ENHANCING CASH FLOW FORECASTING BY THE USE OF SYSTEM DYNAMIC MODELLING TECHNIQUES

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ABSTRACT

This paper examines the use of a systems dynamics modelling technique to enhance the contribution made by cash flow forecasts to decision makers' mental models. It is argued that by making explicit and accessible the dynamic complexity in cash flow relationships, systems dynamics can provide valuable insights for decision making purposes. By permitting the exploration of behavioural responses to perceptions about the financial position of the business, a richer picture of the decision outcome is developed leading to changes in decision makers perceptions about the riskiness of a proposed course of action. A case study of a commercial organisation is used to illustrate these insights.

INTRODUCTION

Many important business decisions are based on forecasts to evaluate the potential financial impact of alternative courses of action on the organisation. Forecasts are usually based on analysis of static cash flow models, consistent with accountancy and financial management practice. The dominant accounting revenue and cost behaviour models depend on simplifying assumptions, such as the classification of costs as fixed or variable relative to changes in volume or activity (Horngren, 1977) and of output increasing/reducing by some percentage. Spreadsheet models frequently reflect these model limitations. In reality very few variables actually behave as indicated by their accounting model relationships. It is commonly accepted that dynamic relationships exist between many of the factors to be considered but forecasts based on static cash flow models cannot be used to represent dynamic behaviour explicitly. Consequently dynamic behaviour is normally dealt with by informal assessments of the causality and of the estimated impact of a change (Franks, Broyles and Carleton, 1985). This may be deemed adequate for predicting outcomes from ongoing repetitive operations, as experience can be drawn on to refine the model and for interpretation of the results, but is considered to be less satisfactory as a basis for analysis where such experiential influence cannot exist.

THE PROBLEM

Decision making requires the development of 'mental images - models of how an organisation and its environment functions' (Mintzberg, 1973). Decision makers often synthesise forecasts to create mental models of alternative futures. Forecasts which focus on cash flows are used to determine that the funding requirements for each of the proposed options are in line with acceptable liquidity levels and borrowing ability, together termed 'solvency', and to determine the financial worth of the option in terms of the present value of future cash flows. Cash flow, long recognised as fundamental to survival, is increasing been seen as central to decision analysis with the assumption underlying 'shareholder value analysis' (Rappaport,1985) that a 'business is worth the net present value of its future cash flows' (Barfield, 1991) .

Decision makers acquire an understanding of possible outcomes by developing mental models based on their experience of similar or analogous situations, often supported by analytic models which vary in terms of their ability to represent behavioural aspects of the decision scenario. Static, spreadsheet based, financial models are widely used for informing decision makers. Such models have limited capabilities for the explicit representation of interrelationships between factors, leaving the decision makers to rely on their domain knowledge and past experience to predict the behaviour arising from interrelationships. In the case of a major investment decision for a small or medium-sized firm the scenario may have elements which are novel to the decision makers. In order to develop an appropriate mental model they need to test their assumptions about the behavioural aspects of the decision scenario. In order to determine how systems dynamics modelling could be used to explore behavioural assumptions where the significant outcomes are in terms of cash flows, we studied a small firm who had recently been faced with making a financial decision. Adopting the interpretivist paradigm we accepted the decision makers' view of what the issues were and the use of solvency as the decision criteria.

CASE STUDY

The client is a small partnership providing legal services. They occupy a leasehold building in the centre of London. One of the partners had expressed a desire to expand the partnership by acquiring additional members of staff and recognised the need for additional office space to accommodate them, another was keen to improve the image of the firm by acquiring a more prestigious building, while a third partner wanted to take advantage of the slump in property prices to acquire a freehold building as a long term investment for the partnership. Methods of acquiring additional space had been explored on several occasions. Reviews of the office property market revealed many offices for sale and for rent, however, the freehold office buildings for sale would involve capital costs obviously beyond the firm's borrowing ability, while most rentals were at substantially higher costs than the existing premises. Towards the end of 1991 a freehold property was identified in the same street which was priced to reflect the fact that it would require extensive building work, taking about 6 months to make it usable as offices. It was established that sufficient capital for the purchase and some building work could be borrowed by the partnership. However under the terms of the partnership agreement, the decision to go ahead with this purchase must be unanimous, and one partner objected to the purchase on the grounds that the partnership did not have sufficiently high predicted fee income to cover the costs which would result from the proposed purchase. He felt that the slump in demand for property made the disposal of their existing leases unlikely in the short term, requiring rental payments to be continued on these until expiry. He felt that there was a high probability of reaching the limit of their borrowing ability before enough cash could be generated from their fees to return the partnership to solvency. Since partners in a partnership do not benefit from the limited liability enjoyed by incorporated businesses he felt that the risk was too great.

Much argument ensued, but the other partners could not commit themselves to higher billing targets and so he would not a agree to the purchase. This placed considerable strains on the relationships between the partners since some of them felt that if they went ahead with the purchase, they would be motivated to obtain new business, render higher bills and keep other costs down; things which would all be in the long term interests of the partnership.

Spreadsheet based cash flow forecasting was undertaken to determine the maximum amount of the funds required and the point at which the cash flows would start to recover. These were based on various levels of fee income resulting from both realistic and optimistic targets. All the spreadsheets showed that there would not be sufficient cash generated by the ordinary activities to support the purchase and that the partnership would exceed, or be uncomfortably close to, its borrowing ability for the foreseeable future.

However the partners who supported the purchase would not accept the decision to abandon the purchase. They argued that the spreadsheet models did not adequately reflect how they would respond to being put in the position of having to find more cash from customer work. They felt that they would be motivated to find extra work, which would lead to more billing in the short term and to expansion from repeat business in the longer term. Perceptions of a poor financial position could also raise the levels at which quotations and subsequently bills are set for some types of work. Some partners also argued that they would reduce costs by avoiding unnecessary expenditure. They felt that many of these points would make the difference between success and insolvency, but that none of this was shown in the spreadsheet models.

The dissenting partner would not agree to the purchase and serious arguments ensued about the future of the partnership. The decision, to purchase the new building or not, appeared to be borderline, since four partners were for it and one against, all on the basis of the same analysis and shared knowledge of the significant factors. The spreadsheets provided a focus, but not a basis for a decision. It was felt that this example could be used to explore the role of the synthesis constructed by the decision makers of their own behaviour in response to feedback about the perceived financial position of the firm. The factors were reviewed and a systems dynamic model constructed centred around the cash balance and their likely behaviour in response to it.

Purchasing the property would require the following expenditure:

Property Purchase	£450000	Q3	(Quarter 3 of the simulation)
Building Costs	£ 92000	Q3	
	£123000	Q4	
Other Costs	£ 10000	Q3	

This expenditure would be part covered by:

Loan	£569500	Q3
Partner Capital Injection	£100000	Q3

The decision criteria for the client was whether the purchase would push borrowings beyond or uncomfortably close to their residual borrowing ability of #100000 for more than a year. This would bring their total borrowings to more than #750000 a level at which the client would be risking insolvency. This decision

criteria was determined by the attitude of the client's bank. The bank would lend to the client beyond their notional total borrowing ability provided that they were convinced that borrowings would quickly return below that level.

The rest of the paper describes what was revealed by the system dynamic modelling process and the client's responses to the models developed

MODEL DEVELOPMENT AND OVERVIEW

The model was developed with the client in three stages. The client had no experience of systems dynamics approaches and needed to be satisfied that a systems dynamics model could represent their existing understanding of the partnerships cash flow behaviour as exhibited by their spreadsheet models. The first stage model was therefore built to mimic the behaviour of their spreadsheet models. During this stage the client realised that a systems dynamic model could represent behaviour resulting from interdependencies and delays better than the spreadsheet model. A second stage model was built, essentially an elaboration of the first stage model, which included these features. During the third stage feedback loops were examined, incorporated into the model, and decision alternative scenarios explored.

The development of the systems dynamics model from a static spreadsheet model by a process of slowly unfolding the behavioural features of the clients cash flow system was successful in maintaining the credibility of the model with the client. The second development stage of allowing the client to elaborate on the static model before explicitly focusing on dynamic behaviour brought to light consequences of the purchase decision which had not been considered in earlier analysis, such as the loss of partner time to manage the project and interest rates increasing as the overdraft increases in size. As each elaboration of the model increased costs the client was ready to explore how they could influence the behaviour of the cash flow system and the transition to the third stage, examining feedback loops, followed naturally.

The systems dynamics model was built using i-think v1.01. The basic structure of the main sector of the model is shown considerably simplified in figure 1. The client bills customers for work done and cash is received over the next three quarters, less 3% bad debts. The market in which the client operates is characterised by a large number of small partnerships of similar size to the client. Predictable business growth occurs organically, estimated by the client at 3.5% p.a., or by acquiring fee earning staff who bring business with them.

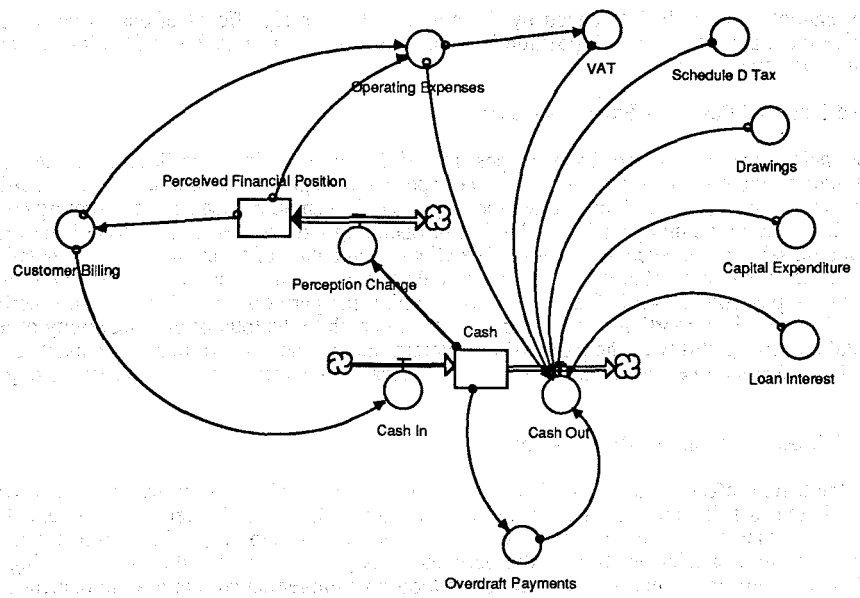


Figure 1: Cash Sector, considerably simplified

The legal profession is an "information" business and personnel (staff salaries and partner drawings), accommodation and taxes are major costs (75%). Operating expenses, excluding accommodation costs, are driven by business volume, partner drawings are largely determined by existing personal financial commitments, and the main business tax (known as Schedule D tax) is determined by partnership profitability.

Many of the significant cash flows have delays associated with them. Receipts are delayed by up to three quarters. Schedule D tax is based on the previous financial year and paid biannually. Increases in operating expenses are delayed by a year and VAT by one quarter.

The model contains four feedback loops as shown in Figure 2.

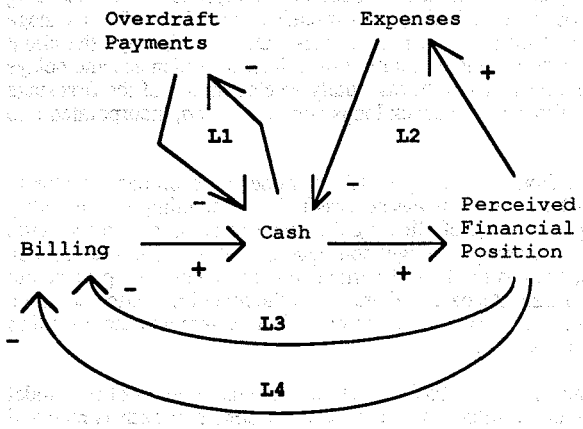


Figure 2: The main feedback loops

L1) Cash - Overdraft Payments - Cash

This feedback loop cannot be directly influenced by the client, but has a significant effect on cash flow behaviour. A positive loop, any negative cash position is compounded by interest payments, the interest rate increasing as the cash position worsens.

L2) Cash - Perceived Financial Position - Expenses - Cash

The client believes their perception of the financial position of the partnership, as indicated by the cash position, will direct them to exercise greater cost control over expenses, a negative feedback loop. Their ability to reduce costs, however, is highly constrained. Discretionary spend is a small percentage of operating costs and the client considered the maximum practical reduction in operating expenses would be 5% of the total operating costs excluding salaries and accommodation. The client's perception of their own financial position was discussed in great detail and a number of alternative models explored. Based on past experience it was finally agreed that a cash position of £-20000 causes concern within the partnership and initiates corrective action. The degree of concern is proportional to the ratio of negative cash to the total borrowing ability of the partnership. The total borrowing ability of the partnership is determined by the value of unsecured assets held by the partnership. The reduction in expenses is not linear with increasing concern as each additional saving is harder to find.

L3) Cash - Perceived Financial Position - Billing - Cash

Customer billing in the legal profession has a significant subjective element. Closer scrutiny of work carried out can uncover legitimate justifications for increasing customer bills. It was estimated by the client that customer billings could be increased by a maximum of 10% by this process. However, this measure should only be undertaken when the financial position of the partnership is poor as they would then be billing at higher rates than their competitors. This negative feedback loop was implemented using a similar control mechanism to the expenses feedback loop described above, the only difference being the ceiling imposed on the effect of the feedback.

L4) Cash - Perceived Financial Position - Billing - Cash

A second billing feedback loop was identified which reflected the partnership's extra efforts to attract new business. When financial concern is triggered the partners will try and make new customer contacts. Over time some of these contacts will become regular customers to the extent that billing expectations can be raised to include extra work from them. After much deliberation it was concluded that this effect was independent of the internal level of concern within the partnership, but a function of effort put to finding new business. It was estimated that each quarter that financial concern was triggered sufficient new customer contacts would be made to translate into a 1% increase in business volume after one year.

Alternative Scenario

Although the client had no immediate plans to increase the number of fee earning staff, if they found an individual who would fit into the partnership, and would bring new business with them, they would consider employing them. The client felt that recruiting such an individual was a viable option if the partnership needed to significantly increase business volume. This option was explored as an alternative scenario with the following agreed characteristics. It is likely that any new fee earner would not join until Quarter 6 of the simulation, after building works had been completed and the partnership had moved to the new premises. Salaries would be increased by an extra £10000 per quarter, effective Q6. The new fee earner would bring cumulative business volume increases of £10000, £8000 and £8000 in Q7,Q8 and Q9 respectively.

MODEL FINDINGS AND INTERPRETATION.

Figures 3a to 3h show the client's cash position simulated over 20 quarters for the decision scenarios. All feedback loops operate as discussed above except where detailed below. The client's residual borrowing ability is a constant £100000 after purchasing the property. The quarterly oscillation in cash position is due to the biannual payment of Schedule D taxes.

Figure 3a shows the cash position assuming the property is not purchased and suggests there not any intrinsic strains on their cash position.

Figure 3b shows the cash position assuming the property is purchased incurring the additional costs detailed above. This suggests that if they do purchase the new property, borrowings will be pushed to close to the maximum for 5 quarters after Q7 and thereafter slowly climb out of danger. Although the client expected borrowings to be high for some time, their expectation had been for a much swifter recovery to the borrowing levels shown in Figure 3a. In order to examine whether a faster recover could be achieved the relative impact of each feedback loop was explored.

Figures 3c to 3e assess the relative impact of feedback loops L2 to L4. Figure 3c shows the relative influence of feedback loop L2 by comparing the reduction of operating costs by different percentages. The client estimated the maximum practical reduction in operating expenses would be 5% of the total operating costs excluding salaries and accommodation. This figure shows the effect of reductions of 1) 0%, 2) 2.5% and 3) 5% and indicates that although expenditure control will reduce borrowings by a small amount it will not speed recovery. Figure 3d shows the relative influence of feedback loop L3 by comparing the effect of increasing customer bills by different percentages. The client considered that the subjective element of customer billing would enable them to justifiably increase customer billing by a maximum of 10%. This figure shows the effect of increases of 1) 0%, 2) 5% and 3) 10%. This result indicates that feedback loop L3 is critical. Increasing customer bills by 5% or less risks the positive loop L1 becoming dominant and the cash position spiralling out of control through ever increasing overdraft payments.

Figure 3e shows the relative influence of feedback loop L4 by comparing different success rates in attracting business from new customers. The client estimated that each sustained effort at making new customer contacts would translate into an extra 1% business volume after 1 year. This figure shows the effect of 1) no extra business volume, 2) 1% extra business volume and 3) 2% extra business volume. This result shows that feedback loop L4 is also critical though the deterioration of cash position is not as dramatic as is the case when L3 is neglected. Unlike L2 and L3 the client could not establish a ceiling for this feedback loop and this figure shows that increasing the volume of new customer business to 2% per quarter still involves a recovery period of over 2.5 years. Since their predicted growth without this feedback loop is less than 1% per quarter, an additional 2% is unlikely to be achieved. It also became apparent that irrespective of the volume of new customer business the impact of this feedback loop does not result in fast enough recovery.

Comparison of Figures 3c, 3d and 3e shows that feedback loop L3, Figure 3d, has the dominant influence in the critical period of 2 years following the purchase. Although effective in the short term the dominance of L3 has serious long term implications for the client's business. Increasing billing by squeezing more fees out of

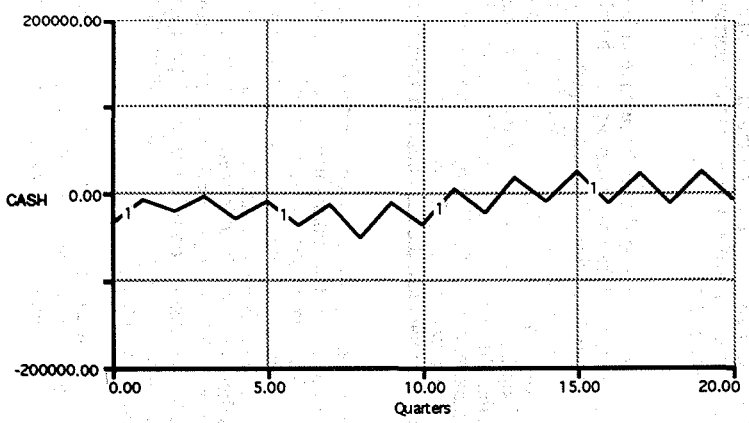
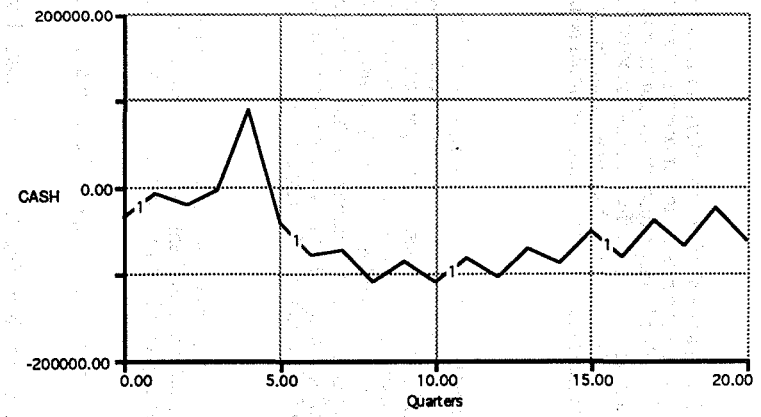


Figure 3a: No Purchase



Figur 3b: Purchasing New Premises

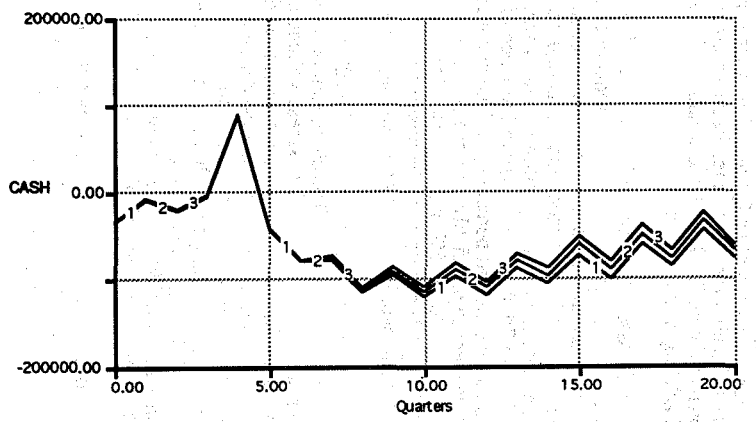


Figure 3c: Expenses Sensitivity Analysis (1=0%, 2=2.5%, 3=5%)

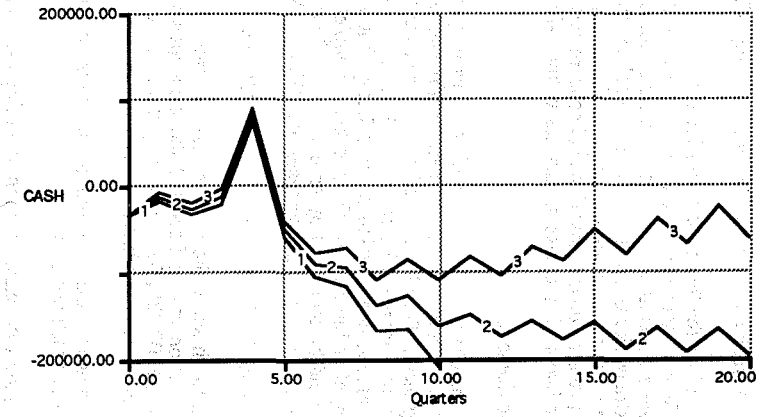


Figure 3d: Customer Billing Sensitivity Analysis (1=0%, 2=5%, 3=10%)

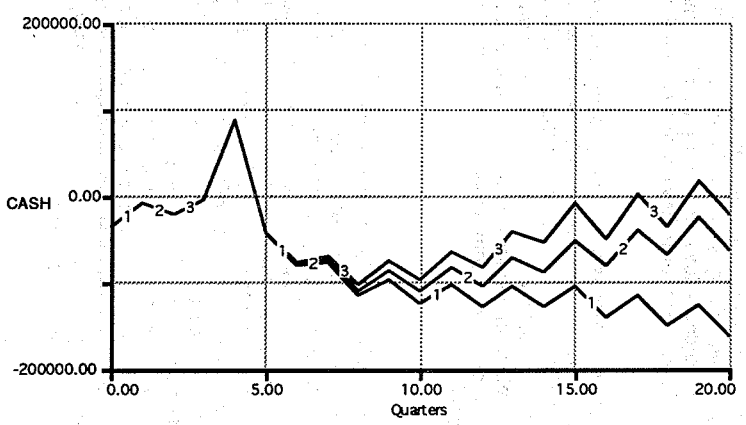


Figure 3e: New Customer Sensitivity Analysis (1=0%, 2=1%, 3=2%)

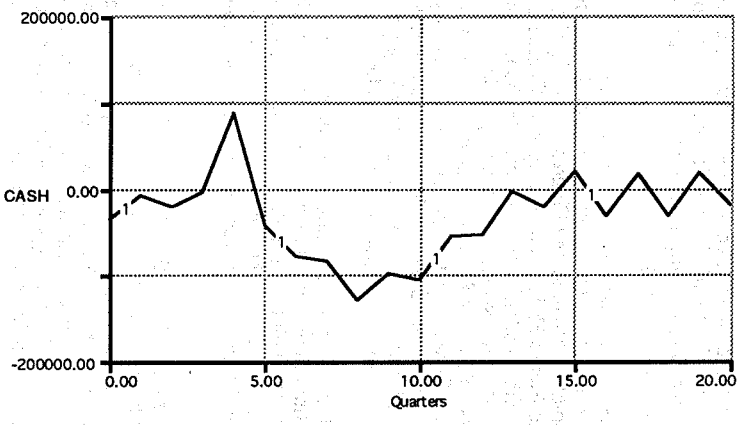


Figure 3f: Additional Fee Earner

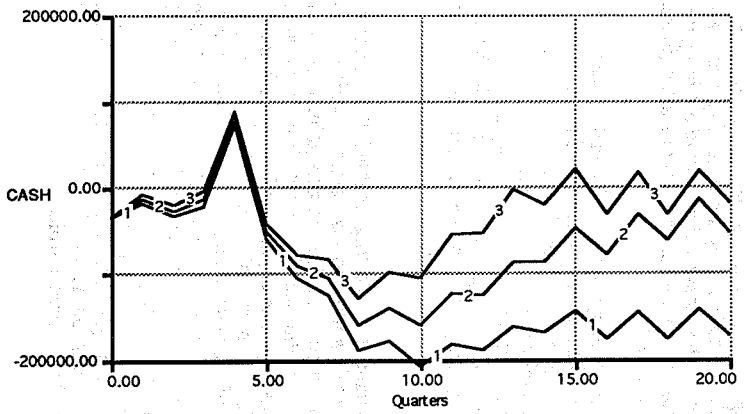


Figure 3g: Additional Fee Earner, Customer Billing Sensitivity Analysis

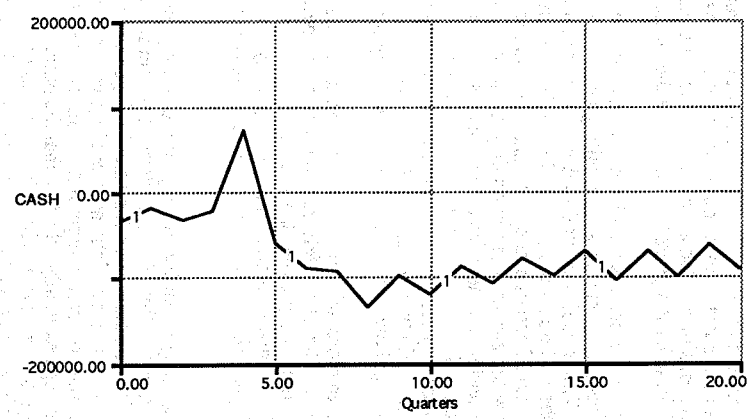


Figure 3h: Additional Fee Earner, Alternative Control mechanisn L3

the same work would place the client at a cost disadvantage compared to their competitors. This would not be important in the short term as customer relationships and service differentiation would be strong enough to avoid losing business. However, the model suggests that increased billing in this way will have to be maintained for at least 3 years by which time the client would be competitively very vulnerable.

The findings described above all show a cash position recovery which was too slow for the client. The main alternative decision scenario was recruiting an additional fee earner under the conditions described in the model overview. The model was modified to incorporate this alternative scenario and Figures 3f and 3g show the impact of the additional fee earner. Figure 3f is equivalent to Figure 3b in the base scenario. Comparison of Figures 3b and 3f shows a deeper trough but faster recovery with an additional fee earner. In the first quarter after the new fee earner is recruited they are an extra cost to the client worsening the cash position. Over the next three quarters the new fee earner increases total business volume by £26000 per quarter accelerating the recovery rate. The cash position behaviour shown in Figure 3f was close to the clients perception of an acceptable recovery rate, but they were still concerned about the effect of L3 on their long term competitiveness. Under this scenario they would still have to squeeze customer bills for 2 years, an unacceptably long period of time. Figure 3g, however, shows that the recovery is still very sensitive to increasing customer bills.

In order to explore whether they could reduce this period an alternative control mechanism for L3 was implemented. The client felt that the maximum period of time they could squeeze customer bills without serious long term competitive damage was 1 year. After discussion with the client the control mechanism of L3 was modified so that bills were increased for only four quarters from Q5 and by 10% irrespective of their cash position. Figure 3h shows that with this alternative control mechanism on L3 recovery is once more slow and painful.

There was a danger that by relying on the billing squeeze they could find that they were jeopardising their future billing capability. Some customers would respond to higher fees by taking their business elsewhere, forcing the firm to continue with greater billings squeezes and/or billing squeezes for a longer period. For a firm who regard their market niche as providing commercial legal services, i.e. 'city services' at lower than 'city prices', the risk of being regarded as an expensive supplier was unacceptable. By representing these interrelationships explicitly, the fact that the purchase would require them to engage in policies that contradict their strategy became clear. The risk of the short term fix becoming a damaging necessity had not occurred to them until this was revealed by a systems dynamics model.

It became apparent to them that recovery within an acceptable time period depended on expanding by taking on a new member of staff and by implementing a substantial and sustained billings squeeze of about 10% . It also became apparent that these actions would not bring the level of indebtedness down to an acceptable level unless they occurred (new member of staff) or started (increases in billings) sooner than they considered possible or had thought necessary.

Finally, the systems dynamics model made clear the size of the business expansion necessary to effect recovery. Since much of the argument had centred around their beliefs about the possibility of finding new business, and this was the area most explored by the spreadsheets, it was surprising to find that the increases required for recovery was (at about 8.25% pa) more than twice their realistic estimate of 3.5% pa. The client learnt that their financial recovery from purchasing the new premises was reliant on the long term application of a short term measure. Exploring their assumptions in this way changed their perceptions about the riskiness of what they were proposing to do; from acceptable risk to unacceptable risk.

DISCUSSION

Systems dynamics modelling enabled the exploration of the decision maker's behavioural assumptions concerning their ability to take actions which would steer the firm towards back to solvency within an acceptable time period . The insights gained changed the decision makers' perceptions about what would be required to meet the cash flow needs if the new building was purchased. They had believed that it would be enough to just squeeze expenses (downwards) and billing (upwards) for a few months. This view had been strongly held. The nature of the spreadsheet models had allowed them to retain these beliefs, since the relative capabilities of the possible policies identified were not apparent. By exploring the relationships between the feedback loops, it was discovered that they had been planning to rely on a billings push policy that could have led them to develop behaviour consistent with that of the system archetype 'fixes that don't work' (Senge, 1990). By demonstrating the interrelationships between these policies in terms of expected cash flow, the systems dynamics modelling made the decision makers realise that it would be unwise to depend on squeezing costs and on pushing billing as instruments for recovery. This realisation meant that they were forced to move away from relying on actions which required relatively small changes to well understood processes, and towards considering actions which required more radical changes, as a basis for recovery.

In order to provide appropriate tool support for decision making, (Alter , 1992) has proposed that, rather than focusing on the technology, the decision making process needs to be better understood. The way in which mental models of the alternative futures resulting from decision options are developed by decision makers is central to this understanding. The systems dynamic approach supported the exploration of the decision makers' assumptions about the nature of behavioural responses, without challenging the validity of those assumptions. This was important in obtaining commitment to, and belief in, the systems dynamics models. We found that despite understanding the nature of the behavioural assumptions on which their mental models were based; the decision makers had difficulty with synthesising, for the purpose of mental model development, the effect of these behavioural assumptions in terms of impact on cash flow. The spreadsheets did not show any recovery but, by continuing to support the purchase, the decision makers were overriding the spreadsheet forecasts and responding on the basis of their mental models. The strong role played by mental models in determining decision making outcomes, highlights the need for tools to aid in the development of richer mental models. By enabling the exploration of the impacts of complex behavioural interrelationships, the systems dynamics modelling used here contributed to the development of richer mental models in the decision makers studied, for the purpose of the decision outlined in the case study.

We were interested in testing the use of systems dynamics modelling for exploring the behavioural relationships where the impact, in terms of corporate solvency, of a decision was being considered. The possible effects of a decision on long term solvency was not amongst the generic corporate problem modes identified by Graham, (1988). However, for long range forecasts, the solvency profile is more important than the individual figures. System dynamics has been suggested as particularly suitable for insight into the co-ordination of operating policies. (Graham, et al, 1990), and for exposing counterintuitive behaviour in systems (Sterman, 1989). We thought that it would be interesting to consider the role of systems dynamics in enhancing intellectual manageability for one-off/occasional financial decisions in small organisations; perhaps leading to the development of tool/method support specifically for that environment. Much effort has been expended in designing suitable decision support systems for the repeating decision e.g. bank lending, but, understandably in view of their nature (and the adoption of spreadsheet tools) , occasional financial decisions have received less attention from the decision support systems community. Following on from this study we intend to consider the development of method and tool support for occasional financial decisions based on the systems dynamics modelling approach.

CONCLUSION

By developing a systems dynamics model to support decision making around a cash flow recovery profile , we have illustrated the application of systems dynamics modelling, as an alternative to the widely used spreadsheet. We see this as demonstrating the usefulness of the approach to financial management, where difficulties in developing forecasting models which incorporate complex behavioural responses has been recognised as a factor limiting their value in the development of appropriate mental models.

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