
Asset Interplay Management™

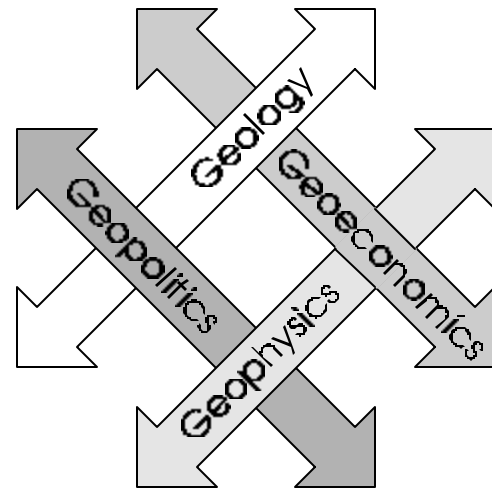
Increases Profit, Decreases Risk

Exploits Interplay of:

- Geology
- Geophysics
- Geoeconomics
- Geopolitics

“Companies and universities have begun...replacing ad hoc decisions with statistical approaches similar to those used in investment portfolio management.”

Oil & Gas Journal, May 20, 1996



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Revolutions in Exploration

In the 1950's, seismic data and the use of well logs yielded tremendous new insight into the Geological and Geophysical (G&G) foundations of petroleum exploration. This was followed in the 1980's by 3-Dimensional seismic imaging, and more recently by 4-D, which captures the flow of petroleum through a producing field over time. This second round of advances further increases the benefits of G&G.

According to a recent article in *Oil & Gas Journal* (May 20, 1996), "*The coming third leap ... will use sweeping, rather than targeted, integration to reap new benefits from 'informationalization'.*"

The article goes on to say that: "*Some companies and universities have begun ... replacing ad hoc decisions with statistical approaches similar to those used in investment portfolio management.*"

Holistic, not Hole-istic

Further advances in exploration management based solely on G&G will not reap the benefits of "informationalization" because they are **hole-istic**, that is, they assess prospects hole by hole, ignoring the crucial importance of the interplay among them. What is needed is a **holistic** approach that addresses the entire portfolio of potential prospects and current holdings.

Portfolio Optimization

Portfolio Optimization goes beyond selecting the best individual prospects by addressing the interplay among prospects. The focus is on how the portfolio as a whole, not any one prospect, behaves in an uncertain world. Instinct and practice to the contrary, **selecting the best prospects**

Selecting the best prospects usually does not result in the best portfolio.

usually does not result in the best portfolio!

An Example

The following example highlights the effects of ignoring the interplay among prospects.

Suppose you are responsible for investing \$10 MM in exploration. Two exploration prospects are available, each of which requires an investment of \$10MM. One is relatively "safe", the other relatively "risky". The chances of success are independent. All information is reflected in the table below.

		NPV	
	Outcome	\$MM	Probability
Safe	Dry Hole	-10	40%
	Success	50	60%
Risky	Dry Hole	-10	60%
	Success	80	40%

Expected Return

The expected returns of the prospects can be shown to be equal as follows:

$$\text{Safe: } 60\% \cdot 50 + 40\% \cdot (-10) = \$26 \text{ MM}$$

$$\text{Risky: } 40\% \cdot 80 + 60\% \cdot (-10) = \$26 \text{ MM}$$

Risk Considerations

Imagine that your continued employment depends on not losing money. You have only a 40% chance of losing your job with the safe prospect, and a 60% chance with the risky prospect. Since they both have the same expected return, intuition would lead us to invest the \$10MM in the safe prospect.

Suppose you could split your investment between the two prospects. Would it make sense to take some of your investment out of the safe prospect and put it in the risky one?

The Diversification Effect

If you split your investment evenly between the two prospects, you still have an expected return of \$26MM. But now the only way you can lose money is with two dry holes.

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This is where interplay comes in. Since the prospects are assumed to be independent, the

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probability of two dry holes is $40\% \times 60\% = 24\%$, cutting your risk of unemployment nearly in half!
Intuition misleads: You can actually reduce risk by taking money out of a safe prospect, and putting it in a risky one. This is known as the *diversification* effect.

The Correlation Effect

The above example assumes that the two prospects are independent. In general, the interplay between two prospects will be more complex, in that their economic outcomes are interrelated. This is known as the *correlation* effect, and comes in two varieties.

- **Positive Correlation** - The outcomes tend to move together. This diminishes the effect of diversification.
- **Negative Correlation** - The outcomes tend to move diametrically. This enhances the effect of diversification.

G & G & G & G

The interplay among prospects cannot be adequately modeled on a strictly Geological and Geophysical basis. It is crucial to address two additional G-Uncertainties that can simultaneously affect multiple prospects:

- **Geoeconomics**
involving uncertainties in oil and gas prices, and other global economic conditions and trends

and

- **Geopolitics**
involving uncertainties in politics, policy, and practices

Asset Interplay Management: AIM

History

Portfolio Optimization was first applied to the stock market in the 1950's by Harry Markowitz who received the Nobel Prize for this work. In 1983, Ben Ball, a retired Vice President of Gulf Oil Corp., and Adjunct Professor of Management and Engineering at MIT, published a seminal paper on transplanting the Markowitz theory from stocks to petroleum exploration sites. In 1990, Ben was joined by Dr. Sam L. Savage, a Consulting Professor of Operations Research at Stanford University, who developed a more accurate way to model the interplay among prospects. Working with clients in the field, Ball & Savage developed an approach built from the ground up on the characteristics of the upstream petroleum industry. The result is AIM, Asset Interplay Management.

What AIM Does

- Models the interplay among prospect due to Geology, Geophysics, Geoeconomics, and Geopolitics.
- Creates trade-off curves between risk and financial and other goals.
- Develops optimum portfolios of exploration prospects, given management's choice of trade-offs.

The ABC's of the AIM Process

A. Assess

- All assets (prospects and current holdings) are **assessed** on a geological and geophysical basis according to current practice.
- The potential interplay among assets is addressed through an array of global geoeconomic and geopolitical scenarios such as price swings, political turmoil, environmental legislation etc.

B. Balance

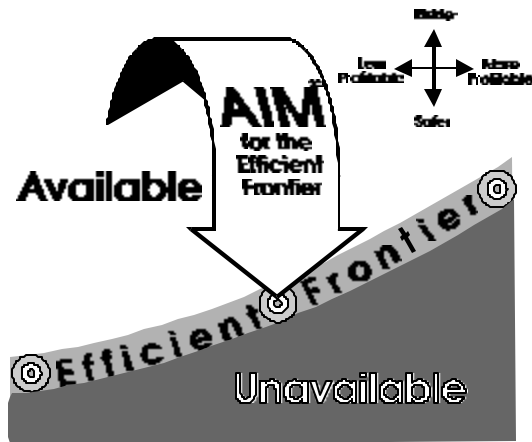
- Conflicting objectives are **balanced** off against one another using Exploration Portfolio LP Optimization Routines (ExPLOR™).
- The outputs are displayed in terms of trade-off curves; efficient frontiers relating net present value, risk, reserve additions, budget levels, etc.

C. Choose

Management **chooses** corporate direction which determines the portfolio and its associated prospects, instead of the other way around.

The Benefits of AIM

- AIM illuminates risk/return trade-offs hidden by the conventional industry practice of selecting prospects rather than portfolios.
- Awareness of these trade-offs provides a rational basis for corporate direction in an uncertain world.
- AIM increases profit without unnecessary risk through optimum portfolios of prospects.



Who We Are

Ben Ball and Sam Savage have a professional relationship dating from 1986. Since 1990 they have been working together in the area of portfolio optimization for petroleum exploration prospects.

Ben C. Ball, Jr. is an internationally recognized petroleum expert. For over twenty years he has consulted to several dozen firms on four continents, ranging from very small to extremely large, and to several governments and agencies—state, national, and international, in addition to serving as expert witness in several dozen cases. For the last twenty-three years he has also held teaching and research appointments at M.I.T., including that of Adjunct Professor of Management and Engineering.

Over 80 of his articles have appeared in technical, professional, and management journals and books, including *Harvard Business Review*, *Petroleum Management, Technology Review*, the *Journal of Petroleum Engineering*,

The conventional industry practice of selecting prospects rather than portfolios incurs unnecessary risk

Petroleum Engineer International, and the *European Journal of Operational Research*. His book, *Energy Aftermath*, which he co-authored with two M.I.T. colleagues, was published by Harvard Business School Press. He received BS and MS degrees in chemical engineering from M.I.T., and completed Harvard Graduate Business School's Advanced Management Program. He retired from Gulf Oil Corporation as Corporate Vice President after thirty years in operations and planning.

Dr. Sam L. Savage is Director of Industrial Affiliates for Stanford University's Department of Engineering Economic Systems & Operations. He received his Ph.D. in computer science from Yale University. After spending a year at General Motors Research Laboratory, he joined the faculty of the University of Chicago Graduate School of Business, with which he has been affiliated since 1994. In 1985 he led the development of a software package that couples linear programming to Lotus 1-2-3. This popular package, called *What's Best!* won *PC Magazine's* Technical Excellence Award in 1986. Sam consults widely and has served as an expert witness. His executive seminars offered to industry and government have been attended by over 2000.

Dr. Savage's *INSIGHT.xls, Business Analysis Software for Excel* published in February 1998 is receiving wide acclaim. In his foreword to this work, Harry Markowitz, Nobel Laureate in Economics, says, "Rarely has such sound theory been provided in such an entertaining manner." See www.AnalyCorp.com.

How We Can Work With You

- Ball & Savage Associates will explain Asset Interplay Management (AIM) in detail, and show how the conventional industry practice of selecting prospects rather than portfolios incurs unnecessary risk within your own organization.
- We will coordinate the AIM process among the required levels of your organization, from Executive Management through G&G and Engineering to Information Systems.
- We will work with you and, if necessary, other consultants to design and implement any required changes in your existing processes to assist you in taking greater advantage of Asset Interplay Management.