Solutions

2.1. a. Some objectives might be to minimize cost, maximize safety, maximize comfort, maximize reliability, maximize cargo capacity (for shopping), maximize maneuverability (in city traffic). Students will undoubtedly come up with others as well.

b. In this new context, appropriate objectives might be minimize travel time, maximize exercise, minimize total transportation cost, minimize use of fossil fuels, maximize ease (suitably defined) of visiting friends and shopping. New alternatives to consider include using a bicycle or public transportation, walking, rollerblading, skateboarding, motor scooter, renting a car only when necessary. One might even consider moving in order to live in a more convenient location.

2.2. Future options can affect the eventual value of the consequence. For example, a university faculty member, when accepting a position at a different institution, may not immediately resign his or her position at the first university. Instead, a leave of absence may be taken. The leave of absence provides the opportunity to decide in the future whether to stay at the new institution or return to the old one. A faculty member would most likely think about the two different situations — resigning the current position immediately versus taking a leave and postponing a permanent decision — in very different ways.

Another good example is purchasing a house. For many people in our mobile society, it is important to think about the potential for selling the house in the future. Many purchasers might buy an unusual house that suits them fine. However, if the house is too unusual, would-be purchasers might be afraid that, *if they decide to sell the house in the near future*, it may be difficult to find a buyer and the sales price might be lower than it would be for a more conventional house.

Finally, the current choice might eliminate a future valuable option. For example, our policy of powering cars with fossil fuels reduces our options for using oil for potentially more valuable and less destructive future activities.

2.3. In the first case, the planning horizon may be tied directly to the solution of the specific problem at hand. If the problem is an isolated one not expected to repeat, this is a reasonable horizon. If more similar problems are anticipated, the planning horizon might change to look forward in time far enough to anticipate future such situations. If the firm is considering hiring a permanent employee or training existing employees, then a planning horizon should be long enough to accommodate employee-related issues (training, reviews, career advancement, and so on). In this broader context, the firm must consider objectives related to hiring a new person (or training), which might include maximizing the welfare of current employees, minimizing long-term costs of dealing with the class of problems, satisfying affirmative-action requirements, or equity in treatment of employees.

2.4. In making any decision, it is important to 1) use all currently available information and 2) think carefully about future uncertainty. Thus it is necessary to keep track of exactly what information is available at each point in time.

2.5. Some possibilities: insurance, hire another firm to manage the protection operation, press for regulatory decisions and evaluations (i.e., get public policy makers to do the necessary analysis), do nothing, develop a “cleanup cooperative” with other firms, or design and develop equipment that can serve a day-to-day purpose but be converted easily to cleanup equipment. Students may come up with a wide variety of ideas.

2.6. The employer should think about qualifications of the applicants. The qualifications that he seeks should be intimately related to what the employer wants to accomplish (objectives — e.g., increase market share) and hence to the way the successful applicant will be evaluated (attributes — e.g., sales). The planning horizon may be critical. Is the employer interested in long-term or short-term performance? The uncertainty that the employer faces, of course, is the uncertainty regarding the applicant’s future performance on the specified attributes.

If the decision maker must decide whether to make a job offer at the end of each interview, then the problem becomes a dynamic one. That is, after each interview the decision maker must decide whether to make the offer (and end the search) or to continue the search for at least one more interview, at which time the same decision arises. In this version of the problem, the decision maker faces an added uncertainty: the qualifications of the applicants still to come. (This dynamic problem is sometimes known as the "Secretary Problem," and has been analyzed extensively and in many different forms in the operations-research literature. For example, see DeGroot (1971) *Optimal Statistical Decisions*, New York: McGraw-Hill, p. 325.)

2.7. Decisions to make: How to invest current funds. Possible alternatives include do nothing, purchase specific properties, purchase options, etc. Other decisions might include how to finance the purchase, when to resell, how much rent to charge, and so on. Note that the situation is a dynamic one if we consider future investment opportunities that may be limited by current investments.

Uncertain events: Future market conditions (for resale or renting), occupancy rates, costs (management, maintenance, insurance).

Possible outcomes: Most likely such an investor will be interested in future cash flows. Important trade-offs include time value of money and current versus future investment opportunities.

2.8. Answers depend on personal experience and will vary widely. Be sure to consider current and future decisions and uncertain events, the planning horizon, and important trade-offs.

2.9. NPV $= \frac{-2500}{1.13^0} + \frac{1500}{1.13^1} + \frac{1700}{1.13^2}$

$= -2500 + 1327.43 + 1331.35$

$= \$158.78.$

Or use Excel's function NPV:
=-2500+NPV(0.13,1500,1700) = $158.78

The Excel file, "Problem 2.9.xls" has the equation set-up as a reference to cells that contain the cash flows.

2.10. NPV $= \frac{-12000}{1.12} + \frac{5000}{1.12^2} + \frac{5000}{1.12^3} + \frac{-2000}{1.12^4} + \frac{6000}{1.12^5} + \frac{6000}{1.12^6}$

$= -10{,}714.29 + 3985.97 + 3558.90 - 1271.04 + 3404.56 + 3039.79$

$= \$2003.90$

Using Excel's NPV function:
=NPV(0.12,-12000,5000, 5000,-2000,6000,6000)
= $2,003.90

The internal rate of return (IRR) for this cash flow is approximately 19.2%.

The Excel file, "Problem 2.10.xls" has the equation set-up as a reference to cells that contain the cash flows.

2.11. If the annual rate = 10%, then the monthly (periodic) rate r = 10% / 12 = 0.83%.

NPV(0.83%) $= -1000 + \frac{90}{1.0083} + \frac{90}{1.0083^2} + \ldots + \frac{90}{1.0083^{12}}$

$= \$23.71.$

Or use Excel's NPV function, assume the 12 payments of $90 appear in cells B13:B24:
=-1000+NPV(0.1/12,B13:B24)= $23.71

(As shown in the Excel file “Problem 2.11.xls”)

If the annual rate = 20%, then the monthly (periodic) rate r = 20% / 12 = 1.67%.

$$NPV(1.67\%) = -1000 + \frac{90}{1.0167} + \frac{90}{1.0167^2} + ... + \frac{90}{1.0167^{12}} = \$-28.44.$$

Or use Excel’s NPV function, assume the 12 payments of $90 appear in cells B13:B24:
=-1000+NPV(0.2/12,B13:B24)= $-28.44

(As shown in the Excel file “Problem 2.11.xls”)

The annual interest rate (IRR) that gives NPV=0 is approximately 14.45%. You can verify this result by substituting 14.45% / 12 = 1.20% for r in the calculations above.

Or with Excel’s IRR function, IRR(Values, Guess), assume the series of payments (the initial $1000 payment and the series of 12 payments of $90) are in cells B12:B24:
=IRR(B12:B24,0) = 1.20%

(As shown in the Excel file “Problem 2.11.xls”)

2.12. a. If the annual rate = 10%, then the periodic rate r = 10%/12 = 0.83%.

$$NPV(Terry) = 600 + \frac{-55}{1.0083} + \frac{-55}{1.0083^2} + ... + \frac{-55}{1.0083^{12}}$$

$$= \$-25.60.$$

Be sure to get the orientation correct. For Terry, the loan is a positive cash flow, and the payments are negative cash flows (outflows). Thus, the NPV is negative.

Or with Excel’s NPV function, assume the series of 12 payments of $55 are in cells B12:B23.
=NPV(0.1/12,B12:B23)+600
= -$25.60

These calculations and those associated with the remaining parts of the question are shown in the Excel file “Problem 2.12.xls”.

b. For the manager, the $600 loan is a negative cash flow, and the payments are positive cash flows. Hence,

$$NPV(Mgr) = -600 + \frac{55}{1.0083} + \frac{55}{1.0083^2} + ... + \frac{55}{1.0083^{12}} = \$25.60.$$

Or with Excel’s NPV function, assume the series of 12 receipts of $55 are in cells B12:B23.
=NPV(0.1/12,B12:B23)-600
= $25.60

c. If the annual rate is 18%, then NPV is about $-0.08. In other words, the actual rate on this loan (the internal rate of return or IRR) is just under 18%.

Using Excel’s IRR function, and assuming the cash flows are in cells B11:B23:
=IRR(B11:B23,0)*12

= 17.97% annually

2.13. Should future decisions ever be treated as uncertain events? Under some circumstances, this may not be unreasonable.

If the node for selling the car is included at all, then possible consequences must be considered. For example, the consequence would be the price obtained if he decides to sell, whereas if he keeps the car, the consequence would be the length of the car's life and cost to maintain and repair it.

If the node is a decision node, the requisite model would have to identify the essential events and information prior to the decision. If the node is a chance event, this amounts to collapsing the model, and hence may be useful in a first-cut analysis of a complicated problem. It would be necessary to think about scenarios that would lead to selling the car or not, and to evaluate the uncertainty surrounding each scenario.