

Chapter 5: Drafting the Simulation

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Introduction

The chapter on the *Art of Simulation Design* explored structural design, this chapter explores the drafting of:

- § **Decisions**
- § **Results**
- § **Models**
- § **Data & Parameters**

at a practical craft level.

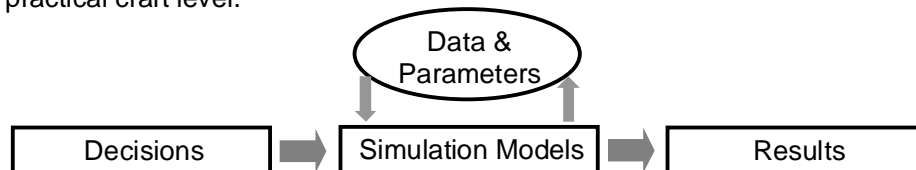


Figure 5.01: Simulation Structure

Decisions

Initially I designed this chapter starting by discussing the model and then moving on to decisions, results and data. However, on reflection, I decided to start with decisions before moving on to results and then the model and data. I did this because it is the interplay between decisions and results that cause the deep thought that leads to learning and the role of the model is to ensure this. Chapter 3 explores decisions as part of the interaction domain and this explores practicalities.

Tough Stone Restaurant Mammoth au Poivre Fricassee Mammoth Mammoth Julienne Mammoth Salad Mammoth Curry Peking Pterodactyl
--

Cartoon 5.01: Decisions - Decisions

Driving the simulation model are the decisions made by the learners and this section describes:

- **Decision Purpose**
- **Linking Decisions to Issues**
- **Decisions Types**
- **Decision Entry Structures**
- **Influence Diagrams**
- **Decision Screening**

Decision Purpose

Decisions are included in a simulation to:

- **Elicit Learning**
- **Support Operation**

Eliciting Learning (Deep Cognitive Processing)

This is the core requirement and (as described in the next section) requires linking the decision to issues and (as described later) linking them to results. Scherpereel (2006) categorises these as those with probabilistic aspects and complex decisions requiring heuristic solutions. Complex, heuristic decisions will take the longest time to make and so need to be reserved for the most important issues. As the other decisions take the shortest time to make they should be reserved for secondary issues. However, as prioritising work is likely to be an issue in any simulation the relative importance of the decisions should not be revealed explicitly to the learners. (Although it can be useful to reveal this explicitly to the trainer so that he or she can check the way learners prioritise their work.)

Supporting Operation

These decisions are not directed at *eliciting learning* but are necessary for operation of the simulated business. For example, for SEED, when projecting the outcome of the entrepreneurial plan it is necessary to schedule production for several years. Here I built in logic into the model to do this automatically. But, if necessary, these decisions may have to be made by the learners even though the take time to make and do not add to learning. These are decisions categorised by Scherpereel (2006) as routine deterministic. In general I try to eliminate these decisions. However where prioritising work is a key learning issue it is appropriate to include routine, deterministic, support decisions.

As part of design it is useful to determine the relative importance of decisions (complex, heuristic = key: probabilistic = secondary and routine: deterministic, support = minor) and check that there is a suitable mix. However, as the importance of decisions change as simulated time passes and issue focus evolves (see Figure 5.2a for evolving issue focus) relative importance changes. So Percent Markup (Figure 5.2a) will start out as a key decision. But as teams learn how customers respond to price and discover their competitors' pricing strategy, its importance declines and becomes secondary and may become minor.

Linking Decisions to Issues

I find it useful to link decisions to the business issues that need to be investigated. Figure 5.02a shows a table that summarise for DISTRAIN simulation, the links between decisions and issues and shows when the decisions are introduced.

Quarter	Decision	No	Issue Focus
1	Percent Markup	3	Profit & Revenue
	Promotion	3	Revenue & Cost
	Marketing (Sales Support)	1	Revenue & Cost
2	Staff Numbers	1	Resourcing, Cost & Forecasting
3	Training Days	1	Improvement & Customer Service
4	Receivable Days	1	Cash & Revenue
	Number of Products	1	Inventory (Cash) & Revenue
	System Improvement	1	Cost & Cash
5	Promotional activities	3	Revenue & Cost

Figure 5.02a: Evolving links between Decisions and Issue (DISTRAIN)

Figure 5.02b explains in detail the issues associated with changing the number of products offered for the DISTRAIN simulation (extracted from the DISTRAIN trainer's manual.)

Issues: Deciding how to change the number of products offered involves balancing the sales change against the inventory change and, perhaps, where too many *similar* products are offered confusing the customer. Here the sales change assumes that customers do not just buy one type of product at a time and so it can be attractive to increase the number of products held. But, against this the inventory increases will increase Total Assets and so reduce Asset Turn and Return on Assets. Also, the increase in inventory must be funded and this will increase Bank Debt and Financial Leverage (perhaps to a level that is unacceptable to the banks).

Figure 5.02b: Issue Detail – DISTRAIN Background Notes

Decision Types

Typically I use decisions that allow the learners or tutor to enter a variable or make a choice. I do not use sliders or radio buttons as I feel that these delay input and so waste time (as explained in Chapter 6 – Design for Value).

Variable Decisions

These allow numbers to be entered. The amount and format of the data is controlled. For example, a number might be restricted to positive numbers less than 10 with no more than two decimal places (0.00 to 9.99), it might be restricted to positive whole numbers less than 1000 (0 to 999) or may positive and negative whole numbers less than 100 (-99 to 99). These restrictions are defined by the format associated with the number (see data structures later). To save further time and reduce the chance of misunderstanding, I pre-populate these decisions on the decision entry screen with appropriate decisions (such as the previous period's decision).

Multiple-Choice Decisions

These allow learners to choose between a small range of options. For example, one SEED decision involved choosing the number of Cuddl-Etoys to offer (between one and seven).

As described in Chapter 3, variable decisions are more *granular* than multiple-choice decisions and take more time to make and, if duration is a major issue, replacing variable decisions with multiple-choice decisions is a way to reduce duration.

Decision Entry Structures

For simple or intermediate complexity simulations where the numbers of decisions are small a single decision entry screen is usually sufficient (Figure 5.03a and 5.03b).

Decisions P1 ACME	
Price	1.90
Promotion	75000
Production	70000

Figure 5.03a: Product Launch

Decisions Y1 Rally		
	Retail	Corporate
Short Term Loan Interest Decision	2.40	2.40
Long Term Loan Interest Decision	1.35	2.40
Term Deposit Interest Decision	0.80	0.80
Promotion	125	200
	Junior	Senior
Operating Staff Numbers	60	35
Quality Improvement	15	12
Productivity Improvement	15	12
Number of Account Managers	15	
Bank Borrowing	12000	

Figure 5.03b: Modern Banking

Appraising Opportunities	
End Selection	
Financial Plan	
Marketing Plan	
Resource Plan	
Policy Advice	
Opportunity Research	<entered>
Business Comments	<entered>

Figure 5.04: Decision Menu

But complex simulations may need several decision entry screens that are accessed from a menu (Figure 5.04). Here, as decisions are entered, this information is flagged by the <entered> legend (to the right of the decision area. (Note: although the Opportunity Research and Business Comments decisions have been entered learners can return to change these before simulation).

Decision Support

For complex Direct Use simulations and Tutor Mediated simulations that have a Decision Support System, besides entering decisions, it may be necessary to review the previous results and forecast the outcomes of the decisions. In Figure 5.05), decisions are the two left columns, forecasts are column three and the previous results in the right-hand column.

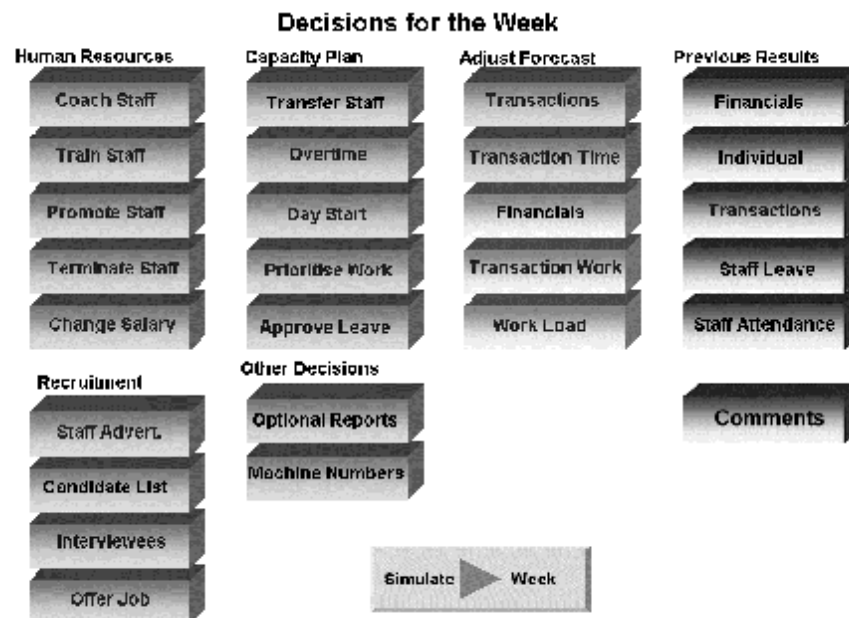


Figure 5.05: Decision Support Menu

Where forecasts are to be made there is the need to both produce reports and enter assumptions where assumptions are estimates of external factors (such as material costs), the impact of decisions (such as sales demand) and the current situation (such as efficiency). The two buttons at the top of the Adjust Forecast column allow the learners to adjust forecast assumptions – here Transactions are estimates of demand and Transaction Time are estimates of the time to process a transaction (taking into account current staff skills and fatigue).

The assumptions and current decisions are used to produce a series of reports showing *key* operational and financial results (that are accessed from the bottom three buttons in column 3). To limit the amount of time required to process the forecast information, I suggest that these should be limited to *key* results. This is illustrated by the three reports at the bottom of the forecast columns that show financial results, transaction work (a detail forecast on a department-by-department and process-by-process basis) and work load (a summary on a department-by-department basis of the *total* work to be done and staff availability).

A particular issue with simulations that allow the impact of decisions to be forecast is that learners will try to test every possible assumption and decision and this must be constrained. There are several ways to deal with this:

1. The number of forecasts allowed is limited (to say 10)
2. Each forecast involves *management* time (a limited resource)
3. Each forecast has a consultancy charge
4. Restrict the *real-time* available to make the forecasts

Two and three allow different forecast and decision changes to be charged for intelligently to reflect the amount of work that might be involved. So for instance producing any forecast report directly after changing assumptions or decisions might have a larger charge than if the same report was produced when no assumptions or decisions had been changed. Point four involves using the computer clock to restrict the amount of time available to make the forecasts. This is appropriate for simulations operating in *real-time* such as PROTEST (my Project Management Simulation).

Decision Entry Stage

Although, generally the simulation cycle consists of decision-making, simulation and, then displaying the results, for some simulations it may be useful to embed decisions in the simulation model. This means that there are four options for decision entry.

- **before simulation**
- **before and during simulation**
- **before and if required during simulation**
- **wholly embedded in the simulation**

Before simulation

This is the normal timing for decision entry as the outcome of reflecting on results and re-planning. This timing is appropriate for both Tutor Mediated and Direct Use simulations. But, the other decision entry stages are only realisable for Direct Use simulations where the learners use the simulation software themselves.

Before and during simulation

This is appropriate for complex Direct Use simulations. For example my BOSMAN (Banking Operations) simulation involved making decisions for a week (before simulation) and then as the simulation progressed, learners could review and make decisions on a day-by-day basis before the full review at the end of the week. Where decisions are made during the simulation, it is advisable to restrict the amount of time that learners spend on decision-making. As described earlier, this can either be by restricting the time available to make the decision, the use of a (simulated) management resource or charging for decision-making and reviewing results.

Before and, if required, during simulation

This is appropriate where decisions can lead to *crises* (such as material shortages) where learners must make *emergency* decisions. However, this form is only appropriate where good operational planning and dealing with crises is a defined learning objective. This is because triggering the need for a decision during simulation focuses on the very short-term, will lengthen the simulation and may disrupt. (Although disruption may be appropriate for simulations focussing on operational issues!)

Wholly embedded in the simulation

This is appropriate for many Process (such as Prospector) and Planning simulations where there are multiple actions that are processed in an unstructured way and where there are multiple paths through the simulation. Figure 5.06 shows the decision menu for Prospector where the menu consists of a combination of decisions and results. For example, at the top of the menu is the decision to search for new opportunities and below this is a report that allows the learners to review the current opportunities. However, although the sequence of the menu reflects the processing sequence for a project through stage-gates, once there are several projects at different stages, the learners make decisions and review results as appropriate. If a final offer is rejected by the client it may be necessary to find another suitable project by going back to negotiating bids, tendering, pre-qualifying or even searching for further opportunities.



Figure 5.06: Embedded Decisions

When deciding the decision-entry stage it is vital to account for the need for learners to have time to reflect. This is particularly important for *real-time* simulations and does restrict the number and frequency of decisions made.

Influence Diagrams

When working with decisions it can help if *influence diagrams* are constructed linking decisions to outcomes. (An influence diagram is a graph-theoretic representation, which may include four types of node (decision, chance, value and deterministic), directing arcs between the nodes (which identify dependencies between them), a marginal or conditional probability distribution defined at each node, and a mathematical function associated with each of the other types of node (Parker, 2002).

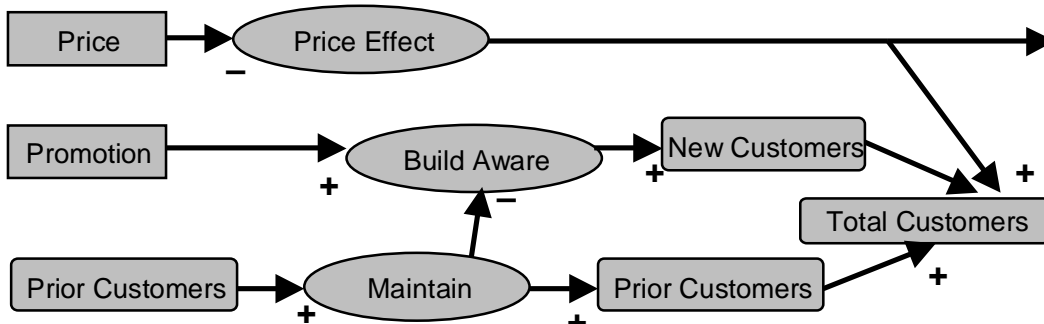


Figure 5.07: Partial Influence Diagram (Product Launch Simulation)

In the partial Product Launch Influence Diagram (Figure 5.07), the Price decision has a straightforward direct, negative effect on the Price Effect. But the Promotion decision has a more complex relationship. Because the product sold is purchased repeatedly, part of the promotion expenditure is needed to *remind* Prior Customers about the product and so Maintain (Awareness). This amount is then netted off the awareness building node to determine the amount remaining to grow the customer base (New Customers). Finally

New and remaining Prior Customers are combined with the price response to determine the Total Customers. Additionally, the Price Effect affects the amount purchased by each customer (off page arrow).

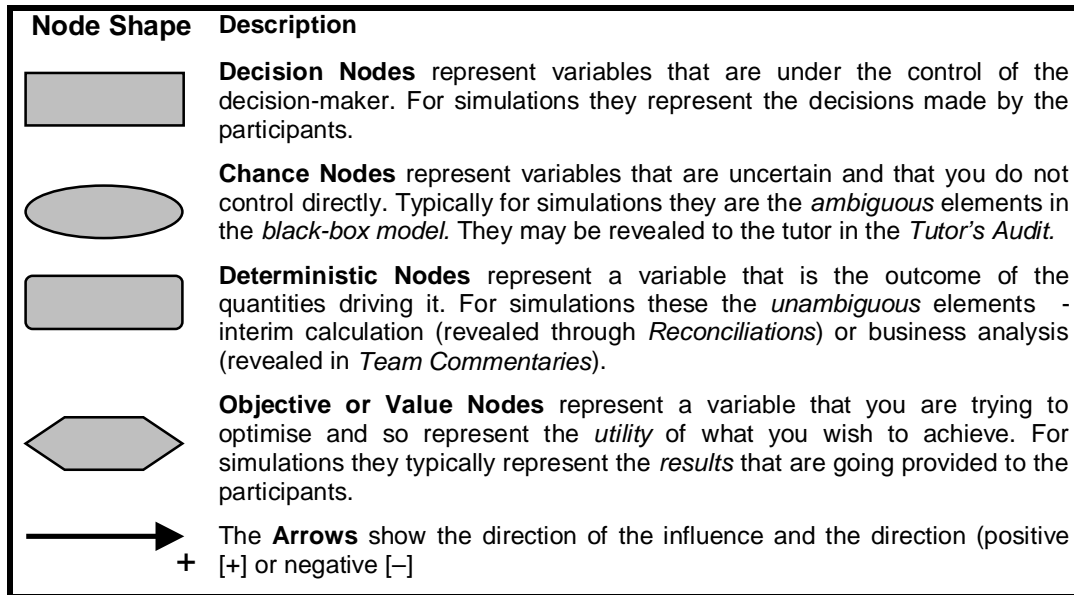


Figure 5.08: Influence Diagram Node and Arrows

I tend not to use influence diagrams. Instead I explain the impact as part of the Tutor's documentation (Background Notes). However, where a significant number of people are involved in the design, an influence diagram can help with the communication.

Decision Screening

Checking decisions is a vital element of simulation design and I do this in three ways.

Key Press Parsing

First, I *parse* the key presses so that for numeric entry only numbers can be entered and, if appropriate, for decimal and negative numbers the minus and decimal point keys are enabled appropriately. (For instance, for negative numbers the minus is only enabled for the first key press and disabled for subsequent key presses.)

Second, after decisions are entered they are checked to see if the decisions are illegal or unusual, where *illegal decisions* are rejected and *unusual decisions* are questioned.

Illegal decisions

These are those that cannot be processed or represent exceptionally small or large numbers. For example, for the Product Launch simulation, a zero price is rejected with the message "*Zero price is not allowed*". There are two situations where decisions are illegal. The first is where it would be impossible to process the decision and the second is where the decision is completely unreasonable. For example, although a zero price might be reasonable, it would cause processing problems. In Product Launch a promotion decision greater than 800,000 is rejected as this is so large that it would bankrupt the company.

Unusual decisions

These fall into several classes – those that are **mistakes** those that are **unreasonable** in business terms, those that are **arbitrary** and those that are **radical**. In Product Launch, promotion is entered as a complete number rather than in thousands - for example the promotion decision might be 70000 but learners might enter this as 70. So the simulation checks to see if promotion is below 1000 but not zero. (This is because zero promotion is an acceptable decision.) Also in Product Launch it would be unreasonable in business terms for the price to be less than unit cost and if this occurs learners are advised "*Price*"

is below Unit Cost". Arbitrary decisions are those where the learners are trying to *break* the model. Besides checking against fixed parameters it can be useful to check against the current situation. For example, where an investment is being made in capacity when this cannot be afforded the message "*Possible Liquidity Problems*" might be generated.

Figure 5.09 shows some decision comments from Modern Banking where the Quality and Productivity Improvement for staff are checked to see if they are low or high.

<p>Flatly Unusual Decision Comments Year 1</p> <p>Quality Improvement Senior staff seems low</p> <p>Productivity Improvement Senior staff seems low</p>

Figure 5.09: Decision Comments

Results

This section explores the results produced from the decisions by the simulation model thus:

- **Result Purpose**
- **Result Groups**
- **Result Formats**
- **Triggering Reflection**

Result Purpose

Results from a simulation have several overlapping purposes:

- Show the Impact of Decisions**
- Link Cause and Effect**
- Measure Progress & Success**
- Explore Strengths & Weaknesses**
- Identify Opportunities & Threats**



Cartoon 5.02: Results

Showing Impact of Decisions

It is necessary for learners to tease out *cause* and *effect* and build the links to business success. The link between decisions (cause) and results (effect) must be ambiguous rather than obvious to ensure that the learners think deeply but it must not be too ambiguous. Further, reports are needed for the tutor to show *unambiguously* the links between decisions and results. Where a decision suggests that there is a *disconnect* between it and good performance, I find it useful to have textual comments to *flag* a possible problem – comments that can either be made as decisions are entered or after simulation. For example, in DISTRAIN the message "**Staff are complaining about workload**" is generated when there are too few staff to handle customers and this is affecting sales.

Linking Cause and Effect

A key, possibly the key part of the decision-making process (Figure 5.9)

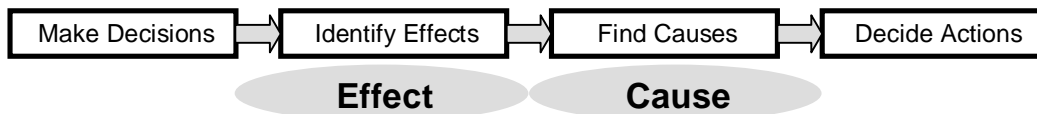


Figure 5.10: Decision-Making Process

The ambiguity and granularity of the results (as discussed in Chapter 3) differ depending on whether the purpose is to help identify effects or find causes.

As ambiguity and granularity are reduced this helps clarify the effect of the decisions on outcomes. But, this causes a problem as once the effects (problem areas, strengths, weaknesses etc.) have been identified it is necessary to determine their cause, before deciding what actions are needed before making the next set of decisions (figure 5.10).

Because finding causes involves *mining* the data and using more granular and ambiguous results, this means that besides *effect ambiguity* there is *cause ambiguity*

(Figure 5.11). So for instance, analysis of causes might have found a decline in profitability. To find the cause the learners must determine the relative impact of profit and assets and then for each datum that affects these their individual importance.

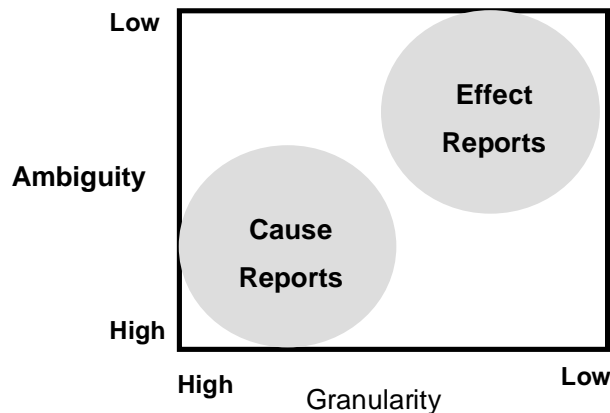


Figure 5.11: Tutor's Cause and Effect Report Groups

Thus it is desirable to separate reports into two groups – those that help identify the effect of decisions and those that shows the causes of these effects. Here the Effect Reports are reasonably unambiguous and with low granularity and the Cause Reports are granular (detailed) and ambiguous (showing *raw data*).

The different report sets (effect and cause) also have implications in terms of report timing and access. For example, *effect reports* might be provided automatically after simulation. But *cause reports* might only provided on demand (or accessed by the learners using a Decision Support System).

Measuring Progress & Success

This is important to measure progress to:

- **Show learning progress**
- **Allow learners to know where they are**
- **Impact engagement**
- **Provide a focus on purpose**
- **Provide performance evaluation**

Show Learning Progress

Although progress is measured in business (and generally financial) terms **progress correlates with learning** and the learners see good business performance as an *indicator of learning*. This means that besides showing *cognitive progress*, measures of success have a major impact of *affection* and *engagement*. Thus, as discussed in Chapter 4 – Design for Progress) at the start of the simulation it should be reasonably easy to do well and difficult to do badly. But, as the simulation progresses it should become progressively more difficult to be successful. If textual comments are made during the simulation, early comments should emphasise all the strengths but only major weaknesses. Later the situation should reverse with the textual comments including all weaknesses but only major strengths (see Strengths and Weaknesses later.)

Allowing Learners to know where they are

This shows what must still be achieved to meet business goals. Coupled with past performance, this shows how learners are improving (or not).

Impact on Engagement

Because learners see simulations as a competitive activity, progress and success measures haven an impact on engagement. Engagement is discussed in depth in Chapter 4 – Design for Process).

Focus on Purpose

A **focus on purpose** is obviously a *good thing*. But there are problems. First, there are different views about business purpose and success. Second, by focussing on a single purpose is likely to cause learners to use similar strategies and a diversity of strategies and actions provide richer learning. Thus, except for simple simulations, I do not define purpose. Rather, I say (for example) *“Your objective is to make your company successful and it is up to you to agree your criteria of success.”*



Cartoon 5.03: Views on Success

Performance Evaluation

This allows a comparison of learners' performance across teams. During the simulation this encourages competition and provides clues about successful and unsuccessful strategies. At the end of the simulation during the review the progress measures provide for a structured discussion of differences between learners and, if desired, provide a way of choosing a *winner*.

Usually a few key results measure progress and success. For simple simulations, like Product Launch, there can be a single primary measure plus a few secondary measures but for more complex simulations there should be multiple measures – typically growth, profitability, solvency and, perhaps wealth creation (see later).

Strategic Profit Model Year 0 Quarter 4	
Profit Margin %	2.5
Asset Turn	2.9
Return on Assets	7.2
Financial Leverage	1.9
Return on Net Worth	13.6

Figure 5.12: Performance Measures

For Product Launch (a simple simulation) the primary measure is cumulative profit and secondary measures are market penetration and cash. For DISTRAIN (Figure 5.12) there are multiple measures focusing on profitability and solvency.

Result Groups

There are two major subdivisions - results that are for the teams and results that are to support the tutor. Each of these subdivides and the subdivisions depend to some extent on whether the simulation is Direct Use or Tutor Mediated. Figure 5.13 lists the different result groups, showing whom they are for and their applicability and, this section details these report groups.

	for whom	Direct Use	Tutor Mediated
Business Results	Learners	Full Results	Preliminary then Full Results.
Business Research	Learners	Not Appropriate	Same for all teams
Ending Review	Learners	At end of simulation	Part of Tutor's Audit
Tutor' Audit	Tutor	Not usually appropriate	Highlight differences between teams
Team Commentaries	Tutor	Part of Ending Review	Extended analysis of a team
Reconciliations	Tutor	In Tutor's Options	Explains calculations to a team

Figure 5.13: Result Groups

Results for Participants

The results returned to the participants separate into three parts - Business Results, Business Research and (optionally) an Ending Review.

Business Results

These show the impact of the team's decisions. For Tutor Mediated simulations where teams interact and where decisions are synchronous, the printer is often a bottleneck and so it is desirable to print preliminary results before full results. These preliminary results comprise a few key results that the teams can work on while the full results are printed. For Direct Use simulations, there is no need for preliminary results for while team results are being printed, teams can review individual reports on the screen.

Preliminary Results - Year 0	
Net Interest Income	3192
Net Fee Income	459
Operating Profit	400
Total Assets	40557
Total Liabilities	35458
Return on Capital %	7.1
Return on Assets %	0.9
Net Interest Margin %	7.9
Capital Adequacy %	18.7
Reserve Requirements	6922
Cash & Balances with National Bank	6925
National Bank Loan	347

Figure 5.14: Preliminary Results

Although the Business Results reports can remain the same throughout the simulation, commonly I introduce new issues by adding reports as the simulation progresses period-by-period.

Figure 5.15 shows a list of reports that comprise the full (Team Results) for Modern Banking. It covers key financial results (Income Statement (Profit and Loss Account) and Balance Sheet), marketing results (Client Changes and Market Sector Reports) and operational results (Staff Workload) plus comments from staff etc. It might have included performance measures (profitability, growth and liquidity).

Team Results
Income Statement
Balance Sheet
Client Changes
Staff Workload
Market Sector Reports
Comments

Figure 5.15: Full Results

Business Research

This provides for all teams, information that would be in the public domain (such as market share, prices and, if appropriate, financial results). Figure 5.16 shows the market's interest rates for loans and deposits – information that they need to forecast profits.

Market Interest Multipliers - Year 0		
	Retail	Corporate
Long Term Deposits	0.80	0.80
Short Term Loans	2.50	2.50
Long Term Loans	1.50	2.50

Figure 5.16: Part of Modern Banking Research

I provide two types of Business Research – Standard Research and Additional Research. The **Standard Research** is printed *automatically* each period and the **Additional Research** provides additional reports that can be used on an *ad-hoc* basis to stimulate discussion and address possible learning issues.

As Direct Use Simulations are not interactive between teams and the marketplace is simulated using virtual competitors, computer generated competitive research is not appropriate but research about the state of the economy and the *simulated* competition is. For example, Product Launch shows *penetration* and *market share* (where penetration shows the proportion of the total market who know about the product and are interested in buying it and market share shows the proportion of these customers who buy from the company). Also for Direct Use simulations, it can be useful to share key results between learners using charts displayed in key places.

As with Team Results, I often provide comments as part of business research to *leak* issues. For example, if cash reserves are inappropriately high I commonly produce the comment "*Bankers applaud <team name>'s prudent policy*"

Ending Review

This provides an analysis of team performance at the end of the simulation. For Tutor Mediated Simulations this will be part of the ongoing Tutor's Audit. But, for Direct Use simulations, it is a separate set of reports prepared at the end of the simulation. The reports in the Ending Review for the *Product Launch* simulation are shown in Figure 5.17. If the Ending Review includes comparisons with other runs, these must be done after several runs.

Summary Results
Operations Planning
Cumulative Efficiency
Marketing Activity
Cost Trends
Comments

Figure 5.17: Ending Review

Results for the Tutor (Trainer)

I divide these into a Tutor's Audit, Team Commentaries and Reconciliations.

Tutor's Audit

This highlights and identifies differences between teams to allow the tutor to decide which teams need coaching and which teams need challenging. It is part of the reporting structure of *Tutor Mediated Simulations*. But *Direct Use Simulations* do not usually have a Tutor's Audit (an exception is where the simulation is exceptionally complex). For Direct Use these reports are accessed from a password protected part of the simulator.

Typically the Tutor's Audit will show for all teams, decisions and key financial results (such as the Income/Profit and Loss Statement and Balance Sheet); key operational results and information about how customers responded to marketing decisions. Thus the Tutor's Audit not only compares and contrasts teams (Figure 5.18a) but also provides information about the inner working of the "black-box" simulation model (Figure 5.18b).

Key Measures Year 0 Quarter 4			
	Team 1	Team 2	Team 3
Net Profit	85	123	159
Sales Revenue	5401	4990	6405
Total Assets	762	685	878
Net Worth	398	440	469
Profit Margin %	1.6	2.5	2.5
Asset Turn	7.1	7.3	7.3
Return on Assets	11.2	18.0	18.1

Figure 5.18a: Team Comparison (DISTRAIN)

Marketing Responses (Counter) - Year 0 Quarter 4			
	Team 1	Team 2	Team 3
Price Response	1.06	1.19	1.08
Promotion Response	0.69	0.69	0.69
Product Range Response	1.00	1.00	1.00
Service Response	1.00	1.00	1.00
Improvement Response	1.00	1.00	1.00
Receivables Response	1.00	1.00	1.00
Market Response	0.74	0.82	0.61

Figure 5.18b: Example of Tutor's Audit (DISTRAIN)

(Figure 5.19b shows that except for price all teams are equal. However, in terms of price, Team 2 is more competitive than the other teams. As reports that reveal the inner workings of the *black-box* models are solely for the use of the trainer they should be unambiguous.

I divide the Tutor's Audit into three parts – a Standard Audit, a General Audit and a Simulation Review. The **Standard Audit** consists of reports that are printed *automatically* each period. The **General Audit** consists of reports that are available on an *ad-hoc* basis to allow the tutor to investigate issues as necessary. The **Simulation Review** reports are

those that can be shown to the group as a whole at the end of the simulation. It may be necessary to have customised Standard Audits and Simulation Reviews for different tutors and different courses.

Team Commentaries

These explore an individual team's results in detail by analysing performance and identifying strengths and weaknesses and are used in two ways:

1. Reports that analyse performance and can be printed and returned to teams.
2. Reports that provide *coaching* information for the trainer.

The reports that **analyse performance** and can be returned to the teams, should be appropriately ambiguous and granular. In contrast, **coaching reports** are for the sole use of the trainer and, as they are not for the teams, should be unambiguous and appropriately granular.

Figure 5.19a shows an Investment Centre analysis for DISTRAIN that can be printed and returned to the team to highlight the financial impact of the three market sectors. Figure 5.19b is just to help the tutor by showing, for each market sector, the way the factors from the *black-box* model drive sales. (This report parallels the Tutor's Audit model (Figure 5.18b) where that model shows market responses across teams on a market-by-market basis and this report shows market responses across markets on a team-by-team basis.

Investment Center Analysis Year 0 Quarter 4			
	Counter	Industrial	Commercial
Sales Revenue	2458	1839	2109
Cost of Goods Sold	1821	1496	1900
Gross Profit	637	343	209
Obsolescence	0	85	0
Contribution	637	258	209
Accounts Receivable	1620	1212	1391
Closing Inventory	1552	1610	1402
Accounts Payable	840	690	877
Net Assets	2332	2132	1916
Contribution %	25.9	18.7	9.9
Asset Turn	4.2	3.4	4.4
Return on Assets	109.3	48.5	43.6

Figure 5.19a: Investment Centre Analysis (DISTRAIN)

Marketing Response Year 2 Quarter 4			
	Counter	Industrial	Commercial
Price Response	1.14	1.10	1.31
Promotion Response	0.69	0.69	0.69
Product Range Response	1.04	1.04	1.04
Service Response	1.00	1.00	1.00
Improvement Response	1.11	1.06	1.17
Receivable Response	1.00	1.00	1.00
Marketing Response	0.90	0.83	1.09

Figure 5.19b: Market Responses (DISTRAIN)

To help the tutor concentrate on managing learning rather than analysing data, I provide a comprehensive list of strengths and weaknesses as part of the Team Commentaries. Not only do these flag problems but also can be used to challenge teams (weaknesses) and “comfort” teams (strengths).

Reconciliations

These reveal how accounting and operating results are calculated. There are several reasons for this group of reports. First a practicality, although it happens rarely, learners do question basic calculations. Before including these reports, even as the simulation designer, I found that it could be a difficult, time consuming task to explain a calculation. Having these reports, all that is necessary is to print the report and return it to the learners. A second reason is that these reports are very useful, perhaps vital during the design stage, to check, validate and calibrate the simulation models. As, often, these design reports are the same reports that help when running the simulation, the design validation reports do not add significantly to design workload. Finally, if later you need to extend or customise the simulation, these reports act as an aid-memoir. Figure 5.20 is an example designed to show how the Cost of Sales was calculated (where the teams' Profit and Loss Account (Income Statement) only show the total Cost of Goods Sold).

Cost of Sales Reconciliation – Year 0 Quarter 1	
Opening Inventory	4716
Material Purchases	5501
Closing Inventory	6002
Cost of Goods Sold	5217

Figure 5.20: Cost of Sales Reconciliation (DISTRAIN)

I only build reconciliations into my Tutor Mediated simulations and my most complex Direct Use, Planning and Process simulations (SEED had an extensive range of design validation reports). For the simpler simulations reconciliations are not so necessary during use but can be useful during design and can provide a comfort blanket for the trainer.

Reconciliations are likely to be detailed and hence granular. But, because the reports provide *raw* accounting and operational data they will be reasonably ambiguous – i.e. the links between cause and effect will not be obvious.

Result Formats

Results from a simulation can be in a mixture of the following formats:

- Numeric Tables**
- Textual Comments**
- Graphs & Charts**
- Other Diagrams**
- Pictures and Sounds**

Numeric Tables

These are the most common form that I use. I believe that for optimal learning, results must be printed. This is because printed results provide a permanent record whereas a screen display is ethereal, Further, learners can make notes on printed results and finally, the amount of data that can be displayed on a sheet of paper is much larger than can be displayed on the screen.

As far as possible screen displays and printout should use a font size of 12 points. This is especially important for screen displays where a group of learners are clustered around the screen and important for the more experienced (older) tutor (whose sight may not be 20:20)

I have shown several examples of Numeric Tables earlier (Figures 14, 18a & b, 19 and 20). To help readability, besides using vertical lines to separate columns, I commonly use horizontal lines to separate areas, define groups or indicate calculated items. (Figure 5.20 uses a horizontal line to indicate that Gross Profit was calculated from Sales Revenue and Cost of Goods Sold and later to separate Balance Sheet items from Profit and Loss (Income Statement) items.)

Textual Comments

Here a comment is made if a decision or result is unusually large or small or to inform of events, the need to undertake a task, inform of progress.

Generating Comments based on decisions and results

Figure 5.24 illustrated how these are generated with a central section representing the normal range of values where no comment is generated. To the left and right of this are where the values are too low or too high and where comments are made.

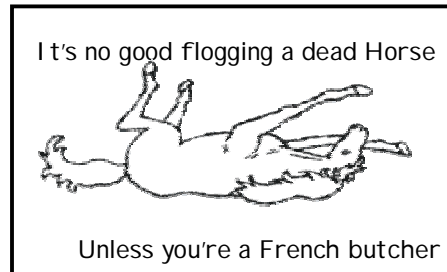


Figure 5.21: Comment Zones and Ambiguity

The size of the central zone and the point where comments are first made is a judgement between giving learners the freedom to make mistakes and identify problems (learn) and constraining the extent of the mistakes and problems (constraining disaffection).

For both the comment zones, comments generated from results close to the central zone are ambiguous. But towards the ends ambiguity decreases. Thus at the boundaries of the central section the comments are ambiguous but at the outer ends, the comments are relatively unambiguous. Thus, as one moves to the extremities, the nature of the issue is more and more clearly revealed and it may be sensible to have several levels of comments (

Also the degree of ambiguity depends on whether the comments are to be provided to the learners or whether they are to be provided purely for use by the Tutor. If provided to the learners they should be *fuzzy* as this enriches the discussion and are not prescriptive. But the degree of ambiguity depends of the level of problem and changes over the range of values for the result or decision generating the comment.



Cartoon 5.04: Text should be appropriately ambiguous

Comment Levels

I use three levels of strengths and weaknesses.

1. **Minor** areas that *might* be discussed and *might* need addressing.
2. **Middling** areas that *should* be discussed and *probably* need to be addressed.
3. **Major** areas that *must* be discussed and addressed.

Accountants feel Inventories seem rather high	Major Weakness
Accountants feel Inventories seem high	Middling Weakness
Accountants feel Inventories may be high	Minor Weakness

Figure 5.22: Examples of weakness levels (DISTRAIN)

Often a strength from one viewpoint is a weakness from another. For example, a highly liquid company is financially safe but may not be using cash for growth and, as a result may be losing out in the marketplace.

Graphs

These allow information to be presented graphically - for example (Figure 5.23) an income and profit graph from Product Launch. Like Textual Comments they are less

granular than Tabular Results and, because they link together results they can be less ambiguous but not necessarily so.

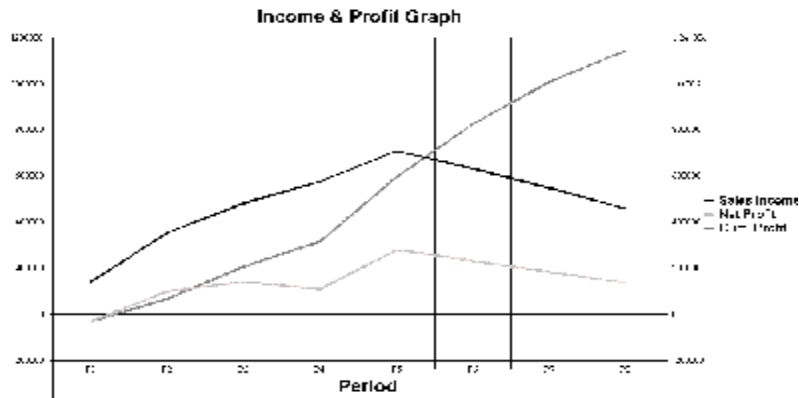


Figure 5.23: Income and Profit Graph

Charts

These may be used to provide results. Examples of these are shown in Figures 24a and b.

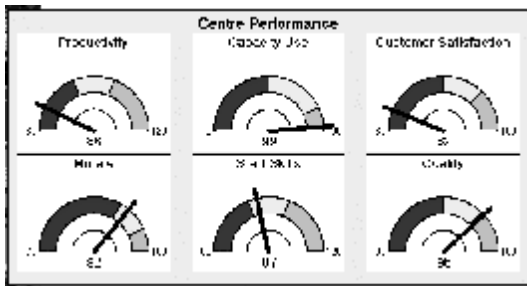


Figure 5.24a: Dashboard Display

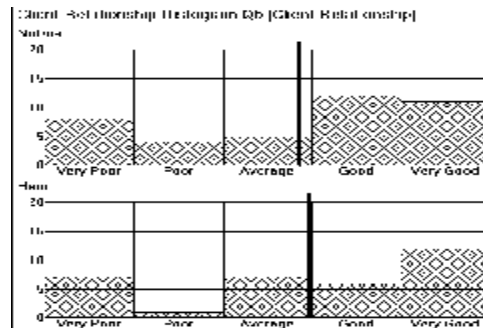


Figure 5.24b: Histogram Display

These and other charts have the advantage that they simplify the cognitive feedback to participants. For example the Centre Performance dashboard is from my BOSMAN simulation and was used to simplify the output and eliminate the need for participants to understand and interpret financial measures. The Histogram from the SMITE simulation allows one to compare the relationships that the competing companies have with their customers. Again these are less granular than tables but, as illustrated by the Customer Satisfaction Dial (Figure 5.26a) they may be ambiguous as they can combine the impact of several metrics. Where this is the case, a report should be provided for the tutor showing how the metric is calculated.

Pictures & Sounds

These allow ideas to be presented, provide an opportunity for engagement and can signal progress. For instance when a team wins a contract in the Prospector simulation, the simulation sounds applause. Similarly, the Gazebo Project (Protest Simulation) has screens that show project problems (such as workers being attacked by hornets (Figure 5.25)). Here, besides the picture there is a loud buzzing sound. Where all learners are in the same room this shows to the other learners that these learners have problems!



Figure 5.25: Hornet Attack

Triggering Reflection

I have already mentioned triggering reflection but because reflection is key to learning I revisit it here. Besides the normal results you should consider results that are provided especially to trigger reflection – to force the learners to take a step back from the immediacy of running their simulated business and think about the longer term and learning. Again, I use textual comments but these are predefined and may be requests from *head office* to provide information (Figure 5.26a) or ask questions about appropriate business issues (Figure 5.26b). The example of the *head office request* is from the Prospector simulation and is one of several produced at predefined points in the simulation. The *Business Issue* comment about buying is from the Product Launch simulation and is produced at the end of the second simulated period just when teams need to think about the ways customers buy the product (and get them to realise that this product is a repeat purchase and so promotion both gets new customers and reminds existing customers to buy).

Besides introducing comments at pre-defined stages, it is useful to introduce comments when learners have reached a key stage in the process. For example in Prospector, learners are warned when they have used half the bidding effort (Figure 5.26c) and therefore forcing thinking towards the complete task (rather than current task). Similarly, Product Launch (Figure 5.26d) advises teams when they are half way to their goal of a cumulative profit of a million and gets them to think whether they have the time to reach the goal.

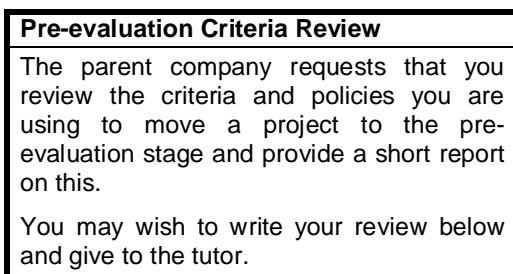


Figure 5.26a: Head Office Request

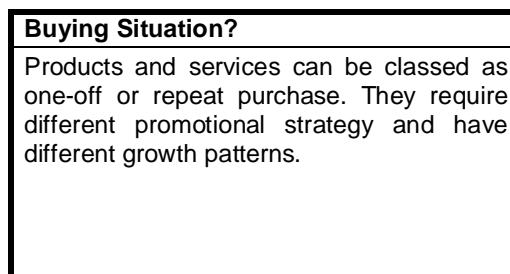


Figure 5.26b: Business Issue

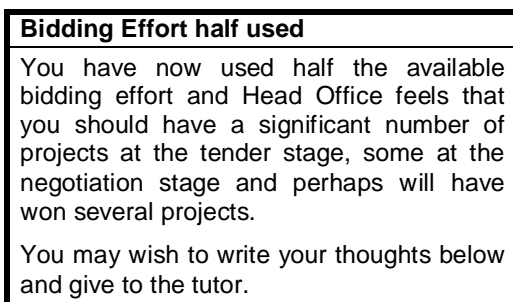


Figure 5.26c: Resource Warning

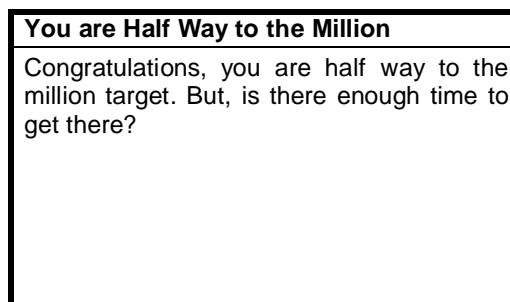


Figure 5.26d: Progress Comment

When wording these comments I was careful not to be too prescriptive and to be suitably ambiguous. Where appropriate, the learners are asked to communicate with the trainer (as both Prospector and Product Launch are Direct Use simulations this will help the trainer judge progress and decide whether the learners need to be challenged or coached).

Simulation Models

The simulation model consists of these components:

- **The Business Models**
- **Learning Support Models**

The Business Models link decisions to results and replicate the business or part of a business. However, this is only part of the simulation model. The second component involves the models required to support the learning process – the Learning Support Models. The development of the Learning Support Models takes substantial effort and possibly more time than developing the models to simulate the operation of a business. (The Product Launch simulation was originally designed when the technology precluded building in Learning Support and hence illustrates the relative sizes of these models. Adding learning support to Product Launch more than quadrupled the size of the model.)

The Business Models

This section explores the different types and forms of models found in a simulation and discusses whether the model should be deterministic or stochastic. This contrasts with Chapter 7 (Design Craft) where the internal algorithmic structure of models is explored.

Main Model Types

Models divide into three main types:

- White Box Accounting and Operations Models**
- Black Box Economic & Marketing Models**
- Business Analysis Models**

White Box Models

These are the models that replicate standard accounting and operational functions. They are akin to the models that are used in corporate and financial planning.

$\text{Sales Revenue} = \text{Unit Price} \times \text{Unit Sales}$ $\text{Manufacturing Costs} = \text{Total Direct Costs} + \text{Manufacturing Overheads} + \text{Depreciation}$ $\text{Closing Inventory} = \text{Opening Inventory} + \text{Production} - \text{Unit Sales}$

Figure 5.27: White Box Models

Black Box Models

Based on economic and business theory, these models determine the impact of decisions. For example, the demand for a product would depend on the impact of the marketing mix decisions of the team and competitors.

$\text{Unit Sales} = \text{Market Size} \times \text{fnPrice} \times \text{fnPromotion} \times \text{fnProduct}$ $\text{fnPrice} = \text{function of price relative to competition}$ $\text{fnPromotion} = \text{function of promotion relative to competition}$ $\text{fnProduct} = \text{function of product features relative to competition}$

Figure 5.28: Black Box Models

Figure 5.28 illustrates how price might affect sales (source Market Strategy simulation) with *fn* indicating this is a function of the parameter (where *fnPrice* is a function of Price relative to the marketplace prices).

These models may be more complex than those described in the economics literature. In Figure 5.29, a price below point A is not likely to increase sales. Prices above point B will cause sales to drop off rapidly. I use several **sources** for these models and the key ones are: the Bernard Keys Library (CD ROM) from ABSEL (<http://www.absel.org>), Kotler (1974) plus my own library of models.

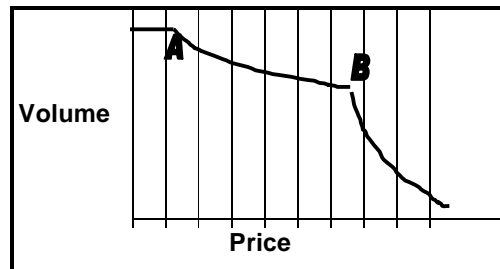


Figure 5.29: Price-Volume Relationship

Business Analysis Models

These are the models that analyse the outcomes of the black and white box models. They are used to calculate measures of business performance (such as Return on Assets, Return on Equity, Breakeven etc.) and then, if appropriate, comment on these. Figure 5.30 illustrates a business analysis model from the DISTRAIN simulation where the Marketing Policy is explored and key results and measures calculated. These provide the trainer with information that can be given to teams.

Marketing Policy Analysis	
	Quarter 1
Sales Revenue	5943
Average Mark-up	21
Gross Profit	1016
Marketing (Selling Effort)	100
Marketing %	1.7
Sales Staff Numbers	16
Sales/Sales Person	371
Average Inventory	6073
Inventory Days	93

Figure 5.30: Business Analysis Report

Typical Processing Sequence



Figure 5.31: Typical processing sequence

Figure 5.31 not only shows the typical processing sequence for business simulations used for management development and business training but also how they differ from simulation models used for corporate and business planning. Business planning models usually consist of just white box and analysis models and the *black box model* is replaced by judgemental input from business executives.

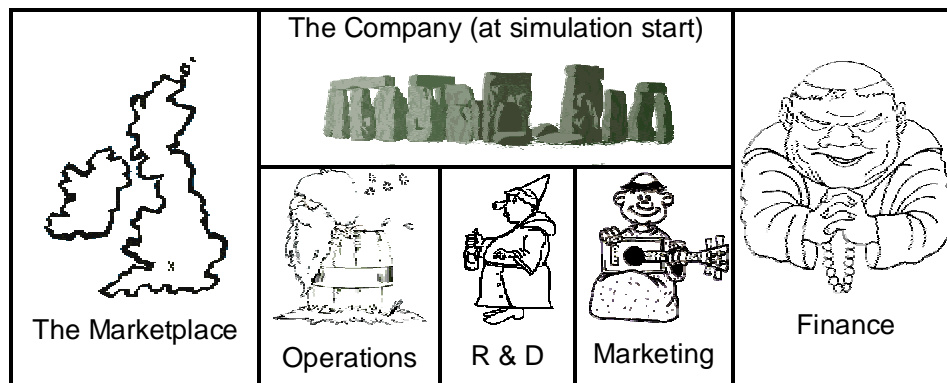
Business Models

This section explores and provides exemplars of:

- **Business Structure**
- **Financial Models**
- **Marketing Models**
- **Operational Models**
- **Business Development Models**
- **Economic & Environment Models**

Business Structure

The starting point for the model is business structure and in particular its functions or units (operations, marketing, finance and, if apt, research and development).



Cartoon 5.05: Business Structure

Depending on the type and complexity of the simulation, the functional structure may consist of several parallel entities at several levels.

For example, DISTRAIN (a Total Enterprise simulation) treats each market sector as a separate, parallel entity (Figure 5.32a). (The arrows show how this information aggregates from the market level to the company level.)

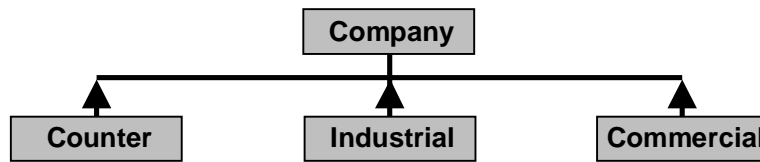


Figure 5.32a: Hierarchy of Business Entities (DISTRAIN)

My TEAMSILL simulation (a complex operations management simulation) has business entities as a series of linked production centres (rather than a branching hierarchy) (Figure 5.32b)

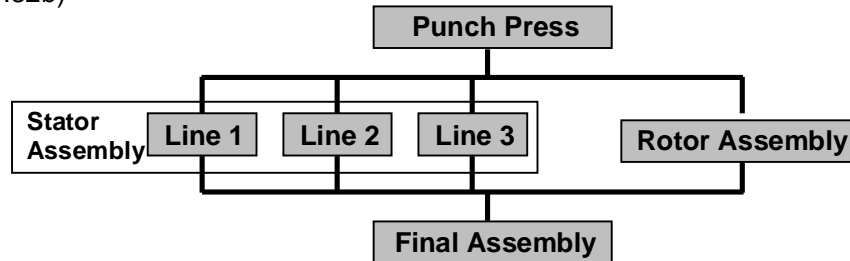


Figure 5.32b: Hierarchy of Business Entities (TEAMSILL)

A simulation with parallel and multiple levels is my SMITE simulation (Figure 5.32c). From the top (company or territory) level, the structure branches into several parallel regions. Below each there are several sales people, each of whom has several areas.

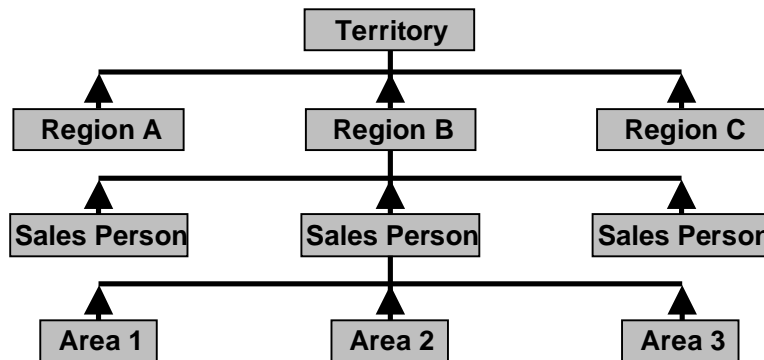
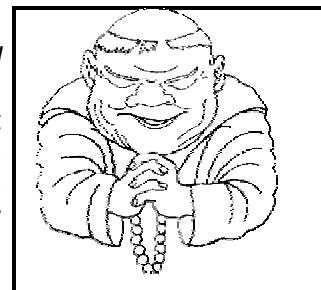


Figure 5.32c: Hierarchy of Business Entities (SMITE)

Financial Models

Just as the “face is for the cartoonist the most expressive and important human feature” (Brad! Brooks and Tim Pilcher, 2001), for the business simulation, the most important expressive features are the financial aspects. Three reports provide a top-level view of the business – the Profit and Loss Account (Income Statement), Balance Sheet and Cash Flow (or Funds Flow) Statement. Driving these are the accounting models that calculate revenue, cost, investments in assets, liabilities and cash receipt and use.



Cartoon 5.06: Bead Counter

Profit and Loss Account (Income Statement)

This measures of how a business traded over a period of time. (Typically for Total Enterprise simulations a year or a quarter.) I try to keep the Profit and Loss Account simple, yet show key costs and measures of profit (Figure 5.33).

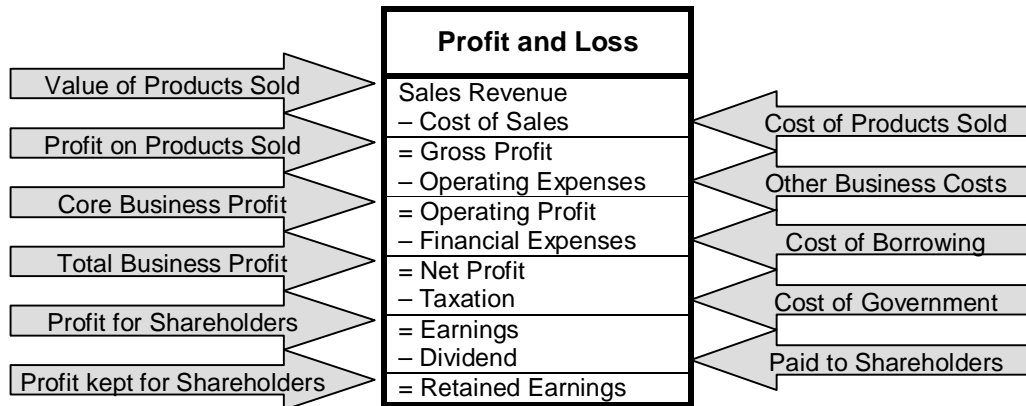


Figure 5.33: Basic Profit and Loss (Income Statement)

Initially, the profit derived from the products sold (Gross Profit) is calculated by subtracting the Cost of the Goods Sold (Cost of Sales) from the Sales Revenue and indicates the extent to which these generate profits. Besides the cost of the products sold (Cost of Sales), there are other business costs (Operating Expenses) and subtracting these from the Gross Profit provides the measure of the profit earned by the core business (Operating Profit). As the company will almost certainly be partly funded by banks, Financial Expenses (the cost of bank borrowing) is subtracted from Operating Profit to calculate Net Profit. Even in the simulated world, the government takes its cut and so Taxation is subtracted from Net Profit to calculate the profit earned on behalf of shareholders (stockholders) – Earnings. The final step is to pay the shareholders a Dividend leaving the profit retained on behalf of the shareholders to help fund the growth of the business (Retained Earnings). Regularly I make the simulated company a subsidiary of a *parent company* that demands a *mandatory dividend* based on the value of Total Equity at the end of the previous period and can *rescue* it if it runs out of cash!

Balance Sheet

This provides a snapshot at one point in time of where the company used funds to invest in things (Assets) and where it obtained the funds (Liabilities and Equity) to pay for the Assets. As for the Profit and Loss Account I try to keep the Balance Sheet simple yet show key information (Figure 5.34).

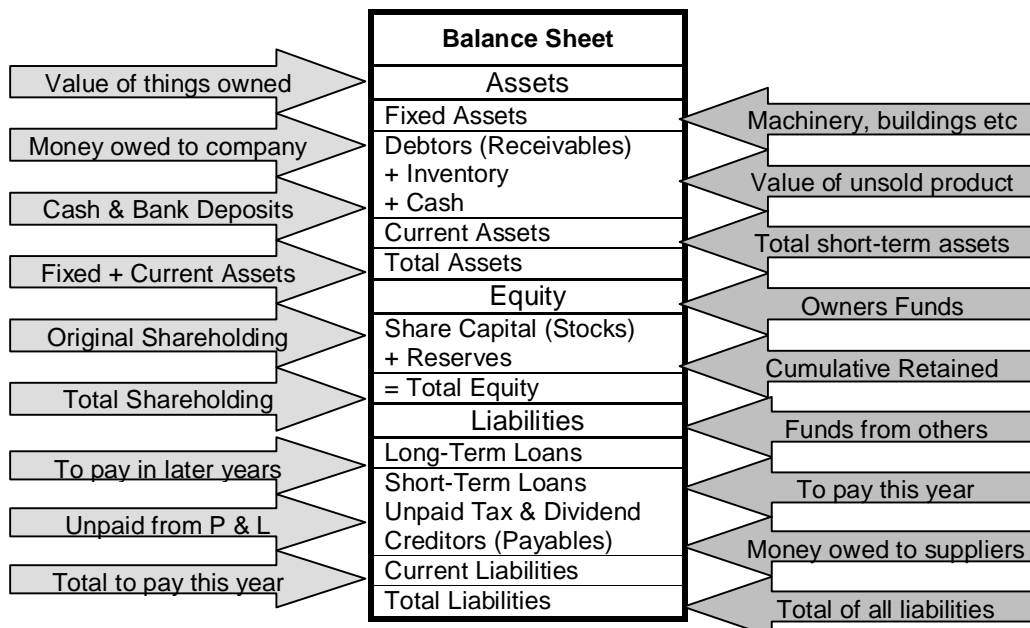


Figure 5.34: Basic Balance Sheet

Fixed Assets are plant, machinery, land, buildings and the like that are used by the company for several years. Next there are a group of assets that are needed for the day-to-day operation of the business (Debtors (Receivables), Inventory and, possibly Liquid Assets (cash and current account deposits at the bank). The total of Fixed and Current Assets is the amount that must be funded by Equity and Liabilities.

Equity is the funds provided by the owners of the company (shareholders (UK) and stockholders (USA)). Total Equity consists of the original amount invested (Share Capital) plus the accumulated Retained Earnings (Reserves). Like Assets, Liabilities consist of long and short-term ones. Although there are several forms of long-term liabilities, the only ones that I use for general management (junior, middle and senior) training are Long-Term Loans. (I believe that the others add complexity without delivering relevant learning – specifically the average line-manager will not be concerned with the intricacies of funding.) For the short-term (Current Liabilities), I find that three types are relevant – Short-Term Bank Loans (Overdrafts), Unpaid Tax and Dividends and Creditors (Payables). Bank Loans incur an interest charge that shows as Financial Expenses in the Profit and Loss Account. The difference between short-term and long-term loans is that I generally provide short-term loans to cover cash needs at a high interest rate automatically. In contrast, long-term loans have a lower interest rate and are decided by the participants. However, long-term loans are for ten years and, once decided cannot be rescinded even if cash flow improves and this forces participants to think about long-term cash flow.

Cash/Funds Flow

This shows how cash flows in and out of the business and provides a link between the Profit and Loss Account and Balance Sheet. Although I generally provide both the Profit and Loss Account and Balance Sheet to participants, unless the simulation focuses on financial issues I do not provide the Cash Flow Statement automatically (but have it available if participants require the information or it fulfils an ad hoc learning opportunity). A basic Cash Flow Statement is shown in Figure 5.35.

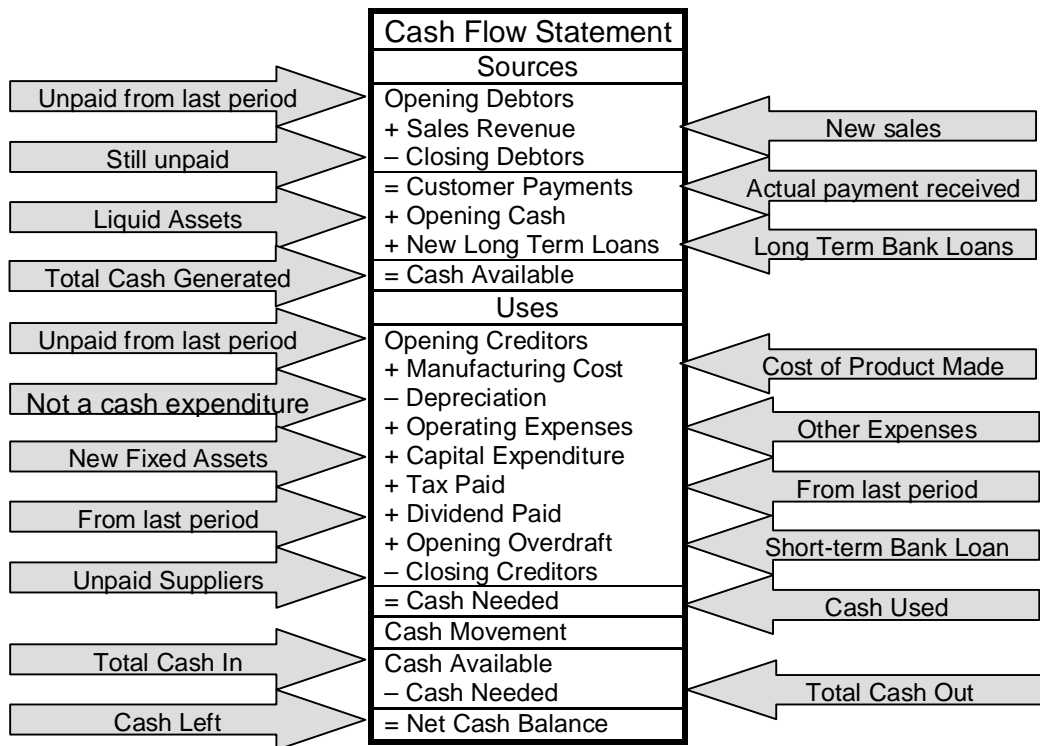


Figure 5.35: Basic Cash Flow

Sources of Cash shows how payment is received from customers and takes into account (any) opening cash and any additional long-term loans agreed with the bank. Where the simulation allows the company increase equity, this is also be included in sources.

Uses of Cash show where *payments* are made and changes in money owed to suppliers. It assumes that all the money owed to suppliers at the start of the period (Opening Creditors or Payables) is paid. Next there is the cost of manufacturing the product (Manufacturing Cost). But, as this includes a charge for using Fixed Assets (Depreciation) and this is *not* an expenditure, Depreciation is netted off cash uses. Besides the cost of manufacture there are other costs (Operating Expenses) and the company may have bought additional Fixed Assets (Capital Expenditure). Tax and Dividends are generally incurred one period and paid in a later one. Short-term Loans (Opening Overdrafts) will need to be accounted for but, finally, not all the suppliers will be paid (Closing Creditors or Payables).

Cash Movement nets the Cash Needed of the Cash Available to see if there is surplus cash (positive) or a cash shortfall (negative) that needs to be funded from short-term loans (Overdrafts) or new long-term loans.

For Total Enterprise simulations, I always include Profit and Loss Accounts (Income Statements) and a Balance Sheet but, only optionally, a Cash Flow Statement. For other simulations, I usually include some form of Profit Statement and elements of the Balance Sheet. But what is included depends on the learning objectives and the learners. For example, for Product Launch, the Income Statement and Balance Sheet are very simplified and abbreviated. For SMITE, although the original version included aspects of the Balance Sheet (Working Capital), a later, customised edition eliminated this and just provided Profit and Loss (Income Statement).

Costing Models

A concern coupled with the financial structure is how revenue, costs and (possibly) assets and liabilities arise from the elements in the structure. Here I use Activity Based Costing (Innes and Mitchell, 1998) or Direct Costing (Savage and Small, 1970) rather than Absorption or Full Costing (where overheads are allocated on a judgemental (or, on occasion, arbitrary) basis to activities). Figure 5.36 shows (for the SMITE simulation) the revenue and costs allocated at different levels in the financial structure.

Area	Sales Person	Region	Territory
Revenue	Revenue	Revenue	Revenue
Gross Profit	Gross Profit	Gross Profit	Gross Profit
Selling Cost Servicing Cost	Selling Cost Servicing Cost Idle Time Management Cost Training Cost Reporting Cost Sickness Cost	Selling Cost Servicing Cost Idle Time Management Cost Training Cost Reporting Cost Sickness Cost Other Region Costs	Selling Cost Servicing Cost Idle Time Management Cost Training Cost Reporting Cost Sickness Cost Other Region Costs Territory Cost Recruitment Cost
Contribution	Contribution	Contribution	Contribution

Figure 5.36: Activity Based Costing Model (SMITE)

Area based financial information consists of the Revenue obtained in the, the Gross Profit earned and the costs, directly, associated with selling in the area. Revenue and Gross Profit were provided to emphasise that different areas had different margins (and,

especially that larger customers obtained better prices). Servicing Cost was the cost of invoicing and delivery. Selling costs consisted of the cost of the time that the sales person spent with the customers in the area and travelling to call on them plus the cost of travel to and from customers.

Sales Person based financial information consists of the aggregate cost of the areas served plus the cost of the time when the sales person was idle (not calling), being trained, producing reports and sick. Additionally the cost of the time the regional manager spent directly with the sales person was calculated. So this built on the area cost adding in the costs that were directly associated with the sales person but not with areas.

Regional based financial information aggregates the costs of individual sales people plus the other cost associated with the region (Other Region Cost).

Territory based financial information aggregates the costs if individual regions and adds territory cost and recruiting cost.

Using Activity Based Costing or Direct Costing ensures that you can accurately analyse business performance within the business – something that could be done if Absorption Costing was done. (Activity Based Costing is vital if information is provided on a Cost, Profit or Investment Centre basis – see next.)

Cost, Profit, Investment and Wealth Centres

These allow one to analyse the financial impact of Strategic Business Units (individual products, markets, customers, functional units, production centres etc.).

Cost Centres show the costs that are directly associated with individual business centres (financial entities). This report form is suitable for parts of the business that are not customer facing and so do not earn revenue. Thus for TEAMSKILL (an Operations Management simulation) each production unit was treated as a Cost Centre.

Profit Centres create a Profit and Loss Account (Income Statement) for each individual business unit (financial entity). Profit Centres extend the information provided by a Cost Centre by showing the Sales Revenue generated by the unit and then subtracting from this the costs to derive a profit.

Investment Centres extends the Profit Centre by showing the assets necessary to support a unit's activity and the liabilities that it is responsible for. Figure 5.37 shows an Investment Centre Analysis for three market sectors (DISTRRAIN simulation).

Investment Centre Analysis Year 0 Quarter 4			
	Counter	Industrial	Commercial
Sales Revenue	2458	1839	2109
Cost of Goods Sold	1821	1496	1900
Gross Profit	637	343	209
Obsolescence	0	85	0
Contribution	637	258	209
Accounts Receivable	1620	1212	1391
Closing Inventory	1552	1610	1402
Accounts Payable	840	690	877
Net Assets	2332	2132	1916
Contribution %	25.9	18.7	9.9
Asset Turn	4.2	3.4	4.4
Return on Assets	109.3	48.5	43.6

Figure 5.37: Investment Centre Example (DISTRRAIN).

The top five lines (Sales Revenue, Cost of Goods Sold, Gross Profit, Obsolescence and Contribution) show the Profit Centre part of this report. They show how (Profit) Contribution is calculated by subtracting the Cost Centre costs (Cost of Sales and

Obsolescence) from Sales Revenue. (Gross Profit is included to show the impact of price differences between the markets.)

The next four lines show the calculation of the Net Assets (Working Capital) (Accounts Receivables plus Closing Inventory less Accounts Payable). These are the assets necessary for the operation of the centres less liabilities.

This data is then used to calculate Contribution % (Contribution as a percentage of Sales Revenue), Asset Turn (Sales Revenue divided by Net Assets) and Return on Assets (Contribution as a percentage of Net Assets). (These figures are for a quarter so both Asset Turn and Return on Assets must be multiplied by 4 to annualise them). Comparing the three market sectors it is obvious that Counter is more than twice as profitable than the other markets and this is due to a larger Contribution %. In contrast, although the Commercial sector has a reasonable Asset Turn, it has a low Contribution % and so its *profitability* (Return on Assets) is low. As a result, learners should try to increase the sector's margin. For the Industrial sector, learners should try to reduce Net Assets and increase margin.

Wealth Centres are an extension to the Investment Centre to determine the wealth (Residual Income) generated and, if appropriate, the cash generated or used (Figure 5.38). Here a charge is made for the capital employed (Net Assets in Figure 5.38). This is calculated by multiplying the capital employed by a *notional, minimum acceptable* interest rate – a rate that represents the minimum return acceptable for the businesses owners (share or stockholders).

Wealth Centre Analysis Year 0 Quarter 4			
	Counter	Industrial	Commercial
Contribution	637	258	209
Cost of Capital	117	107	96
Residual Income	520	151	113
Previous Net Assets	1635	2039	1910
Contribution	637	258	209
Net Assets	2332	2132	1916
Cash Flow	-60	165	203

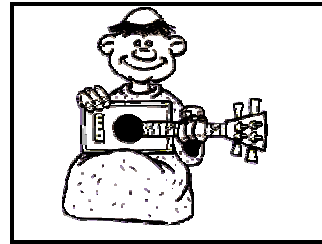
Figure 5.38: Wealth Centre Example (DISTRAIN).

In Figure 5.38, two-thirds of the wealth generated by the business came from Counter but this was at the expense of cash flow. However, the cash required by Counter was more than adequately supplied by Industrial and Commercial. A report showing how individual market sectors generate and used cash are key to Strategy Simulations. As for these, the learners will have to manage multiple market segments some of which will be growing rapidly (Stars) and hence using cash that will need to be funded by Cash Cows (who are generating cash). Additionally, I believe that for Strategy Simulations, Residual Income should be shown on a market-by-market basis as this shows whether or not the sector is adequately profitable. (An alternate is to compare the sectors' Return on Assets (Figure 5.37) against a minimum acceptable level of return).

Invariably, I build the simulation model as a series of Cost Centres and wherever possible and appropriate as a series of Profit Centres. Depending on the sophistication of participants and the tutor, I build Investment Centre models and, although, I believe that building wealth is the key business purpose, I only build Wealth Centres rarely.

Marketing Models

These are the models that turn marketing decisions (price, promotion, product offering, etc.) into sales demand. Demand that is also impacted by the marketplace, the operational situation, market structure, demand pattern and the economy.



Cartoon 5.07: Marketing

Price Models

Models based on economic theory (Figure 5.39a) tend to have constant elasticity or constant slope (Hirshleifer, 1984) and show the price/volume relationship as a single line with the volume as the independent variable (x-axis) and the price as the dependent variable (y-axis). However for business simulations, I prefer a more complex relationship (Figure 5.39b) and show the price as the independent variable (x-axis) and the volume as the dependent variable (y-axis).

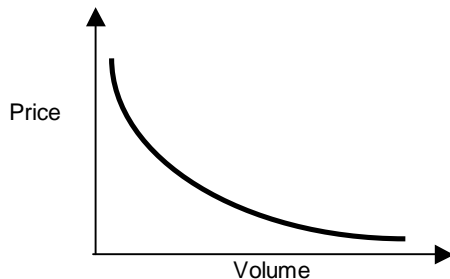


Figure 5.39a: Economic Theory Price Model

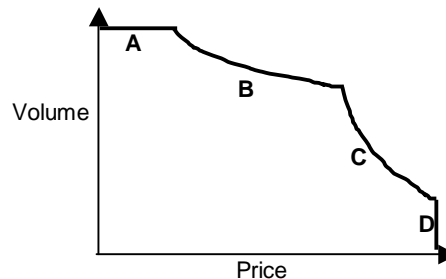


Figure 5.39b: Pragmatic Price Model

My *pragmatic* price model (Figure 5.39b) has four zones:

A is where the price is so low that it will not effect purchases (in other words all the people who have a need are satisfied).

B is where the price is reasonable but customers are relatively insensitive to price.

C is where the price is reasonable but customers are relatively sensitive to price.

D is where the price is so high that a reasonable expectation is that no customers will be willing to purchase the product. (There is an anecdote about an early business simulation where a price of one million was entered and a single unit was sold and this was enough to ensure that huge profits were made – by dropping sales to zero above a certain price this undesirable result is prevented.)

Because in simulations (as in the *real* world) it is difficult to determine the *right* price, I provide comments where the price is above or below certain levels (Figure 5.40).

Comment	Situation
Accountants feel price is low	Price is close to the bottom of Zone B
Sales feel price is high	Price is in middle of Zone C
Customers complaining about price	Price is close to the top of Zone C

Figure 5.40: Examples of Price comments

Price models have been explored significantly in the simulation literature

Promotional Models

These include the promotion mix (Advertising, Direct Selling, PR etc.), communication needs (AIDA - Awareness, Interest, Desire and Action) and selling cycle. For example, Modern Banking involved promotion (advertising) for both Retail and Corporate clients plus direct selling via Account Managers for the Corporate Clients.

Figure 5.41 shows a simple promotion response model. Here, even if there is no promotion some customers will buy. But as promotion increases the impact on sales will saturate and will have no additional effect. Because it is difficult to determine the impact of promotion it is helpful to use comments to provide *clues* about the impact of the current promotional level on sales. For example when promotion is low a comment about the number of customers who know about the company is appropriate and where it is high the accountants may complain (as they would).

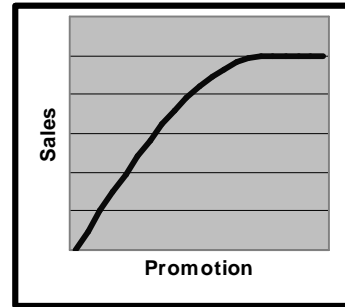


Figure 5.41: Promotion Response

The promotion model shown in Figure 5.41 is very basic and both Product Launch and Banking Challenge had more complex models that took into account the fact that both made sales to existing and new customers. For Product Launch (as shown in the Influence Diagram – Figure 5.7) a proportion of the promotional spend *reminded* existing customers to buy and then the balance used to get new customers. With Product Launch, the impact of promotion was greater before competition enters the market. For Banking Challenge, promotion had little effect on existing customers but a large effect on getting new customers.

My SMART simulation had an even more complex promotional model that was based on the AIDA promotional model (Figure 5.42) and where there were multiple types of promotion (advertising and sales force). For descriptions of several promotional models see Kotler (1984).

Attention or Awareness
Interest (and information)
Desire (i.e. wish to purchase)
Action (i.e. purchase)

Figure 5.42: AIDA Model

Product Offering Models

Typical product features that impact sales demand are range, performance, quality, and payment terms.

Range: Figure 5.43 shows how changing the number of products offered (SKUs) impacts sales demand. The pattern follows a PARETO pattern with 40% of the range providing 80% of sales demand. (It is slightly stylised from the normal 80:20 and this was justified as there was some *cross-elasticity* between products – i.e. a customer might wish to purchase several different products.) As it is difficult to judge the impact of range on sales, comments are made when the range is unusually large or small.

Product Range Parameters										
Number of Products	100	200	300	400	500	600	700	800	900	1000
Percent of Possible	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Percent of Sales	56%	67%	74%	80%	84%	88%	91%	95%	97%	100%
Number vs. Current	17%	33%	50%	67%	83%	100%	117%	133%	150%	167%
Sales vs. Current	64%	76%	84%	90%	96%	100%	104%	107%	111%	114%
Inventory Need	41%	58%	71%	82%	91%	100%	108%	115%	122%	129%

Figure 5.43: Product Range Response (DISTRAIN)

Performance: Figure 5.44 shows how performance can impact sales. As for promotional responses the curve flattens. However, the performance response may then start to decline because for some products excess performance may discourage purchases (consider for a moment a little old lady purchasing a Bugatti Veyron). (I remember well a course in Harare, where on delegate was boasting about his new, top of the range car – until another asked him where he would find a mechanic to service it! The drop off in demand of overly “sophisticated” products comes as a shock to the average engineer or technologist!

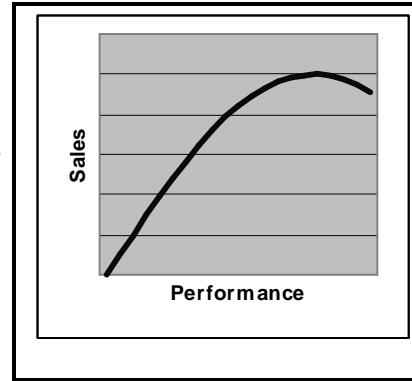


Figure 5.44: Performance Response

DISTRIN included a decision about Receivable Days (Debtor Days) that had an impact on Working Capital that if cut significantly reduced demand.

Marketplace Models

For Total Enterprise appreciation simulations (like DISTRIN and Modern Banking) I tend to have a few separate markets that must be served. Each market differs in terms of growth potential, price sensitivity, product and promotion needs, ability to deliver profits etc. DISTRIN has three markets (Counter, Industrial/OEM and Commercial) and these differed in terms of price sensitivity and inventory need (Figure 5.45).

Product Category	Counter	Industrial	Commercial
Price Sensitivity	Low	Average	High
Inventory Sensitivity	High	Average	Low

Figure 5.45: Market Driver Response

For Total Enterprise strategy simulations I have more segments with the learners deciding the number of markets to serve. For example, my Global Operations simulations starts with teams serving one market (Europe) but they can expand around the world (into a total of eight markets). However, because strategy involves deciding whether or not to serve a market (based on its attractiveness and strategic fit), with Global Operations normally learners only serve four or five markets (rather than all eight).

Operational Situation

This assesses the impact of the current operational situation (reputation, relationship, inventory variety, service levels, staff skills, etc.) on sales demand.

Reputation takes into account how the company has performed in the past. For example, for Modern Banking sales demand is impacted by the bank’s reputation for quality.

Relationship takes into account the long-term relationship with customers. For Modern Banking this separates customers into two groups – existing customers and new customers (who joined the bank this period). For SMITE, new customers are difficult to sell to (requiring more sales calls) and sales to customers depends on the length of the relationship.

Inventory Variety takes into account that where a company sells a range of products there must be sufficient inventory to supply “off-the-shelf”. For example, the DISTRIN simulation allows learners to decide the number of product lines (SKUs) to sell. However, demand for these follows a Pareto Curve and this means that at some point the additional inventory relative to additional sales means that it is uneconomic to add to range offered. In contrast, for the SEED simulation the number of products in the range directly impacts inventory levels.

Service Levels are a measure of the extent to which demand can be served “*off-the-shelf*”.

Staff Skills are an important determinant of how much is sold in the SMITE simulation. Here each sales person has *three* skills areas – product knowledge, industry knowledge and sales skills. Each sales person differs and has a different propensity to improve. (It is perhaps worth mentioning that the reason for the DISTRAIN simulation was to improve the sales forces’ industry knowledge by having them run a company that replicated one of their customers.)

Market Structure

Typically I divide each market into three zones – *company* demand, *served* market demand and *potential* demand (Figure 5.46). Here the served market is the market served by *all* competing teams and thus Company Demand expressed as a percentage of the Served Market is Served Market Share. The Served Market Demand expressed as a percentage of Potential Demand shows the extent to which the total market is *penetrated* and this provides an indicator of potential sales growth. Finally, Company Demand expressed as a percentage of Potential Demand Total Market Share (but, I feel, that this measure is much less useful than Served Market Demand or Penetration).

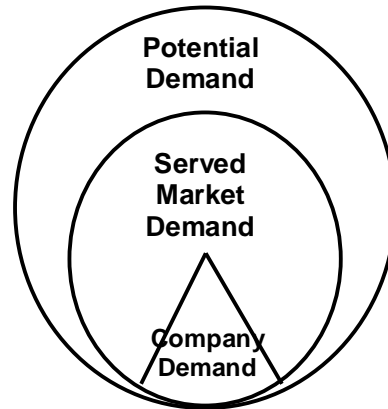


Figure 5.46: Market Structure

Demand Patterns

This involves deciding natural market growth, seasonality and variation. As this adds *complexity* to the simulation, commonly I create simulations with no market growth or variation (but where the served market is significantly less than the potential demand).

Market Growth: My Service Challenge simulation had three market sectors – one of which was growing, one of which was declining and one initially grew and then declined. These patterns were chosen because the growing market sector used one resource. The declining sector used the other resource and the third sector used both. Thus these patterns meant that the learners had to continuously re-assess resource needs and increase and reduce them as appropriate.

Seasonality: Where the period simulated is a year (as is the situation for Modern Banking) seasonality is not apt. But, where the period simulated is less than a year, I often include seasonality and this was the situation for DISTRAIN where one market sector had major seasonality – seasonality designed to test learners’ ability to forecast and manage cash flow. But neither Product Launch and SMITE had any seasonality as this would have added irrelevant complexity and hence diminish learning. Another aspect of the seasonal pattern is where the seasonal peaks and dips occur. My Teamskill simulation involves running a capacity limited factory on a month-by-month basis. I placed the seasonal peak in the second half of the year. This meant that initially it was reasonably easy to schedule the factory but soon it was necessary to build inventories to ensure that it was possible to meet demand during the seasonal peak.

Demand Variation: Teamskill had five finished products that had a Pareto pattern with the variation in demand being less for the higher selling products than the lower selling products (Figure 5.47).

	Model 1	Model 2	Model 3	Model 4	Model 5
Sales Mix	46%	28%	17%	7%	2%
Variation	2.7%	2.3%	0.9%	0.9%	0.6%

Figure 5.47: Demand Patterns for Teamskill

For most of my simulations I have no demand variation as it makes it more difficult for learners to link cause and effect and see where their actions have impacted sales and where this is due to the short-term variation in demand.

Operational Models

These are the models concerned with the internal operation of the company, its resources, supply chain, efficiency and losses.

Resource/Capacity Models

These show resource needs against capacity. Figure 5.48 that shows how many junior and senior staff were needed to perform different tasks and in total. Finally the total Operating Staff needs are compared with the Actual Staff Numbers employed to see the extent there were too many or too few staff (under or over capacity).



Cartoon 5.08: Operations

Staffing Needs - Year 2		
	Junior	Senior
New Client Work	1	1
Demand Deposit Work	27	2
Long Term Deposit Work	13	2
Overdraft Work	8	9
Long Term Loan Work	4	18
Operating Staff Needs	53	31
Actual Staff Numbers	60	35

Figure 5.48: Staffing Needs Report

Supply Chain Models

These show how materials flow into, through and out of the business. This is illustrated in Figure 5.49 that shows how inventory changes during the period. It links the starting position (Opening Inventory) with the Inventory Purchase decision to show how much inventory is available to service sales (Cost of Sales) and shows (for Industrial products) that there are losses because of obsolescence. Finally, based on all of this the inventory on hand at the end of the quarter (Closing Inventory) is calculated.

Inventory Movement Year 2 Quarter 4				
	Counter	Industrial	Commercial	Total
Opening Inventory	3116	1889	6583	11589
Inventory Purchases	2000	2000	1000	5000
Available Inventory	5116	3889	7583	16589
Cost of Goods Sold	3378	1889	4175	9441
Obsolescence	0	100	0	100
Closing Inventory	1739	1901	3408	7048

Figure 5.49: Inventory Movement Report (DISTRIN)

For simulations exploring operational management (like Teamskill – Figure 5.32b) the supply chain model can be complex.

Efficiency Models

These provide information about how well the operating unit is working. This is illustrated by Figure 5.50 that shows the elements of inventory cost – holding cost, obsolescence cost and profit lost because of inventory shortages.

Inventory Cost - Year 0 Quarter 4				
	Counter	Industrial	Commercial	Total
Average Inventory	5477	5538	5603	16619
Inventory Holding Cost	274	277	280	831
Obsolescence	0	831	0	831
Inventory Cost	274	1108	280	1662
Inventory Losses	5	15	5	25
True Inventory Cost	279	1123	285	1687

Figure 5.50: Inventory Losses (DISTRAIN)

Business Development Models

These cover new product development, productivity, quality and systems improvement etc.

New Product Development

These models and decisions are appropriate for Strategy Level Total Enterprise simulations but less so for Appreciation Level Total Enterprise simulations. The New Product Development decision can range from deciding to develop a new product (Global Operations simulation) through deciding to change the strength or power of existing products (Executive Challenge simulation) to deciding the actual design of the product (Technique simulation).

My Global Operations simulation involves deciding how much to spend on developing a new, more sophisticated product and if developed over several periods, the total development cost is less than if developed in a single period. The cost of new products is the same as the cost of existing products and this was done so there was no penalty for offering the latest product (even if customers did not want it).

My Executive Challenge simulation involved changing product power (Power Boat version) or product strength (Pharmaceutical Version). The strength or power impacted production costs and any previous products were disposed of (at cost). This disposal at cost meant that there was no impact on the Profit and Loss (Income Statement) but impacted product availability (i.e. inventory of the old product was not available to service demand).

My Technique simulation involves the strategic development of a high technology company and new product design involves deciding microprocessor type, memory size and source of mechanical hardware. These decisions determine the power of the new product and its cost.

When deciding to change or develop a new product the learners must consider customer needs, the possible impact on demand and costs together with the development cost and investment. Although the new product development for Global Operations does not impact cost, for both Executive Challenge and Technique it impacts cost and require a re-evaluation of price.

Productivity, Quality and Systems Improvement

These involve making decisions that involves expenditure and investment in one period that leads to possible cost and investment reductions in that and the following periods. My RESERVE simulation was especially developed for Research and Development Staff to help them understand the link between R & D and commercial success and exemplifies this with decisions covering five R & D areas (performance, quality, materials, processes and basic research) that impact costs (Figure 5.51) of two products (LOTS and HITS).

R & D Impact Forecasts - Year -1		
Products	LOTS	HITS
Unit Warrantee Cost	1.96	3.74
Unit Material Cost	19.42	29.41
Unit Scrap & Rework Cost	1.96	2.93
Unit Labour Cost	9.53	9.53
Unit Capacity Cost	19.12	19.12
Profit	1.06	1.23

Figure 5.51: Impact of business improvement decisions

Modern Banking involves ongoing decisions for Quality and Productivity Improvement (Figure 5.52) separately for Junior and Senior Staff where the amount of this investment depends on the number of staff employed.

Each year you can spend on improving staff quality and productivity. **Quality Improvement** enhances the staff's ability to deal with clients and the expenditure is evenly split between costs charged to the Income Statement and capital investment in equipment. **Productivity Improvement** enhances the staff's ability to handle larger number of clients and the expenditure is split so that a quarter is charged to the Income Statement as an expense and the rest is capital expenditure. The capital expenditure associated with Quality and Product Improvement is depreciated at 25% per year.

Figure 5.52: Quality and Productivity Improvements

For example, DISTRAIN allows learners to decide to install an *electronic linkage* that links the distributor's inventory system with their suppliers systems and eases ordering and reduces inventory (Figure 5.53).

Electronic Linkage
 This involves you leasing equipment and communications links to enable you to electronically transmit orders and so shorten supply times. This will allow you to better react to customer needs and reduce inventories. It is expected that this will allow you to increase sales but the successful use of the linkage is likely to necessitate increased staff skills. If you decide to go ahead with the Electronic Linkage you will not be able to rescind your decision.
 It will cost \$25,000 to lease the equipment and communications links each quarter.

Figure 5.53: Systems Improvement

When analysing the attractiveness of improvements learners will need to forecast demand, improvement and ongoing cost and investment. From this, and depending on learning objectives, learners can assess the investment (Payback Period, Internal Rate of Return or Net Present Value).

Economic & Environment Change Models

These models impact the way the economy (inflation, currency fluctuations), technology, etc. change over time. As with all models it is important not to include changes that are not directly relevant to learning. For example, **inflation** may be a factor but including it necessitates learners updating all price, cost and capital investment information every period – work that will add nothing to learning (unless, of course, the purpose of the simulation is to explore how to manage in a high inflation environment). Likewise, for a simulation addressing international issues it is arguable whether fluctuating currency rates. I have two simulations that can include **currency fluctuations** – Global Operations and INTEX. With both I feel that better learning is delivered without currency fluctuations as it allows the learners to concentrate on strategic issues rather than operational ones. Likewise, **technology changes** can add complexity without corresponding learning. An exception to this is my Technique simulation. This was developed specifically for Philips BV as the finale of a senior management course. As such it was appropriate and

necessary for technology to change as simulated time passed. However, the additional complexity meant that the simulation takes two full days to run and even then the learners are challenged.

Finally, as discussed in Chapter 3, making Ad Hoc changes to the Economy and the Environment without warning may be real but lead to disaffection. It is important to provide some forewarning so learners can be proactive rather than reactive.

Performance Measurement Models

As discussed earlier, measuring performance is important to track learning and for engagement. This section describes and discusses the ways I use to measure success in terms of:

- **Market Strength**
- **Growth**
- **Profitability**
- **Liquidity**
- **Wealth Creation (Economic Profit)**
- **Efficiency**

But not

- **Share (Stock) Value**

Market Strength

This measures the *strength* of the company in the marketplace relative to other companies. Market Strength can be measured in terms of:

§ **Market Share** measures the company's sales relative to a market's total sales and there are several issues associated with market share measurement.

1. Is Market Share, Company Sales relative to Served Market Demand or to Potential Market Demand (Figure 5.48)?
2. Is Market Share based on value or units?
3. Is Market Share based on demand or actual sales?

I think that the most meaningful measure is unit demand relative to served market demand as this measures the impact of a company's marketing decisions relative to those of its competitors. If the measure is based on potential market demand then it is distorted by the extent to which the market is penetrated (see next). Likewise, if based on actual sales, the measure is distorted by the extent to which the company (and its competitors) are able to service demand. Finally basing on sales revenue rather than actual sales double counts the impact of price.

§ **Penetration** provides another measure of how well the company is doing in the market place (it measures the Served Market Demand relative to the Potential Demand – Figure 5.48). Because Product Launch involved the introduction of a new product, penetration was a key measure of the how successful the company was at informing customers of the existence of the product.

Growth

These can be measured in terms of changes in:

§ **Unit Sales Growth** is a measure of how the company is increasing its supply of products or services. As it is a combination of growth at the expense of the competitors and the natural growth (or decline) of the market, it can provide a distorted picture of success.

§ **Sales Revenue Growth** is a measure of how the company is expanding in the marketplace. For the same reasons as for Unit Sales Growth, it can provide a distorted picture of success.

- § **Profit Growth** shows expansion in the marketplace, improved margins and the ability to manage and reduce costs (efficiency). For the same reasons as for Unit Sales Growth, it can provide a distorted picture of success.
- § **Market Share Growth** provides a measure of how well the company is doing *relative* to other companies. But, Sales Revenue Growth may be high because the market is growing rather than the company is being competitive and this will be shown as negative market Share Growth.

Profitability

This measures how *efficient* a company is at generating profit thus:

- § **Gross Profit to Sales** is calculated by expressing Gross Profit as a percentage of Sales Revenue. It provides a measure of margin and shows the extent to which price covers the cost of the product sold.
- § **Operating Profit to Sales** is calculated by expressing Operating Profit as a percentage of Sales Revenue. It provides a measure of the profitability of the core business and shows the extent to which Gross Profit covers the other costs.
- § **Return on Assets (ROA)** is calculated by expressing Operating Profit as a percentage of Total Assets and is a measure of the profitability of the core business.
- § **Return on Capital Employed (ROCE)** can be calculated in several ways. The one that I generally use is Operating Profit expressed as a percentage of Total Assets less Unpaid Tax & Dividend and Creditors. In other words, it measures Capital Employed as Total Assets less the debt (liabilities) that are not paid for. An alternative is to use Total Assets less Current Liabilities. Like ROA it is a measure of the profitability of the core business.
- § **Return on Equity (ROE)** is Earnings expressed as a percentage of Total Equity and so is a measure of profitability for the share (or stock) holders.
- § **Asset Turn (or Sales to Total Assets)** is Revenue expressed as a fraction of Total Assets and so is a measure of the efficient use of assets.

Liquidity

These measures how *safe* the company is in the long and short-term.

- § **Capital Gearing (or Financial Leverage)** is the money borrowed from banks (long and short-term loans) as a percentage of Total Equity. Therefore it measures the risk to bankers and suppliers. I use it as a key indicator of businesses solvency (bankruptcy risk) and typically use 50% as the tipping point. Below 50% the company has the ability to fund growth through bank borrowing. Above 50% then the company is becoming risky and this may affect their ability to borrow to fund investment in Fixed Assets. Commonly, once Capital Gearing exceeds 50% I start charging a premium on the interest charged by the bank. (But because I usually set up the scenario with the company as a subsidiary, the parent company can guarantee loans and so the company cannot become bankrupt.)
- § **Current Ratio** is calculated by dividing Current Assets by Current Liabilities and is a measure of the company's ability to operate in the short-term. However, although I have the information to produce this ratio I do not routinely do so as for participants to act on this ratio they have to be able to manage the short-term flow of money and this means that the only simulations where I do use this measure are Tactical Total Enterprise Simulations and Planning Simulations.
- § **Quick, Liquidity or Acid Test Ratio** is calculated by dividing Current Assets less Inventories by Current Liabilities and is a measure of the company's ability to operate in the short-term. By discounting Inventories, this ratio assumes that a company's difficulties may be because they are producing the *wrong* products or their inventory

is obsolete. Like the Current Ratio and for the same reasons, I rarely use this measure.

§ **Income Gearing** is calculated by expressing Financial Expenses as a percentage of Operating Profit and so shows the extent to which the company can pay the bank.

Wealth Creation (Economic Profit)

These measure the extent to which the business generates optimum profits.

When I was working for GE (in the 1960s) we used a measure called *Residual Income* to measure how investment projects generated wealth using the formula in Figure 5.54.

$$\text{Residual Income} = \text{Profit} - \text{Capital Investment} * \text{Obligatory Interest}$$

Figure 5.54: Measure of Wealth Creation

Obligatory Interest (or Cost of Capital) is the minimum return that is acceptable (taking into account the current economic situation and investment risk). A similar concept is *Economic Value Added (EVA®)* (Ehrbar, 1998). Residual Income and Economic Value Added are measures that combine a desire for growth with a desire for profitability by charging for the cost of capital investment.

Measures of Wealth Creation are needed because growth and profitability often clash. This is illustrated in figure 5.55 (that shows for my Market Strategy simulation how sales, profit, profitability and wealth creation varies depending on price over a five year period).

Price	20	22	24	26	28	30	32	34	36	38
Market Share	12.3	10.7	9.4	8.3	5.4	4.5	3.7	3.1	2.6	2.2
Sales Revenue	24129	23006	22026	21163	15181	13225	11624	10296	9184	8242
Profitability	38%	56%	71%	84%	84%	87%	88%	89%	88%	87%
Wealth Created	943	1727	2313	2756	2205	2125	2017	1895	1770	1697

Figure 5.55: How Growth, Profitability and Wealth Creation interact

In figure 5.55, Market Share and Sales Revenue (both measures of growth) fall as the price increases. Profitability peaks at a price of 34 at a point where Sales Revenue is less than half that at a price of 20 and where market share is about a quarter that at a price of 20. But wealth created (by netting from profit a charge for capital) peaks at a price of 26 and is significantly higher than the wealth created either at high growth or peak profitability. (As Market Strategy measures a company's performance over five years instead of using Return on Investment (ROI) and Residual Income, I used the Discounted Cash Flow (DCF) measures of Internal Rate of Return (IRR) to assess profitability and Net Present Value (NPV) to assess wealth creation (Bierman & Smidt, 1971).)

Efficiency

One way simulations differ from the real world is that it is possible to assess the cost (lost profit) due to poor forecasting and lack of control. As illustrated in Figure 5.56, I commonly provide a report for the tutor that quantifies the cost of poor forecasting and control and then adds the accumulated *Efficiency Losses* to Actual Profit to provide a measure of *Potential Profit*.

Efficiency Loss Summary Year 2 Quarter 4		
	Current	Todate
Marketing Losses	0	0
Inventory Losses	241	1273
Staff Cost Variance	15	703
Total Losses	256	1976
Net Profit	561	3007
Potential Profit	818	4983

Figure 5.56: Efficiency Losses Report

The Efficiency Loss Summary (Figure 5.56) shows sources of losses from poor marketing (excess advertising and lost profit because tight credit control reduced sales), poor inventory management (lost profit because of inventory shortages, holding cost and obsolescence) and staff cost variances (overtime, idle staff cost and profit lost because staff shortages lost sales).

Share or Stock Value:

At first seems to be appropriate to calculate a share or stock price as it a key business objective to maximise shareholder return. However, there are four reasons why I do not do use share or stock value:

1. Focuses on a single objective
 2. No agreed model
 3. Not relevant
 4. Confused causal links
1. A focus on a **single objective** conflicts with the need for the multidimensional objectives of profitability, growth, survival and wealth creation. Using a single measure of performance will cause learners to explore a narrow range of strategies and hence reduce the *richness* of the business experience.
 2. **No agreed model** exists to link business actions with share or stock value and, no model is possible because share or stock values are a combination of objective and subjective perceptions. (I well remember my Economics Professor at LSE explaining that stock value is based on perceived company performance, the perceptions of how this impacted value, how the perception of perceptions affected value, how the perceptions of perceptions of perceptions affected value and so on!) So creating share or stock value model linking share price to accounting results may be intellectually satisfying to the designer but is ungrounded.
 3. Few if any learners will be concerned *directly* with maximising share or stock value. Rather they will be concerned with managing profitability, growth, survival and wealth creation which means that calculating and using share or stock value is not relevant to the learners.
 4. Finally, the **complexity** of a share or stock value model means that learners will not be able to identify the links between their results and the value – let alone links between their decisions and the share or stock value.

The extent to which you include measures of business success will depend to learning objectives, the *sophistication* of the learners and the *sophistication of the trainer*. For Total Enterprise Simulations, I measure Return on Capital Employed, Return on Equity and Capital Gearing and for the most sophisticated groups Residual Income (although, personally, I feel that this is a key measure). For a simple simulation like Product Launch, I just measure Cumulative Profit.

Deterministic vs. Stochastic Models

A further decision to make is whether the simulation is to be deterministic (with no *random* factors) or stochastic (with *random* factors). In general I find it better to build deterministic models. This is not because one is more difficult to build than the other or more real than the other but because with a deterministic model the results are due wholly to team decisions (and so they have no excuse for poor performance).

Further, for simulations where the decisions of one team interact with the other teams, the business simulation is sufficiently dynamic and difficult without *random factors*. Both the total enterprise simulations (DISTRAIN and Modern Banking) are deterministic.

However a stochastic model is appropriate because of the nature of what is being modelled or where the simulation is to be run repeatedly by participants (Prospector is an example). With Prospector, there had to be variations in the characteristics of projects to

manage and these were generated randomly. (Figure 5.57 shows a relationship between project size and probability.)

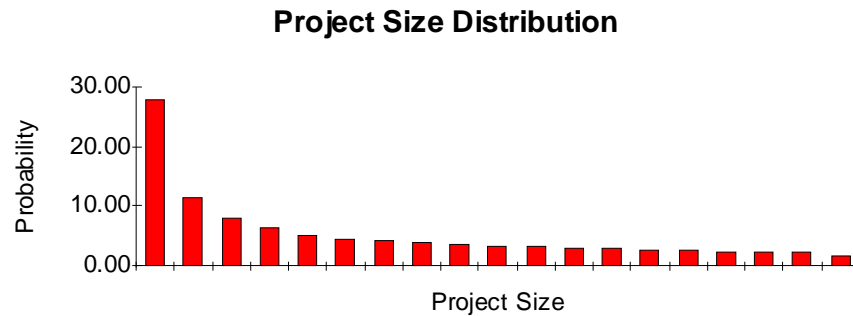


Figure 5.57: Project Size and Probability %

Where there is no interaction between teams (simulations such as Product Launch, SEED and Prospector) a case may be made for a stochastic model. But as adding random factors will make it much more difficult for participants to understand how their decisions affect results. Thus, unless handling random fluctuations is an issue or you can afford the time for participants to run the simulation multiple times, I feel that a deterministic model is the better choice.

If you are using a stochastic model it is important during the development stage (and sometimes during use) to be able to repeat the sequence of random numbers. During the design stage, this allows you to check the models, their dynamics and calibration without having to take into account different stochastic events. During use, it means that each participating group faces the same problem. (This was particularly important for my Teamskill simulation as this simulation was run twice as national contests in the UK and, if the stream of random numbers differed between teams, this would have been unfair.)

Learning Support Models

Designing a business simulation for management development and business training is different from building a model for corporate and business planning where the design is almost entirely concerned with the business model (described earlier). However, for a simulation used for learning, there is the need to provide models to:

- **Support the Trainer (Tutor Support System)**
- **Validate the Simulation**
- **Simplify the Simulation**

Supporting the Trainer

As described earlier, these models are to provide reports for the tutor (described earlier) to help him or her manage learning..

Validating Models

These models are used during simulation design to ensure that models are correct. As such they overlap with the Tutor Support Models, to a large extent they already exist. But, for exceptionally complex simulations (such as the SEED simulation) it may be necessary to create additional models to help validation.

Simplifying the Simulation

Often it is necessary to embed models that help to simplify the simulation or automate some decisions. With DISTRAIN, the Staff Numbers decision was not introduced until the second quarter. Before this introduction, the model determined the number of staff required *intelligently*. Likewise to simplify the SEED simulation, the model had to determine a production schedule. A schedule that *intelligently* smoothed out the seasonal pattern and built inventories to *smooth* production.

Data and Parameters

The simulation model uses data and parameters to drive the way the model performs and capture the current operating situation. But, beyond the data and parameters used by the simulation model, I use data files to manage the simulation, to store text and comments, define report and decision structures and provide on-line, context sensitive help. I briefly review the types of data that I use here and return in more detail in the section on Simulation Architecture in Chapter 6 (Design for Value).

Driving the Simulation Model

Parameters: I use this term to identify the data that drives the simulation and is common to all teams and thus includes interest rates, basic cost data, market sizes etc. Depending on the simulation I use up to three data structures.

1. A vector that contains constants that are common to all products, markets or operational units.
2. One or more arrays that contain the constants that differ between products, markets or operational units.
3. An array that contains the parameters that change over time.

Commonly, simulation authors argue that a *feature* of their design is that users can easily modify parameters. When I started designing simulations (40 years ago) I felt that the ability for users to change data was a *good thing* but experience has made me change that view. The reason for this is that whenever you change the parameters that drive the simulation model you *must* recalibrate it so that is stable, delivers learning and is engaging. A time consuming and costly process that needs to be done by a skilled person and *not* left to the average trainer.

Team Data: I use this term to identify the data that is specific to individual teams. Structurally you will have overall company data (such as total sales revenue, total fixed assets, total debts etc.), data for individual products, markets or operating units etc. As the team situation changes over time, you will need to capture data on a period-by-period basis and, if the simulation is interactive between teams, you will need to capture data on a team-by-team basis.

Managing the Simulation

Because I find it attractive to provide different versions of simulations to serve different learning needs and audiences, I store the data that defines which decisions and results are to be produced and when. Where they are embedded in the simulation model they are more difficult to find and you need to have to compile a different version of the simulation for each version. For example, the Product Launch simulation has five versions ranging from the basic (original) version to a progressive version (that introduces reports to explore additional business issues). Besides versions to address different learning needs, you may need versions for different client groups and different languages.

Text and Comments

I store all text and comments in data files rather than embed them in the simulation model (as is the situation when you use a spreadsheet). I do this to allow me to localise to different languages and company terminology. A particular example of this is localising a UK simulation for the American market. Here we have trivial spelling differences (labour vs. labor) and more profound terminology differences (Debtors vs. Accounts Receivable). Storing text and comments in files they are in a defined format and easy to find and change. Where they are embedded in the simulation model they are more difficult to find and you need to have to compile a different version of the simulation for each version.

Report and Decision Structures

When I began designing simulations the technology meant that it was necessary to build the report and decision structures into the simulation model (code). Today my platform includes Reporting and Decision Entry engines that take team data and uses records from the reporting file to assemble reports and decision entry templates.

On-line, context sensitive Help

This should be a hypertext based database that provides context sensitive help with using the software and the current task, explains reports and individual results and, for some Direct Use Simulations, provides an online version of the participants' manual.

Putting it all together – an example

So far this chapter has explored each element separately but in practice simulation creation involves moving between all elements. Here I explore this in the context of a recent addition to an existing simulation. One of my long-term clients wanted to add the exploration of “offshoring” work. I have included this to illustrate the thought and work associated with a single decision.

Background

The simulation was Service Challenge - a total enterprise simulation that replicated a service company selling into three markets delivering the services using a combination of two resources. The markets ranged from a price insensitive one requiring a premium quality service to a price sensitive one requiring a basic service. The service company was in direct competition with several other companies and time was progressed on a year-by-year basis. The decisions are price and promotion (on a market-by-market basis), increases or decreasing resource numbers and expenditure on quality improvement (on a resource-by-resource basis) and long-term loans.

Issues

My starting point for this was to start building a list of issues that need to be addressed specifically:

1. Resource cost reduction
2. Service quality reduction
3. Impact on Productivity
4. Initial Impact

Resource cost reduction would be particularly useful for the basic service as it would increase margins and/or allow a lower price. But resource cost reduction would be balanced in the long-term by higher fixed costs.

Service quality reduction would impact the sales of the premium product. Again this would have a short and a long-term effect. In the first year of offshoring the resources would be learning their job but would never reach the same skills level as the domestic staff without a greater expenditure on quality improvement.

Impact on Productivity assumed that the existing staff and offshored staff would have different skills and work rates and so the output per resource would differ.

Initial Impact is the cost of setting up the offshoring and the impact on productivity and quality as the offshored staff learn their job will affect profits in the first year with a recovery the following ones.

Duration and Timing

Despite adding to the simulation's complexity the client did not wish to extend the simulation's duration beyond its current length of one day. This limited addition to a single non-granular decision that would be introduced about halfway through the simulation.

New Decision

Reflecting the single day duration constrain, the offshoring decision would be an all-or-nothing decision. In other words, they would be asked to offshore *all* resource work rather

to do this for each of the two resources separately or to partially offshore the resources. This meant that when the offshoring decision was introduced, participants only needed to decide Y(es) or N(o) in response to the question Offshore? However, although the decision's granularity was reduced it needed to be an ambiguous decision (neither obviously good or obviously bad) and a *foreground* decision (an important decision).

Next it was necessary to decide whether, once offshored participants could rescind the decision in a later year. Deciding whether to do this was a balance between complexity and reality. Specifically, being able to rescind the decision would mean that the learners accept they made a mistake and thus onshoring is unlikely but possible.

Besides the new decision, offshoring will mean that learners will need to increase their quality investment, change prices and may need to increase resource levels. Increasing quality investment is likely to be ongoing for several years as it will take time for the learners to find the right level. In order to take full advantage of lower resource costs, learners will need to adjust prices. Although this may not be necessary for the high end market, it will be advantageous to cut the prices in the middle market and cut the prices in the low end market significantly. Increasing resource levels may be necessary in the year the company offshores to cover the disruption as the company moves offshore. But, this may not be necessary if the company has surplus capacity and, a drop in quality levels is likely to lead to a drop in demand. If the company increases resource levels then for the year following offshoring, the company may need to reduce resource levels.

Influence Diagram

When a team decides to offshore there are the initial impact (Figure 5.60a) and the ongoing impact (Figure 5.58b). In figure 5.58b Improve refers to the existing decision – Quality Improvement – an expenditure that needs to be increased to counteract the impact of offshoring on quality.

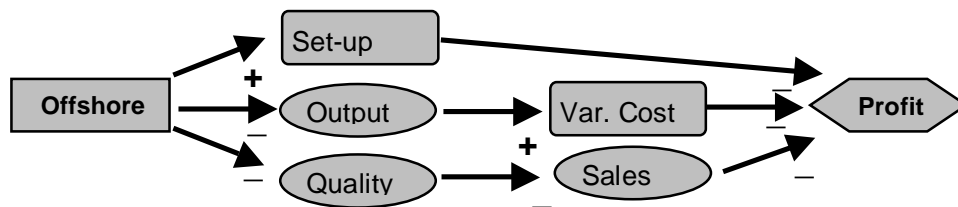


Figure 5.58a: Initial Impact

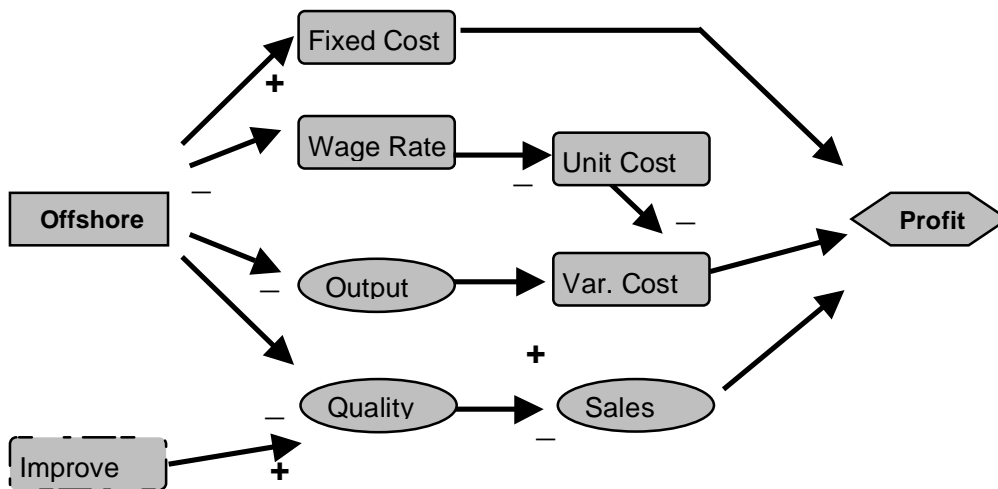


Figure 5.58b: Ongoing Impact

The offshore decision box to the left is shown with a solid perimeter indicating that this is the new decision. In contrast the improve (quality) decision box has a dashed perimeter

indicating that it is an existing decision (that may or may not be adjusted by the learners). To simplify the diagram I did not include the resource level and the price decisions and the elements that follow them.

Dynamic Aspects

I needed to decide when the offshoring decision would be introduced and its ambiguity.

As, already mentioned, I decided to have the offshoring decision introduced about halfway through the simulations six years. This meant that it would be introduced either in year 3 or year 4. This would be as workload began to drop yet give enough time for the impact of the decision to be felt. The making the introduction in year 3 or year 4 gave the tutor the flexibility to decide (based on the current situation) exactly when to introduce the decision.

The second dynamic aspect was to decide the amount of ambiguity. The constraint on this was the number of years for the learners to learn to handle offshoring. As this would only be three or four decision periods (simulated years), I decided to reduce the ambiguity associated with the initial impact (Figure 5.58a). Here I removed the effect on quality of new staff learning their job and, although the impact on output as offshore unit was set up would be uncertain in the real world, I decided that it would be precisely defined and this information provided to the learners before they decided whether or not to offshore. Also to reduce ambiguity, I removed the output effect from the ongoing impact by making offshoring as productive as the local resources.

Calibration

This involved deciding the effect of the offshoring decision on results and testing how this evolved over the last few simulated years.

I felt that a combination of the cost of offshoring and, possibly, the loss of capacity during the initial year would overwhelm the resource cost savings. Thus any advantage would be during the following two or three years. This had two implications. First, it ensured that the offshoring decision was not obviously good or obviously bad and, as a result, learners had to think through and discuss the decision – this was to ensure that the decision was a suitably ambiguous, foreground decision. Secondly, with only three or four years remaining to the end of the simulation, learners had to take a short or long term position.

I decided to have an annual fixed cost to cover the cost of operating the overseas office. And I needed to set this so offshoring was only profitable if sales were sufficiently high.

In order to ensure adequate quality, the investment in quality improvement would need to be increased. As I felt that quality problems would be greater with the high skills resource and insignificant with the low skills resource, the drop in quality for the high skills on out sourcing would be several times greater than the drop in quality for the low skills resource.

To calibrate the simulation, I set it up with two teams that, except for the offshoring decision, had the same decisions. When I offshored one team in the third year, without any increase in Quality Investment and zero Setup Cost and Offshore Overheads, poor quality caused a major drop in sales. I created a spreadsheet to allow me to analyse the results and compare them to the non-offshored company. I used this to record the impact of different Quality Improvement decisions. Based on this, it was likely that a 25% reduction in costs would not provide an opportunity for improvement and so I increased the offshore resource cost saving to 50%. Based on this I set the setup and overhead costs.

Participants' Handout

When the offshoring decision is introduced, the learners are provided with a handout that provides them with information about the task and possible outcomes so that the offshoring decision will be made logically. In other words to ensure there was enough

information to enable to consider and discuss all aspects of the decision and decide how they would check that it was a success.

Offshoring Resources

The current globalisation of IT and communications infrastructure means that it is possible to consider the possibility of moving the resource work overseas and hence reduce costs.

Because of the need for both resources to work on the Level 2 service, both Resource A and B will be offshored.

Moving to an overseas location will reduce resource costs by 25% but will involve a fixed cost each year of ??? AUs and a one off cost of ??? AUs to cover redundancy and setting up the overseas location.

Also, setting up the overseas location will reduce capacity in the first year by about 10%. Also, it is likely that the skills of the overseas staff will be less than local staff and, initially this may be significant. This is not expected to be a problem with Resource B but may be a problem with Resource A.

If later, you feel that is necessary, you can move the resource work back on shore. Because of more liberal labour laws this will only cost ??? AUs but capacity will be again be reduced by about 10% in the year when resources are onshored.

If you decide to offshore, to help you assess it's impact a new report will be provided showing the current offshore quality related to the onshore quality.

Figure 5.59: Offshoring Handout

New Reports

The impact of offshoring on resource costs, set up cost and ongoing fixed cost is unambiguous but the impact on quality and through this sales and the need to increase expenditure on quality improvement. These meant that besides providing information to the learners there is a need to provide (unambiguous) information as part of the Tutor Support System. It was this part of the design that was the most difficult as it was necessary to provide sufficient information for the learners to (eventually) make good decisions and to provide unambiguous information to the tutor to ensure that learning could be managed.

Team Results: The key need here was to provide clues about the differences in quality between past onshoring and offshoring. I did this by providing a report showing the quality of the new offshore resources relative to the quality of the onshore resources and several comments.

Business Research was added to by commenting when a team moved offshore and when (if) it moved back onshore.

Reconciliations: The costs associated with moving offshore (Offshore Start-up Cost) and the ongoing cost (Offshore Fixed Costs) are part of the Operating Expenses and so needed to be added to this report.

Tutor's Audit: As I calibrated the simulation I identified new reports that I needed to explain results. Initially these were a Margin Analysis report that compared the price charged against resource costs and a Percentage Profit Centre report that was the existing Profit Centre report but with the measures expressed as a percentage of Sales Revenue. These allowed me to check that offshoring was reducing resource costs correctly.

Team Commentary: I added both the Margin Analysis and the Percentage Profit Centre to this.

Decision Comments flagged when a team moved offshore and if it moved onshore.

New Parameters and Team Data

Driving the Offshoring Model I needed several parameters (figure 5.60a) and data fields to store team decisions, operational and accounting data (figure 5.60b).

Parameters	Note
Offshore Setup Cost	Cost to move offshore [PE24]
Onshore Setup Cost	Cost of moving back onshore [PE26]
Offshoring Overheads	Ongoing extra offshore cost [PE25]
Offshore Cost Multiplier	Cost saving over onshore cost [PR11]
Initial Quality for each Resource	Expressed as a fraction of current onshore quality [PR10]
Offshore Disruption Factor	Reduces days available [PR12]
Onshore Disruption Factor	Reduces days available [PR13]

Figure 5.60a: New Parameters

Team Data	Note
Offshore Decision	Yes or No [TF115]
Offshore Start Year	Used to indicate work is done offshore [TF116]
Last Onshore Quality by Resource	Used for onshoring comparison with offshoring [TR24]
Relative Quality %	Quality as a percentage of last onshore quality [TR25]
Cost Multiplier	Either 1 or less [TR27]
Offshore Cost Saving by Resource	Used in business analysis report [TR26]
Offshore Cost Saving by Market	Used in business analysis report [TM47]
Total Offshore Cost Saving	Used in business analysis report [TF119]
Offshore Fixed Costs	Used in business analysis report [TF117]
Offshore Start-up Cost	Used in business analysis report [TF118]
Net Offshore Income	Used in business analysis report [TF120]

Figure 5.60b: New Data

The Model

Beyond the existing model, I needed new models to assess:

- § Starting to Offshore
- § Offshoring Impact
- § Returning to Onshore

Starting to Offshore: This procedure is executed when offshoring starts (ie when the offshore decision is set from No to Yes). It charges for setting up the offshore office, resets resource quality and sets the year when offshoring starts.

Offshoring Impact: This procedure executes the ongoing aspects of offshoring. It is used when ever the offshore start year is not zero, It charges the offshore fixed cost, reduces resource costs, assess the economic impact of offshoring, compares current quality levels with the last onshore quality levels and produces appropriate comments.

Returning to Onshore: This procedure is executed when after the company has been working offshore the offshore decision is set back from Yes to No. It charges for the move back, resets quality levels and sets the offshore start year back to zero (signifying that the company is now working onshore).

Background Notes (information for the tutor)

Finally, I needed to provide some notes for the tutor running the simulation