A Game Changer:

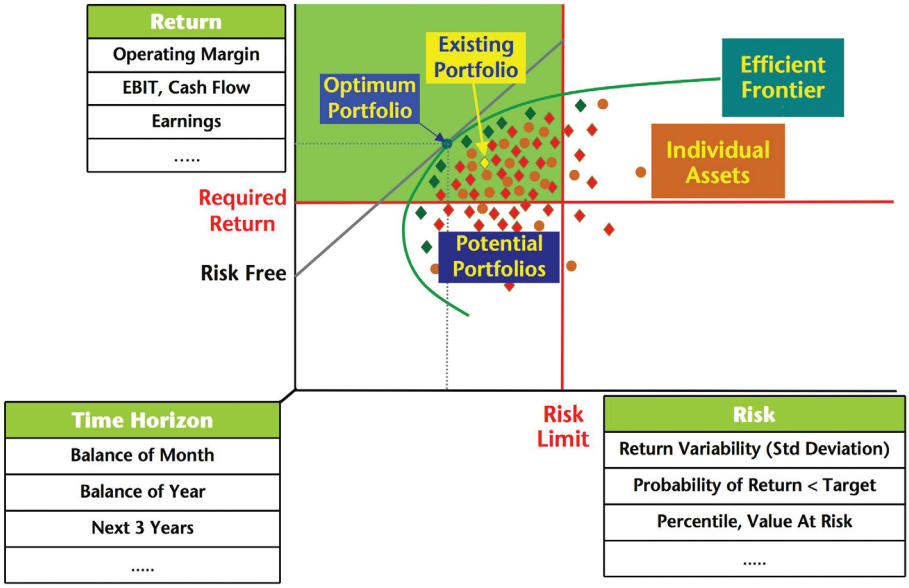
Full-Simulation Real-Time Portfolio Management

This article discusses new developments that enable the challenging application of modern portfolio theory in energy trading and risk management.

By Dr. Salim J. Jabbour

PORTFOLIO MANAGEMENT is a process through which a company estimates risks and returns of corporate assets and evaluates alternative decisions to improve its existing risk/reward position. In the 1950s, Harry M. Markowitz developed a new portfolio selection technique – known as Modern Portfolio Theory (MPT) – a concept that provided a foundation for many advances in the field of financial economics, including William Sharpe's Capital Asset Pricing Model (CAPM).

Figure 1: Efficient Frontier Portfolio Optimization



Source: Abacus Solutions Inc.

In 1990, Harry Markowitz, Merton Miller, and William Sharpe won the Nobel Memorial Prize in Economic Sciences. Using Modern Portfolio Theory, a portfolio manager can rigorously show how portfolio variance (i.e. risk) can be reduced through diversification.

According to a Forbes article (April 9th, 2009), "Modern portfolio theory preaches a wonderful sermon about diversifying away risk. In practice, it is harder done than said. The problem lies in the failure of theory practitioners to recognize and react to correlation factors, resulting in withering portfolios and the erosion of the true benefit of MPT: diversifying away risk".

Efficient Frontier

Diversification, the corner stone of Modern Portfolio Theory, is achieved by combining a number of individual assets that are weakly (preferably negatively) correlated among each other. The risk of the resulting portfolio is lower than the weighted average of the risks of individual assets.

Corporate requirements often include a risk limit and a minimum required rate of return. Figure 1 divides potential return-risk alternatives into four groups of assets based on their ability to meet a required return on investment without exceeding a risk limit. Three of the four groups are not acceptable as they fail to meet one or both of the risk and return requirements; only assets and portfolios that fall inside the top left quadrant (coloured green) meet both requirements and are acceptable.

Finding the most efficient / most optimised portfolios is a complicated process that requires extensive analysis that can be time consuming. Three building blocks are required:

1. Asset Valuation: A process through which the expected risks and returns of each asset are estimated. Asset or specific risk can be caused by many factors (including asset specific factors as well as market factors) and can be managed (reduced) through diversification.

2. Portfolio Valuation: A process through which the expected risk and return of a portfolio of assets is estimated. This process requires estimating correlations among various assets to determine how risks of individual assets impact each other, preferably reducing overall risk through weak and negative correlations.

3. Portfolio Optimization: A process through which potential portfolios are identified and their risks and returns calculated to identify a set of alternatives that offer the best risk/return

combinations; the best alternatives are a set of portfolios, called *Efficient Frontier*, that offer the maximum possible return for a given level of risk. An efficient frontier portfolio is one where no added diversification can lower portfolio risk for a given return expectation. Alternately, no additional expected return can be gained without increasing portfolio risk. The estimated risk of efficient frontier portfolios is called 'systematic' or 'market' risk that cannot be reduced through diversification.

After estimating the return/risk situation of an existing portfolio, managers search for changes to improve their position. They often explore many combinations of assets (i.e. portfolios) that fall inside the green quadrant before they select an alternative that meets corporate requirements. Due to many factors, including non-linear conditions and complicated inter-commodity and inter-temporal relationships, closed form analytical solutions are not adequate to find optimum portfolio alternatives. Full simulation is required to develop an acceptable number of realistic scenarios and to assess risks and returns of portfolio alternatives. This process is quite cumbersome and has been too challenging to be practical since the inception of MPT back in the middle of the last century.

Portfolio Management Applications

Portfolio management applications can be divided into two categories:

1. Short Term Applications: Short term portfolio management applications include operation and operation planning activities through which traders and asset managers seek to balance their portfolios, improve their expected profits, and/or reduce their expected risks. Trading decisions that can be optimised through a structured portfolio management process include position management in various markets, commodities, and time frames as well as credit risk management with various counterparties that have different risk profiles and circumstances. Short-term asset management decisions include generation production, outage management, fuel procurement, emission management, electric transmission, and fuel transportation management.

2. Long Term Applications: Long term portfolio management applications include capacity planning decisions (asset acquisition and disposition decisions) and miscellaneous strategic decisions.

Facilitating these decisions requires providing users with needed results for return, risk, and timeframe metrics.

1. Returns: Results can include financial metrics (e.g. Operating Margin, EBIT, Cash Flow, Net Income, etc.) and volumetric metrics (e.g. energy production, net position, fuel requirements, etc.).

2. Risks: Results can include return volatility, probability of meeting a target, specific percentiles for specific returns, expected loss, expected values of "extreme" outcomes, etc.

3. Timeframes: Metrics include balance of week, balance of month, balance of quarter, and balance of year for short-term applications and next few to 15-20 years for long-term applications.

Return, risk, and time metrics are multi-dimensional and vary significantly based on user needs and perspectives. Beside financial and volumetric short and long term measures, metrics span many functional areas including generation, trading, credit, and finance to name a few. Different users can have significantly different metric needs and preferences. Commodity Trading and Risk Management (CTRM) systems should therefore be totally configurable and should allow users to select needed metrics.

Implementation Challenges

A number of practical issues have limited the effective application of portfolio optimization to date in the energy industry. Implementing an efficient frontier portfolio optimization capability requires addressing four key challenges:

1. Broad Capabilities: A portfolio management process requires a broad set of applications to simulate reasonable scenarios, estimate asset risks and returns under different scenarios, estimate the risk/return position of the existing portfolio, and identify decisions to improve the existing risk/return position. Figure 2 overleaf outlines the following needed key applications:

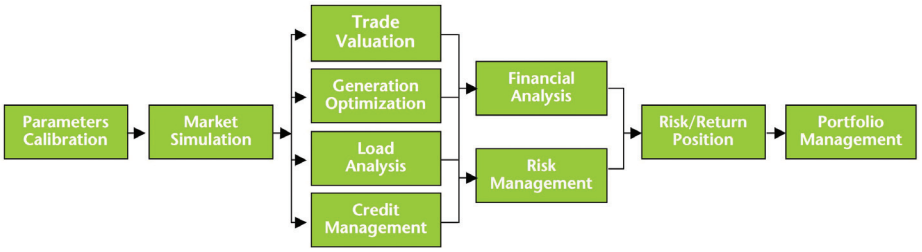
- Parameters calibration to estimate the simulation parameters needed by the stochastic simulation process.
- Market simulation to simulate forward and spot prices and market values for interrelated markets and commodities over an extended time period.
- Trade valuation tools to assess alternative return and risk metrics for generation units, trades, loads, and other assets.
- Generation optimization to simulate the operations of a fleet of power plants under different market prices and various unit, plant, and portfolio operating limits and availability scenarios.
- Load analysis to estimate gas and electric loads for a set of customer classes in one or multiple locations for a specific time frame.
- Credit risk management to evaluate the credit rating of counterparties and estimate the

impacts of potential credit changes including counterparty, collateral, contract, and exposure risks.
- Financial analysis to estimate revenues, costs, profits, and various key financial measures for different scenarios.
- Risk management to calculate various risk measures for multiple volumetric and financial metrics needed for making decisions.
- Optimization tools to identify realistic and practical changes that can increase portfolio return and/or reduce its risk.

2. Computational Capability: A computational infrastructure is needed to enable the performance of needed simulations and analysis within a reasonable time. Computational issues are the most significant challenge facing the implementation of portfolio management in the energy industry due to two main reasons:
- Stochastic simulation is by itself a major challenge given the complexity associated with simulating physical assets, a process that can be quite difficult to accomplish within a reasonable runtime (particularly for a reasonable number of scenarios).
- Identifying a reasonable set of portfolio changes that have the potential of reducing estimated portfolio risk and/or improving estimated portfolio returns. Stochastic simulation of a number of alternative portfolios, a process that builds on the stochastic simulation of the existing portfolio, creates additional computational challenges that include both runtime and data management issues.

3. Rigorous Analytics: Rigorous solutions are extremely important in risk management. While lack of rigor can simply imply a lack of accuracy or precision in many cases, the case is unfortunately considerably more complicated and serious in risk management where inadequate attention to analytical rigor can create misinformation and misleading answers. As discussed earlier, risk and portfolio management is a process that capitalizes on correlations and diversification; poor representation and handling of this core concept can lead to wrong solutions and bad outcomes. The challenge is to find a delicate balance that enables good analytics while avoiding the rather common and notorious trap of paralysis by analysis.

Figure 2: Portfolio Management Applications



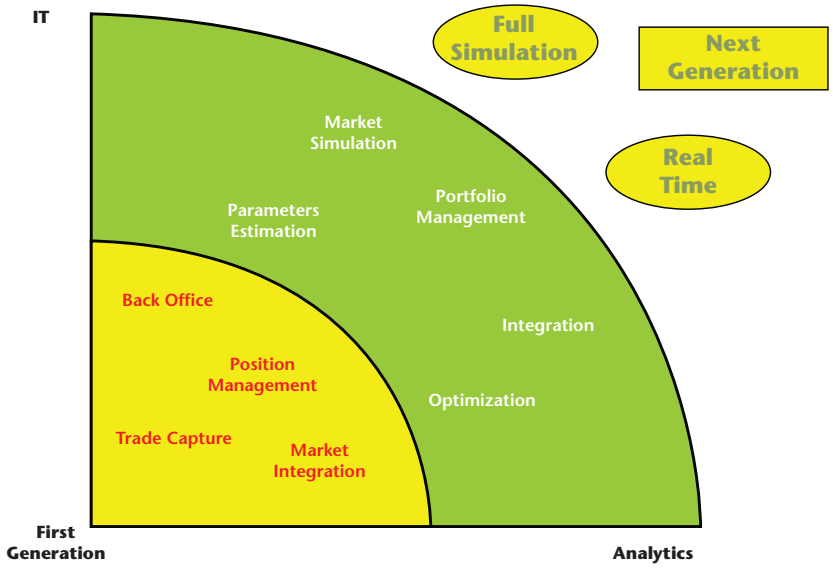
Source: Abacus Solutions Inc.

4. Integrated Solutions: The energy trading and risk management space continues to rely on too many applications that are often poorly integrated. Lack of integration can lead to costly inefficiencies, risky inconsistencies, and very difficult situations. Most efforts to integrate disparate systems often face insurmountable challenges and fail to achieve needed objectives; resulting outcomes range from "flawed integration" where inconsistent data is meshed into an illogical nonsensical and unrealistic perspective to "spreadsheet integration" where a set of tools (often spreadsheets) are used to consolidate and reconcile different solutions from different tools and applications. None of these approaches solve the integration challenge and most are prone to serious errors and mistakes. A seamless integrated solution avoids all of these challenges by offering multiple applications with consistent data structures, reconciled analytics, rigorous solutions, and logical interoperability on a single platform.

Second Generation CTRM

First generation energy/commodity trading and risk management systems trace their beginnings

Figure 3: Second Generation CTRM Systems



Source: Abacus Solutions Inc.

Figure 4: Real-Time Full Simulation Portfolio Management
A Game Changer

Source: Abacus Solutions Inc.

to the last decade of the last century; almost all commercial ETRM/CTRM systems were developed during the 1990s using 32-bit architecture and serial programming methods. The focus was mostly on transactional needs, a set of requirements driven by the introduction of trading to the vertically integrated utility industry. Recent developments in information technology (such as 64-bit architecture, parallel processing, and grid computing) and heightened interests in rigorous risk management methods needed to meet increased markets volatility and increased regulatory and management scrutiny, made legacy first generation systems outdated and unable to meet evolving industry needs. A second generation CTRM technology was recently introduced to the energy trading space, a technology that capitalizes on recent hardware/software advances and offers computational and performance capabilities that enable the much needed real time full simulation portfolio management needs. As illustrated in Figure 3, this next generation technology embodies new and advanced applications needed to support the integrated requirements of portfolio management.

Looking Ahead

Senior management and corporate directors are raising the bar on risk managers. Recent market turbulence and on-going market volatility have heightened the importance of efficient and effective risk management practices, a situation that requires and necessitates the use of improved tools and techniques. Recent advances and innovations are enabling integrated real-time full simulation risk and portfolio management (Figure 4). Management expects solid well founded solutions and they expect them when they ask for them – in real-time. •

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SATURN: A Game Changer

SATURN is a web-based integrated enterprise commodity transaction and risk management system, offering decision support capabilities and unique real-time full simulation portfolio management. SATURN is viewed as a game changer technology, primarily because it enables much needed important applications that have not been achievable despite many attempts in recent years. SATURN's unique capabilities can be attributed to four differentiating features:

1. SATURN is a fully integrated system that offers broad applications including trade capture and valuation, market simulation, parameter calibration, generation optimization, load analysis, credit management, business intelligence, financial analysis, risk management, and portfolio optimization.
2. SATURN has a set of full simulation and optimization capabilities that enable superior and rigorous solutions including advanced Efficient Frontier portfolio management and optimization.
3. SATURN is based on a modern architecture that makes it easy to deploy, easy to maintain, and an easy to use system in addition to providing on command vertical and horizontal scalability.
4. SATURN delivers superior performance that enables the processing of large amounts of data very quickly and facilitates key applications in real time or near real time.

SATURN uses very efficient optimization techniques that enable finding solutions extremely fast; according to several benchmarks, SATURN is 50-100 times faster than competing tools. Equally importantly, SATURN uses a 64-bit architecture that enables holding over 100 times more data in system memory than legacy 32-bit systems and then retrieving it extremely fast for real time processing.

SATURN's ability to offer sophisticated full simulation portfolio optimization solutions in real time is a significant breakthrough and a game changer. SATURN embodies proprietary methods that blend theoretic techniques and practical insights which enable finding optimised solutions very efficiently and therefore quickly. SATURN users can perform real-time on the fly portfolio optimization using a full simulation solution, a process that typically takes many hours (even days) and requires many powerful computers. Finding these solutions very quickly facilitates improved trading decisions that improve portfolio returns and/or reduce portfolio risks.