Computerised Management Games: the feedback process and servomechanism analogy.

Hall, J.J.S.B. Hall Marketing and Cox, B.M. Imperial College

ABSTRACT

This paper suggests that the proactive management of the dynamics of the simulation process will better meet learning objectives in terms of transferable skills.

The paper explores the analogy between the system and behaviour of computerised management games and servomechanisms. The aim of this approach is to facilitate the measurement and control of the learning process so as to effectively and consistently meet learning objectives (transferable skills) through clarification of cognitive and affective dynamics.

To this end a conceptual, two-dimensional model, in cognitive and affective space is suggested and explored in terms of learning and behavioural success.

Finally a classification of simulations in terms of feedback mechanisms, level of tutor interactions and degree of computer support is suggested.

INTRODUCTION

The paper addresses the difficulty of managing the dynamics of the process inherent in the use of computerised management games. By drawing an analogy with servomechanisms it is suggested that parallels exist in terms of dynamic behaviour and approaches to managing the two systems.

In drawing this analogy a computerised management game is considered as a feedback system involving groups of participants, the tutor and a simulation model.

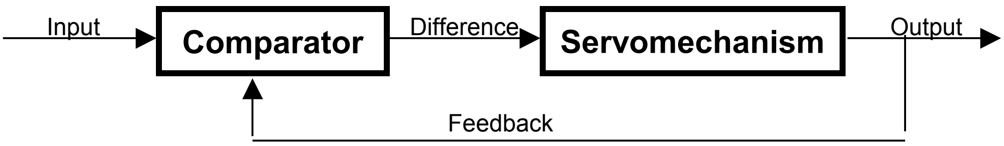

Figure 1 - The Basic Servomechanism

In the basic (simplest) servomechanism the comparator matches the output with the input and feeds the difference into the servomechanism so that it tracks towards the output (Figure 1). A parallel has been drawn between this and the business feedback system [Forrester 1961]. A parallel not only in terms of the feedback process but also in the response of the system over time.

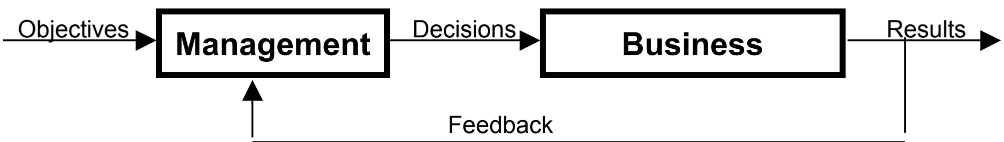

Figure 2 - Industrial Dynamics Model

A further parallel is drawn between the basic managerial decision-making process inherent in the industrial dynamics model and the basic game process (Figure 3).

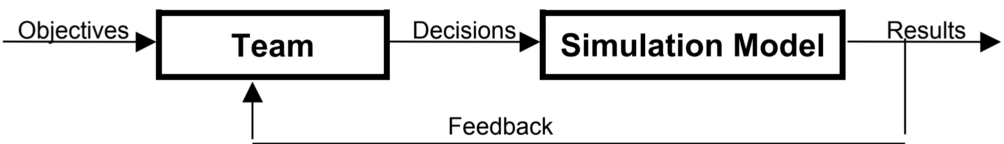

Figure 3 - Basic Game Process

THE ANALOGY EXPLORED

The learning curve can be viewed as a progressive reduction of the distance between objectives and cognition. This classic shape is similar in shape to the response of a servomechanism to a step change in input [Coyle 1977: 37].

With the servomechanism the ability of the system to reach its goal is influenced by the system response in terms of the speed of response and the smoothness of this. (This parallels the duration of the learning activity, its consistency and effectiveness.)

A major problem facing the control system designer is how to balance the speed of the response of the system to differences between input and output with the need to discount (smooth out) erratic patterns. This is paralleled by games where speed of learning has to be balanced with emotional (affective) pressure.

With a servomechanism this problem of balance can be addressed mathematically by describing the control system in terms of 'real' and 'imaginary' components [Argand diagram]. (The 'real dimension' describing the true difference between input and output and the 'imaginary dimension' describing the effect of delays). We suggest that learning in cognitive terms, parallels the 'Real Axis' and the 'Imaginary Axis' is paralleled by an affective one. This leads to a two dimensional concept of Cognitive - Affective Space (C-A Space).

A concept of a two-dimensional geometric space was proposed to describe the mental attitude of people in response to advertising [Langhoff 1967]. In learning terms, Bloom's Taxonomy also discusses the Cognitive Domain and the Affective Domain [Bloom 1959]. (Although the affective domain was in terms of learning objectives rather than behaviour and motivation whilst learning).

Langhoff, in describing C-A space, discussed movement (the purchaser being lead towards the advertiser's objectives) and actions appropriate to position (improving cognition or affection or both).

However, neither of these models describes a negative domain either in terms of cognition (confusion) or affection (disaffection). Yet, as regularly observed and described experiential learning can move into these negative areas. [Cryer 1988a, Hall 1977, Jones 1989, Lundy 1984]

THE ANALOGY APPLIED

This paper suggests a model of C-A space that is similar to the servomechanism Argand diagram.

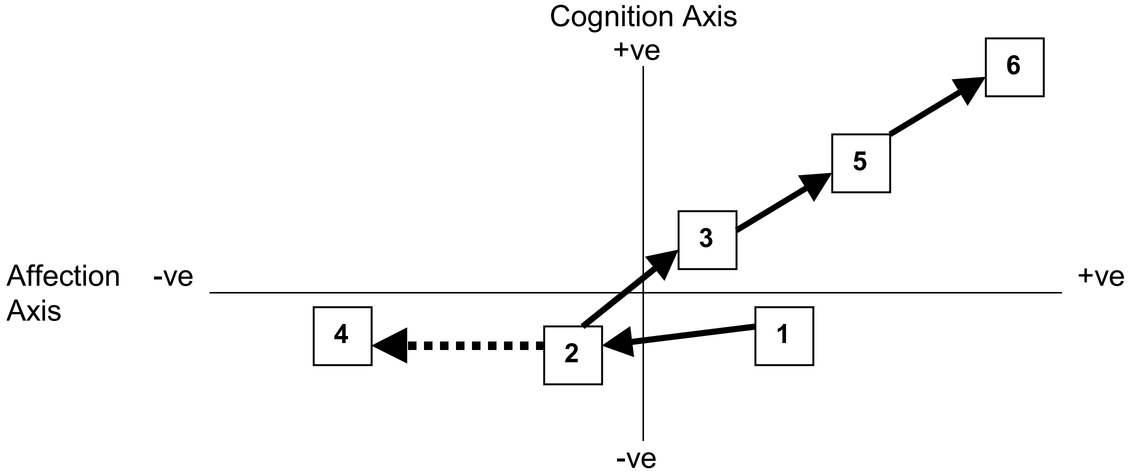

Figure 4 Cognitive-Affective Space

1. Initially, teams are likely to start the game somewhere in the lower right quadrant (i.e. positive affection but negative cognition). Lack of knowledge of the problem, the response of the simulation model to their decisions and, if the game is interactive (where each team's results are influenced by the others), the response of competing teams means that there will be misunderstandings and a degree of confusion (negative cognition). However, the perceived opportunity to prove themselves in management terms means that the teams are anticipating success and so the team is likely to have a positive affection.

2. As a team develops its knowledge they are very likely to perceive the game as more complex than first realised and initial decisions will not be 'right'. Thus the results of the first decision may reduce affection and cause movement towards or into the lower left-hand quadrant.

3. As the game progresses learning is indicated by movement on the cognition axis and perceived success will cause positive movement on the affection axis.

4. Conceptually, there would seem to be point of inflection on the disaffection axis where the team or the individual become progressively more disaffected and reduce dissonance by distancing themselves from the game [Lundy 1984, Cryer 1988b]. This point, where a team's behaviour becomes 'unstable' is analogous to the points on the real-imaginary axes of a servomechanism where it becomes conditionally unstable [Nyquist stability criterion]. Like the servomechanism, the level of cognition and the affective maturity of the participants (high frequency system gain) influence this line of instability.

The concept of a line of affective instability provides an explanation for observed behaviour. However, its quantification is difficult especially since crossing the line means that the team becomes disaffected with a perception of no learning and a waste of time. A situation that is unacceptable to the professional trainer and hence must be avoided making experimental verification difficult.

5. Although some negative feedback (in affection terms) can help in the early stages of the game and is generally argued positive feedback is generally more effective [McGregor 1960]. To an extent, this is automatic for increased cognition leads to 'success' and perception of learning.

6. Ultimately a team's position should move towards the upper right hand corner of the upper right hand quadrant (high cognition coupled with high affection - happy, knowledgeable participants) with all teams' converging (with like degrees of cognition and affection).

GAME DESIGN

The classic response curve (as previously mentioned as in terms of the learning curve) illustrates the response to a step increase in the target (as participants are presented with a new problem where participants have to assimilate knowledge, receive feedback and learn about solutions to the problem). Ideally a smooth increase in cognitive knowledge should occur throughout the game and the target level (in terms of learning objectives) should be achieved at the end of the training session.

Unfortunately this is not the universal pattern - especially where the game is used on a short course by practising managers. Variations in the participant group (in terms of experience, motivation and perceptions) means that, cognitively, the same game may present a wide spectrum of challenge (from the too simple to the too complex). If perceived as too simple the group is likely to exhibit the response pattern which may be described as "overshoot and collapse" (Coyle 1977: 45). In terms of games and C-A space this can be explained by early 'success' being motivating followed by a realisation that the game is not sufficiently challenging and will not fulfil learning objectives.

Another pattern is where the game is over complex (in terms of participant knowledge, perceptions or time scale). Here the dynamic behaviour may be likened to an unstable system with participants making sophistic and then arbitrary decisions.

Sophistic decisions refer to those that are based on erroneous logic in particular in terms of cause and effect. They may be due to:

LACK OF KNOWLEDGE
INSUFFICIENT THOUGHT
CONDITIONING

Lack of knowledge is indicated where, for example, prices are raised, promotion cut yet sales are expected to rise. A too tight a timetable means that actions may be taken without fully considering the implications (for example production levels increased without corresponding increases in capacity). 'Conditioning' is indicated where groups take actions according to "folk wisdom", without thinking of the implications - for instance groups may believe that cutting stocks is, universally, a 'good thing' without considering implications (in terms of decoupling production and sales). Hence sophistic decisions indicate cognitive problems.

Arbitrary decisions occur due to disaffection. Lundy explains this thus "They make an initial decision based on illogical reasoning; then, when the results arrive and are poor they immediately change their strategy and try something else. They often continue to do this throughout the game" [Lundy 1984]. This, we suggest, describes a team's initial movement from the bottom right hand C-A space quadrant parallel to the Affective Axis into the bottom left hand quadrant. Further it suggests that too great a level of confusion (negative cognition) rapidly translates into disaffection.

How can this be overcome? There seem to be two considerations - the natural response of the system (based on the design and calibration of the simulation model) and, secondly, its managed response.

Natural Response - Returning to basic servomechanism theory. A step change in input represents a very rigorous test of the system response. This is also true for games. Too high an initial step causes groups to perceive the task as impossible and too low a step causes overshoot and collapse. One solution is to design a step and ramp system. An example of this is where a team takes over a 'cash rich' company but where market growth will reverse this [MANAGEMENT CHALLENGE], where inflation erodes profitability [RESERVE] or where changes in markets [SERVICE CHALLENGE] or seasonal patterns [TEAMSKILL] create increasing business difficulty. The step & ramp pattern maintains cognitive pressure without the instability caused by too large an initial step.

An alternative to the step and ramp pattern is the staircase pattern [TEMEWORK and SUBCONTEST] where, instead of a smooth increase in business problems, major new problems occur regularly. Another option is the ramped staircase [PRODUCT LAUNCH] where, besides smooth increases in cognitive pressure, new problems occur.

Managed Response - The natural response of a game is part of its design and 'calibration'. In contrast adaptive response takes into account the actual conditions encountered during a game (i.e. group dynamics, experience, knowledge, course content, exact timetable). It involves the tutor 'managing' the game and may involve support by the software. Managed response involves lengthening decision periods, additional feedback (in terms of predefined and adhoc information, additional tasks, teach-ins). For it to be effective the tutor must identify the need and have the resources to provide the feedback.

A CLASSIFICATION OF GAMES

Servomechanisms can be classified in terms of First, Second and Third Order systems [Coyle 1977: 138]. It is suggested that games be expressed in a similar way. The model described earlier represents a first order game (Figure 3 and Figure 5). Below this exists one where an individual replaces the 'team'. This, a zero order system is not represented in servomechanisms but is encountered in Computer Based Training (CBT) and hence does not provide the 'richness' of environment (provided by the team's aggregate knowledge, experience and creativity) necessary for management education [Hall 1986].

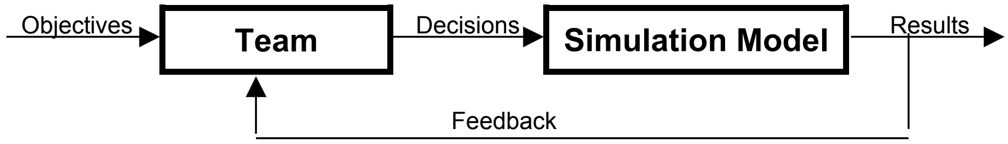

Figure 5 - First Order Game

Above a first order game a second order game is proposed that involves the tutor managing learning based on his or her knowledge of the game and team decisions and results (Figure 6).

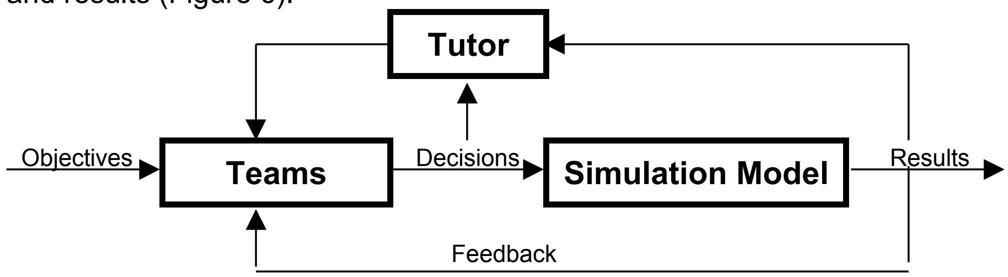

Figure 6: Second Order Game

Here the tutor observes the team, analyses decisions and evaluates results to determine whether problems exist. Problems that may be due to lack of cognition (knowledge), disaffection or both. Based on this diagnosis and on experience, he will decide what feedback is needed. The 'content' of this feedback will depend on cognitive needs and its 'style' will depend on affective needs (Figure 7).

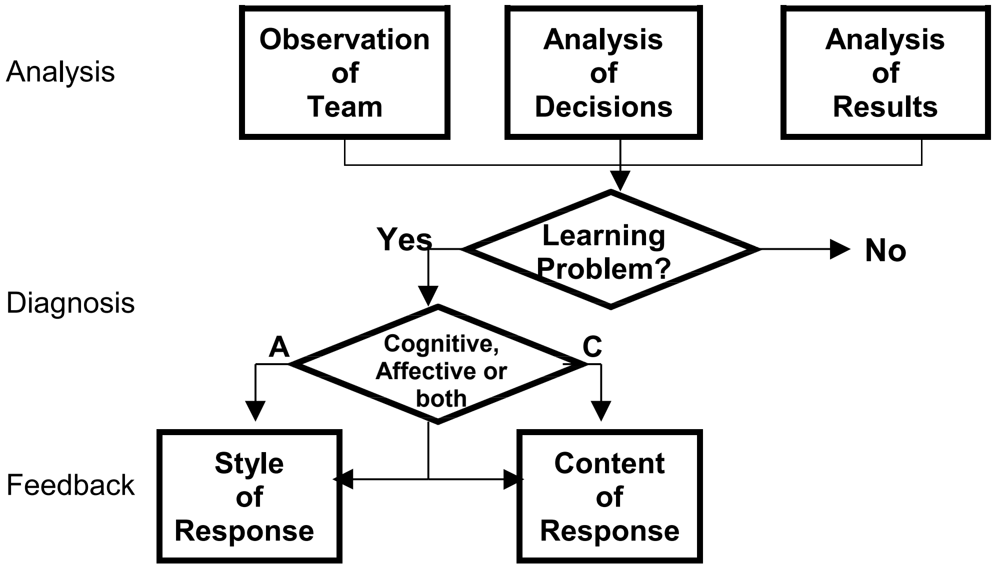

Figure 7: Learning Process Management

During the early stage of the game it may be appropriate to provide 'positive' feedback of, perhaps, a prescriptive nature. Later the style might be neutral with the tutor asking general questions that require a degree of deductive thought before they can be related to current, specific, needs. On other occasions, where a team 'feels that it can do no wrong' they might be forcefully questioned about their objectives and how these are being met (providing negative behavioural feedback).

Experience suggests, especially for short courses for practising managers, there are a number of practical difficulties. At an operational level, the tightness of the timetable gives a limited time to gather and process the diagnostic information. At a strategic level the tutor's range of knowledge must be extensive. For a total enterprise game he will have to know about strategy, marketing, finance, operations, forecasting etc. Finally, one can argue that the emotional involvement of participants may make them unwilling to receive feedback from the tutor.

Thus above the second order game model we propose a third order game model where software acts as a proactive aid (diagnosing problems and providing appropriate feedback and support to tutor and participants) and hence overcome the practical difficulties manifest in second order games (Figure 8).

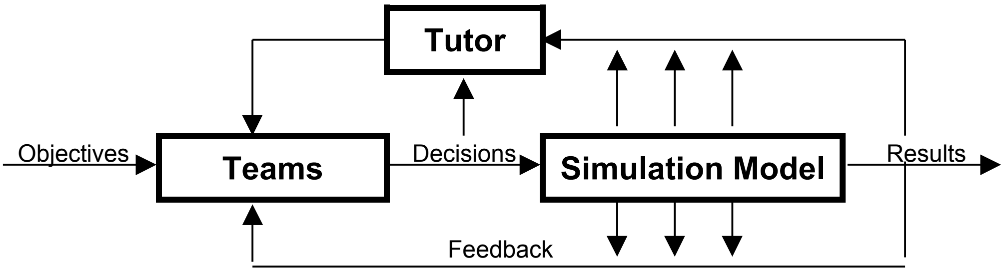

Figure 8: Third Order Game

Thus first order games rely on the Natural (or designed) Response of the system. Second order games add Managed Response where the tutor 'manages' the game. Third order games extend this managed response with the software providing direct support to the process. This software should provide measures of position in C-A space, diagnosis of cause of problems (in cognitive or affective senses) and additional, directed and reactive, feedback.

CONCLUSION

This paper suggests that by drawing an analogy between computerised management games and servomechanisms a framework for managing the learning process in terms of progress through C-A space is provided.

Further utilising system dynamics theory game design in terms of natural and managed response may be considered. Natural response is limited (damped) through design and calibration and managed response is based on the tutor 'managing' the learning process (with or without software) support.

By focusing on a process directed towards meeting learning objectives and providing a theory to describe the dynamics of this process a means of better controlling learning and obtaining transferable skills is furnished.

REFERENCES AND FURTHER READING

Bloom, B.S. (1959) *A taxonomy of educational objectives: the classification of educational goals, handbook 1: cognitive domain,* David McKay, New York.

Coyle, R.G. (1977) *Management system dynamics,* John Wiley & Sons

Cryer, P (1988a) Managing and behavior in educational games, simulations and workshops: a motivational perspective, *Simulation/Games for Learning,* 18 (2).

Cryer, P (1988b) Insights into participant's behaviour in educational games, simulations and workshops: catastrophe theory application to motivation, *Simulation/Games for Learning,* 18 (3).

Forrester, J.W. (1961) *Industrial Dynamics,* MIT Press

Hall, J.J.S.B. (1977) *Decision Administrator's Guide,* Hall Marketing

Hall, J.J.S.B. (1986) Computer aided management education, *Banking & Financial Training,* 3 (3).

Hertzberg, F, Mauser, B and Snyderman, B.B. (1966) *The motivation to work,* John Wiley & Sons, New York.

Jones, K. (1984) Running, or stumbling through, simulations, *Simulation/Games for Learning,* 1984.

Langhoff, P. (1967) Options in campaign evaluation *Journal of Advertising Research.*

Lundy, J. (1984) The effects of competition in business games, *Games and Simulation,* 10.

McGregor, D.M. (1960) *The human side of enterprise,* McGraw-Hill, New York

GAMES

Hall, J.J.S.B. (1971) TEAMSKILL, Honeywell Information Systems, London

Hall, J.J.S.B. (1977) PRODUCT LAUNCH, Hall Marketing, London

Hall, J.J.S.B. (1983) TEMEWORK, Hall Marketing, London

Hall, J.J.S.B. (1984) MANAGEMENT CHALLENGE, Hall Marketing, London

Hall, J.J.S.B. (1988) RESERVE, Hall Marketing, London

Hall, J.J.S.B. (1989) SERVICE CHALLENGE, Hall Marketing, London

Hall, J.J.S.B. (1992) SUBCONTEST, Hall Marketing, London

