gift certificates. Prior experimental research has shown that intergroup competition can increase performance (Schmitt 1984; Tjosvold 1984).

A key aspect of competition that has not been addressed well at the group level relates to the timing and form of feedback that is received. For individuals, research in social learning theory has shown that the sign (positive or negative) of feedback that people receive is a key determinant of the level of their performance (Bandura 1978; Bandura and Cervone 1983; Ilgen et al. 1979; Podsakoff and Farh 1989). Reactions to performance feedback occur through a self-evaluative mechanism in which comparisons are made between feedback and the performance goals that have been set. Individuals who are committed to explicit performance standards and who obtain negative feedback about performance can become more highly motivated to produce. However, as noted by Bandura and Cervone (1983), performance is not a monotonically increasing function of the discrepancy between negative feedback and performance. If performance is continuously below expectations and individuals come to believe that the standards are not attainable, motivation will decline. But if the discrepancy is more moderate and goals seem attainable, performance can be increased.

In this study we investigate this phenomenon in a group context. Workgroup studies have suggested that competition facilitates performance only when the group believes it has a reasonable chance of winning (Tjosvold 1984). Other researchers have hypothesized that higher performance should result when feedback indicates that the group is either close to the lead or close behind compared to being far ahead or far
H2: Groups who are provided with feedback that they are just ahead or just behind will outperform those whose feedback indicates that they are always ahead or always behind.

**Participation and Slack**

Slack has been defined as the difference between an individual's best estimate of performance and the standard chosen when participating in standard selection (Waller 1988; Young 1985). Since Cyert and March's (1963) conjecture that slack is a reaction to uncertainties in the environment, research has sought to identify other moderating variables that would cause individuals to choose a work standard that was less than their best estimate of performance. For example, an individual's risk preferences, the degree of private information, and the different incentives used cause subjects to choose standards below their best estimates (Kim 1992; Waller 1988; Young 1985).

At all three of our field sites, the reduction of slack was mentioned as a major reason for group competition. Management in particular felt that workers were not performing to their capabilities and were choosing standards that were easily attainable. As a result, they promoted competition by designing incentive schemes that rewarded teams who met their weekly standards. Further, the teams who performed the best over a specified time period (usually a quarter) won a bonus. Feedback was provided to team members regarding the competitions on a weekly basis.

Some of the workers that we talked to told us that the possibility of attaining the bonus had caused them to raise their work standards which is consistent with the literature on feedback. Extending the results of both Bandura and Cervone (1983) and Podsakoff and Farh (1989), we hypothesize that groups that always receive feedback that they are leading in a competition will become increasingly satisfied and confident. As more and more positive feedback is received, their self-evaluation and comparison to other groups will cause them to no longer doubt their ability to achieve their goals (Taylor et al. 1984). Thus, they will tend to decrease their effort by building more slack into their standards than those always receiving negative or alternating positive and negative feedback.

**H3:** Groups receiving feedback that they are always ahead of others will build in more slack than those in the other competitive feedback conditions.

**II. Experimental Design and Method**

Ninety-six undergraduate subjects from advanced cost-accounting classes volunteered to participate in the experiment. Subjects received a fixed number of extra credit points and financial compensation for their participation. The extra credit points were thought to be appropriate as the topic of the experiment coincided with class discussions on management control system design.

**Experimental Design**

The experiment involves a $3 \times 2$ completely crossed, repeated measures design. The two independent between-subject variables were: intragroup cooperation (present, absent) and intergroup competitive feedback (always ahead, just ahead or behind, and
always behind the leading group). The third factor, time (three periods), was repeated within-subjects.

Intrigroup cooperation was operationalized by allowing group members to assist each other through verbal or physical means in performing the task. Subjects in the noncooperative groups were not allowed to communicate with or help each other in any manner, they were instructed in performance of only their particular task, and a large wooden divider was set up between subjects so that they could not see their fellow workers. A two-way mirror and a live microphone allowed researchers to directly observe any violations of the cooperation rules, and subjects did not violate these rules.

Intergroup competition was operationalized by having groups vie for a bonus at the end of a series of performance periods. Following each production period, subjects were provided with feedback on how they were doing relative to other groups. The actual performance of groups was not the feedback given to subjects. Although actual feedback would have some advantages, the experimental manipulations used to test the theory could not be done with any degree of control using actual performance.

Competitive feedback was of three types. One group (labeled always ahead) always received feedback that they were in the lead; the second group (labeled just ahead/behind) was told, in an alternating sequence, that they were either one unit ahead of or one unit behind the leading group; the third group (labeled always behind) was always told that they were behind the leading group. The sequence for all three types of feedback was predetermined before the experiment began for control and to allow consistency in the manipulation within each group.

The dependent variables were performance and slack, and they were measured in each of three production periods. Performance was measured as the actual number of good units produced within a period. Slack was measured as the difference between a group’s best estimate of their production and the standard they selected.

Experimental Task

The experimental task involved building a toy castle from four subassemblies made from Loc-Blocs. Each of the four subjects in a group was required to build a component and attach it to the subassemblies being passed to him or her. Each subassembly was intricate, and the level of difficulty was set intentionally high (through pretests) so that subjects had to concentrate to produce a final product of “good” quality. Care was taken to ensure that no subject’s task was more difficult or time consuming than that of others. Subjects could use any color block to match the required shape. However, to add complexity in construction and to strengthen the cooperation manipulation, one

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3 Manipulation checks revealed that the feedback stimulated feelings of competition. This procedure has been used for more than 20 years in the psychology literature (see Nadler 1979 for a comprehensive review). The Human Research Committee at the university approved all procedures used in this experiment, and following the experiment we fully informed subjects regarding all manipulations.

4 Using actual feedback would not enable comparison of the results since each group’s performance would probably be different. Thus, there would be no consistent manipulation, and we could not perform statistical tests.

5 This task has been used in two other experiments (Young 1985; Young et al. 1988).

6 A completed castle was deemed of good quality if it could pass three tests that subjects were informed of before production. The first involved being able to rotate the castle without it collapsing. In the second, the experimenter made sure that correctly shaped blocks were used in construction. A final test involved inspecting the castle at four key points where prespecified colors and shapes had to be correctly in place. If a castle passed all three of these tests, it was considered a “good product.”
location on each subassembly had to be filled with a block of a particular shape and color. Subjects who were allowed to cooperate could communicate to others or move down the line to ensure that the color and shape matched.

Incentive Scheme

The incentive scheme consisted of two components. The first was a payment each period as shown in equation (1). The second component was a bonus that was paid at the end of all production periods. The payment per period was:

$$Y = 0.10(A) - 0.10 |A - S|,$$  \hspace{1cm} (1)

where:

- \(Y\) = the pay for each worker in each group,
- \(S\) = the group standard chosen by workers, and
- \(A\) = the actual performance of the group.

Thus, if actual group performance, \(A\), is less than the group standard chosen, \(S\), then compensation is reduced by $0.10 times the difference between \(A\) and \(S\). If \(A\) is greater than the group standard, the group makes the same compensation as if it had exactly met its chosen standard. The group can earn more only by raising its standard and meeting it.

This incentive scheme was chosen because it is consistent with the philosophy in many new manufacturing environments in that individuals are encouraged to forecast their production very carefully and then to perform to standard without over- or under-producing (Schonberger 1982). In addition, it has been pretested in previously published research and shown to have strong motivational properties (Young 1985).

To induce intergroup competition, subjects were told that a bonus based on performance relative to other groups would be awarded at the end of the last production period to the group producing the most good quality units. At the end of each period, groups received feedback about their performance relative to others for that period as well as a cumulative performance standing. Since pretests indicated that a subject could earn up to $12 without the bonus, we set the level of the bonus at $24 to be split equally among the four team members. The literature on profit and gainssharing indicates that bonuses can range from 5 to 100 percent of base salary in organizations (Doyle 1983); our bonus was set at the midpoint of this range (50 percent of possible base pay) to achieve a high level of motivation and performance.

Taken together, the two types of incentives were designed to (1) promote accurate forecasts of daily performance and impose work discipline (to meet the standard) and (2) generate motivation so that each period’s cumulative performance affected a bonus based on sustained performance.

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As a point of clarification, subjects were told that only the number of good units produced up to the standard they selected would be counted toward the bonus determination. Thus, there was no benefit to producing more than the standard. This is consistent with the daily incentive scheme that discourages production past the standard selected. Teams winning the bonus were determined before the experiment began for control purposes. Thus, actual performance had no effect on the outcome.

We calculated the price paid per unit of production according to the total number of dollars that we had for the experiment and divided this by the number of subjects and periods, allowing for the final bonuses.
Experimental Procedures

Subjects were asked to sign up for a three-day period that included five sessions: a 30-minute training session, one 15-minute trial production period that fully simulated the actual production period, and three measured production periods. We used the trial production period to reduce the effects of differential learning. Subjects were randomly assigned to groups of four and groups were randomly assigned to one of six experimental conditions.

When subjects entered the university’s organizational laboratory, an experimenter led them to one of three experimental production rooms. Experimenters were located in adjacent rooms and recorded observations via a two-way mirror. The chief experimenter used headphones to monitor the rooms, and groups were videotaped over the course of the experiment. Before the experimental runs occurred, subjects were informed that they were being observed and that they could be taped. Each experimenter followed a detailed script to maintain consistency across experimenters and to control for researcher expectancy effects (Rosenthal 1966). To avoid subject attrition, we went to great lengths to make sure subjects would return on subsequent days (e.g., we telephoned them each day), and there was no attrition over the three-day period.

Day 1. On the first day, subjects were asked to read a short case (see the Appendix) that discussed the competitive production setting and explained the experimental task. Subjects were instructed as to what they could do to help one another in the cooperation conditions and how they would receive feedback regarding their relative standing. Each subject was randomly assigned to one of four positions on a production line at the beginning of the experiment. Position assignments were permanent; however, subjects in the cooperation condition could move temporarily to help coworkers.

Each subject was given 30 minutes to learn his or her task, and those in the cooperation condition were given extra time to gain familiarity with each other’s tasks. Previous research (Young 1985; Young et al. 1988) and pretests indicated that subjects learned their tasks after about 15 minutes. After the training session, subjects were asked to produce as many good quality products as they could for 15 minutes; they each earned $0.10 for each good quality castle that the group produced. The flat rate of $0.10 was used to get subjects accustomed to obtaining pay for performance and for motivational purposes. At the end of the period, the experimenter counted and recorded the number of good quality castles produced. The experimenter then told the subjects that they had to wait for the experimenter to tally up the results to see how their group had done relative to other groups. After counting the good units, the chief experimenter returned to the room and told subjects of their standing based on that day’s results, and, beginning in the first actual production period, how they were faring cumulatively. As an example, subjects in the always ahead group received a relative performance report based on their performance relative to the other groups.

Waller (1988) observed in his experiment that learning in a three-period experiment decreased after the first period. This bolsters our reasons for eliminating this period from our analysis.

Subjects in the experiment volunteered to participate. Rosenthal and Rosnow (1991) and Birnberg et al. (1990) point out that volunteer subjects may be biased on a particular dimension and not necessarily representative of the general population. Although we did not notice anything unusual about our subjects, there is always the possibility of bias in the results.

This script is 35 pages long and details everything that was said to subjects and all of the actions taken by the experimenters. It is available from the authors on request.
that stated "Your group is in the lead and X good castles ahead of the next best group. Cumulatively, you are X good castles in the lead." The "Xs" were predetermined each period by the experimenters for each performance report.

Toward the end of training on the first day, groups were shown the incentive scheme that would be used for the rest of the experiment. The experimenter explained how the scheme worked by going over it several times on a blackboard, then quizzed subjects to ensure that they understood the scheme. The scheme was left on the blackboard so that subjects could refer back to it.

Day 2. On the second day, the trial and first measured production periods, each lasting 15 minutes, occurred. The groups were asked to determine their best estimate of the number of units they could produce. After making this decision, each group wrote this number down and placed the information in an envelope and sealed it. At this point, in conformance with the ideas that competitive feedback would mediate the relationship between the best estimate and the actual standard selected, the experimenter reentered the room and performed the competitive feedback manipulation by revealing the group's performance standing based on the previous day's production. Given the relative standing information, group members then negotiated with each other until a unanimous decision about their work standard was reached. The group then informed the experimenter of the group standard, which was recorded. Since slack was defined as the best estimate of performance minus the actual standard selected, these procedures provided us with the measure of group slack.

Subjects then worked for a 15-minute period, after which a questionnaire was administered to gather information relating to other behavioral variables of interest. At the end of the second period on Day 2, the competitive feedback procedures were followed.

Day 3. The second and third measured production periods on Day 3 used the same procedures as outlined for the first measured period. To avoid any end-game strategies or motivational problems, subjects were not told for how many periods the game would continue. At the end of period 4, the (predetermined) group winning the weekly bonus was announced, and subjects then filled out a final questionnaire, which contained the same questions as the previous questionnaires plus manipulation checks. Finally, subjects were thoroughly informed about the purposes of the experiment and the manipulations that were used, and each subject who did not receive the bonus was given an additional $4 to equalize payments across subjects.

III. Results

Even though we randomly assigned subjects to experimental conditions, we performed analyses of variance on demographic data related to subjects. This data included age, gender, academic major, amount of full-time and part-time work experience, and the number of accounting courses subjects had taken. The results indicated no significant differences across cells, and thus no systematic bias in the experimental results.

12 As this is one of the first studies in this area, we decided to use the questionnaires between periods to develop behavioral constructs related to group cohesion and commitment to standards for future research.

13 Across all experimental conditions, subjects made $11.25 on average.
Manipulation Checks

The manipulation of competitive feedback was assessed by subjects’ responses to two statements, the first of which was “It seemed that our team was always leading other groups.” Subjects responded on a seven-point Likert scale that ranged from “strongly disagree” (1) to “strongly agree” (7). An ANOVA was used to test for significant differences across conditions. A main effect was found for competition ($F = 124.99, p < 0.000$). The marginal means for the three competitive manipulations across cooperative conditions were in the right direction: always ahead, $\bar{x} = 6.77$; just ahead/behind $\bar{x} = 4.60$, and always behind $\bar{x} = 1.78$. Thus, the feedback element of the competition manipulation was shown to work as expected.

The second statement, “The performance of other teams influenced our team’s production goals,” was designed to assess whether standard setting was affected by competitive feedback. The same scale was used as before. An ANOVA across conditions indicated a main effect for competitive feedback ($F = 6.768; p < 0.002$). Again, the marginal means were in the right direction: always ahead, $\bar{x} = 4.47$; just ahead/behind, $\bar{x} = 5.63$; always behind; $\bar{x} = 5.72$. Contrasts among the groups indicated significant differences between the always ahead and just ahead/behind groups ($t = 3.303, p < 0.001$) and between the always ahead and always behind groups ($t = 3.05, p < 0.003$). No difference was found between the just ahead/behind and always behind groups ($t = 0.248, p < 0.800$). It is clear from this manipulation check that those just ahead/behind and always behind were more strongly affected by the feedback compared to those in the always ahead condition. Table 1 contains descriptive statistics.

The cooperation manipulation check used four statements combined into one scale. These were: “No one is allowed to help me if I run into trouble on my task during production” (negatively scored); “I can help others in performing their tasks during production;” “I can see how well my other team members are performing during production;” and “I can communicate freely with others during production.” Subjects responded to each statement on a seven-point Likert scale that again ranged from “strongly disagree” (1) to “strongly agree” (7). Scale reliability for this four-item scale was quite satisfactory (Cronbach’s alpha = 0.82).

The four items in the scale were summed and the resulting variable was used as the dependent measure in an ANOVA across the experimental conditions. The results show a significant effect for cooperation ($F = 68.14, p < 0.0001$). The marginal mean for groups in the cooperation condition was 19.30, while that for noncooperation, 18.83, indicates that the significant difference was in the desired direction. These results indicate a successful manipulation of cooperation.

Table 1 presents descriptive statistics for the best estimate of performance, actual group standard selected, slack, and actual performance. Several patterns are worth noting. First, best estimates and group standards increased over time in almost all of the experimental conditions. Second, the range of best estimates and standards is higher for the just ahead/behind and always behind groups than for those always ahead. Third, when comparing group best estimate changes (period 4 vs. period 2), those given always ahead feedback had a smaller change than the other two groups. The pattern of

*We expected subjects who were just ahead/behind to feel that they were sometimes in the lead and sometimes not. This would cause them to fall between the always ahead and always behind groups.
Table 1
Descriptive Statistics for the Six Experimental Conditions
(n = four groups per cell with four subjects per group)

<table>
<thead>
<tr>
<th>Cooperative Feedback Manipulation</th>
<th>Cooperative Groups</th>
<th>Noncooperative Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ahead</td>
<td>Behind</td>
</tr>
<tr>
<td>Group Best Estimate:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Period 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>mean</td>
<td>16.75</td>
<td>18.50</td>
</tr>
<tr>
<td>s.d.</td>
<td>5.13</td>
<td>2.37</td>
</tr>
<tr>
<td>Period 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>mean</td>
<td>17.25</td>
<td>22.25</td>
</tr>
<tr>
<td>s.d.</td>
<td>4.09</td>
<td>1.84</td>
</tr>
<tr>
<td>Period 4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>mean</td>
<td>17.50</td>
<td>22.00</td>
</tr>
<tr>
<td>s.d.</td>
<td>3.31</td>
<td>2.53</td>
</tr>
</tbody>
</table>

| Group Standard:                  |        |        |        |        |
| Period 2                         |        |        |        |        |
| mean                             | 16.50  | 18.50  | 14.75  | 17.75  |
| s.d.                             | 4.76   | 2.37   | 1.98   | 4.22   |
| Period 3                         |        |        |        |        |
| mean                             | 17.00  | 19.75  | 15.75  | 19.75  |
| s.d.                             | 4.44   | 1.13   | 1.53   | 4.22   |
| Period 4                         |        |        |        |        |
| mean                             | 16.00  | 20.75  | 16.25  | 22.00  |
| s.d.                             | 3.80   | 0.88   | 1.84   | 4.84   |

| Group Slack:                     |        |        |        |        |
| Period 2                         |        |        |        |        |
| mean                             | 0.25   | 0.00   | 1.00   | 0.00   |
| s.d.                             | 0.45   | 0.00   | 1.79   | 0.73   |
| Period 3                         |        |        |        |        |
| mean                             | 0.25   | 2.50   | 0.75   | 0.00   |
| s.d.                             | 0.45   | 1.55   | 1.34   | 0.73   |
| Period 4                         |        |        |        |        |
| mean                             | 1.50   | 1.25   | 0.00   | 0.00   |
| s.d.                             | 2.13   | 1.98   | 0.73   | 0.73   |

| Actual Production:               |        |        |        |        |
| Period 2                         |        |        |        |        |
| mean                             | 16.75  | 17.50  | 17.75  | 18.75  |
| s.d.                             | 3.45   | 1.55   | 2.77   | 5.18   |
| Period 3                         |        |        |        |        |
| mean                             | 16.25  | 19.25  | 15.50  | 20.50  |
| s.d.                             | 3.04   | 1.13   | 0.52   | 5.34   |
| Period 4                         |        |        |        |        |
| mean                             | 15.50  | 21.25  | 17.50  | 22.75  |
| s.d.                             | 2.69   | 0.86   | 1.55   | 5.53   |

Change in group standards is consistent with the results of the best estimates. Those groups given always ahead feedback tend to have lower group standards, and these standards do not change as substantially in comparison with the other groups.
Table 2
MANOVA Results for the Effects of Cooperation and Competition on Actual Production and Slack

<table>
<thead>
<tr>
<th>Factor</th>
<th>Actual Production</th>
<th></th>
<th>Slack</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F-Statistic</td>
<td>Probability</td>
<td>F-Statistic</td>
<td>Probability</td>
</tr>
<tr>
<td>Between Subjects</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooperation</td>
<td>3.91</td>
<td>0.052</td>
<td>1.75</td>
<td>0.189</td>
</tr>
<tr>
<td>Competition</td>
<td>14.91</td>
<td>0.000***</td>
<td>12.07</td>
<td>0.001***</td>
</tr>
<tr>
<td>Cooperation by Competition</td>
<td>0.10</td>
<td>0.913</td>
<td>11.03</td>
<td>0.001***</td>
</tr>
<tr>
<td>Within Subjects</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooperation by Time</td>
<td>3.40</td>
<td>0.038*</td>
<td>2.60</td>
<td>0.082</td>
</tr>
<tr>
<td>Competition by Time</td>
<td>12.30</td>
<td>0.001***</td>
<td>5.80</td>
<td>0.000***</td>
</tr>
<tr>
<td>Cooperation by Competition by Time</td>
<td>3.77</td>
<td>0.006**</td>
<td>3.70</td>
<td>0.006**</td>
</tr>
<tr>
<td>Time</td>
<td>45.24</td>
<td>0.001***</td>
<td>4.59</td>
<td>0.013*</td>
</tr>
</tbody>
</table>

* Significant at the 0.05 level.
** Significant at the 0.01 level.
*** Significant at the 0.001 level.

Patterns in the data for group slack are more difficult to detect. Regarding actual production, the always ahead group produced consistently less than the other two groups and its production in period 4 versus period 2 actually dropped.

Tests of Hypotheses

**Hypothesis H1**: Hypothesis H1 predicts that subjects in cooperative conditions will perform better than those in noncooperative conditions. Results of the repeated measures MANOVA (with time as the repeated measure) showed a marginally significant main effect for cooperation \( F = 3.91, p < 0.052 \); see table 2; however, no subjects in the noncooperative groups produced more than those in the cooperative condition. An explanation for this may be that subjects in the noncooperative condition had more time to produce output since they were not allowed to move to help one another. Workers who were cooperating had to physically move from one station to the next, which seemed to slow production, and in some cases they stopped to discuss their performance. But those who were unable to cooperate stayed in the same location and simply produced more output. Although this result seems surprising, given anecdotal evidence from industry, the results suggest that cooperation may be effective only in certain situations. For example, if the production line is not well-balanced, then cooperation may aid production managers in finding bottlenecks as more individuals are needed in certain parts of the line than in others. Cooperation may also lead to improvements once a line is balanced by reducing the number of workers required to perform a particular task. These and other possibilities can be explored in future studies.

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15 In testing hypotheses H1 and H3 with repeated measures MANOVA, Mauchly's sphericity test revealed that the assumption of symmetric covariance matrices (equal variances on the diagonal and zero covariances off the diagonal) was violated. As a result, we were forced to use the multivariate as opposed to univariate tests to assess effects (see Latour and Miniard 1983 for a discussion).
Hypothesis H2: This hypothesis states that workers who receive feedback that they are just ahead or behind the leading group will outperform those in the other competitive feedback conditions. To be most informative, we report the results of this hypothesis on a period-by-period basis rather than by summing across periods. In addition, since competitive feedback interacts with time, it is inappropriate to simply sum the performance variables across the three periods and perform a single linear contrast. We performed a series of linear contrasts comparing the just ahead/behind group to the always ahead and always behind groups, respectively, for all three performance periods. Table 3 shows the results of all the contrasts by period. In period 2, the just ahead/behind group did not produce significantly more than the behind group (t = 0.92, p<0.05), nor did they produce significantly more than the always ahead group, although the marginal means show that the difference was in the predicted direction (x̄ = 18.175 for the just ahead/behind group, x̄ = 17.25 for the always ahead group). Thus, the hypothesis was not supported for period 2. However, for both periods 3 and 4, the contrasts show strong support for the hypothesis, with the just ahead/behind group significantly outperforming both the always ahead group and the always behind group.

Hypothesis H3. Hypothesis H3 suggests that workers receiving competitive feedback that they are always ahead of the next best group will build in more slack than
those in the other competitive conditions. In table 2 the results of the repeated measure MANOVA show that both the competitive feedback main effect and interactions are significant (p < 0.01). The results of the contrasts by period are shown in table 3. For the second period, the hypothesis holds, with the always ahead group producing more slack than either of the other groups. In period 3, the hypothesis is only partially supported because, although the always ahead group produced more slack than the always behind group, the just ahead/behind group created significantly more slack than the always ahead group. In the fourth period, the always ahead group created more slack than the always behind group, but no more than the just ahead/behind group. Overall, there is moderate support for this hypothesis.

IV. Discussion

Using insights gained from site visits to major manufacturing organizations and the current literature on manufacturing, we have examined how cooperation and competitive feedback affect workgroup performance and slack. As noted by Safizadeh (1991), research on workgroups has been difficult to interpret because of lack of control in some field research and/or poor experimental designs. Because we performed this study in the laboratory, we were better able to manipulate the variables of interest while holding other variables constant. We believe that this study does have implications for firms employing workgroups, as discussed below.

The intragroup cooperation hypothesis was not supported, and the results were in the opposite direction to that predicted. The results suggest that the form of cooperation that we manipulated may not yield greater output than noncooperation on this task. While this is surprising, we observed from behind the two-way mirrors in the laboratory that cooperating subjects did spend time moving from their work stations to help each other. Further, there was a certain amount of morale boosting, through verbal encouragement, that occurred in these groups. In contrast, noncooperating groups did little else but work hard to meet their standard. These subjects appeared very intense and the mood in these groups was quite somber. It could be that if the experiment had lasted significantly longer, the cooperative groups would have outperformed the noncooperative groups.

Our results indicate that the cooperation construct needs to be investigated more thoroughly before clear conclusions about its effectiveness can be drawn. It seems that cooperation may be effective only under certain conditions and for specific kinds of tasks. Although we were careful to select a difficult task and attempted to “balance the line” by performing pretests, it appears from Chase and Aquilano (1988) that one major benefit of cooperation is to aid manufacturing designers over time in developing a balanced line. It could be that cooperation improves group performance only when the line is unbalanced and some individuals have more difficult tasks to perform than others do. However, since production management texts indicate that line balancing is

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We should note that the best estimates of the always ahead group tend to be lower than those of the other two groups. In fact, in the last production period, the always ahead group is lower than the other two groups. It is possible that lower performance in previous periods affected the group’s perception of their best estimate. This possibility does not affect our definition of slack as a conscious decision to set the standard below perceived best performance. However, this result does hint at a potentially interesting interaction between prior performance and the perceived best estimate which could be studied in a future experiment with a larger number of performance periods. We thank one of the reviewers for suggesting this.
a central part of a good manufacturing process (Chase and Aquilano 1988) and that production lines at major manufacturing facilities such as Toyota are balanced (Schonberger 1982), we felt that cooperative effects would continue to be derived even with the line that we used.

The hypotheses regarding competitive feedback were for the most part supported. Those groups receiving just ahead/behind feedback tended to produce more units than the other groups. Those groups receiving feedback that they were always behind also produced more units in all three periods than the groups receiving feedback that they were always ahead. The results regarding competitive feedback extend the work of social learning theorists (e.g., Bandura and Cervone 1983; Podsakoff and Farh 1989) to a multi-period group context and provide preliminary evidence on the strong motivation associated with alternating the sign of feedback.

An implication for organizations employing internal competition is that some level of competition is good for motivation, but workgroups that begin to fall behind may become debilitated over time and production may decrease. Conversely, some workgroups may excel in performance. This imbalance may cause coordination problems both within a division and across divisions. Thus, organizations will have to consider how competitions affect overall manufacturing performance and strategic and production planning.

Further, it should be noted that although significant differences in budgetary slack were found across some experimental conditions, the relative amount of slack built into standards was quite low (see table 1). It appears from these results that the low levels of slack occurred because workgroups were highly motivated to attain both a high level of compensation based on their daily standards and the final bonus. If firms desire to reduce slack, our findings are that offering the right combination of incentives to workers will provide this result.

Finally, as suggested in many studies on the effects of incentives, there is the possibility that individuals with a high need for achievement may at some point no longer be motivated by money; more pay may not result in more work (McClelland 1972, 1985). Such individuals are affected by financial rewards but tend to use them as a benchmark for social comparison with others. Social factors such as prestige and position will often override financial factors. Although such issues related to individual characteristics can be overcome via random assignment to experimental conditions, future research should consider measuring individual need for achievement to understand more clearly how this important variable affects the results of research on the motivational effects of incentives.
Appendix

TOYCO Corporation

Castle Division Case

Castle Division is the newest division of the TOYCO Corporation. It produces a new product line of toy castles. The toy castles that are produced in this division are part of a set of toys, including toy bridges, knights and dragons, all of which have a medieval theme. These other toys are made in different divisions. Production of the castles has to be carefully planned so that the total number of castles will match the total number of other toys (one castle per set).

Castle Division was established in November. Because the toy castle is the newest entry into the medieval theme market, management is still not sure how many good quality castles it can produce. Management needs to have this information in order to determine how many orders it can fill for Christmas.

Castle Division has selected you to be a production trainee. Your job is to work with three other employees in a team to make castles. Remember that each subassembly of the castle that you make, and each final product, has to be of the highest quality. A poor quality castle cannot be counted in production and will ultimately decrease your compensation for the job. At the end of this training period, only the teams with the best performance will be selected as full-time employees. You will be competing against four or five other teams.

In addition to their daily compensation, the best performing teams will receive an end-of-training financial bonus. Management is seeking employees who can be hired and trained so that full production can begin in mid-December. Remember, it is your team and not you as an individual that is eligible to be hired as full-time employees. You will be instructed in how to make such castles shortly.

References


