

**A SIMULATION ENHANCEMENT TO OBSERVE, MOTIVATE
AND EVALUATE INDIVIDUAL PERFORMANCE**

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INTRODUCTION

A problem common to most large scale business simulations is how to observe, motivate and evaluate individual performance during the course of a game's competition.¹ Direct observation of individual performance, for example, is often frustrated since the presence of an observer at a group decision session tends to produce artificial discussions meant to impress the instructor. Further, when the observer leaves the group, the discussion is frequently taken over by one or two dominant individuals, while the others merely follow along with the group. Motivation of the passive players to become active participants is obviously desirable both for their own learning experiences, and for the benefit of the group. Unfortunately attempts to motivate their participation through a system of differential rewards is also frustrated, since no basis exists for differentiating individual contributions. As a result, many game administrators apply a single grade to the entire team based on the overall group performance. This evaluation comes long after completion of the competition and passive team mates share equally with the active participants in the success or failure of the team. Although this problem can be partially alleviated through meetings of a simulated Board of Directors at which each team member is responsible for a report, such sessions are frequently exercises in public speaking and not representative of skills at decision making or strategy formulation. Peer grading is another possible solution, but it normally meets strong resistance from students.

The purpose of this paper is to describe an enhancement to the COMPETE [2] simulation which provides a direct, meaningful basis for observing, motivating and evaluating individual performance in a team effort. Further, although it has been designed specifically for the COMPETE simulation, it could be readily adapted to a number of other computer based games. The core of the enhancement is the provision that each member of the student team become the manager of a profit center and is paid a salary. All salaries are charged against their profit centers and both profits and salaries become a factor in student evaluations.

¹ The type of simulations referred to here are those in which several students assume the role of a management team and make decisions on levels of controllable variables (e.g., price, advertising, production).

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Performance in the game is based on the following three criteria:

1. The record of performance in terms of earnings, market share, and inventory control for the profit center under the student's control.
2. The improvement in a student's performance record over the previous period.
3. A student's salary record.

All players receive individual reports at the end of each period of play detailing their performance relative to all other players for the period, and for the game-to-date.

Profit centers are created by assigning four person teams to each of the companies in the game. One person is elected by the team as President with the power to hire, fire, determine salary levels, to allocate resources among his player-managers, and to assign them various task responsibilities. The overall performance of the firm is used as the basis for evaluation of the President. In COMPETE, the U.S. market is divided into three regional areas, one each in the North, South and West and the simulation output includes regional Income Statements. Regional profit centers are then readily created by having the President assign each of the remaining three players to manage a region. Their performance is evaluated on the basis of the regional outcome.² A player may resign from one company, be hired by another, or even draw unemployment benefits. But regardless of his career decisions, final evaluations are based on a cumulative record of past success or failure.

Each manager defines a set of objectives, the attainment of which depend on variables under his control. In turn, the objectives become criteria upon which he may be observed and objectively evaluated. The immediate feedback which each person receives through the individual performance reports creates a stimulating learning environment and serves as a powerful individual motivator. The following is a detailed set of the rules and procedures utilized to implement the enhancement. A sample of the student reports and the added decision form are attached as exhibits to this paper.

ORGANIZATION OF THE ENHANCEMENT

The initial organization of the simulation is usually accomplished during a single class meeting in which the game and its decisions are briefly reviewed. Students are given an advance assignment to read the student manual so that the introduction is relatively brief. The first decision is due the next day, and processed prior to the second class session. Another decision is made during the second class. At the end of this class (after all decisions are turned in) students are ad-

² Regional assignment was compatible with the COMPETE simulation. Other games, however, provide alternative means of creating profit centers.

vised that a complete reassignment of teams will take place and that additional rules will be explained during the next class.³

The enhancement is introduced during the third class and students are completely reassigned, although the original “companies” continue in existence. This provides the new teams with a limited data base, and gives everyone a chance to become familiar with the game. Further, the experience of playing two rounds, and then being reassigned emphasizes the individual aspects of play by breaking down some of the initial group loyalty that naturally develops. Reassignment is accomplished by having the original team Presidents draw names in a lottery. The Presidents then serve out the remaining two periods of their four period term of office with the new management team.

Team Organizational Structure

All teams are composed of a President and three regional managers. The President serves for four periods at a time and may be reelected. He is accorded broad executive powers, which may be delegated at his discretion. He may, for example, hire new employees and fire others. He does not require the support of his managers (at least not until election time) and may, if he deems it proper, fire any or all of them. Elections are by secret ballot (filed with instructor) with all four team members voting. In case of a tie, the instructor may act for the stockholders or hold a run-off election. In addition, the President determines his own salary level and that of his employees. He is responsible for calling all meetings, and for completing the decision forms. In general he is responsible for broad strategic considerations and the allocation of the firm’s resources among regions. He assigns (and/or reassigns) his personnel to regions, and may limit or expand their resources (such as an advertising budget) as he determines best for the overall strategy. Evaluation of the President is based on the overall performance of the firm.

Regional managers are solely responsible for decisions as to the levels of controllable variables within each region (e.g. price, level of advertising by media, number of salesmen, production orders, etc.). They must negotiate their own salary with the President, obtain assets from the firm, and then allocate them to the regional marketplace. Managers are free to resign from one firm and go to work for another, assuming, of course, that the new team will extend them an offer of employment. Regional managers are evaluated on the performance of the regional area under their control.

³ The course in which the game is played consists of cases, assigned readings and the game. The three different activities are mixed together so that the sequence of class meetings described above may take place over several weeks.

INDUSTRY A - COMPANY 6 - PERIOD 3

INDIVIDUAL PERFORMANCE REPORT

FOR

JANE GOLDEN
SECOND PERIOD OF UNEMPLOYMENT

EMPLOYEE NBR. 12 negotiation between the
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ria of evaluation, and are
of activity involved, and
ers is applied against the

*** UNEMPLOYED ***

CURRENT PERIOD GOAL VARIABLE AND WEIGHT

<u>GOAL VARI</u>	<u>Number on Team</u>	<u>Multiplier</u>
EARNINGS	1	120
	2	75
	3	55
MARKET SH	4	43
	5	37
ERROR INI	6	35
	7	33
SALARY INDEA	0.00	
SALARY LEVEL	56000	

1 Exhibits 1 and 2.

OBJECTIVE FUNCTION VALUES

<u>FUNCTION</u>	<u>CURRENT PERIOD</u>	<u>GAME-TO-DATE</u>
PERFORMANCE INDEX	0.20	0.72
IMPROVEMENT INDEX	0.19	0.73

may occur as the result of
enhancement operates a

ods. During this time, his
s set at 80% of the lowest
/ment compensation, his
yed for four continuous

GRADE INDICIES

<u>FUNCTION</u>	<u>INDEX</u>
CURRENT PERIOD	0.33
GAME-TO-DATE	0.70

ON

ntifiable form. This was

adopting, in principle, the objective functions described in Sewall [3]. In this paper, Sewall suggests an objective which is a weighted~ combination of several goal variables. Each team determines their own set of weights to be applied to a fixed set of four goal variables. The weights assigned are presumed to reflect the relative importance of various goal variables in contributing to the objectives of the firm. As the game progresses, teams may alter their weights reflecting changes in emphasis of goals. Performance is

⁴ These multipliers have been developed specifically for the scale of activity in COMPETE. Other -games will require a different set of multipliers although the relative size should re- main constant. In general the multiplier should be large enough to make before tax earnings sensitive to changes in the salary level.

evaluated through measurement of comparative achievement on the objective function. One interesting ramification is that the same weights are applied to evaluations of all members of a team. Hence, a regional manager must allocate his resources so as to maximize his own performance measures subject to the constraint that regional objectives must be consistent with the objectives of the firm as a whole.

Goal Variables

The four goal variables are calculated as index values (average = 1.00) and reflect individual performance as compared to the performance by all other players for that period. They are defined as follows.

1. Earnings Index: This is an index of the before tax earnings of the area under control of the individual student. If he is a regional manager, then the calculation is based on his regional earnings compared to the area income from all other firms. If he is President, then overall company earnings are compared to the earnings of other companies.

This is a measure of the profit center's relative profitability and obviously assumes a goal of profit maximization.

2. Market Index: This is an index of the market share captured by the regional area under the

$$EI(I) = \frac{m \times EARN(J, K)}{\sum_{k=1}^m EARN(J, K)} \tag{1}$$

where: EI(I) = Earnings Index for the *i*th student operating the *j*th area for the *k*th firm.
 I = Index for student = 1, ..., n
 J = Index for region = 1, ..., 4 (note: 1=North, 2=South, 3=West, and 4=all regions combined).
 K = Index for company = 1, ..., m
 EARN(J,K) = Earnings, before taxes, from the *j*th region of the *k*th company.

control of the individual student. As in the case of the Earnings Index, calculation depends on whether the student is a regional manager or a President.

$$MI(I) = \frac{\sum_{k=1}^m \text{SHARE}(J, K)}{m} \quad (2)$$

where: MI(I) = Market Index for the i^{th} student operating the j^{th} area for the k^{th} firm.

SHARE(J,K) = Market share, as a percent of units from all products in the j^{th} region of the k^{th} company. In case of a President the j^{th} region becomes the overall company. SHARE is an average over the three product shares in each region. Again comparison is only with SHARE's in the same region.

The importance of this variable as a goal depends in part on the objectives of the firm. However, market share is also a measure of opportunity. Low share can be an indication of a firm that is not fully seizing the opportunities available to it.

3. Error Index: This is an index of the extent to which inventory levels are not balanced with demand (difference is referred to as error) within the region under control of the individual student.

$$ERI(I) = \frac{1 + \frac{\sum_{n=1}^m \text{ERROR}(J,K)}{\text{NBR}}}{1 + \text{ERROR}(J,K)} \quad \text{and,} \quad (3)$$

$$\text{ERROR}(J,K) = \frac{[\text{POTENTIAL}(J,K) - \text{UNIT}(J,K)]}{\text{SALES}(J,K)} \quad (4)$$

where: ERI(I) = Error Index for the i^{th} student operating the j^{th} area for the k^{th} firm.

ERROR(J,K) = Absolute difference in magnitude between potential unit sales and units available for sale, expressed as a fraction of units actually sold for the j^{th} region of the k^{th} company.

POTENTIAL(J,K) = Potential Unit Sales generated in the j^{th} region of the k^{th} company. The COMPETE simulation provides estimates of demand and actual sales. The latter, of course, depend on inventory being available. Potentials are determined as the sum of unit potentials for all three products in each region.

UNIT(J,K) = Units available for sale in the j^{th} region of the k^{th} company. Units are determined as the sum of units available for all three products in each region.

SALES(J,K) = Sales, in units, in the j^{th} region of the k^{th} company. Sales are determined as the sum of unit sales for all three products in each region.

In this formulation the error by a student is determined as a fraction of his own sales level. Hence, the summation in the numerator of the error index is an average fractional error. Since smaller errors are more desirable, calculation of the error index is inverted thereby yielding a value which increases as the amount of error decreases.

4. Salary Index: This is an index of the salary received by an individual as a reward for his efforts on behalf of the firm.

$$SI(I) = \frac{n \times SALARY(I)}{\sum_{i=1}^n SALARY(I)} \quad (5)$$

where: $SI(I)$ = Salary Index for the i^{th} individual.
 $SALARY(I)$ = Salary paid to the i^{th} individual.

The significance of this index as a measure of individual performance is obvious. Although readily manipulated the use of the multiplier and the effect of salary expense on profit operates to constrain student-managers in much the same way as it does in the everyday world of business. By making a player responsible for a specific profit center, each one develops some power (or lack of it) in negotiating salary levels. He has a market in which his skills may be valued, and there tends to be a positive relationship between salary levels and area performance.

Two special conditions, which require deviations from the above calculations, should be noted. First, since it is possible to have teams other than four players, care must be exercised in developing the index values. In the case of two person teams, both the President and the manager are evaluated on the overall team performance, and both declare Region 4 as their responsibility. For three or more person teams, each manager declares a region as the basis for his evaluation. This declaration is reported on the Payroll Report Form (see Appendix 1).

Second, when a student becomes unemployed, certain special definitions are applied.

1. Earnings Index and Market Index are set at 0.0 for as many periods as the player is unemployed.
2. Error Index is set at 1.0 for as many periods as the player is unemployed.
3. Salary Index is determined by deriving the salary from the unemployment compensation figure (i.e.: $SALARY(I) \cdot .8 \times \min.[SALARY(I)]$). This figure is then included in the computation of the salary index. After two periods of benefits, the index drops to 0.0, if the player has not been reemployed.

Objective Functions and Evaluation

The goal variables are collapsed into a single score which reflects a player's current period performance. This score, called an Index of Performance, is derived as a weighted average of the three goal indicies: earnings, market share, and error.

$$PERFM(I) = W1(K) \times EI(I) + W2(K) \times MI(I) + W3(K) \times ERI(I) \quad (6)$$

where: PERFM(I) = Index of Performance for the i^{th} student employed by the k^{th} firm.

W1(K) = Weight assigned to earnings by the k^{th} firm (see Decision Form, Exhibit 1).

W2(K) = Weight assigned to market share by the k^{th} firm.

W3(K) = Weight assigned to error by the k^{th} firm.

Weights are subject to two limitations:

$$W1(K) + W2(K) + W3(K) = 1.0 \quad (7)$$

$$\min[W1(K), W2(K), W3(K)] = 0.2 \quad (8)$$

The last constraint may be explained with the argument that stockholders will demand at least some minimum emphasis on all three measures. The exact level of each weight becomes a portion of the firms' decisions, and is reported along with other decision variables (see decision form in Exhibit 1). For unemployed players, weights are fixed at 0.5 for earnings, 0.3 for market share, and 0.2 for error.

In addition to current period performance, a measure of period to period improvement may be calculated. This score, called an Index of Improvement, is derived as a weighted average of the period to period change in each of the goal indicies, as follows:

In this way it is possible to observe and reward both current period performance in the game and the improvement in performance by a player. The player who starts off badly has a chance of competing with players who capture an early lead, and this in turn keeps him from becoming initially discouraged.

$$IMPROV(I) = W1(K) \times [EI(I)_t - EI(I)_{t-1}] + W2(K) \times [MI(I)_t - MI(I)_{t-1}] + W3(K) \times [ERI(I)_t - ERI(I)_{t-1}] + 1.0 \quad (9)$$

where: $t = 1, \dots, t$ (periods of play)

Cumulative game-to-date, functions may also be calculated both for performance and improvement. In either case the most meaningful game-to-date measure, given the possibility of weights changing during the course of the game, is an average

of past and present performance indicies, weighted by the number of periods played.

Finally, in order to give individual salaries meaning, and to sustain long term motivation, a Grade Index is derived as the average of the Performance, Improvement, and Salary indicies.

$$GI(I) = \frac{PERFM(I) + IMPROV(I) + SI(I)}{3} \quad (10)$$

Since this index is based on a student's current period performance it reflects his overall attainment for that period relative to all other players. In a like manner the cumulative Performance, Improvement and Salary indicies may be combined to provide an equitable and observable overall measure of student performance in the simulation. Students are advised that a percentage of their grade in the course will depend directly on this final game-to-date Grade Index. Instructors wishing to place different emphasis on the three objectives (performance, improvement and salary) can easily apply a different weighting function at this point.

PERFORMANCE REPORTS

The criteria described above are readily programmable and hence, it is possible to modify existing source programs of computer based games to allow input of salaries and weights, computations of the various indicies, and output of a complete performance report at the conclusion of each round of play. To produce the game-to-date measures, it is also necessary to modify the existing program so as to provide a set of history cards for each player along with the regular company history cards.

To facilitate data entry an added decision form was created, whose format generally follows that of the existing COMPETE decision forms (see Exhibit 1). Student teams are required to key punch their own decision cards, and the payroll decision card becomes the fourth card in a team's decision deck.

A history card, detailing past performance on each of the goal variables, and cumulative performance on the objective functions, for each player, is created as part of the modified output of the simulation.

With the exception of the alterations to allow input of the decision cards, and new history cards, all of the modifications to the COMPETE simulation are contained in a single subroutine, which calculates the indicies, and writes the individual reports. A sample report for both an employed and unemployed player are presented in Appendicies 2 and 3. A complete listing of the program modification is available upon request from the author.

SUMMARY

This paper described an enhancement to the COMPETE simula-

tion which is adaptable to other gaming situations. The purpose of the enhancement was to create a game environment in which individual performance (as opposed to group performance) may be observed, motivated and evaluated. These objectives are accomplished by introducing a job market into the simulation. By delineating specific, although flexible, objectives, measurement of performance was readily programmed. This, in turn, allowed the development of individual measures of performance and the routine preparation of progress reports. Through these reports students are continuously advised of their progress, with the result that each is motivated to actively participate in the simulation.

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APPENDIX 2

INDUSTRY A - COMPANY 4 - PERIOD 3

INDIVIDUAL PERFORMANCE REPORT

FOR

TOM ZENI
NORTHERN REGIONAL MANAGER

EMPLOYEE NBR. 11

*** SIGMA SOUND SYSTEMS ***

CURRENT PERIOD GOAL VARIABLE AND WEIGHT

<u>GOAL VARIABLE</u>	<u>INDEX</u>	<u>WEIGHT</u>
EARNINGS INDEX	0.96	0.25
MARKET SHARE IND.	0.89	0.50
ERROR INDEX	1.15	0.25
SALARY INDEX	0.75	
SALARY LEVEL	70000	

OBJECTIVE FUNCTION VALUES

<u>FUNCTION</u>	<u>CURRENT PERIOD</u>	<u>GAME-TO-DATE</u>
PERFORMANCE INDEX	0.97	0.96
IMPROVEMENT INDEX	1.02	1.02

GRADE INDICES

<u>FUNCTION</u>	<u>INDEX</u>
CURRENT PERIOD	0.91
GAME-TO-DATE	0.90

APPENDIX 3

INDUSTRY A - COMPANY 6 - PERIOD 3

INDIVIDUAL PERFORMANCE REPORT

FOR

JANE GOLDEN
SECOND PERIOD OF UNEMPLOYMENT

EMPLOYEE NBR. 12

*** UNEMPLOYED ***

CURRENT PERIOD GOAL VARIABLE AND WEIGHT

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<u>GOAL VARIABLE</u>	<u>INDEX</u>	<u>WEIGHT</u>
EARNINGS INDEX	0.0	0.50
MARKET SHARE IND.	0.0	0.30
ERROR INDEX	1.00	0.25
SALARY INDEX	0.60	
SALARY LEVEL	56000	

OBJECTIVE FUNCTION VALUES

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<u>FUNCTION</u>	<u>CURRENT PERIOD</u>	<u>GAME-TO-DATE</u>
PERFORMANCE INDEX	0.20	0.72
IMPROVEMENT INDEX	0.19	0.73

GRADE INDICIES

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<u>FUNCTION</u>	<u>INDEX</u>
CURRENT PERIOD	0.33
GAME-TO-DATE	0.70

REFERENCES

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3. Sewall, Murphy A., "Objective Functions for Instructional Marketing Games," Combined Proceedings, 1974 (Chicago: American Marketing Association).