THE DESIGN OF AN INTERNET GAME[1]©

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ABSTRACT

This paper discusses the design of a total enterprise management simulation or business game called *Compromise©*. The game works on a network. The business game has four functions: an executive, a comptroller, a marketing and a manufacturing function. In order to successfully compete with other firms in the marketplace, each firm must effectively communicate via electronic messaging between the functions in order to produce a set of decisions. The paper includes the rationale, the parameters the decision sets, individual player evaluations, information feedback to the participants and the assessment of the quality of the decisions themselves.

THE RATIONALE

The internet or world wide web provides a media for college/university level business education to create opportunities for students and classes that, until now, were very difficult to include in simulation environments. Students who were not residents on campus especially students who held full time jobs and were only part time students faced hardship when their team-mates held discussion or group decision making meetings. If the class was one in which there were a large number of part-time or fully employed Students, either extensive amounts of class time would need to be devoted to the "game" or simulations were assumed to be unworkable.

If a student missed a group meeting, especially several such meetings, it frequently was assumed by the team members present and by the instructor, that the student was not a committed participant. To overcome this problem, many faculty assigned a particular role to each student or the students themselves split up the tasks and work load in a manner that got the work done. But, no matter how the tasks were assigned, groups frequently made joint decisions at a common point in time. Decisions were finalized on the basis of a group understanding (or by a dominant teammate). The group work was generally applauded as it has been assumed that teams, read group decision making, was to he encouraged. After all, Vice Presidents of firms frequently worked in teams to solve the high level problems of a firm.

The internet is a network that allows people in different locations and/or with different time schedules to participate as a team in joint decision making. This network can now support exercises such as business games. Thus, classes of evening, fully employed students can work together, but are not required to work at a common place or time.

One of the primary assumptions in a distributed process or networked environment game is that electronic communications between

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players improves and clarifies the thought process. In fact, networked group-ware may be a better learning environment than that found in traditional face-to-face discussions. The electronic media requires participants to be logical and clear in their written communications. If not, messages are misunderstood, and requests for clarification soon follow. In the instance of traditional "within team" communications, taking place around a table, assumptions are often made (sometimes correct sometimes not) about what an unclear or illogical statement means. The fact that a communication must be written enforces additional clarity. For example, if manufacturing needs more money to purchase raw materials, they need to request a specific amount and justify the profit impact of the request to the Comptroller. Before one can explain the need for resources, one must understand the relationships between the requested resources and performance - an important relationship that is frequently missed in-group discussions.

In an internet game, no single function can he allowed to drive the firm. If it did, the remaining team members would he just add-ons, not vital participants. A firm's success generally depends on the effective interaction among the business functions. Thus participants improve their ability to understand and to describe complex reasoning as the game progresses. The participants also gain an improved understanding of how and why a firm is a highly interactive entity. That is each function requires an effective interaction with all functions and no single function alone is responsible for success or failure.

This is a competitive simulation - there are winners and losers. In addition, each team is in a multi-person, prisoners' dilemma type game with the ability to communicate between players on the same team.

THE PARAMETERS

Compromise© has been designed to encompass four primary business functions: The Executive, which approves (or disapproves) the decisions of the three operating functions, but the Executive can not itself change decisions; The Comptroller, which "controls" the funds through budgets and changes in budgets; Manufacturing, which is responsible for the production of the firm's products; and Marketing, which is charged with the responsibility of marketing and selling the firm's products. The simulation has up to five firms in direct competition with each other in three independent markets. The firms compete in three non-overlapping markets, where the demand for any one product is independent of the demand of the other two products.
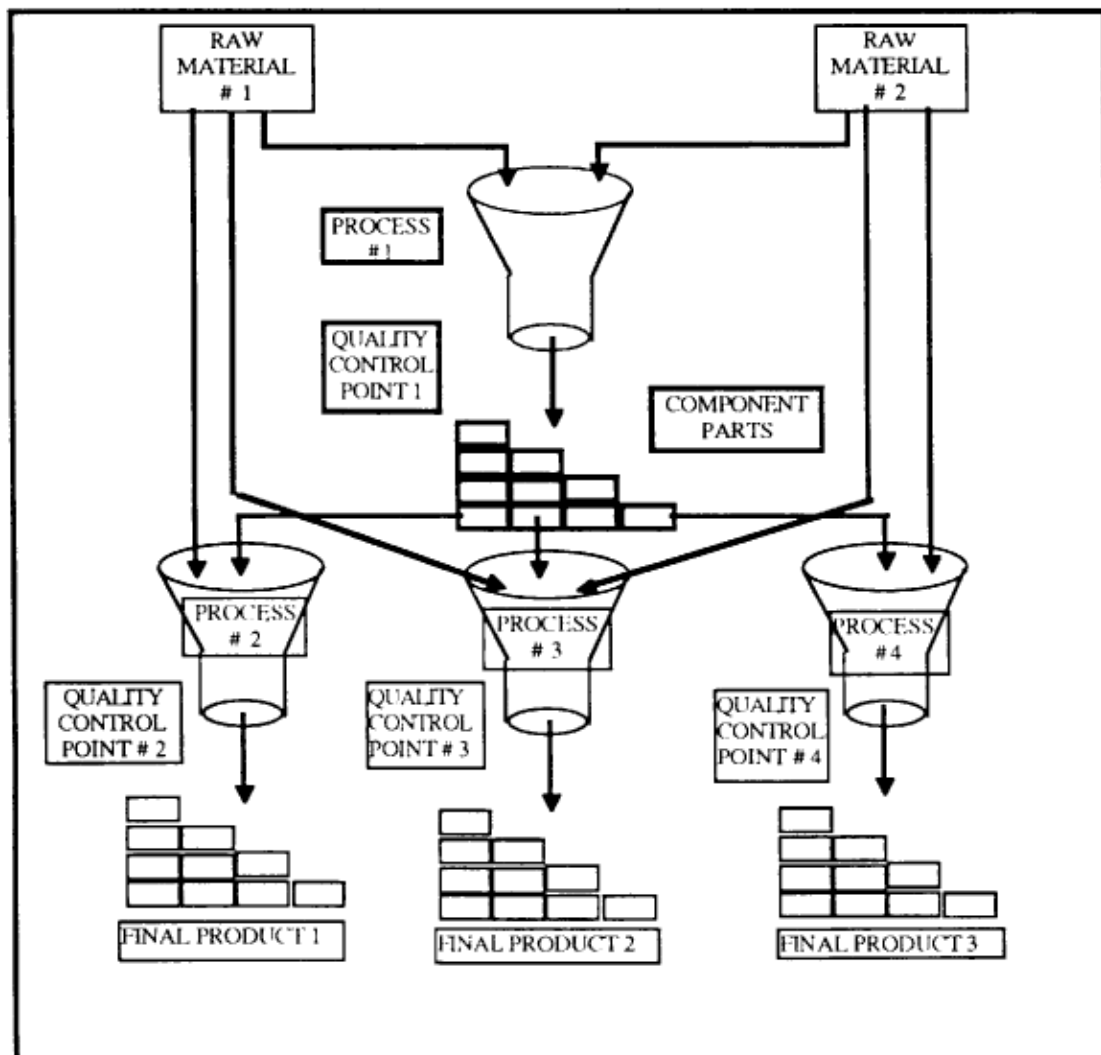
THE DECISIONS

There are three primary decisions sets that need to be made for each simulated period of three months. As might he expected the decision sets are highly inter-related. Marketing can only sell what products are available and manufacturing should produce the products in proportion to what is demanded in the market place. Both marketing and manufacturing work under budget constraints established by the comptroller's function. Information, requests and decisions flow to and from all functions of the firm during the decision cycle.

Manufacturing

Each firm's manufacturing function produces three products using two raw materials and three distinct processes (Processes 2. 3 & 4 all use the same capital equipment) with quality control points at both the intermediate and final stages of production.
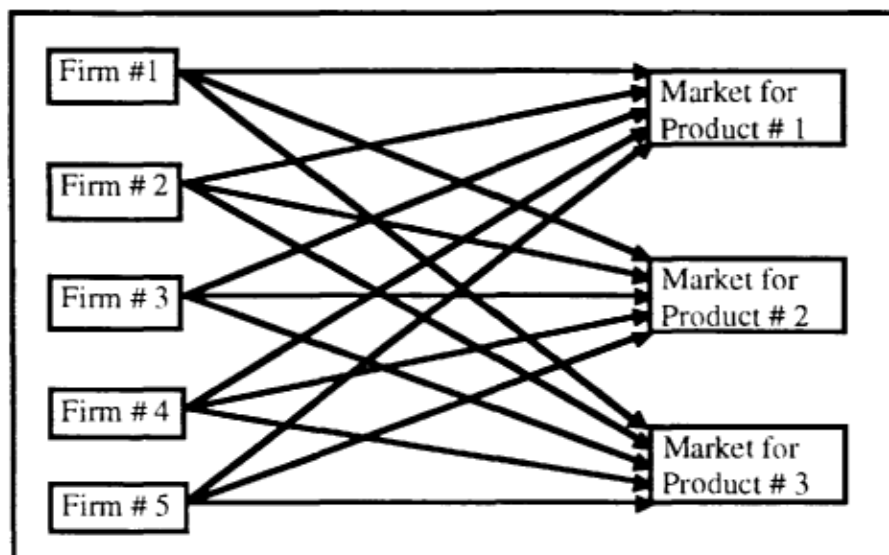
FIGURE 1

THE MANUFACTURING PROCESS

In addition, manufacturing has a Process R&D function which affects manufacturing efficiency. That is, the more money spent on Process R&D, the fewer the labor hours per unit produced and the less frequent the breakdowns. The manufacturing process is shown in Figure 1. Note that product quality as defined by the Quality Control expenditures, is determined by manufacturing hut is an important variable in determining product demand.

Marketing

The market place for this game is three independent markets. There is a market place for product #1 a market place for product #2 and yet another marketplace for product #3. Figure 2 represents the current market configuration for *Compromise©.*

FIGURE 2

THE MARKET PLACE

Marketing utilizes advertising/promotion and pricing to stimulate demand and contracts with commissioned sales reps to sell the products to the proper channels. Total or industry demand for any single product is a function of: the total amount spent by all firms on Advertising/ Promotion: the industry harmonic mean of price for the product; the number of sales representatives for all firms; and the quality of the product defined by the quality control budget of the product during the product manufacture. Market share or individual firm sales is a function of the same set of variables hut with higher elasticities. (See Gold and Pray 1984)

The individual items that marketing must decide include; the price of each product the Advertising/Promotion expenditures for each product and the total number of sales representatives to contract with for selling the products.

The Comptroller

The comptroller establishes budgets for marketing and manufacturing and entertains requests for budget changes. Budgeting is done on an incremental basis. That is, after the initial budgets are set by the game administrator, the decisions arc based on changes -not zero based budgeting. For example, if Marketing wants to increase its advertising, it must seek a percentage budget increase from the controller. The controller does not have to grant the entire budget request and in fact may decrease a functions budget. The controller reviews the available cash and the requests for cash and decides how to meet the requests. Fore instance, when manufacturing requests a change in the raw materials purchasing budget, its Quality Control - R&D budget or its capital equipment budgets, the Comptroller is not required to change the budget. The Comptroller should, not must, explain the limitations to the cash position and provide rational for the denial or granting something less than the amount requested.

Note also that Manufacturing decides the allocation of the QC-R&D budget but the Comptroller has final authority upon the total amount budgeted.

In addition to deciding upon the budgets, the Comptroller's office also invests excess cash in money market instruments (short term or three month certificates), one year notes and twenty year bonds. The office is also responsible for raising needed cash by borrowing in the short term (three months), selling one year notes and *I* or selling twenty year bonds. The interest rates vary according to demand by the industry. The controller's office is also responsible for maintaining a cash position to fund the reasonable and ordinary expenses of the firm

The Executive

The Executive office plays thc role of reviewer. That is, before any decisions are final, the Executive must sign off or **OK** the decisions. If the decision is approved, then the submitting operating function is notified and the decisions are forwarded to the simulation administrator for running the next period. If any of the decisions are not approved the decision set is sent back to the appropriate function for changes. Since the Executive office can not actually make any changes the Executive must couch the recommendations with logic and in ways that will get the operations function to change their opinions. Note that the Executive has a rime constraint. The Executive can continue to refuse to approve the decisions, hut at a specific point in time new decisions must either he submitted or the previous set ol decisions will assume to be apply to the next period. Thus, if the subordinate does not wish to follow the Executive function's directives, the functional office only has to refuse to change until it is too late. This feature encourages compromise among the players on a

team and requires the intra-team communications he both logical, and well written in order for the desires of the message sender to he understood.

The Time Frame

The reporting time frame for this game is broken down into 12 periods per simulated year and the decision cycle is quarterly or every three reporting periods. As a result, monthly statements are produced with quarterly consolidations and are provided to the participants but quarterly decisions are made. The simulation model however runs four cycles per month or twelve cycles per decision period. Thus it is possible to have a stock-out condition even though a firm had inventory at the beginning of a month and inventory at the end of thc same month.

Decision variables are exponentially smoothed prior to determining their affect upon demand or manufacturing efficiency. But, because the model iterates twelve times before the next decision period, the lagged affects are reduced to nil by the last iteration. I-low last the lag affects dissipate is controlled by the size of the alpha value in the exponential smoothing model and can he changed by the game administrator.

INFORMATION FEEDBACK

All information is not provided to all participants. Each function obtains information that is specific to its mission In addition information may requested by each function from others and forecasts of one function are provided to others

Manufacturing

Every month, Manufacturing receives:
1. Inventory levels for raw materials # 1 and # 2

2. Inventory levels of the component parts. -
3. Unit timc and labor costs for manufacturing processes # 1 thru # 4
4. Labor hours utilized and labor hours available.
5. Labor available from the layoff pool
6. Last quarters unit direct manufacturing cost (Labor and Materials) by product
7. Overhead rate as a percentage of direct manufacturing cost.

Marketing

For every month, marketing receives:
1. All firms' products' prices (exact)
2. All firms' allocation of Sales Representatives by product (exact)
3. All firms' Market share by product (Estimate +1- 2% of actual)
4. All firms' promotion budget by product (Estimate +1- 10% of actual)
5. Customer quality perceptions all products (Estimate +1- 5%)
6. Two economic indicators - the current seasonal index and an estimate for the next four quarters and an economic cycle index for the current quarter and an estimate for the next four quarters
7. Sales growth rate for the current quarter (percentage change in unit sales)
8. Unit Sales by product of the firm in the quarter just completed
9. Sales lost by the firm due to inventory shortages
10. Units of inventory, by product at the end of the period for the firm

The Comptroller

For every month, the Comptroller receives:
1. The cash generated from sales
2. The cash generated from investments
3. The amounts of unexpended budgets for Manufacturing and Marketing
4. A cash Flow Statement
5. A Balance Sheet

The Executive

Every quarter the Executive receives:
1. Market share information (By firm not by product) for the quarter
2. The quarter's P & L Statement
3. The quarter's Balance Sheet
4. Economic forecasts for the next quarter and the next year
5. The total overhead costs (in local currency) for the last quarter

Note that the Executive receives less detail, less specific operations information and in reduced volume and frequency than the operational functions.

PRO VIDING INFORMATION TO OTHER FUNCTIONS

Marketing is a firm's eyes and ears as far as the firm's sales are concerned. As such marketing is responsible for determining forecasts of future sales. Each quarter, Marketing is to provide Manufacturing with an estimate of unit sales by product for the upcoming quarter and for the same quarter one year hence. These estimates are to assist manufacturing in determining its capital expenditures for expansion and its plans for ordering raw materials. Marketing provides the Comptrollers office with an estimate of upcoming sales in the currency of the game for the upcoming quarter and the same quarter a year in advance. Marketing also provides the Executive with a market-share estimate by product for the upcoming quarter and the same quarter for the following year.

FUNCTION PERFORMANCE EVALUATIONS

It has often been said that people do those things on which they are evaluated. Each function is evaluated against the industry standard or based upon their ranking with their counterparts in the other organizations. Each function's position vis-a-vis their competitive counterparts using a two-tuple or a scatter diagram is included with their quarterly report. Thus each function is compared to its counterpart in the other firms.

Manufacturing

Manufacturing's ratings are based upon the "value of the inventory as a percentage of sales (raw materials, goods-in-process and finished goods). (small is better) at the end of each quarter and the quarterly average unit direct cost of manufacturing (raw material and labor per unit produced). These two values are computed and plotted on a graph along with the data for the other firms in the competition and distributed to all the firms' manufacturing functions.

Marketing

Marketing's rating are based upon each product's market share (bigger is better) and the average percentage gross margin (bigger is better). These three points per firm for all firms are plotted and distributed to all the firms' Marketing functions.

The Comptroller

The controllers function is evaluated on the percent of unspent budgets for manufacturing and marketing (smaller is better) and the income it has obtained on it's cash investment operations. As is the case for the other functions, the results arc plotted for all firms and the graph is distributed to all the *firms'* Comptroller's Offices

The Executive

The Executive's evaluation is based upon the firm's ROA (Return on Assets or Profits divided by assets) per quarter and ROS (return on Sales or Profits divided by sales). Assets not investment are used because the investment per firm is common among the simulated firms, hut the assets employed may vary. These two points per firm are plotted and sent to each Executive function.

THE MODEL

The Cold and Pray Model

The Gold and Pray (1984) model **is** used in this simulation for several reasons.[3] First it is easy to apply as it makes each decision variable statistically independent. It is easy to evaluate the quality of the key decisions as the point elasticity for each variable is easily calculated. The general formulation for demand is:

$$D = K * P^{-(a1+a2*P)} * M^{(a3a4*M)} * S^{(a5-a6*s)} * Q^{(a7-a8*Q)}$$

and the same form equation with increased elasticities arc used to determine market share.

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[3] See the Gold and Pray article for specifics, space limitation for this paper do not allow a detailed discussion of this model

ASSESSMENT OF DECISION QUALITY

The exponents on each primary decision variable are known and do not have interaction terms with any other variable, thus the first derivative for each term can be easily determined. Since the best managerial decisions result when the marginal rates of return are equalized over the set of decision variables (and profit is maximized when these marginals equal the marginal costs)[4] , then the quality of the set of decisions can be determined by the proximity of the first derivatives of the decision variables. The more similar these four elasticities are, the better the decisions are! The formulation of demand uses the three marketing decision variables and one manufacturing decision variable (QC) which the demand equations require to determining product demand. If the same style formulation is applied to the results of the Process R&D budget in manufacturing, then it too can he compared to the QC budget and the three major marketing decision variables for optimality.

Other measures are also used to determine the quality of the decision making. The forecasts which marketing is required to submit to Manufacturing, the Comptroller and the Executive are easily measured for quality - the smaller the errors, the better the forecasts. Excess cash and emergency cash as well as the size of the unspent budgets are additional measures. The point is there are numerous variables which can he used to evaluate the decision making ability. Profit as a single measure need not he used and in fact profit may not be a good measure of any teams decision making ability. (For a discussion of this issue see Teach 1990)

ADMINISTRATION OF THE GAME

While the games' decisions and all the interactions are played out on the Web, the actually running the game is done at a home base, controlled by a game administrator. The decisions are taken from files produced by the Web and the results and reports are written to files, which are accessed by the Web to be sent to the appropriate participants. All participants do not receive the same reports and information.

This game structure also allows for intervention by an instructor or game administrator. Almost any kind of intervention can take place. In addition the game is structured so that intra team communications are automatically copied to the game administrator for review and tracking. Of course some participants may communicate outside the official lines of communications, hut most participants will follow the rules.

REFERENCES

Gold and Pray (1984), 'Simulating Market and Firm-Level Demand Functions in Computerized Business Simulations, <u>Simulation & Games</u>, Vol. 15,. pp. 346-363.

Davidson, Ralph K., Vernon L. Smith, and Jay W. Wiley (1958) <u>Economics: An Analytical Approach</u>. Richard D. Irwin, Home-wood IL p. 346

Teach, Richard D. (1990), 'Profits: The False Profit in Business Games,' <u>Simulation & Gaming</u>. Vol.21, No.1, pp. 12-26

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[4] See Davidson, Smith and Wiley. <u>Economics: an Analytical Approach</u> page 346 or any basic economics book for the proof