Running The Model

To run the model, click on **"Run,"** and then click on **"Run preferences"** to choose the number of trials (try 5,000 to start). Choose "Run" again and wait until the simulation stops. That's it!

You can stop and continue the simulation at any time using the applicable commands from the **"Run"** menu.

Viewing the Output

Click on **"Run,"** and then on **"Forecast windows."** From there, click on the reports you want to see and open them. Two additional menus, **"Preferences"** and **"View"** also appear on the menu bar. The **"View"** menu selects the type of statistics that are displayed for each Forecast Cell. The **"Preferences"** menu alters the format of the displayed charts. By the way, the reports can be copied and pasted into a Word® document using **"Paste special"** as a **"picture."**

Saving and Re-running

Your simulation run can be saved using the **"Save Run"** command in the **"Run"** menu. To re-run the simulation, say with a different number of trials or with a different probability of a crash, etc., select **"Reset"** from the **"Run"** menu, make any necessary changes, and then choose **"Run"** once again.

Final Word

These directions are enough to teach you the basics of this software and to allow you to get started with Crystal Ball®. You should be able to work effectively with the simulation model in a short period of time. Use the on-line help menu for additional pointers.

CASTERBRIDGE BANK

Susan Newson returned to Casterbridge Bank refreshed and revitalised from a long weekend hiking in the Lake District, ready to begin the annual recruiting drive for analysts at the bank's London office. The scent of late spring flora and the roar of cascading waterfalls were still fresh in her mind as she gazed out over a bustling London morning. Beginning with the first of twenty waiting voice-mail messages (all marked urgent, of course), she recognised the booming voice of the Chairman, Michael Henchard:

> Sharon, I've been getting a lot of flack from division managers about frequent shortages in analysts in London. It strikes me that our analyst hiring targets were too low last year. But in some months there seem to be loads of analysts with no projects to work on. I can't sense whether we over-hired or under-hired last year!
>
> I'm convinced we need to get a handle on our hiring policies for the new analyst recruiting cycle: It's costing us money when we are understaffed and when we are overstaffed. Either come up with one of your MBA equations or get an HR consultant to sort it all out. Kindly book a time on Friday to discuss this with me.

Well, here it was, the proverbial "deep end." This is why Susan had fought so hard to get this prime position in personnel at Casterbridge: the challenge. Putting her MBA networking skills to work, she immediately phoned an ex-classmate, Don Farfrae, who had started up an HR consulting company in London after graduating from business school:

"Well Sue, I think we could do a quick but effective study of your problem and help you to decide the right analyst staffing levels for the coming year. I can put three of my best people on it right away, shouldn't take much more than a few weeks, and cost £20,000 at the most."

"Hmm, since you put it that way, can I give you a call back?"

Surely she could put together a relatively simple model of the bank's analyst staffing problem and come up with an answer for Henchard by Friday. Perhaps then he would start getting her name right!

The Bank

Even as a relatively new London investment bank, Casterbridge had a reputation for excellence in client service. Casterbridge routinely attracted the best clients and prided itself in its excellent professional staff. In its earliest years, the bank's focus had been on expanding rapidly and taking aggressive advantage of the lucrative banking opportunities in the 1980's. With high profitability and high growth, no one paid much attention to developing sound internal management practices and decision-making.

Now that its market position had stabilized, Casterbridge was sorely in need of more efficient internal management. Many of the methods and standards used at the bank were beginning to become a liability as the business matured and growth and profitability rates settled down. For the first time Casterbridge had to consider costs seriously and improve staffing efficiency. Internally the bank was in a state of flux, struggling to get its costs under control, while retaining its much envied reputation and clientele.

The Analyst Position

The best and brightest from top colleges and universities around the world vied for the lucrative and demanding position of analyst at Casterbridge. After graduating with a Bachelors Degree, analysts would join the bank in the summer to work in any number of areas providing analysis, research, and support skills to the MBA professional staff. A new graduate could expect to be involved in anything from preparing privatization "beauty contest" proposals, to aiding mergers and acquisitions, to research and analysis for large clients. In addition, a large part of the bank's business consisted of the more standard debt and equity financing for major clients' business activities. These "projects" could take anywhere between a few days to six months to come to fruition.

Analysts were paid extremely well and were typically expected to work any hours necessary to serve the clients' interests. On an annual salary of around £32,000 ($48,000), analysts could expect to be very busy much of the time. In addition to a direct salary cost of $4,000 per month, an analyst's labour cost to Casterbridge typically also included another $2,000 per month in indirect support costs such as training, health insurance, and other employee benefits. In common with most international investment banks, Casterbridge performed all internal accounting and client charging in US $—a sad indication of the decline of the once great British Pound.

Most analysts found that three years of strain and stress at Casterbridge was about all anyone could stand. Departing analysts usually enrolled in MBA programs at top business schools, joined finance departments of major multinational corporations, or transferred to management consulting.

Work Flow Management Problems

The investment banking industry has always been characterized by uncertainty in the level and timing of banking engagements, which are driven by the needs of its

clients. Because the business world is fundamentally unpredictable and subject to large swings in fortune, the future demands of the bank's clients are uncertain.

Clients' demand for analyst services fluctuated quite a bit. In some months, the demand for analyst time on client projects exceeded the number of analysts in the London office. The operations department would handle these shortages by temporarily transferring staff from other Casterbridge offices in Europe (mostly Paris and Frankfurt) and/or by pooling analysts from various departments within the London office. Unfortunately, despite the promise of global staffing optimization, transferred staff tended to be less efficient than those working in their home office, typically by a factor of 60%, due to factors such as language, culture, and training differences.

In other months, however, there were not enough client projects in the London office to keep all of the analysts busy. When this happened, the otherwise idle analysts would be assigned to do internal research work.

In this environment the bank tried to recruit the "right" number of analysts from the main pool of graduating students in June. Offers were made after the April recruiting round with responses due in May. Newly hired analysts were asked to start work on July 1.

The immediate cost of recruiting too many analysts was obviously the salary and indirect support costs that would have to be paid when no profitable work was being done. On the other hand, the cost of recruiting too few analysts was the implicit cost of staffing projects with transferred staff from other offices or departments, who were inherently less efficient.

Demand for analysts was affected by both market and internal factors, resulting in a clear seasonal cycle with peaks in September and March. Over the long hot summer as clients (and senior bankers) basked in the Mediterranean sun, the demand for analysts experienced a prolonged lull known as "the beach effect." Come September the backlog became pressing causing a sudden flurry of activity in order to complete the work. Just as this was accomplished the Christmas season arrived and the Alps filled with snow, drawing the fun-loving bankers and corporate leaders to the slopes and après-ski. The low demand at this time was exacerbated by the reluctance of clients to consider committing to new projects before the new budget year beginning in January. Once flush with a year's worth of funding, clients would be eager to engage the bank to perform work and the flood gates opened once again, with work levels building to a peak in March.

In addition to these month-to-month changes, there was a significant economic effect on the levels of client work in any year. If the global or European economy was particularly buoyant, then workloads would rise significantly as mergers, acquisitions, and privatizations were proposed in the bullish stock markets. The converse was true when economic activity slowed.

The bank charged its customers fixed fees or percentages of the value of deals or issues, based on an internal billing rate of $10,000 per month for an analyst's time. For example, if the M&A division had a one-month project for a client that they anticipated would use three person-months of analysts' time, they would charge the client a fixed fee of $30,000 for the project.

Alternative hiring strategies

Casterbridge's past analyst hiring strategy was straightforward:

Estimate the 'right' number of analysts to hire for July 1, and then hope for the best.

Trying to remember some of the lessons she learned in her HR courses at business school, Susan Newson thought that a more creative hiring strategy might be

much more effective. For example, there was an inherent inefficiency in having all of the new analysts start work on July 1. Perhaps if they allowed new recruits to choose to start at the beginning or at the end of the summer (either July 1 or September 1), then any remaining imbalance might be less costly.

However, some of the new recruits who would choose to take the summer off and start in September might happen upon better job opportunities while enjoying their last free summer, and therefore might not show up for work in the autumn. Susan recalled the experience of a classmate in Personnel at a large consulting firm, whose firm had adopted a flexible start-date strategy for its university recruits; about half of the new recruits chose to start work in July. Of the remaining half who chose to delay their start-date to September, between 70% and 100% fulfilled their promise to join the firm.

Susan also thought there might be some merit to engaging in December recruiting in order to capture students who graduate at mid-year. Susan thought that mid-year recruiting, if done correctly, could help to alleviate analyst staffing shortages. In fact, the option to do December recruiting might even allow Casterbridge to hire fewer analysts for July 1 and then make a mid-year correction if need be. Analysts hired in the December round would be asked to start work at the beginning of January.

Data gathering

A brief conversation with Tom Hardy (whom Susan had replaced after he had been promoted to head of personnel for global operations at Casterbridge) clarified the basic facts of the situation. As of April 1, Casterbridge had 63 analysts and was about to enter the usual round of recruiting leading to final offers for July. Of the offers extended, not all would be accepted, despite the reputation of Casterbridge. Tom estimated that the bank was most likely to employ about 70% of the graduates that were extended offers, which was Casterbridge's historical acceptance rate for analyst offers.

Throughout the year the bank experienced some degree of analyst attrition, which varied between 0% and 20% per month. Tom, however, treated retention as being 95% (the rough average rate) in all months as he was considering the year as a whole. According to Tom, the bank had generally tried to match the expected staff levels with the average workload, which seemed quite reasonable. Tom then explained the elegantly simple formula he had used in the past to match expected analyst levels with average workload:

> We want to try to hire the right number of analysts to match the average demand of about 90 in any month. Therefore what I do as a rule of thumb is to use the following equation to find Q, the number of offers to make for July:
>
> $$\text{Average demand} = (\text{estimate of number of analysts as of July 1} + \text{number of accepted offers}) \times (\text{average annual retention rate})$$
>
> So this year's relationship would be:
>
> $$90 = (63 \times (0.95)^3 + 0.70\,Q) \times (0.95)^6$$
>
> (Note: $(0.95)^6$ here is an approximation to $(1 + 0.95 + 0.95^2 + 0.95^3 + \ldots + 0.95^{11})/12$, the average retention rate based on Tom Hardy's assumption of a retention rate of 95% in each month.)

That is to say we should make about, erm... about 98 offers. It's that simple!

With the new pressure on costs, Susan was not so sure that it was "that simple," and so she decided to inquire into the matter further. As it turned out, the bank had kept data on past staffing levels and workload on a reasonably consistent basis in activity reports generated by the HR department. Susan found the file of dog-eared paper. Although the numbers went back five years or so, she thought that it would take only a little manipulation to prepare some useful numbers.

Deciding that a good basic set of historic numbers was the first priority, Susan had her assistant Anthony compile average analyst months worked by month from the five years of data that she had found. Given this pattern, she could now estimate the number of analysts that would be required in the coming year (see Figure 5.6 and Table 5.20). However, a number of complications existed. The average numbers, Anthony noticed, hid quite a wide variation both in month to month levels and between years. A quick look back at some market trends showed that the yearly variation seemed to depend quite heavily on the state of the global economy; during recessions

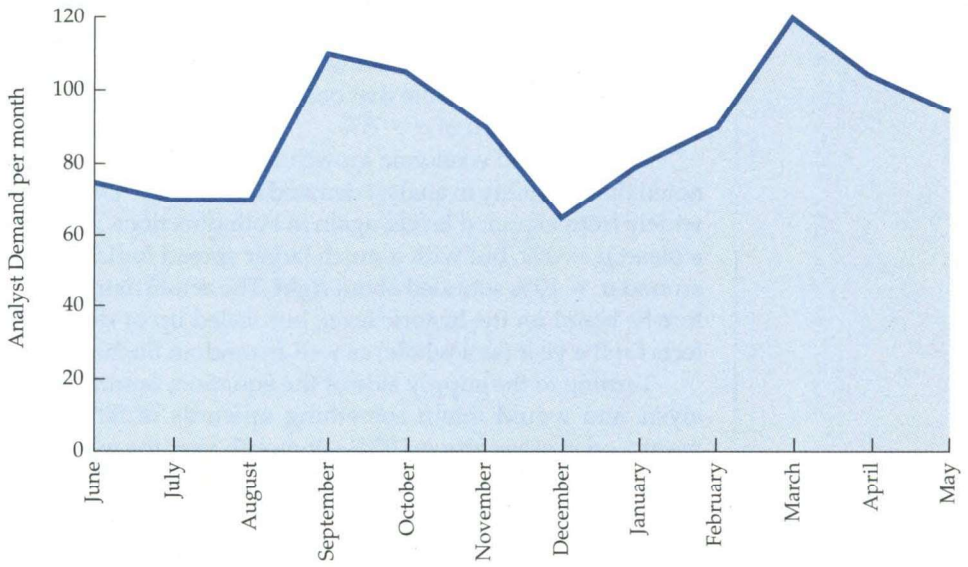

FIGURE 5.6
Demand fluctuation at Casterbridge bank.

TABLE 5.20
Estimated analyst demand levels at Casterbridge bank.

Month	*Analyst Demand*
June	75
July	70
August	70
September	110
October	105
November	90
December	65
January	80
February	90
March	120
April	105
May	95
Total	1,075
Average per month	90

work was down, and in periods of expansion it was higher throughout the year. The monthly variability did not seem to have such a simple explanation, and after failing to find any link between it and the average length of engagement, they decided to live with a little uncertainty. Both sources of variability would have to be added to the basic forecast that Susan had developed in order to arrive at realistic demand numbers.

The data began to spin in Susan's head: This much complexity and uncertainty required a break for lunch in the park! Having picked a quiet spot under a huge old beech tree, she contemplated the hiring problem over an avocado and bacon sandwich. With so many related variables, it was clear that the problem would require some sort of structure. Reaching for a napkin, Susan spent a while jotting down what she had discovered that morning about hiring at the bank.

First, she knew that analyst demand was not deterministic, as the historic numbers might suggest if taken at face value. Both the uncertain economic climate over the year and monthly "random" uncertainty had to be considered. These two factors could dramatically change the level of analyst demand from the historic levels.

Obviously the bank had a pretty good idea of the way in which the economy was expected to perform each year, so that the main effect on analyst demand levels would come from unexpected economic growth or decline. Susan guessed that estimates of economic growth would be extremely unlikely to be more than 10% different (either higher or lower) from the actual outcome. Therefore, it seemed reasonable to model the change in the demand for analysts due to unexpected economic conditions as a random variable that obeys a Normal distribution with mean $\mu = 0\%$ and a standard deviation of $\sigma = 5\%$.

In addition to economic growth influences over the whole year, Susan had also noted the variability in analyst demand each month. Demand seemed to fluctuate quite widely from expected levels, again in both directions. A Normal distribution also with a mean $\mu = 0\%$, but with a much larger spread indicated by a standard deviation of around $\sigma = 10\%$ sounded about right. The actual demand in any month would therefore be based on the historic level, but scaled up or down with random economic effects for the year (as a whole) as well as random fluctuation for the month in question.

Turning to the supply side of the equation, Susan knew that the bank had 63 analysts and would retain something upwards of 80% of them at the end of each month, on average around 95% per month over the whole year. Looking more closely at the monthly average retention rates (see Table 5.21), Susan began to try to fit a story that would make sense with the numbers that she had collected. In January (once year end bonuses were received) and in September (after a relaxing summer and as the business schools kicked off a new term) the bank would probably experi-

TABLE 5.21
Observed average analyst retention levels at Casterbridge Bank.

Month	*Average Retention Rate*
January	90.0%
February	95.0%
March	95.0%
April	95.0%
May	97.5%
June	97.5%
July	97.5%
August	97.5%
September	90.0%
October	95.0%
November	95.0%
December	95.0%
Simple Average	95.0%

ence higher than average rates of attrition. In contrast, during the summer months, retention would be higher as many analysts applied to business schools and began researching other job opportunities. Thus the peculiarities of the banking year seemed to fit the observed behaviour of analysts, reassuring Susan that she had sufficiently detailed information with which to work. A uniform distribution between 80% and 100% appeared to be the most realistic way to model the uncertainty in the retention rate for January and September, 95% to 100% for the summer months and 90% to 100% for the rest of the year.

Now, she thought, if the bank makes offers to graduating students then they know that they only expect to have 70% of them accept. Susan thought that the number of accepted offers should therefore obey a binomial distribution with a probability of success (i.e., accepted offer) of $p = 0.70$ and the number of trials n would be equal to the number of offers extended, thus resulting in the expected result of a 70% acceptance rate.

Next, the number of analysts at Casterbridge in any month would depend on the level in the previous month and the attrition rate of existing staff. However, for recruiting months the level would also be boosted by incoming new recruits at the start of the month. (Susan summarized these ideas on her napkin, shown in Table 5.22.)

Turning the napkin over, Susan mopped up some mayonnaise and started to think about the costs involved in the analyst hiring decision that Henchard was so worried about. It struck her that the real costs of an imbalance of supply and demand would be the costs to the bank of having staff idle or the cost of using less efficient transferred staff during analyst shortages. Both of these costs would impact the all important contribution to earnings.

Susan knew the analyst salary costs and the indirect support costs for staff members. Given this and the rough amount of revenue that an analyst should earn for the bank in a normal month ($10,000), a contribution to earnings figure could be calculated. If an analyst had to be transferred in from elsewhere to fill a staffing shortage, then costs would rise by about 60% and hence reduce the contribution accordingly. It thus appeared to be marginally better for the bank to have too few rather than too many analysts. (See Table 5.23 for Susan's analysis of costs and earnings contributions.)

TABLE 5.22
Susan Newson's napkin formulation of the hiring problem.

Henley's Sandwich Bar

Hiring Problem

Units: Number of Analysts

Model of Demand for Analysts

H_i = Historic average analyst demand in month i
X = percentage unanticipated economic growth per year
$X \sim N(0\%, 5\%)$
Y_i = Random noise in demand in month i compared to expected historic level in month i
$Y_i \sim N(0\%, 10\%)$
D_i = Demand for analysts in month i
$D_i = H_i (1 + X) (1 + Y_i)$

Model of Supply of Analysts

Q_i = Number of offers made by bank to analysts to start in month i
A_i = Number of analysts who accept offer to start in month i
$A_i \sim B(Q_i, 0.7)$
R_i = Percentage retention rate of analysts in month i
$R_i \sim U(80\%, 100\%)$ for September and January
$R_i \sim U(95\%, 100\%)$ for May, June, July and August
$R_i \sim U(90\%, 100\%)$ for February, March, April, October, November and December
P_i = Number of analysts employed at start of month i
$P_{i+1} = (P_i)(R_i) + A_{i+1}$
$P_0 = 63$

TABLE 5.23
Susan Newson's back of the napkin analysis of costs and earnings contributions.

Henley's Sandwich Bar	
Monthly salary and indirect labor support cost	
Monthly Salary	$4,000
Monthly Indirect Cost	$2,000
Monthly Total Cost	$6,000
Monthly Contribution to Earnings of productive analyst	
Revenue per analyst month	$10,000
Monthly Total Cost	$6,000
Contribution per analyst	$4,000
Costs and Contribution of Transferred Workers	
Inefficiencies of Transfers	60%
Monthly Total Cost of Transfer	$9,600 (= $6,000 × 1.60)
Revenue per month	$10,000
Monthly Total Cost	$9,600
Contribution per transferee:	$400

Calculations of Earnings Contributions

Let E_i = contribution to earnings from analysts' work in month i
If demand equals supply of analysts then $E_i = 4{,}000\ D_i = 4{,}000\ P_i$
But if not then earnings contributions are computed one of two ways each month, depending on whether there is a shortage or an excess of analysts in month i:

Excess of analysts in month i

If $P_i > D_i$ then $E_i = 10{,}000\ D_i - 6{,}000\ P_i$

Shortage of analysts in month i

If $D_i > P_i$ then $E_i = (10{,}000 - 6{,}000)\ P_i + (10{,}000 - 9{,}600)\ (D_i - P_i)$

As the first of the English summer sun attempted to break through the rain clouds, and the birds twittered over the dull rumble of distant traffic, Susan inspected her napkin with pride. She now had a much clearer view of the analyst hiring problem and how the different sources of uncertainty might interact. Given the relatively high cost of a mismatch in analyst numbers, Susan was convinced that Tom Hardy's solution was in fact probably costing the bank money.

Susan now understood how to model the events and then recommend a hiring policy for the new recruiting cycle. Despite some simplifying assumptions, particularly regarding the distributions of variables, Susan was confident that her formulation of the problem retained sufficient realism. She rewarded her efforts with a chocolate fudge brownie and returned to the office with renewed energy. Dusting off her laptop, she quickly replicated the structure of the problem in a spreadsheet on her computer.

All in a day's work

It was Monday afternoon. Susan mulled over her spreadsheet and double cappuccino. How many new analysts should the bank make offers to? Did it make sense to offer recruits the option of starting at the beginning of September? Should the bank be more radical and hire twice each year instead of only once? Which strategy was best for the bank? How could she show Henchard the monetary implications of each strategy? Full of hope that all this would become clear in the next few hours, Susan reached for the mouse, knocking her coffee onto the keyboard.

Assignment:

(a) Briefly, what does it mean to hire the "right" number of analysts? What is the objective in trying to decide the "right" number of analysts to hire?

(b) Briefly explain Tom Hardy's hiring strategy. What are the strengths and weaknesses of his approach?

(c) Prepare a two-paragraph explanation of Susan Newson's basic approach to the analyst hiring decision. What are the strengths and weaknesses of her approach?

(d) Consider the "fixed-start" strategy of making offers to new graduates to start on July 1. A simulation model of the fixed-start strategy is provided in the Excel® spreadsheet CASTRBDG.XLS for use with the simulation software Crystal Ball®. This spreadsheet model is designed to forecast the distribution of earnings as a function of the number of offers Q that Casterbridge makes to new graduates to start on July 1. Review this spreadsheet to make sure that you understand all of its components. The number of offers Q is input to the spreadsheet in cell D6, and the contribution to earnings is computed in cell O19. Run the simulation model with a number of different values of Q in the range between $Q = 10$ and $Q = 110$. Which value of Q results in the greatest expected contribution to earnings? What is your optimal hiring strategy? Is your strategy more profitable or less profitable than Tom Hardy's strategy? What is the expected difference in the contribution to earnings between the two?

(e) Now consider a "flexible-start" strategy of making offers to new graduates to start on either July 1 or September 1. Modify the simulation model CASTRBDG.XLS in Crystal Ball®, to help you decide the optimal number of offers that the bank should make given the flexible-start strategy. Make whatever assumptions that you think are reasonable and are supported by your knowledge of the case. Is the flexible-start strategy more profitable or less profitable than the fixed-start strategy? Why? What is the expected difference in earnings contribution between the two?

(f) **(Challenge)** Now consider a more complicated strategy involving December recruiting. In December recruiting, offers are made in December for graduating students to start work on January 1. December recruiting would cost Casterbridge approximately $22,000 in fixed costs of visiting campuses, interviewing, arranging for call-backs, etc. Develop your own December hiring strategy. Test your strategy out by modifying your simulation model in Crystal Ball®. Then decide the optimal number of offers that the bank should make with a fixed-start strategy combined with December recruiting, as well as with a flexible-start strategy combined with December recruiting. Once again, make whatever assumptions that you think are reasonable and are supported by your knowledge of the case. Is December recruiting worth the cost? Why or why not?

NOTE: There are a number of ways to develop a December recruiting strategy. For example, one strategy might simply be: Make $Q1$ offers for July 1, and make $Q2$ offers for January 1, where $Q1$ and $Q2$ are chosen optimally by testing a bunch of different possible values. Another more sophisticated strategy might be: Make $Q1$ offers for July 1. If, on average, there is a shortage of S analysts in June-December, then make $Q2 = f(S)$ more offers in December, where $f(S)$ is some function of the shortage number, for example $f(S) = S/(0.70)$ (The value of 0.70 accounts for the average acceptance rate).