

Financial Modeling in Medicine: Cash Flow, Basic Metrics, the Time Value of Money, Discount Rates, and Internal Rate of Return

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In this article, the authors cover tools for financial modeling. Commonly used time lines and cash flow diagrams are discussed. Commonly used but limited terms such as *payback* and *breakeven* are introduced. The important topics of the time value of money and discount rates are introduced to lay the foundation for their use in modeling and in more advanced metrics such as the internal rate of return. Finally, the authors broach the more sophisticated topic of net present value.

Key Words: Finance, accounting, revenue, cash, management

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INTRODUCTION

In this article, we introduce basic concepts from the realm of finance and accounting. Using these concepts may affect how you look at a wide spectrum of decisions, from purchasing a house to leasing a car or buying long-distance service. We provide examples from our own practices demonstrating how these business tools can be used (and also misused if not well understood) in making decisions. The goal of this article is not to imply or propose that a radiologist should become an accountant or international financier. Rather, it is to provide radiologists and other readers with a better basis to communicate with, lead, and manage the business and financial personnel with whom they will inevitably work to a greater degree in the near future.

FINANCIAL MODELING AND DISPLAYS: TIME LINES AND CASH FLOW DIAGRAMS

One of the most common challenges in running a business is setting up a business plan [1]. Probably the most critical part of a business plan is the financial projections,

or *pro forma* (predicted financial performance displayed in projected future financial statements of a new business venture). This is done over a time horizon and maps out when and to what degree cash either leaves an enterprise as it is paid out or flows into the coffers from revenue. Depending on the institution and situation, this planning horizon can be as short as a year or in some cases up to or even over a decade. Financial modeling is usually done on a spreadsheet and is often displayed graphically as a time line or cash flow diagram, with inputs and outputs marked as they are likely to occur. For a venture to be successful, the value of the cash coming in clearly has to exceed the value of that going out. The critical subject of how to compare the value of cash now versus cash in the future will be discussed in depth.

An example is provided in Fig. 1. This shows a typical investment of the kind we often do in imaging. There is a large up-front investment (the down arrow at the beginning of the time line) and then a resulting revenue stream over time (the up arrows that follow). Obviously, these are estimates, and one of the keys to great planning is getting the best information to create accurate projections. A common question that arises at this point is the appropriate length of a planning horizon. The answer should cover the likely useful economic life of an investment and also take into account your ability to realistically make estimates or scenarios on the basis of decent information.

Sometimes this is fairly straightforward. For example, if you are leasing a machine that you are likely to keep through to the end, then the lease length is a reasonable choice because it covers the macroscopic period affected

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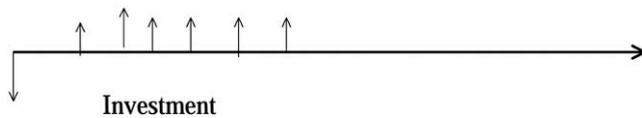


Fig. 1. This illustrates a time-line approach for illustrating capital flows in a simple investment case, with time zero on the left and time subsequent going to the right. The initial down arrow is a capital outflow or investment in a new center. The subsequent up arrows illustrate revenue (or, better, cash) inflows that result from running the imaging practice.

by your initial lease decision. Sometimes, though, determining the appropriate time frame can get quite complicated, particularly when you may be planning on selling or exchanging a machine before its useful life is over. Then, the comparison needs to include the costs of swapping out and the economic value gained or lost as a result. Even if you have every intention of leaving the contract alone for the entire life of the machine, you should still look at the issues related to leaving early so that you know your options if you get into financial distress or upgrade to a better machine.

In diagnostic imaging, we often come in contact with vendors who have already done rosy financial models of how much money a new device will make for our practices. We may also hire consultants specifically charged with the task of creating financial models and projections to help with tough decisions. This is a good time to discuss what to look out for in someone else's projections and some serious pitfalls in using a generic financial model.

Not surprisingly, the biggest problem with generic models is that users often don't take the time to adequately personalize them. You need to make sure that all of the key values really make sense in your region and in your practice. A manufacturer's rosy projections from another part of the country with markedly different reimbursement, labor, and tax issues may look very different once you spend the time to make the model your own.

A second way to botch financial modeling is to use an inappropriate time horizon when evaluating an opportunity. If the horizon is too short, you may miss out on opportunities that require several years to yield substantial returns. If the horizon is too long, you are probably overestimating your ability to do accurate projections that far in the future. Strong financial modeling relies on picking the right horizon for the life of a decision.

A third way to limit the value of your model is to try to do it all yourself. In particular, if you overlook input from key personnel and departments outside your own division, you may not use accurate estimates, and your real-world results may deviate markedly from your projections.

An additional pitfall and a common beginner's mis-

take is to assume that modeling means coming up with just one well thought out plan. As you acknowledge risk in your estimates and as you look at different strategies to be successful, you will need to use more than one scenario to address significant decisions. Great business planners, like great chess players, use multiple "what-if" scenarios and plan their responses several moves in advance. A related pitfall in creating budgets in large institutions is the tendency to use "fudge factors" for major items rather than scenario analysis or taking a harder look at risk and uncertainty.

Finally, be careful when you see plans and models that (1) don't allow for changes in cost and revenue over time; (2) don't look at options and exit strategies; and (3) don't anticipate problems and surprises, probably the worst mistake. These are all very common and often even well-intentioned mistakes. Good analysis is hard to do, but when done well, it can be one of the most important success factors in determining why some businesses do well and others don't. Although great planning cannot by itself guarantee success, a lack of planning or outright bad planning is quite predictive of failure. One of the great things about electronic spreadsheets (yes, at one time they were not electronic) is that once you have set them up, it is quick and easy to ask those what-if questions and consider changes and alternatives to your original plan.

HANDLING UNCERTAINTY IN THE BUSINESS PLAN

A very important issue in doing projections is handling uncertainty. Because we can't really predict the future, what a plan really does is provide a best projection on the basis of estimates. Every entry in your model is an estimate of an amount (and also often of the time that it will occur), and therefore, the projections and any metrics that you derive from them carry along this risk and uncertainty. An interesting feature is that not all risk is necessarily bad. If you overestimate a future cost to your organization or underestimate income, then those turn out to be good risks, even though in everyday parlance, we usually use *risk* only in a negative sense.

Although everyone handles this problem differently in putting together a plan, most planners and budget offices use different scenarios to handle the range of uncertainty in a plan. These usually include the most likely scenario, based on your best estimates. Most modeling also involves developing additional projections including both better-than-expected and worse-than-expected scenarios. Financial forecasting is often done with a trio or so of discrete models, but bear in mind that there is obviously a spectrum of intermediate possible outcomes as well. First-time planners often immediately jump to focusing on the vaunted "worst-case scenarios": an earthquake

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