

The role of System Dynamics Models in improving the Information Systems Investment Appraisal in respect of Process Improvement Projects

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Abstract

This paper examines issues in the Information Systems (IS) investment appraisal (IA) domain in respect of process improvement projects. It discusses the role of system dynamics (SD) models in evaluating the four (cost, benefits, risks & flexibility) aspects of an IS investment appraisal exercise.

There is evidence that many organisations perceive that they are not getting a satisfactory financial return from their IS investments. There may be a variety of underlying reasons for this problem. With references to the Software Engineering, Investment Appraisal and SD literature, this paper demonstrates that a significant factor in this problem is the failure to incorporate all of the relevant forces and feedback effects in the techniques utilised for evaluating IS investments, particularly in respect of process improvement projects. It also examines the various ways in which SD may contribute to our understanding of the IS development lifecycle.

Introduction

This paper briefly reviews some issues in the Information Systems (IS) investment appraisal (IA) domain. These are examined in greater depth in previous papers by the author (Kennedy, 1996, 1999). It then considers how SD modelling may assist in addressing some of the issues raised.

The "traditional" investment appraisal techniques such as Payback, Accounting Rate of Return [ARR], Net Present Value [NPV] and Internal Rate of Return [IRR], as commonly used, are not able to measure many of the benefits offered by IS investments that are intended to gain tactical or strategic business advantages. This is a particular problem with those projects designed to achieve a 'transformation' of the business processes (Kennedy, 1999).

Despite the evidence that IS investments can, in some circumstances, yield competitive benefit, reported performance is very mixed (Hayes & Garvin, 1982; Kennedy, 1996, 1999; Lincoln, 1990; Meiklejohn, 1989; Porter & Millar, 1995; Qureshi, 1993; Strassman, 1990, 1985; Ward et al, 1995). In the author's opinion the need for concern

in the state of IT evaluation within industry may be gauged from the numerous instances of unsatisfactory findings from research conducted to date (Kennedy, 1999).

Numerous authors have chronicled the unsatisfactory performance of IS developments. From their own and other's investigations, Remenyi et al (1991) reported the following findings:

- IT expenditure is not linked to overall productivity increases.
- 70% of firms report that their IT systems were not returning the company investment.
- IT overheads are consistently larger than anticipated.
- 31% of firms surveyed report a successful introduction of IT.
- 20% of IT spend is wasted.
- 30%-40% of IS project realise no net benefit whatsoever.
- 90% of firms did not have a systematic evaluation process.
- but 24% of firms surveyed report an above average return on capital from their IT.

These figures illustrate why managing IS/IT is one of the major business challenges. Organisations are not able to effectively evaluate the costs and benefits of IT and so make poor investment decisions. This is confirmed by a survey, which investigated how 48 organisations assess the value of IT and what techniques they use to assess the value of IT (Qureshi, 1993), which concludes that many organisations are not getting 'value for money' from their investments.

Qureshi's (1993) survey, that investigated 48 organisations and their attitude towards IT, found that the difficulty experienced by organisations in assessing intangible benefits was exacerbated by the culture barrier existing between business and IT managers. The survey also uncovered some interesting information on the on how organisations' business and IT plans are linked. While 60% of organisations had separate business and IT plans, 67% of the IT plans were de-coupled from the business plans. SD, though an increased understanding of structure and process, may facilitate a closer 'alignment'.

Most organisations are still using 'traditional' financial management investment appraisal techniques (Hutchinson, 1995; Weston & Copeland, 1988), such as Payback, Accounting Rate of Return [ARR], Net Present Value [NPV] and Internal Rate of Return [IRR] for evaluating all IT investments (Hares & Royle, 1994; Ballantine et al, 1995; Remenyi et al, 1991). It is argued that although these "traditional" investment appraisal techniques are suitable for evaluating IT investments that automate the organisation's operations, where the prime motive of the project is cost displacement, they are not suitable for evaluating IT investment that are intended to gain tactical or strategic business advantages (Kennedy, 1999).

Hares & Royle (1994) state that there is much to be gained by ensuring that the IA is conducted against a clear strategy plan of projects that are judged to be worthy of investment

Hares & Royle (1994) state that CBA is usually undertaken for one of two reasons- either to show that the proposed computer application benefits outweigh the costs over the lifetime of the project or to show that the payback period for the investment

(the time when the benefits outweigh the costs) can be met. Both reasons are valid. But they are not enough.

They argue that the problem with techniques of an 'accountancy type' is that they calculate and measure financial figures on a project-by-project basis only. To date there has been no built-in mechanism to ensure that financial investments are made in the context of the company's business strategy plans.

It is argued that because one of the major benefits offered by a MIS is gained by an increase in the quality of the decision making within the organisation it cannot be evaluated effectively by techniques that only consider quantitative and financial data. For IT investments that are designed to gain strategic advantage the benefits are likely to be even more difficult to measure than those of an MIS because of the increased number of external and internal factors which are involved (Kennedy, 1999).

This paper will suggest that organisations that are using narrowly focused evaluation techniques are missing opportunities, while taking on large risks and costs that can be avoided through the use of appropriate and effective evaluation techniques.

Hares & Royle (1994) identify the following elements of an investment evaluation:

- Cost
- Benefits
- Risks
- Flexibility

Costs

The conceptual problems with the costs of IT projects are mainly concerned with the identification, categorisation and measurement of 'indirect costs'. IT costs are consistently larger than anticipated and overheads, especially in user departments, are frequently understated (Remenyi et al, 1991, Willcocks, 1992, Earl, 1989 and Hochstrasser, 1990).

Bell et al (2000) have reported some of the problems with the poor performance of algorithmic cost models, such as those propounded by Boehm (1981) in estimating software costs. They have proposed the Holon Methodology as an example of the combination of hard and soft approaches including SD modelling.

Benefits

Perhaps the most serious problem with traditional methods is their inadequate treatment of the benefits of IS developments. There are conceptual problems with the identification and measurement of 'intangible benefits' (Remenyi et al, 1991), Ward et al (1995) and Hochstrasser, 1990).

Remenyi et al (1991) identify the following types of Benefits:

- Regulatory Compliance
- Financial Benefits
- Quality of service Benefits
- Customer perception Benefits
- Internal Management Benefits

- Dis-benefits

Ward et al (1995) suggest that anticipated benefits from a project are often not realised. This is because, in many organisations, no steps are taken to ensure that expected benefits have materialised. A benefits management programme is therefore required. They suggest a model:

- Identifying and structuring benefits
- Planning for benefits realisation
- Execution of the realisation plan
- Evaluating the results of post implementation review - potential for future benefits

Risk Evaluation

The author (Kennedy, 1999) would suggest a risk management programme comprising:

- Risk identification - recognise risks of project
- Impact Assessment - Quantification of the damage / loss if the adverse risk occurs
- Probability - What is the likelihood of the event happening
- Avoidance - What steps can we take to minimise the changes of the event

Flexibility

Flexibility is the degree to which a project is able to adapt to uncertain issues at the time it was being planned.

Important Selection Criteria.

For any technique to be accepted in this domain, it needs the following attributes:

- A technique that takes account of all important aspects of company performance - not just short run financial returns.
- A technique that offers indicators of future as well as past performance - financial figures are held to be poor on the former.
- A technique which takes account (albeit with difficulty) of intangible costs & benefits - the traditional view is to accurately measure that which can be done easily & ignore the rest.

These subsidiary criteria may also be important:

- A track record - a tried and tested approach is likely to be received much more readily than an untried idea.
- Inherent simplicity - busy executives are more likely to apply a straightforward approach than one which needs considerable time and effort to master.
- Flexibility - each organisation is unique in terms of its strategy, its competitive position, and other key criteria and will need an approach that is able to accommodate such diversity.
- Measurability - an approach where the information required is obtainable is eminently more useful than one that requires figures that are impractical to obtain.

Willcocks' (1992) Evaluation Guidelines:

- Link evaluation across stages & time
- Involve key stakeholders in evaluation at all stages
- Assess the actual against the planned impact of IT
- Evaluate & re-evaluate at all stages of the project

- The concept of learning should be central to the evaluation process. The clamour for adequate techniques may reveal a 'quick-fix' orientation; in the long run getting it right may prove more difficult but add greater value

Why System Dynamics?

From a partial review of the Software Engineering (SE), Investment Appraisal (IA) and SD literature, the application of SD to IS/IT management and Investment Appraisal appears to lie in the following four areas. Kennedy (1999) discusses some other potential areas of application to IA.

Business Value of Proposed Process Changes

Firstly (and of most direct relevance to the Investment Appraisal of IS based process change projects), we may develop models of a business showing business processes before and after a proposed process change. The anticipated value of the benefits derived, (in terms of greater revenues, resources saved or perceived improvements in quality or reputation), can be compared to the estimated costs. This would be of considerable value in “Process Transformation” or “BPR” type projects.

A classic example of how constructing a SD model may lead to a better decision being taken and, in this instance, avoid an expensive error being made, is the “Domestic Manufacturing Company (DMC)” case study as described and analysed in Coyle (1996). This case (disguised & simplified) is based on a consultancy assignment.

The management problem in this case was that “DMC's” manufacturing activities were faced with a very unstable and completely unpredictable order pattern with two peaks and troughs each year. As a result the responsible (Raw Materials) Manager was heavily criticized within the firm for the extreme volatility in Raw Material Stocks, and by DMC's suppliers for the great variations in Raw Material Order Rate.

The preferred solution of the Raw Materials Manager is that DMC should invest a sizable sum of money in acquiring, and subsequently operating, a Management Information System (MIS) so as to allow him to exercise control over the quantity of raw materials in the delivery delay pipeline.

From comparing the results, Coyle guides us to conclude that implementing the MIS, with the existing policies, is by no means as good as changing the firm's policies.

Furthermore implementing the IS may well require further policy changes. Coyle leads us to “the essential insight that simply implementing an MIS is unlikely to be effective in any system, not just DMC, unless one carefully studies the system's policies. Introducing the MIS has changed the system, so it is intuitive that the old policies might not be good for the changed system.”

Coyle summarises the implications for the Information Systems (IS) investment appraisal domain as: “Testing the effects of putative information systems in the inexpensive world of the model is a most fruitful area of system dynamics application”

This concept can be extended into a structured method. Wolstenholme et al (1993) describes such a System Dynamics based methodology for MIS evaluation, which he and his co-workers termed "BISEM" (Bradford Information System Evaluation Methodology). They state that it is intended to be used as a "complement to existing methodologies for the structured development of MIS". They envisage that it "is to operate in parallel with the evolution of the MIS life cycle, but to remain at an objective, strategic level in contrast to, but supporting, the detailed development of the MIS".

As in the example drawn from Coyle (1996), above, Wolstenholme et al's work takes a strategic view of MIS and is aimed at providing a systemic and dynamic evaluation of the effect of an MIS on its host organisation. This contrasts with the (isolated) project bias of most Information System Evaluation Methodologies (Hares & Royle, 1994).

They describe the methodology as a "tool for creating a 'virtual reality' of the organisation and its MIS, which can be used to improve understanding of the impact of alternative specifications and configurations of the MIS on the organisation"

As described by Wolstenholme et al (1993) 'BISEM' "involves the creation of a System Dynamics model of an organisation prior to implementing an MIS. The MIS is then superimposed on the model of the organisation; not in terms of individual, detailed information flows, but in terms of its anticipated effects on the physical and information processes of the organisation and the operational strategies which convert information into action. The model, and hence the MIS, is evaluated in terms of high-level organisational performance measures and against alternative scenarios for the evolution of the organisation."

Wolstenholme et al (1993) describes two case studies. The first is to assess the effect of implementing an MIS on a logistics organisation and the second case study assesses the effects of implementing an MIS on a military battlefield operation.

From the outcomes of these projects Wolstenholme et al (1993) conducted a self-evaluation of the 'BISEM' method they concluded that BISEM's weaknesses (1 & 2) while it's potential contribution to MIS Evaluation (3-12) were:

1. "System Dynamics may not be rigorous enough to support a detailed low-level assessment." The current author has demonstrated that, in another IA context, (Kennedy, 1997a & 1997b), SD *need not* per se 'lack rigour' if the modelling process is controlled with 'rigour' as an aim. The pursuit of 'rigour' might however, limit the scope of the model, especially the inclusion of some intangible or 'soft' factors.
2. "The very detailed representation of explicit physical and information flows can be difficult or impossible with current tools." The current author would comment that this is becoming less of a problem as the tools mature over time.
3. "In the early stages of procurement BISEM can usefully contribute to the study of MIS.
4. In particular, by focusing on the formative phases of the life cycle, the ultimate MIS specification may be improved, thereby improving anticipation of latent or

potential problems and lessening the risk of an expensive retrofit at a later point.

5. The technique has a great deal to offer in the design phases of MIS, and the fuzzy (often iterative) boundary between design and assessment. The ability of the technique to incorporate subjective data in these phases is particularly advantageous.
6. System Dynamics models can be constructed quickly. Model construction time can be reduced further through the use of interactive software packages, such as STELLA. But because the hard modelling aspects of System Dynamics are so deceptively simple to learn, care must be taken that the broader objectives of the technique are understood if misapplication is to be avoided.
7. Changes to the models to reflect alternative procedures or MIS facilities can be readily implemented.
8. The method successfully integrates elements of both the hard and soft systems paradigms, which is particularly desirable when studying conceptual future systems.
9. Whilst the harder (executable) modelling constructs of System Dynamics are capable of supporting low-level numerical modelling, the overall objective of a System Dynamics study should be orientated towards a softer analysis. The technique's limited range of primitive analytical constructs compels the analyst to adopt a specific (usually high-level) approach that can sometimes limit the scope of analysis achievable. For example, low-level multi-attribute discrete objects cannot be explicitly modelled within System Dynamics. In the early stages of MIS assessment low-level objective data is scarce, thus a high-level, softer approach is appropriate.
10. System Dynamics provides an excellent medium for elicitation of information, problem formulation, and system model design.
11. Influence diagramming provides a sound communicative medium through which to express, capture and structure ideas without compelling the client to become excessively involved in technical detail.
12. Existing System Dynamics tools greatly facilitate interaction with the user and the design and implementation of qualitative and quantitative models that address levels, rates and trends.”

This is an impressive list of potential advantages. The reasons why the widespread commercial adoption that might have been expected to ensue has not transpired will be examined in the conclusions to this paper.

Models to Contribute to our Understanding of the IS Development Lifecycle & Project Management

Lehman and his co-workers examine the various ways in which SD may contribute to our understanding of the IS development lifecycle, (especially in respect of evolutionary software), from a Software Engineering perspective.

In a sustained series of experiments, (termed the “FEAST” study), they have constructed and compared the results from ‘black box’, ‘white box’ (SD) and other classes of process models of selected collaborator systems. These systems are selected so as to take advantage of the available process evolution metrics and other global data

about process components and structures that other members of the Software Engineering community have collected over many years.

Their major contribution to this area is in providing the evidence (from a Software Engineering perspective) that the IS development lifecycle may be viewed as a “complex multi level multi loop feedback system, the long term behavioural patterns and trends of software processes are largely determined by its internal dynamics which, in turn is feedback generated and controlled”. In later work they have described the evolution of their own approach towards simulating the effects of the decisions made by the managers of these processes and generally placing greater emphasis on ‘human factors’, so moving closer to those authors approaching the issues from a traditional SD approach. The key findings of a selection of their papers are described below.

Lehman (1996) briefly reviews the difficulties encountered in achieving further major improvement in some aspects of the software evolution process. He suggests that this may be due, in part, to the fact that the “global process” is a “complex, multiloop multilevel feedback system”.

As a starting point he summarises the early work showing that a 1970’s study recognised the feedback property. Discussing an earlier version of the OS/360 IBM operating system growth curve, it was observed that, "... the ripple is typical of a self stabilising process with positive and negative feedback loops. From the long-term point of view the rate of system growth is self-regulatory, despite the fact that many different causes control the selection of work implemented in each release, with varying budgets, increasing numbers of users reporting faults or desiring new capability, varying management attitudes towards system enhancement, changing release intervals and improving methods ...".

He states, “as observed in the quotation above the ripple in this plot suggested that negative feedback may be an indicator of self-regulation of OS/360 evolution. The chaotic (in a strictly technical sense) behaviour exhibited over the final releases is, similarly, likely to have been due to feedback. It appears to reflect instability resulting from the positive feedback that led to pressure for excessive functional growth in evolving release 20 from release 19”.

Lehman (1994) suggests that a possible constraint on software process improvement arises from the fact that the global software process that includes technical, business, marketing, user and other activities constitute a multi-loop, multi-level feedback system. He states that “to change the characteristics of such a system requires one to consider, design or adapt and tune both forward and feedback paths to achieve the desired changes in externally visible behaviour. It should, therefore not come as a surprise that the overall improvements achieved fall far below expectations. After all, current world-wide process models and improvement activities focus primarily on the forward technical path and overlook the many feedback paths and the constraints that they impose on improvement of the project”.

Lehman (1998) describes the research approach being used in the (“FEAST”) study as being to construct black box, white box (SD) and other classes of process models of selected collaborator systems on the basis of the available process evolution metrics

and other global data about process components and structures. This paper examines how the feedback that exists in these processes involves many humans in many roles. “These observe, interpret, communicate, listen and act (or not). Global models of their activities cannot, however, in general, reflect the actions or behaviours of individuals. The level of detail which global process models can reflect is, therefore, limited. As a complex multi level multi loop feedback system, the long term behavioural patterns and trends of software processes are largely determined by its internal dynamics which, in turn is feedback generated and controlled. Process models must, therefore, reflect the feedback phenomenon. Individual human assumption and decision plays a central role in the feedback processes and this must be taken into account when considering the human dimension, the role and impact of people, in and on the process. Individually this cannot be done, but the aggregate effect of many individual decisions by many people may, in general, be represented by statistical means. One constructs, therefore, meaningful models relating to global process behaviour over time without addressing individual behaviour. In practice, this is not a significant limitation since individual actions have, in general, only local, impact on the long term performance of the global process”.

In Kahen et al (2000) they describe the evolution of their own approach towards simulating the effects of the decisions made by the managers of these processes, while the earlier “FEAST” SD models simulated real-world processes with the intention of increasing the understanding of these processes.

Lehman (1997) considers three process related issues: software process improvement, feedback in the software process and business process improvement. Lehman states “the first is currently the principal focus of the software process community. The second, it is believed, should be. The third is equally relevant”.

In Wernick and Lehman (1999) they describe a high-level system dynamics model of a defence system composed of hardware and software components. They demonstrate how this simple feedback-based model demonstrates the influence of the global process on the evolution of the software specification and implementation. In this case study model the outputs closely simulate actual and expected metrics for the real-world project. They concluded inter-alia that feedback external to a software production process may significantly influence that process.

In a counter-point to Lehman and his co-workers, Abdel-Hamid & Madnick (1991), examine the various ways in which SD may contribute to our understanding of the IS development lifecycle (and project management in particular) from a SD perspective. Despite the different starting points there are considerable overlaps in the two teams conclusions.

They summarise some of the problems of Software Engineering as “the record shows that the software industry continues to be plagued by cost overruns, late deliveries, poor reliability, and users' dissatisfaction”

They conclude that the root cause is that although there have been major technical advances, “A comparable evolution in *management* methodologies, however, has not occurred”.

They cite Merwin (1978), as pointing out that an overall software engineering management discipline is missing. He stated: "Programming discipline such as top-down design, use of standardised high level programming languages, and program library support systems all contribute to production of reliable software on time, within budget. ... What is still missing is the overall management fabric which allows the senior project manager to understand and lead major data processing development efforts." Although the language is a little dated this author would contend that the requirement is still current. Indeed it is disappointing to note that many early references are still relevant due to the lack of fundamental progress in this field.

In parallel with Lehman, they argue that chief among the obstacles to progress in software engineering project management is the "lack of a fundamental understanding of the software development process" and they extend the argument to state, "without such an understanding the likelihood of any significant gains in the management of software development front is questionable".

Abdel-Hamid & Madnick (1991), state that "The first and primary purpose of the model is to enhance our understanding of the software development process" and "The second purpose of our model is to make predictions about the general process by which software systems are developed". They argue that, the model would "serve as a framework for experimentation to test the implications of new managerial policies and procedures, especially where controlled manipulation of the system itself is impossible, or at least impractical or undesirable due to time, cost, inaccessibility, political or moral considerations, etc." This latter statement is in parallel with Wolstenholme et al (1992, 1993), above.

Abdel-Hamid & Madnick (1991) argue "a major defect in much of the research to date has been its inability to integrate our knowledge of the micro components such as project management, programming, and testing for deriving implications about the behaviour of the organisation in which the micro components are embedded."

In a similar vein to Lehman's line of reasoning they suggest that this "micro-oriented" work is a useful beginning in helping us obtain a better understanding of software development. They add, "However, before we can say that we have *a complete* understanding, it is necessary to show that our knowledge of the individual components can be put together in a total system."

They quote Jensen and Tonics (1979): "There is much attention on individual phases and functions of the software development sequence, but little on the whole life cycle as an integral, continuous process - a process that can and should be optimised".

Abdel-Hamid & Madnick (1991) agree that "a corollary of the above assertion is that the interactions and interdependencies that tend to characterise our management systems will similarly characterise the problems that beset such systems. They suggest that this does indeed seem to be the case in software development, where " no one thing seems to cause the difficulty but the accumulation of simultaneous and interacting factors.... "(Brooks, 1978).

Abdel-Hamid & Madnick (1991) point out that an integrative perspective allows us to trace the chain of consequences stemming from a particular managerial intervention “Consequences are not given much attention, and apparently logical solutions may prove faulty as their consequences ramify. Furthermore, since the consequences of a decision often occur much later than the decision itself, it is difficult for the members to trace backward from the disruptive consequences to determine precisely what caused them. The members cannot make such an analysis, simply because there are too many competing explanations. Thus, the only thing members can do when a new problem arises is to engage in more localised problem-solving.”

Abdel-Hamid & Madnick (1991) point out that this statement highlights two “new” complicating factors, namely, that the consequences are *dynamic* and that they are *complex*. The system dynamics modelling approach addresses both of these issues.

Process Flight Simulation

Thirdly, we may develop ‘Process Flight Simulators’. The concept is that a dynamic model is built of an organisation that allows managers to simulate and study situations before encountering them in reality and so deepen their understanding of the organisation and the likely impact of policies and decisions.

Rubin et al (1994) describe the use of "Process Flight Simulation", using SD techniques in this domain that helps assess the impact of improvements in process maturity. They describe the construction of a dynamic model of an organisation. This model may consist of processes, events, patterns of behaviour, structures and information feedback flows. Once managers are confident that they have developed a satisfactory model of their organisation, they can simulate a wide variety of business circumstances and scenarios. They state“...We have provided a simulation model that helps a manager ask "what-if?" questions about different management scenarios. It’s our strong believe that organizations should simulate their software processes before embarking upon expensive and potentially disruptive changes to their existing organizational culture.”

Strategic Decision Making Process

Fourthly SD can play a significant part in the strategic decision making process. This clearly has implications for the Information Systems (IS) investment appraisal domain but this aspect is not dealt with in detail in this paper. As an example, Dyson (1990), states, “In order to evaluate possible future states of the organisation, which is the result of adopted strategies and the impact on the organisation of uncontrolled inputs, some kind of *corporate system model* of the organisation is required.”

Dyson (1990), states that currently, in most organisations, this will entail the use of a corporate financial model to provide financial projections. Such models typically involve accounting relationships and what Dyson terms “rudimentary attempts” at modelling the behaviour of the organisation. Due to the inadequacy of these “rudimentary attempts”, he states that there has been a “growing interest in the development of behavioural simulation models using ideas of system dynamics”.

Dyson (1990) concludes: "This is a part of the strategic planning process where models have an enormous potential to improve the effectiveness of planning where perhaps the potential has by no means been fully realised."

Conclusion

SD has a direct, but yet to be realised in widespread commercial application, potential for evaluating IT investments. Several of the approaches examined in this paper utilise a system dynamics modelling tool to simulate the likely effect on the organisation of a proposed IT investment so that the likely benefit can be evaluated by management in advance and without disturbing the actual system. Additionally, an organisation could have an enhanced understanding of cost structures, time dependencies and human resources that would enable the model to estimate intangible costs and benefits that traditional cost/benefit analysis (CBA) cannot measure.

Coyle (1996) summarises the implications for the Information Systems (IS) investment appraisal domain as: "testing the effects of putative information systems in the inexpensive world of the model is a most fruitful area of system dynamics application"

There is, thus, an impressive range of potential advantages for utilising SD in the ISIA process. Why then has the widespread commercial adoption that might have been expected to ensue not transpired? The author would suggest the following rationale:

The first reason is that SD does not fit the expectation of most managers engaged in an IA exercise. CBA is usually undertaken to show that the proposed computer application benefits outweigh the costs over the lifetime of the project or to show that the payback period for the investment can be met (Hares & Royle, 1994). There is already a proposed solution. SD encourages a wider evaluation of the fundamental IS/decision-making requirements. As Coyle (1996) demonstrates, this might not entail an IT solution at all.

Secondly, most managers engaged in an IA exercise are used to techniques of an 'accountancy type' which calculate and measure financial figures on a project-by-project basis only (Hares & Royle, 1994). They are not used to ensuring that financial investments are made in an 'integrative manner' or in the context of the company's strategic plan.

Thirdly, most managers lack familiarity with the basic feedback concept SD in any practical sense. "Current world-wide process models and improvement activities focus primarily on the forward technical path and overlook the many feedback paths and the constraints that they impose on improvement of the project" (Lehman, 1994).

In addition the lack of familiarity may count against SD base methods. It may be felt to lack:

- A track record - a tried and tested approach is likely to be received much more readily than an untried idea.
- Inherent simplicity - busy executives are more likely to apply a straightforward approach than one which needs considerable time and effort to master.

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