# Portfolio Management

## The Probability Perspective

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How does a project get into your portfolio? Investment ideas can come from various sources: your exploration department proposes prospects; business development is on the lookout for acquisition candidates; or engineering evaluates development and acceleration projects. Perhaps you have regional teams charged with identifying all three types of projects and more. Ultimately, some process must be used to choose among available projects to construct a portfolio designed to meet your suite of business goals.

Most companies view this set of decisions as (at least) a two-part process. First, projects must pass a set of corporate economic guidelines. These guidelines, or "hurdles," are usually based on net present value (NPV) or one of its derivatives (i.e., rate of return, PI, IE, etc.) Traditional thinking has it that since the purpose of the corporation is to create value it would be foolish to consider projects that return less than the corporate cost of capital. Many companies go further, and set their hurdle rates beyond the cost of capital as insurance against taking on marginal projects.

The second part of the process is often more subjective. Once the pool of passing projects is assembled, how do we choose among them? A method often proposed in business schools is to rank the projects in descending order according to some measure of performance. Again, this is usually a derivative of NPV. This "rank table" is cut off at a predetermined spending limit, and projects above the cut-off form the portfolio.

While the reasoning behind hurdles and rank tables seems obvious and appealing, it is, unfortunately, flawed. Hurdle rates and rank tables often don't work for two reasons: Companies pursue multiple goals and projects interact.

While many oil and gas companies have value maximization as a stated objective, they subject this goal to a number of constraints. In fact, it is rare for NPV to play more that a supporting role in most upstream planning exercises. Planning targets are more likely to be along the lines of net income, net cash flow, annual production, reserve adds, finding and developing costs, exploration and capital spending, some sort of capital return ratio, and so on.

In a world with multiple financial and operational goals, the value of a project is not in its separate NPV, but in its contribution to an interrelated portfolio charged with creating value while meeting those multiple goals. Different types of projects have different parts to play in a diversified portfolio. A project that contributes crucial cash flow in certain years may not meet corporate finding and development targets, but it's presence allows the company to pursue a project that can compensate for this lack. The surprising result is that projects that do not meet corporate targets can, when added to a portfolio, increase the portfolio's likelihood of meeting those same targets. Because of this, the use of hurdles and rank tables will often lead to inferior business decisions because they eliminate needed components from consideration. In fact, the higher the hurdle, the more the potential harm to portfolio performance.

FIG. 1

| | Type | Max Rate | Decline Rate | Reserves | Capital M$ | Pc | Risked NPV M$ | MAX # PER YR | MAX # TOTAL | Description |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Existing | 5.0 MMcf/D | 25% | 10.0 Bcf | 0 | 100% | 8,908 | 1 | 1 | Long Life, Low Rate, Low OPEX Gas |
| 2 | Existing | 700 B/D | 30% | 1.75 MMB | 0 | 100% | 8,944 | 1 | 1 | Long Life, Low Rate, Low OPEX Oil |
| 3 | Existing | 7.5 MMcf/D | 27% | 15.0 Bcf | 0 | 100% | 10,401 | 1 | 1 | Long Life, Med. Rate, High OPEX Gas |
| 4 | Existing | 1000 B/D | 27% | 2.5 MMB | 0 | 100% | 1,233 | 1 | 1 | Long Life, Med. Rate, High OPEX Oil |
| 5 | Existing | 25 MMcf/D | 35% | 30.0 Bcf | 0 | 100% | 20,388 | 1 | 1 | Short Life, Med. Rate, Low OPEX Gas |
| 6 | Existing | 2500 B/D | 33% | 3.0 MMB | 0 | 100% | 26,579 | 1 | 1 | Short Life, Med. Rate, Low OPEX Oil |
| 7 | Existing | 50 MMcf/D | 30% | 50.0 Bcf | 0 | 100% | 20,196 | 1 | 1 | Short Life, High Rate, High OPEX Gas |
| 8 | Existing | 9000 B/D | 90% | 4.0 MMB | 0 | 100% | 30,086 | 1 | 1 | Short Life, High Rate, High OPEX Oil |
| 9 | Explor | 31 MMcf/D | 25% | 84.0 Bcf | 37,256 | 15% | 4,213 | 2 | 10 | High Risk, High Reward Gas; Inv. Spread 5 yrs, 3 yr Prod. Delay |
| 10 | Explor | 4450 B/D | 23% | 12.0 MMB | 37,256 | 12% | 4,504 | 2 | 10 | High Risk, High Reward Oil; Inv. Spread 5 yrs. |
| 11 | Explor | 18 MMcf/D | 25% | 42.0 Bcf | 37,256 | 38% | 4,930 | 2 | 10 | Med. Risk, Med Reward Gas; Inv. Spread 5 yrs, 1 yr Prod. Delay |
| 12 | Explor | 2220 B/D | 23% | 6.0 MMB | 37,256 | 25% | 5,227 | 2 | 10 | Med. Risk Medium Reward Oil; Inv. Spread 5 yrs. |
| 13 | Exploit | 7.8 MMcf/D | 25% | 21.0 Bcf | 37,256 | 68% | 2,957 | 2 | 10 | Low Risk Low Reward Gas; Inv. Spread 5 yrs. |
| 14 | Exploit | 1100 B/D | 23% | 3.0 MMB | 37,256 | 58% | 3,302 | 2 | 10 | Low Risk Low Reward Oil; Inv. Spread 5 yrs. |

FIG. 2

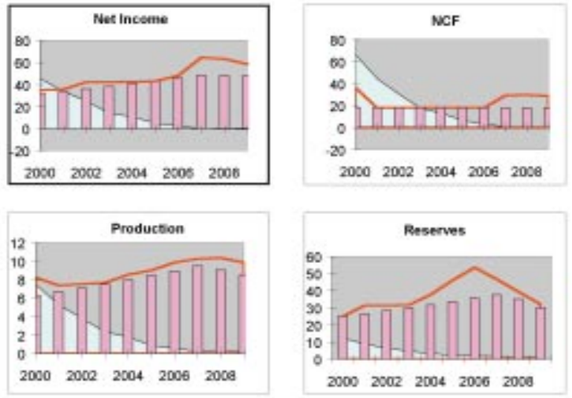


FIG. 3

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|---|
| Overhead | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Existing 1 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Existing 2 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Existing 3 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Existing 4 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Existing 5 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Existing 6 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Existing 7 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Existing 8 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Exploration 1 | 1.33 | 1.06 | 0.85 | 1.23 | 1.73 | 2.00 | 2.00 |
| Exploration 2 | 1.25 | 1.00 | 0.76 | 0.83 | 1.35 | 1.72 | 1.48 |
| Exploration 3 | 2.00 | 1.60 | 0.91 | 0.25 | 1.14 | 2.00 | 2.00 |
| Exploration 4 | 2.00 | 2.00 | 2.00 | 1.70 | 0.82 | 0.44 | 1.03 |
| Exploitation 1 | 2.00 | 1.48 | 0.00 | 0.52 | 2.00 | 2.00 | 2.00 |
| Exploitation 2 | 2.00 | 2.00 | 2.00 | 0.48 | 0.79 | 2.00 | 0.72 |

### Example Portfolio

As an example, let's assume that you must assemble a portfolio from the pool of producing properties and exploration prospects summarized in Fig. 1. Note that fractional projects are possible—think of these as joint interest projects. This portfolio could belong to a medium-sized independent, or it could be a division of a larger company. The scale is unimportant to the analysis—the same concepts apply whether we are considering companies for a mega-major or wells for a Mom and Pop small independent.

Your task is to maximize value while ensuring that corporate targets for net income, net cash flow, BOE production, and BOE reserves are met. In Fig. 2, corporate targets are shown as orange bars, the expected value performance of the selected portfolio is shown as a red line, and the base business (producing properties) is shown as a blue area for each of four corporate metrics. (Metrics are defined as the type of target goal being pursued. Net income is a metric, U.S. $30 million in year 1 is a target.) You have been able to schedule your projects within the constraints to meet the goals on an expected value basis (the red lines). Initial investments go out 7 years, while you track 10 years of performance. This explains the falloff in target values in the last 3 years. NPV at 10% of the portfolio illustrated is U.S. $310 million.

These results were achieved by drilling the exploration and exploitation "type projects" of Fig. 1 in the following order and interest (Fig. 3):

You have assembled a workable portfolio that meets all of your corporate targets on an expected-value basis, the board has bought off on your plan, and you appear to be growing the value of the company. You are confident of making your bonus, which is heavily weighted toward the net income target. Everything seems to be going well for once.

### Potential Acquisition

Meanwhile, outside of the portfolio/planning loop, Business Development has been looking at an acquisition opportunity. It is a partially developed gas field, with proved reserves of 35 Bcf. The property will require further investment of U.S. $5 million in each of the next two years. The seller isn't budging from a price of U.S. $36 million. The acquisition's profile is shown in Fig. 4.

At this price, the project has an NPV at 10% of U.S. $1.08 million, and an ROR of 8.7%. Since your cost of capital is 10%, clearly adding such a property will destroy value in your portfolio. Or will it?

### Portfolio Analysis

This problem was analyzed using a portfolio management model (Perspectives) that optimizes portfolio project timing and investment working interest based on risk/reward tradeoffs for multiple metrics, (i.e., project interactions.) Probability distributions for each project are generated using a Monte Carlo simulator, and this information is used in a lin-


FIG. 4

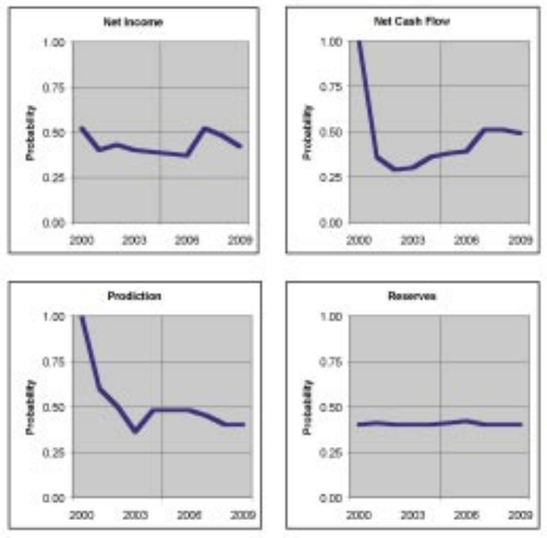


FIG. 5

ear programming routine to minimize risk at a given NPV, subject to the constraints of the various corporate goals.

One valuable piece of information that has been missing from our analysis to this point is the *probability* of achieving the various targets we have set for ourselves. The model described above allows us to calculate these probabilities. Up to now, we have been content with the fact that we were meeting the goals on an expected value basis. However, this is a rather small portfolio, heavily dependent on exploration because production from the existing properties is declining quickly. While our goals are being achieved on an expected-value basis, the annual probabilities of achieving these goals for the portfolio displayed in Figs. 2 and 3 are, in fact, discouragingly low, as shown in Fig. 5.

However, if we take on the proposed negative NPV acquisition, we can generate a new portfolio that has the same NPV (U.S. $310 million), but with the higher probabilities of meeting the four corporate targets. (Alternately, we could generate a higher NPV portfolio at the same risk, but since we are looking at four different metrics over 10 years, an exact match would be difficult to achieve.) The risk profile of the portfolio with this additional choice (the red line) is shown in Fig. 6.

Recall that we are under a minimum net cash flow constraint, so it is not as if we added the acquisition "for free." The acquisition displaced other, higher expected-value projects in the year it was purchased. How, then, can we add a project with a negative NPV to our portfolio and still raise the NPV (or lower the risk) of the whole? The answer lies in the interaction of the properties in the portfolio. The new portfolio is shown in Fig. 7. While there is no striking pattern to the realignment, The addition of the net income, net cash flow, production, and reserves attributable to the acquisition allowed the other projects to be rearranged in such a way that NPV could be maintained while risk was reduced. The negative NPV of the acquisition does not reduce the NPV of the portfolio because the property's characteristics allow other projects to be used more effectively.

## Conclusions

The point here is not that acquisitions are superior to exploration, or that low NPV acquisitions are always desirable. Each portfolio is unique, and each set of targets and projects will interact in a unique way. The lesson is that the interactivity among projects is often more important than the economics of the separate projects. Because of this interaction, hurdles do not screen out the projects that are not economical. They merely limit choices available to the model in trying to construct an interactive portfolio that meets all the company's goals. The higher the hurdle, the more limited the choices. In a similar way, rank tables do not rank projects in order of contribution to the portfolio. Projects' importance to the portfolio is a function of interactions between projects. Specifically, the importance is partly afunction of the goals you seek to achieve and partly a function of the other projects you have in your portfolio. This level of importance is often counter-intuitive. Much can be learned about your projects and your corporate goals by investigating these interactions from a portfolio perspective.

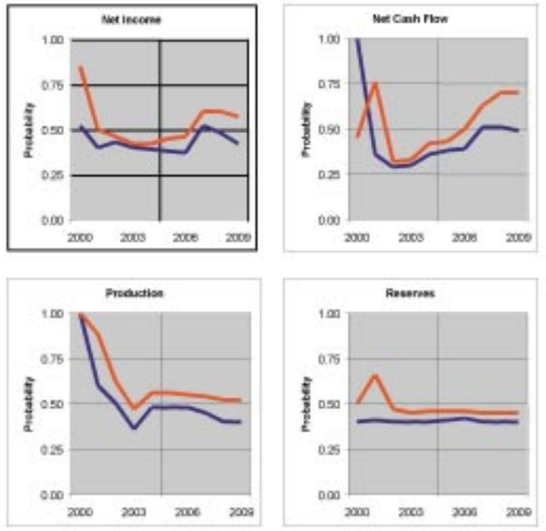


FIG. 6

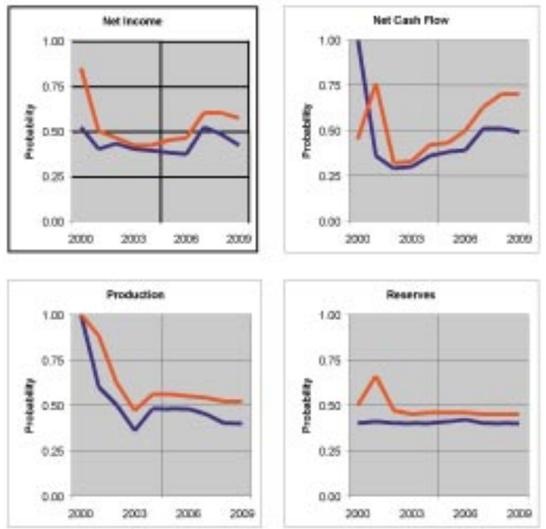


FIG. 7

This simple example illustrates the significance (and counterintuitive nature) of project interactions. Project interactions impact the business performance of all oil and gas companies. Unfortunately, when decisions are based on rank-tables and are made on a project-by-project basis, the impact of project interactions is not obvious. The impact of these interactions is often first seen as a "result" when quarterly or annual performance summaries are prepared.

Portfolio management provides decision-makers with the opportunity to describe and manage these interactions. As portfolios grow, interactive effects become more pronounced and more difficult to predict. Clear portfolio management can help decision-makers understand these interactions and thus make better decisions with a better understanding of the business performance impact of their decisions. Portfolio management will not resolve the decision-makers' dilemma. However, portfolio management can provide the decision-maker with concise, quantitative business performance assessments for each investment decision. Portfolio management will reduce the decision-makers' dilemma to selecting a preferred business performance option rather than just selecting investments.

John I. Howell III is the Founder and President of Portfolio Decisions Inc., a consulting practice designed to help oil and gas companies improve business performance by balancing risk, profit, and growth. He has lectured on portfolio management as a strategic tool at worldwide conferences for more than 8 years. Prior to starting PDI, Howell worked for Shell Oil for 21 years, holding technical, supervisory, and managerial positions in exploration and production.

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