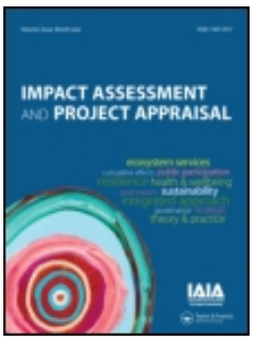

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Business models

The business of modelling: some anecdotes on modelling in business and story-telling

Paul Tayler

There has been a tremendous increase in the use of computer modelling in business appraisal and decision-making over the last ten years or so. This has been driven in part by the adoption of large spreadsheets for modelling every major financial transaction, and also by the widespread availability of cheap computer power on every desk. This paper draws on the author's experiences in industry and management consulting, and argues that much of this computer modelling activity does not follow what might be termed a 'scientific' path. Models as actually used in business may be more usefully thought of as contributing to the 'story-telling' within an organisation by which it articulates and justifies its business planning.

Keywords: business modelling; policy; economic appraisal

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ABOUT TEN YEARS AGO I was interviewed for a job in the business modelling group at one of the UK's leading management consultancies. Towards the end of the interview, the manager posed the following question:

> "You've just finished building a model for your client, which will be used to help them decide whether or not to make a major investment decision, and you've run their input data through it. You're just about to go into a meeting with them, at which you'll be presenting the results. You just discovered, through a chance conversation in the corridor, that the conclusions you are forced to draw from the model results are the exact opposite of what the Chief Executive wants to do. You're sure that there are no errors in the model. How are you going to handle this meeting?"

Looking back with hindsight, the question as posed raises some serious doubts — how can you be sure there are no bugs in the model? How can good consultants fail to discover what their client is thinking until the assignment is nearly over? However, in the heat of the moment I answered directly, and fumbled an outline of the following argument: computer models are not magical — they do not tell the future of themselves. All they are is an encapsulation of certain assumptions about how the world works. They take data about the state of the world now, and project forward to predict how it may be in the future. If my clients do not agree with the model results, then there are three basic things which can be at fault:

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- The structure of the model — the equations and relationships programmed into it — may not reflect adequately their view of how the world is.
- The input data may be incorrect in some respects.
- The client's view of how the future will work out may be wrong, despite them sharing the modeller's concepts of model structure and input data."

Therefore, in the hypothetically imminent meeting, I proposed that we discuss whether the client is still happy with the model structure, whether they wish to change their input data assumptions, and finally invite them to change their minds.

My interviewer grinned; I guessed that I had given the 'right' answer to the question, and indeed I got the job. Occasionally I give the same question to interview candidates myself (but will have to think of a new one now). I tell the story because it encapsulates my experience of modelling in business very well.

The group I joined, the Business Dynamics Group at Coopers and Lybrand Management Consultancy, was the first such business modelling group, at least in the UK. Numbering about 35 consultants, it works in a wide range of areas, and uses advanced techniques in data analysis and strategic modelling. However, almost all of what follows relates to work in the (technically) mundane realm of spreadsheet financial modelling to support major business decisions.

Business modelling is to some extent a logical development from operational research and management science, in that it is about (mainly) quantitative problem solving in real-world applications. It employs the same kinds of people who would have done operational research 20 years ago, although some of the techniques and knowledge required have changed. It has been very much driven by the phenomenal growth in the use of personal computers (PCs) in business and elsewhere, although some argue that the causality runs the other way, with the possibility of using software such as spreadsheets to analyse problems having driven the demand for the hardware to be put on every desk.

My aim in this paper is first to give some flavour of the way in which computer models are now widely used in business. Second, I wish to voice some scepticism. This may be superfluous — most people have heard stories about computers sending pensioners million-pound gas bills, so the notion that computers sometimes get things wrong is unlikely to be very shocking. However, scepticism about the computer model as a product, that is, as a black box which tells us the right answers, does not mean that the process of modelling is worthless. Even in business, where truth and falsity are largely determined by the bottom line, a pretty objective measure on the whole, there is scope for a great deal of subjectivity in modelling. There are always considerable uncertainties, and there are often political pressures of one sort or another bearing on the modeller. The third point of the paper is to try to argue that modelling should be seen as a form of 'story telling', whose function is often to spin a narrative web around issues, which people and organisations can then tell back to themselves.

The paper is itself a story-telling exercise, and is necessarily anecdotal in places. Names and some details have been changed to maintain confidentiality. If that seems insufficiently 'objective', please either treat the following as a piece of amateur anthropology, or quit now.

Opiates for decision-makers

Peter Beck, a former senior planner with a major oil company, has noted the tendency for managers in business to become addicted to numerical forecasts, indeed explicitly likening this process to addiction to narcotic substances (Beck, 1983). This tendency has not been reduced by the greater availability of models and forecasts, in fact very much the opposite.

The pattern for the widespread use of financial models for major business decisions seemed to become firmly set around the end of the 1980s. This seemed particularly true for the many large-scale privatisation and restructuring activities in the major utilities in the UK, where large public-sector monopolies were often split up along vertical or horizontal lines (sometimes both) and new commercial trading arrangements were introduced. These tasks, often to be accomplished to very demanding timetables, required predictions to be made of the future prospects of organisations which did not yet exist, trading in markets which had not yet been established, and valuations of their present worth to be calculated accordingly. A challenging, and obviously not always a very precise, enterprise.

In about 1990, I had day-to-day responsibility for the modelling carried out on behalf of one such nascent company in its negotiations with government and their financial advisors. We were often processing new sets of assumptions every day, exploring the impacts of different regulatory regimes, capital structures, investment plans, and so on, in order to advise our clients how best to approach these discussions.

The process rapidly became self-sustaining, in the sense that every new model run spun off ideas and reactions from senior people who would ask for "just a couple more runs" to check out some new possibilities. So much so, that one day an economist colleague

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returned in fury from a meeting with the client, asking rhetorically what they would choose to look at first if he entered the boardroom with a closely-argued strategic analysis from his team in one hand, and "a page of numbers from your bloody model" in the other. The model output seemed to be favourite every time.

Now our 'opponents' in the negotiations also had a computer model. Over time, the two models seemed to co-evolve as rival projections and analyses were produced. Some parts of the negotiations became in effect a battle between the two models, as rival sets of outputs 'proved' that particular courses of action would be good or bad for the company. This was sometimes quite fruitful, because when outputs purporting to represent the effects of exactly the same policies showed wildly varying consequences, it forced everyone to have quite careful discussions about their assumptions. These discussions did not always lead to the decisions which our clients wanted, but they allowed them to avoid the worst policies being imposed on them, and generally produced some reasonable decisions on the part of government.

Personal experiences

A little later, I was working on an assignment for Sunrise plc, a leisure company contemplating making a bid to acquire the rights to operate in a completely new market. The size of the investment, and the time it would take to recover the initial outlay, made this a very real 'bet your company' decision. It required market forecasts and financial projections for the company up to 15 years ahead, and I was involved both in modelling and forecasting Sunrise's possible future market share, and in assessing the implications for its finances and valuation using a different model.

This was the biggest decision in the company's history, so the work was naturally quite pressurised. We all worked into the night on many occasions, generating forecasts and writing up the background and justification for them in a chapter of Sunrise's bid document. However, one of the things which struck me about this assignment was the only act for which I received significant praise from the client. No, not working until 3 am to prepare a presentation for next day's Board meeting.

It arose just a few days before the bid was made public, and a new equity participant had just joined the bid consortium. This new player already had forecasts in the public domain, which were consistent with ours in the long term, but not in the short run. What to do? It really was only half an hour before the key meeting, just as in my job interview. I blush to report that I found a solution which involved a 'manual intervention' in the specification of a multiple regression model. I uttered dire warnings to my clients about the difficulties of defending this on technical grounds, if the need should ever arise, but they were delighted, professing to be highly impressed with my (rather dubious) ingenuity. It seemed very important to them that 'the story' told by the model had the right narrative, and kept their new investor happy.

I was told quietly after the event that the Chairman did not really understand the concept of net present value which underpinned the valuations produced by our model, and that in fact the size of the ultimate bid which was (successfully) entered was determined by other factors entirely. I have no way of knowing if this was true, although based on other things I saw it was plausible. However, the bid and the model results were reasonably consistent with one another, and the explanation in the bid document was regarded as an essential part of the whole operation.

This was several years ago, and the trend towards the models being used to 'tell the story' seems to have strengthened. The justification for major business decisions, even when written in narrative form, is increasingly backed by computer modelling. This continues to be the case in, for instance, recent privatisations, corporate acquisitions, refinancing operations, bids for television broadcasting rights, major asset sales, and all kinds of corporate planning.

Mr 10 percent

Those in the business of making forecasts know very well that the output of models always has to be modified in the light of judgement and qualitative information not available to the model. For three years I had a line job in an energy company, in which my main responsibility was to forecast the wholesale price for the product.

We had an array of different computer models, and the official forecasts were always, we said, based on a 'synthesis' of the different outputs plus any other information which we deemed relevant. Just to make things interesting, 10% of my annual salary was based on the accuracy (or otherwise) of the forecasts I issued. This certainly tended to concentrate the mind, although some of that concentration was devoted to the annual negotiation of the tolerances within which forecasting accuracy was to be established.

The forecasts were produced with reference to several computer models, and to information from elsewhere. The big question was always how much weight to assign to the different (and usually slightly conflicting) sources of guidance. In this I was heavily influenced by the desire to maximise my own earnings, but there were always other social factors at work too. Forecasts were used for different purposes by different people within the organisation, and they exerted different kinds of subtle pressure to get the predictions they wanted.

For example, the sales team tended to want the forecast price to be as low as possible, because that would make it easier for them to sell futures contracts for next year's output at an apparently acceptable price. The company planners, however, usually

wanted a high price forecast, so that the projected company profitability would look better. (However, one year they were keen for a low forecast, because they wanted to persuade the directors to adopt a more aggressive cost-cutting policy.)

The production people mainly wanted the forecast to be wrong, because they thought they could do the job better. The engineering and new construction division tried to ignore my department and hired some merchant bankers to come up with a different set of forecasts entirely to justify building new capacity, which ours did not. All in all, the annual forecast publication and quarterly updates were fairly tense and politicised events, and I quickly learned that it was as important to address the internal politics of the forecast and its presentation as it was to make the analysis and judgements which produced the key numbers.

Some random observations

A Coopers and Lybrand survey of complex spreadsheet models used for important financial decisions (for instance, to build or not to build a power station, the price at which to bid for a rival company) a few years ago showed that something like 90% of them were wrong. 'Wrong', in this context, means that they contained significant programming errors (not just incorrect data assumptions), sufficient to change the valuation calculated by the model by at least 20%. In one case, the results were out by a factor of more than two.

Experience shows, in fact, that unless such models are developed in accordance with reasonably strict software development principles there is a near-certainty of error (Batson and Eyles, 1994). This fact, however, has had no impact on the ever-increasing popularity of such models in helping to take major decisions. Why not? I would suggest that one important reason is that relatively little effort is expended on comparing predicted results against actual outcomes, which would have to be done several years after the event in some cases. Even when this is done, it is amazing how difficult this can prove to be.

For example, some awkward people in the strategic planning department in my energy company once wanted to know why some of my forecasts made two years before were 'wrong'. In that two-year period between forecast and comparison, there had been both a major regulatory intervention and a significant change in government policy, either of which was sufficient to completely undermine the key assumptions on which the forecasts were produced. A junior member of the department muttered that, if this is what happened, there was really little point in producing any more forecasts. Fortunately, more experienced and wiser views prevailed, and we continued using our models.

An experienced IT (information technology) consultant once wondered aloud to me about the use of models in business planning. If they are really so necessary, is it not puzzling that business was able to operate at all before about 1980, when there were no PCs and no spreadsheets? How did all those decisions get taken? The answer is that, while large organisations did make use of larger computers, most issues which now demand a computer model were calculated quite slowly and in a simplified way by hand. Sensitivity analysis could be carried out, if at all, using 'back of the envelope' assessments. This kind of modelling had to be driven more by intuition about which were the most important factors, since it was computationally unfeasible to examine them all.

Conventional planning works well when the business environment behaves predictably, but in recent decades the pace of change and innovation (social as well as technical) has become so great that extrapolation of past trends often fails

Today, however, it is perfectly possible to cram all sorts of features into a model (although whether this is always a good idea is another matter). The key thing which the availability of extremely cheap computing power gives is the opportunity to perform very many simulations and permutations with even very complex models. It is possible to examine search space which might have taken literally years to explore before. The flip side is that there is also the opportunity to become 'hooked' on more and more model runs; the availability of PC models could be compared with the first availability of crack cocaine to management which had only just been tentatively inhaling...

Obviously I have been selective in my choice of anecdotes to put forward a particular point of view. However, there is ample documentation of the general difficulties of forecasting and modelling the future (see, for example, Mintzberg (1994) and the references cited therein, especially in the chapter on business forecasting). Mintzberg argues that conventional planning works well when the business environment behaves predictably, but that in recent decades the pace of change and innovation (social as well as technical) has become so great that extrapolation of past trends often fails.

The same applies to modelling: a model contains assumptions about how the world behaves, and so long as the present continues to unfold along the same lines, then the model will do well. However, the prediction of 'turning points' — the times when discontinuity sets in and new regimes of behaviour appear — is elusive (Casti, 1991).

Discussion

I started with the viewpoint that a computer model is simply a means of translating assumptions about the state of the world now and some presumed relationships between selected parts of it into predictions about its future state. I then noted that people often seem to become 'addicted' to models, demanding seeming endless revisions and experiments: this is a tendency that many colleagues report too. I then commented on the way in which model results seemed to be needed and expected to form part of the 'story' behind a decision, even in cases where it is not clear that the model results are the most important influence on the decision that is taken.

Furthermore, in many real-life cases, the issues are very complex and cannot be encompassed satisfactorily in any one model: a synthesis is required to reach any sensible closure. It is also sometimes (frequently?) the case that this complexity and uncertainty means that the model, and the model builder, are subject to considerable 'political' pressure of one form or another. I suggested that, in practice, many models are not subject to sufficient verification and testing (I have much evidence for this, but cannot possibly publish it!). Finally, the availability of computers to run models was suggested as a driver behind doing more and more modelling.

All this points to a serious danger in the use of models in business (and in many other areas besides). If the above is true, or true some of the time, then there is the potential for the computer model to become simply another part of the rhetoric of the dominant strand of thought in an organisation. The computational power becomes harnessed to long searches for combinations of inputs, which produce the outputs, which someone wants in order to justify the decision, which they already knew they wanted to take. I have no doubt that this happens. It is in no way a new phenomenon, but the availability of the desktop computer can magnify the effects.

> "There is evidence that in some places the 'scientific' approach to decision-making is treated as part of that great institution called the 'corporate rain dance'. Real decisions are taken as they always have been — on the basis of personal feeling, judgement, nous — and perhaps a measure of bias." Beck (1983) page 8

On the other hand, the use of modelling as a way of 'telling the story' presents opportunities as well as threats. One example of a 'good' model is one we developed for a retailing organisation. This company had a very unpredictable but seasonal pattern of orders, and they wanted some tool to help understand what was going on in their busiest quarter of the year. It was clear that each year was different in some respects, but they wanted to be able to make better estimates of the ultimate size of their annual sales 'peak' once demand had started to grow.

Table 1. Purpose and characteristics of models

Modelling Objective	Characteristics of system to be modelled	Critical modelling activity ('success factors')	Example
'Prediction'	Relationships within the system very well-understood	Faithful translation of known laws into software	Laws of physics
	Possible to measure accurately present state of system	Very accurate data collection	Day ahead weather forecasting
'Insight'	Good understanding of some aspects of behaviour, but also areas of uncertainty or missing data	Thorough examination and exploration of alternatives where gaps exist	Predicting next year's profits for a company in a well-established business
			Climate change modelling(?)
'Shared understanding'	Causal relationships are controversial	Consultative and collaborative approach to modelling process	Predicting profitability for a novel product in ten years' time
	Decision for which we are modelling has major strategic and/or 'political' consequences for those involved	Development of consensus and 'ownership'	Human systems, especially where individual behaviour is key to dynamics

The model developed and given to the sales manager was fairly simple, but was regarded as quite excellent by the client, who thereafter invited us in to do further modelling work on other issues. The reason the model was perceived as excellent was not mainly because of its predictive accuracy — this was fair, but the inherent instability of the market seemed to confound forecasting. Rather, the manager was pleased because it was 'his model': he had been closely involved in its specification, and the factors which were included were those which he had indicated were important.

This meant that, when it was delivered, the inputs corresponded well to his mental model of how the market worked, and he was able to experiment with different possibilities, using the software as a sort of mental prosthetic which enhanced the exploratory power of his imagination. He could run possibilities through the model, and check whether his visualisation of what was happening as the sales round unfolded was borne out by the rigorous logical checking of the computer model. Thus the model was felt to be

a success because of its subjective factors, and its fit with the particular person who was its principal user, and because of the process which we had followed in its development, rather than because of the accuracy of the numbers which dropped out of it.

Conclusion

Models can be used for different purposes. The classic (or 'naive scientific') view of modelling is that it is about constructing a sufficiently good representation of the world to enable specific numerical forecasts to be made. A second view is that modelling allows us to develop a deeper understanding, even where precise forecasts are hazardous. By using the model to vary assumptions and inputs we can develop insights into the different possible dynamics and behaviours of a system. There is also (at least) a third view: a model can be used as a medium for creating a shared understanding of an issue (see Table 1).

My anecdotes relate to modelling activities which were really in the second or third category (they were in problem domains which were sufficiently complex that the real challenge was to develop better insights and create a shared understanding) but which the organisations seemed to want to treat as if they were in the first category of purely predictive activities. This is, frankly, quite normal, and it is unlikely to change much, not least because business people are not academics, and often do not have time to consider all the aspects of a problem before taking a decision.

What should the modeller do, if s/he is sympathetic to the arguments and stories recounted above? I tentatively suggest the following:

1. Recognise that you are not engaged in a purely 'scientific' modelling exercise. Your model is being built for a particular person or organisation, and will inevitably be heavily shaped by subjective factors which are peculiar to them. There is no single 'right' model; an appropriate model is contingent on a lot of specific organisational factors.
2. However, this does not mean that it does not matter what model you build. You are responsible for the integrity of the 'story-telling' that is done through the medium of the model. The fact that it may be possible to change assumptions so as to get to a desired conclusion makes it even more important that the model is correct from a technical point of view (that is, that it is tested and otherwise verified). As the cost of computing power continues to fall, the size of models seems to increase, and the probability of error seems to go up more than linearly with size.
3. You may encounter situations in which the model gives 'unexpected' results. Assuming that this is not due to programming error, you will have to decide whether it is the modelling assumptions (logic and data) which are at fault, or whether people's preconceptions about likely outcomes were wrong; that is, you have actually learned something from running your model. At this point, you really need to think hard about where you might be in the spectrum between modelling the laws of physics and modelling problems from sociology. Obviously, in the former case it is much more likely that the modelling surprise is a genuine discovery. In the latter case, as well as modelling sociology, you are probably going to be drawn into the sociology of modelling — the ways in which the model content is shaped by the social context.
4. Finally, and as if that were not enough, the really important skill now becomes the process skill, because it is the modelling process which becomes at least as important as the final product (the 'finished' software). The premium on interpersonal skills, on knowledge elicitation, and on helping others to translate their knowledge of an issue into modelling language, is very high. This, even more than technical expertise, will be the continuing challenge as the technology grows and offers more and more opportunities to deploy computer modelling in even more contexts.

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