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# Investment Portfolio Data Management

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## Introduction

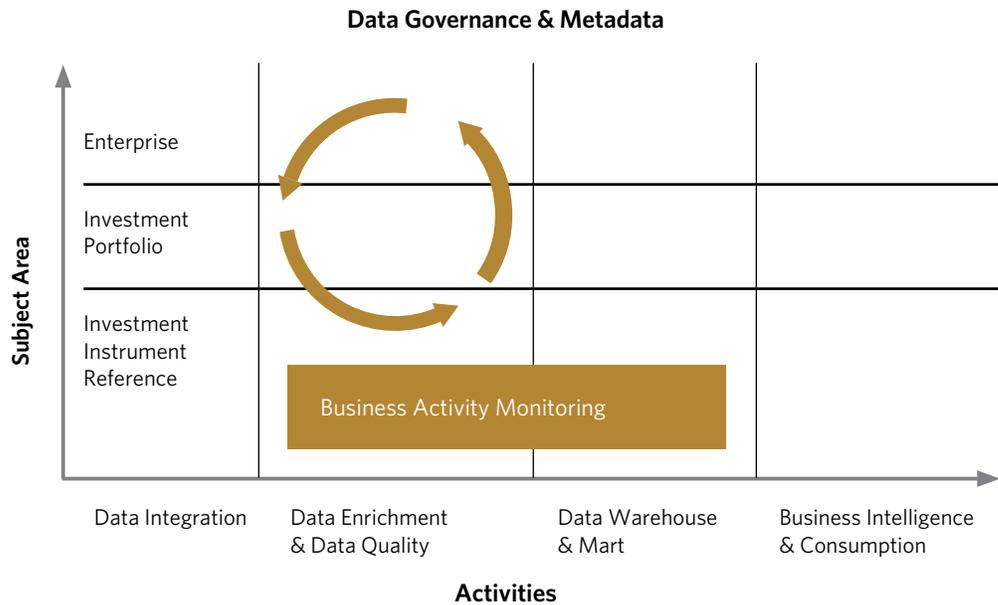
What is it about managing portfolios that leads to a characteristic set of data management requirements? Most significantly, it is that investors demand elaborate investment accounting and sophisticated performance measurement to achieve total return or mandate-specific return objectives, protecting themselves from unfavorable outcomes as they entrust their wealth to hired managers. Deriving from investor protection considerations, portfolio data discipline is imposed from the outside by industry and regulatory standards like GIPS®, Sarbanes-Oxley and Solvency II. Beyond its consumer protection role, investment portfolio data helps fund managers devise and direct an investment process that underpins a competitive offering to the marketplace.

Here we will examine the particulars of data management among investment managers. Fortunately there is a useful framework available to us as we pursue our analysis. The data management task in investment institutions may be characterized as a matrix of activities operating on subject areas. Figure 1, taken from a recent Eagle Investment Systems white paper that deconstructs the data management task in financial institutions<sup>1</sup>, depicts the matrix.



# Introduction

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*Figure 1: Data Management Subjects and Activities for Investment Institutions*

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Three subject areas form the vertical dimension in the figure. First, Investment Instrument Reference Data Management faces the external environment—the full spectrum of factual and subjective information regarding securities and their issuers and counterparties. If we move our perspective toward what clients own and what managers do, we enter the world of Investment Portfolio Data Management. Finally, Enterprise Data Management concerns the firm’s supporting business activities such as trading, risk and compliance, finance, human resources, sales and research.

Within each of these spheres we find essentially the same set of data management activities shown on the horizontal of the figure:

- Data Integration maps and moves data between stores;
- Data Quality establishes validity in the data to ensure its credibility;
- Data Enrichment aggregates and infers to promote analytical insight;
- Business Intelligence frames questions and helps the business to find answers.

Pervading all these activities are three unifying processes put in place to ensure their success. The first of these is Data Governance, or how the business organizes its efforts and assigns responsibilities to succeed in all its data management work. Secondly, meta data or “data about data” creates opportunities to add flexibility and consistency in deployment of the data asset across the enterprise. The third process is Business Activity Monitoring, the mechanics of conducting data management activities on a daily basis under comprehensive process controls.

This paper takes the subjects/activities matrix as a point of departure to focus primarily upon the middle slice —Investment Portfolio Data Management. We do not elaborate further upon how the framework applies to this slice. Rather, we seek to identify the distinguishing characteristics of the investment portfolio subject that determine how the four key activities must be organized to support the particular needs of this industry. A deeper understanding of data management challenges faced by this industry can inform our understanding of how investment management organizations can direct their data management resources and programs toward goals of efficiency, compliance and growth.

As we examine factors that make investment portfolio data management unique, we will organize our analysis according to the four data management activities cited above. This approach clarifies the uniqueness of data management in this business while mapping each activity to the common data management tasks of all financial institutions.

## Distinguishing Characteristics of The Industry

The investment portfolio data resource is typically a massive and multi-dimensional one, owing to the compounding of several factors. Hundreds of different securities must be held in client portfolios so that the law of large numbers through diversification can mitigate the risk of loss as managers pursue a variety of strategic mandates and sector concentrations. Thousands more securities must be monitored for potential future use. The industry is quite fragmented in numbers and types of service providers playing various roles—brokers, custodians, fund managers—and each of them establishes a sometimes highly individualistic data source. Reams of analytical information are acquired and further developed internally. Since analytical value is a subjective matter, firms collect a lot of it in hopes that a signal will emerge from the noise. A time dimension figures prominently as well. In a dynamic global investment marketplace, portfolios cannot simply be created and left alone, but must be tweaked and trimmed constantly in response to a steady stream of external shocks and internal course corrections. From this dynamism it follows that investment recordkeeping means maintenance of long periods of history. Firms commonly maintain daily data stretching back as much as a year, as well as monthly data for their longest-tenured client on the books, which may have been incepted during the Eisenhower administration or, in the case of some mutual funds, the Roosevelt era.

Adding to the challenges confronting investment portfolio data stewards is that this mountain of information for which they are responsible has an intricate internal logic. Internal inconsistencies among component parts can severely compromise data credibility and thus usability of the entire data resource. This would be bad enough if investment information was simply a record of what happened in the past. But in this industry, data is much more—it is the best available means of successfully navigating toward the future. If the firm loses data integrity, it loses its compass.

In some industries, it is enough that data be complete and clean. In investment management, it must also be meaningful. Some of the basic facts that come in the door each day do qualify by this standard—the name of a security's issuer or its price. But for many business users and clients of the firm, meaning is not achieved in the data without considerable processing to aggregate, infer and otherwise enrich to produce derived data that is easier to interpret. In performance measurement, at the extreme, the basic facts of daily security-level returns are themselves of limited utility. However, performance analysts feed great quantities of these daily facts into a highly complex analytical mill that turns out insights into whether the investment process has added value for this customer during that time span.

There is yet more bad news for investment portfolio data stewards. Consumers of portfolio information within the firm are highly paid resources working under time pressures that can be severe. It is not enough that their information be accurate and meaningful. It must be easy to access and quick to arrive when ordered. Information that is hard to find or slow in coming will simply not be used, and may well tempt a search for unauthorized alternatives that leave the firm vulnerable to information risks. Probably the most common of these risks arises from overuse of spreadsheets, where critical enterprise data transformations may be taking place with no transparency or quality monitoring. This phenomenon, which has taken on the label "Excel hell", is a key red flag for firms as they navigate the regulatory standards mentioned at the beginning of this section.

# Implications For Investment Portfolio

## Data Management

So volumes, rules, enrichment and speed form the backdrop of investment portfolio data management. We can examine these challenges more closely within the framework.

### Data Integration

The first of the four investment data management activities, data integration, moves data to the firm's own data store. We have cited the basic reasons for the very high volumes that investment firms must accommodate. A closer look at data integration challenges contributing to high volumes focuses on the two major data classifications.

#### Investment Instrument Reference Data

An investment organization's first data management challenge is to comprehend the environment of securities, issuers, analytics, ratings and prices. Securities on record may number upwards of 100,000 or even millions in the case of global fixed income managers. Investment instrument reference data originates in dimensions of subject matter and geography, and the firm must deal with numerous providers to assemble all it needs.

#### Security Identifiers

While there are industry-standard security identifiers, there are several coexisting standards necessitating careful cross-referencing across several identification schemes. Each day new securities are issued, existing ones disappear in maturity or merger, and others change their identifier as issuers reorganize. All of these events must be recognized immediately and correctly for what they are, and appropriate action taken to mark changes to existing identifiers and initiate new ones.

#### Pricing Data

In theory, every security reprices every time it is traded. Trading frequency ranges from extremely high to almost never, but firms must arrive at a satisfactory daily price at least for every held security in order to value their managed portfolios every trading day. Insurance companies price officially on a monthly basis but must support daily portfolio management. Firms investing globally receive prices originating in dozens of exchanges and time zones, and quoted in multiple versions such as bid, asked and closing.

Where trading is thin and prices are difficult to establish, firms must resort to estimation methods based upon available data. The Financial Accounting Standards Board (FASB) in its Topic 820 (formerly FAS 157) guidelines requires that assets be assigned their "fair value." FASB and its international counterpart IASB are cooperating to achieve common fair value guidelines. Both American and European mutual fund authorities employ fair value concepts in their regulations. But what value is fair? The ideal yardstick is market pricing (adjusted for trading costs) in an active market where the asset could readily be traded. Barring such a market, "market observables" must be incorporated where possible into a fair value estimate. For example, seldom-traded or privately placed debt may require price estimates that take the current government bond yield for a like maturity, tack on a typical "spread" to

arrive at the bond's implied yield, and use the standard yield-to-price relationship to arrive at the price estimate. Price data vendors offer security coverage that can be comprehensive, but their investment manager clients develop opinions as to the different quality of quotes in different categories. Multiple pricing sources may thus be used in a best of breed approach. Exchange rates are similar to prices for reference data purposes, and are apt to be subjected to rule-based selection in order to arrive at a gold copy that mediates among sources.

### **Analytical Data**

Analytical data such as ratings, statistical estimates of risk and yield calculations are a mix of the objective and the subjective. Even objective data such as financial statement ratios have a subjective aspect in that they are normally considered helpful but not conclusive in guiding investment decisions. Firms typically collect long lists of analytical measures from several different sources in an evidence-building or triangulation approach. This data-focused approach lets firms describe their investment processes as "thorough" or "multidisciplinary."

### **Investment Portfolio Data**

In this paper we take a middle-front office perspective and define portfolio management activities as including portfolio analysis, performance and risk measurement, and information delivery. We exclude portfolio construction, modeling, pre-trade compliance, execution and portfolio accounting. Actually these are somewhat arbitrary distinctions in that data circulates through all the "offices" every day. Good reference and portfolio data management is critical for ensuring that consistent information is shared with the front office and business users alike. For example, data cleansing in an automated, rules-based workflow can deliver securities and positions that are ready for compliance testing with no interruption of the trading process. Similarly, portfolio managers can only be confident they are properly executing their investment strategies if they have a clear picture of their current deployments and exposures, regardless of the complexity of instruments and portfolio structures. Risk management systems require the same high quality information. But purely to keep a manageable scope for this discussion we will focus upon the Investment Portfolio Data Management that begins its work post-trade, after receiving an update of fund holdings and transactions from an accounting system.

Before we examine some of the data management challenges presented by portfolio accounting, we must note that investment managers are challenged even to establish the new day's accounts in time to meet their daily workflow needs. Each morning managers require a picture of their funds reflecting yesterday's trades and cash movements but updating prices and corporate actions (splits, mergers, etc.) to reflect all of what is known about the new day. However, securities custodians keep their books only on the basis of what has happened, so that, for instance, a split to occur today will not be reflected until end of day when the event is official. This time lag induced by custodian practices has required investment managers to resort to shadow accounting practices that establish the accounts with a perspective they can use to launch their day's trading. Providers are beginning to respond to this need with services that make the necessary adjustments to achieve the start of day view.

Since most larger and some smaller firms receive data from multiple different accounting systems, investment portfolio data management must establish a common data model and then align all sources to it. This may call for data loads to follow an intricate mapping from source fields to the aligned target set. For example, one accounting source may have a single list of transaction types and another source a hierarchy of types and subtypes. If the common data model uses a single set of types, the type/subtype system must be mapped to a single list of types in a way that achieves consistency with the first source. The mapping must be modified if the source accounting system or the target model change their data definitions.

In some applications accounting is performed under alternative sets of accounting rules (say, Generally Accepted Accounting Principles or International Financial Reporting Standards) or event-recognition perspectives such as trade date versus settlement date. Business users may require that both versions be maintained. Accounting sources can multiply just like investment instrument reference data sources.

Accounting further challenges investment portfolio data management in its use of investment instrument reference data. Especially when a security is newly issued or otherwise has undergone a change of identifier, accounts may use a temporary identifier until their own reference data sources can process the change. But firms must hold to the principle that their own reference data establishes the standard, and accounting input must reflect that standard, be clearly mapped to it, or be "failed." This discipline is a good example of a way in which firms monitor and preserve the internal logic of investment management data.

Data conflicts may arise even from the basic definition of a portfolio. Accounting for a pension fund may arrive from the custodian that splits portfolios along asset class lines, or reports cash in an omnibus account. The parts may then need to be reassembled correctly in the data load phase to be correct at the pension fund level.

### **Data Quality**

The rules that form the internal logic of the investment portfolio dataset are well understood. Trades must add up to positions, accruals must drop when income arrives, market values must reflect current prices, and the like. Challenges in this sphere arise primarily in the effective detection of rule violations, and setup of workflows that automate a complete program of monitoring, notification and error correction.

Investment portfolio data quality issues arise primarily for two reasons. First, data may be received and loaded in erroneous condition, despite checks run at load time. Error checking can be particularly difficult since a data point may not be faulty in isolation, but only in context. Nothing is odd about a 1000-share position unless it was 100 shares yesterday and no transaction activity can account for the change. A second source of quality problems lies in the fact that in this business, history is constantly being rewritten. Late accounting events and reference data corrections arrive at random and upset the internal logic. Those changes

must be detected and appropriate reprocessing initiated very rapidly. A valid change not fully incorporated at every point can leave data errors where corrections have simply not caught up with the event. Probably the greatest data quality challenge that managers face arises from the multiplicity of players having a say as to what portfolios own and what managers have traded. Managers maintain systems that let them enter and track the orders they send to brokers. Those trade order management systems then feed accounting systems with executed trades to render an accounting book of record. But custodians and brokers maintain their own versions of the story, which could contradict details of the managers' records. Conflicts of this type must naturally be resolved quickly and accurately, a mandate that gives rise to one of the most demanding functions of managers' middle offices—broker and custodian reconciliation.

The internal logic of portfolios interferes with a simple batch processing approach to integrating accounting data, especially positions. Once a fund's positions are loaded, a check must be run to verify performance results for that security and all rollups within the fund. Nothing short of a full rollback of that fund's load can be accepted, pending resolution.

It might be assumed that all such data quality lapses should receive instant remediation, but that would ignore the human need for a consistent picture under a known set of assumptions. Cognitive processes are challenged by a view that is constantly in flux. Firms routinely isolate their clients from changes occurring after reports are issued, if it is possible to reflect changes in the next period's report. Internal users as well may prefer to use a data snapshot reliably reflecting the world at 10am in preference to seeing a report subject to small changes every time it is run. This preference can vary according to user persona within the firm. A fund manager may demand un-buffered data updates for time-critical trading purposes, while a risk manager might prefer a more stable picture that benefits from comprehensive data validation and enrichment processes.

Error detection and correction must take place within a well-defined workflow comprising several elements. Key stakeholders must be notified when data quality is compromised to alert them to take action (or suspend follow-on workflows) where appropriate. This is especially true when repair requires manual intervention or managerial judgment as to the best course of action. As remediation takes place, approvals may need to be formally recorded at successively higher levels of management before data can be judged publishable to this or that consumer group. Given a complex data quality process and very high volumes, automation of control handoffs and status monitoring are likely to be essential.

Complicating the firm's efforts to manage data status within the quality workflow is the notion of data "fit for purpose." Not every use of data requires passage of every quality assurance hurdle, and time pressures may dictate data deployment for some purposes without all of the testing required for others. For example, fund managers may require only a minimum set of security validations to do the job of identifying an asset and its basic descriptors, while all checks must pass before the same asset is released for client reporting where analytics and performance returns are displayed for external consumption. Managers may devise unique ways to classify portfolios in order to demonstrate their success at adding value, but at the same time challenging automated data validation processes.

## Data Enrichment

We have stated that Investment Portfolio Data Management must enrich in order to extract meaning from a mountain of data. Enrichment is done along several dimensions and at several levels.

The first step is the most basic enrichment of original sources during data load that unpacks and parses simply to isolate individual data points for storage. Flags are set. Sources and update times are noted. But this ETL activity is minimal processing, and much still remains to be done.

### Enrichment at the Field Level

Most of the serious enrichment work takes place at the individual field level, as one or more measures are combined in some way to produce other more useful ones. Aggregation is the most basic of these processes. Since investment quantities are what statisticians call “random variables,” field-level aggregation seeks central tendency, dispersion and trends. Summarization views data fields in two ways. First, it sees them vertically within a portfolio, such as the sum of position market values at a point in time. Second, it views them horizontally across time for a given security, for example, in a stock’s standard deviation of price during the past year. Aggregation of a field may also take place after the portfolio is grouped within a hierarchy of characteristics, for example, asset type, country and industry. Group aggregation requires loading and maintenance of all such characteristics for every owned or traded security. Data gaps will inevitably appear for particular securities or time periods, requiring that aggregation methods either adapt or produce a “N/A” result according to rules that are not necessarily industry-standard but must still be accepted by clients and other external recipients of the information.

Analysts trying to describe investment portfolios lack the neat absolute standards of, say, chemists, who can reduce any substance to its molecular structure, specific gravity and the like. Instead, funds must be measured in relative terms, using as standards hypothetical portfolios that one could construct by mechanical means, known as indexes. This requires firms to add index information to their complement of reference data. Indexes are awkward to manage in that they are neither securities nor portfolios, but have characteristics of both. Some index comparisons are conducted only at summary levels, but the insights offered by indexes are richest when all the securities that comprise them, or their “constituents,” are included in the analysis. Managing index constituents requires periodic update of weights sourced from commercial data vendors, not accounting systems. In order to compare portfolios to indexes, data managers must determine and physically establish these portfolio/index associations in the data. In some cases the portfolio’s internal structure is complex enough that it is only comparable to a hybrid mix of indexes. This can necessitate an elaborate procedure to synthesize hypothetical “custom” indexes as blends of multiple market indexes.

In their mission to preserve and grow client wealth while minimizing risks, portfolio managers have increasingly exploited opportunities offered by derivative investments. Derivatives are contractual agreements about securities rather than securities themselves.

This fact requires investment portfolio data management to widen its definition of an investment and broaden the scope of enrichment to make abstract agreements meaningful. Unfortunately, conventional portfolio accounting offers little help in the effort to make derivatives even comparable to other types of investments. For one thing, derivative agreements appear in the accounts isolated from the real securities upon which they depend, leaving it to data managers to clarify those dependencies. Two examples of those relationships are the links between a futures contract and its underlying index, or between an equity swap contract and a basket of securities comprising its “equity leg”. In the latter case, the basket with contents not explicitly included in the accounting may not even be physical but rather conceptual like an index. A second challenge arises from accounting’s approach to ascribing market value to an investment. One key objective of investment portfolio data enrichment is to gauge the extent of “exposure,” or the deployment of wealth to different markets whose fortunes thus determine the portfolio’s fluctuations in value. The usual metric for assessing exposure is accounting market value, and this is valid for non-derivative investments. However, accounting’s focus upon value inherent in the derivative contract itself will mask how the agreement entails significant exposure to particular sectors of the market as gross effects. Enrichment can’t achieve meaningful exposure information without establishing linkages to the securities underlying the contracts and calculating their “exposure values,” the market values of the underlyings whose fluctuations are the true determinants of contract profit and loss.

Another field-level enrichment often necessitated by investment client demand is exchange-rate conversion to a currency not considered the “base” currency by accounting. Accounting for multicurrency portfolios typically reports values and trades in both the currency of the security’s exchange and the “base” currency in which the portfolio’s owner spends income and other cash that the fund might throw off. However, some firms require translation to yet a third currency to enable aggregation of a group of funds having multiple different bases. This requirement necessitates conversion of values to the new base before reporting can take place. If conversion is done at report time, latency in reporting is introduced. Alternatively, if values are converted and stored in databases for subsequent rendering on reports, the data model must somehow accommodate them and clearly identify them as being distinct from the primary accounts of record.

### **Enrichment at the Fund Level**

Clearly field-level enrichment is a complex process, but the mandate to enrich does not end there. Every firm must also enrich data at a summary level, with a scope that incorporates groups of holdings or even the entire portfolio.

The simplest example of fund-level enrichment is portfolio compositing. This is the process of building synthetic portfolios as combinations of actual portfolios. Compositing can add meaning if, for example, an investment strategy cannot be sufficiently understood or evaluated by analysis of just one representative portfolio. Thus compositing can be seen as yet another way to let the law of large numbers find a signal in a noisy system. Once the composite is defined as to its member funds, data must be created for the composite,

either in the data store or at report time, reflecting alignment with the investment portfolio data model to permit ease of information delivery and comparisons. The performance measurement profession, in its Global Investment Performance Standards (GIPS®), has established detailed rules governing construction and maintenance of composites whose performance can be reported in advertising and sales presentations. Once compositing has been done, standard field-level enrichment can be conducted at the level of the composite “portfolio.” However, part of the enrichment task is profiling of composite members in cross-sectional terms, such as the dispersion of rate of return across members, or the maximum and minimum levels of members’ average price/earnings ratios. For portfolios that own “securitized funds” such as exchange-traded funds, or invest in derivatives that give exposure to market indexes such as the S&P 500, a valuable fund-level enrichment is to recast the portfolio in terms of its component regular securities only. This is “look-through analysis” where we do that math that breaks the shells of owned funds and indexes to see the securities held within them. Only by looking through can we accurately measure portfolio traits arising from security characteristics like sector membership or bond duration. Look-through enrichment must process all owned securitized funds, which may be several in number and nested to multiple levels. This is another example of an enrichment for analytical or performance purposes in which the accounting records mask information vital to the firm.

## **Special Considerations for Performance Measurement**

### **Derivatives Exposure Values**

Performance measurement makes heavy use of accounting data, but there are important differences in how performance analysts and accountants view the world. These differences lead to special data management activities to accommodate performance reporting. Two prominent examples are derivatives performance analysis and measuring returns on portfolios including cash. We have mentioned how some widely used types of derivatives are not well described by the accounting view of their contracts, and this is especially true in measuring the performance of those contracts. The so-called “exposure values” of the securities underlying options and futures must be calculated before sensible rates of return may be produced.

### **Returns Including Cash Balances**

Rate of return calculation for the portfolio inclusive of cash requires a significant enrichment of the accounting data that goes into the calculation. Why measure performance inclusive of cash balances? The reason is that the share of a portfolio’s value held in cash significantly affects its performance. We raise cash to be more defensive or reduce it to be more aggressive in our asset deployment. To understand the data enrichment necessary to include cash in our portfolio return calculation, we first focus upon the calculation formula itself. The rate of return of an investment over a certain period of time is a fraction. The numerator consists of the increase in the portfolio’s value during the period plus any income received. The denominator consists of the amount that was invested during the period to earn this return. We convert the fraction to a percent to get the familiar rate of return.

Portfolio transactions during the period affect the return fraction. If we buy more of a security we must add the value of that purchase to the denominator (invested amount). If we fail to do so, then the bought security's addition to ending value will look like a positive return, which it is not. Similarly, if we sell some of the investment or take income out of it, we must add back those amounts to the numerator or their impact to reduce ending value will look like losses, which they are not.

Thus far our return formula is fine for a single security investment like a stock or bond. But we want to measure return on the entire portfolio inclusive of cash because of the importance of cash in investment strategy. At the portfolio level, buys and sells are just reallocations of our funds between securities and cash. The buys do not increase total fund invested capital, and the sells do not decrease total fund value at end of period. However, accounting transactions do not include these balancing flows of cash, so we must create them in order to do performance return calculation at the fund level. As we track our security transactions to measure return, we must somehow account for the fact that every security transaction like a buy or a sell is settled with a cash transaction in the opposite direction. But whereas performance measurement standards see the trade date of a security transaction as its "effective date," physical cash settlements occur some days later, on settlement date. Moreover, cash settlements typically cover the net of multiple recent trades, making it impractical to match individual cash settlements to their original security transactions. Thus, accounting standards conflict with performance measurement standards as to the timing of cash flows related to security transactions.

To maintain consistency with its trade date standard, performance measurement practice requires firms to create an offsetting cash transaction for every security transaction on the latter's trade date. This is the data enrichment required for performance, and it is a significant one, resulting in as many synthetic cash flow transactions as there are actual security transactions. Cash-only transactions such as contributions and withdrawals do not require synthetic transactions, as cash movement occurs on the same date for both trade and settlement purposes. When reporting cash movements purely as accounting events, we must be careful to exclude the synthetic performance-driven cash flows.

### **Business Intelligence**

Business intelligence (BI) conceptualizes a complex dataset as a set of "fact tables" of information sought by business users to be examined from all angles with the aid of "dimension tables" of the stable descriptors that are the typical viewpoints of analysis. In the retail sales world, facts might be purchases of shoes by customers and dimensions might include salesperson, product ID and month. The investment management business and its data model involves certain data structures that require departures from key aspects of the classic multidimensional approach. The first is that security data is logically a companion to all types of accounting and performance data, and securities have lots of attributes. Securities thus fit poorly into either the fact table or dimension table mold. Placed in fact tables, security measures would need to make repeat appearances in tables containing asset positions, transactions, performance measurement returns and others. If security is instead a dimension, its dimension table would contain more measures than normally considered desirable.

A second challenge is that performance measurement data does not aggregate from its details. In other words, a three-year portfolio return is not any type of rollup of three-year security returns. The rollup must first take place on single-period returns, and then those returns must be chain-linked to build the requisite list of multiperiod returns. The compute-intensity of chain linking and other performance analytical processing confounds on-the-fly aggregation within the standard framework of multidimensional analysis. Performance measurement thus calls for pre-aggregated fact tables.

Certainly a large proportion of even non-performance enrichment that investment firms must apply to their data to convert it to information, particularly fund-level enrichment, cannot be produced by reporting or BI tools as a practical matter. Some enrichments involving complex calculations, like dispersion statistics across time, slow down processing more than users would tolerate in an online interaction. What is needed is machinery that can commit such calculations to the database in ways that fit well with the way BI tools source data.

# Conclusion

Every industry presents its own challenges to successful data management. We have cited some of the ways in which investment portfolio data management is impacted by a long list of special requirements of the business that it serves. The investment world is one where high data volumes face significant quality challenges amid complex enrichment requirements. These are inconvenient truths, and in a simpler world portfolio data management would neatly fit a standard pattern suited to a wide variety of financial businesses. In the world we actually have, template approaches can only inhibit our success in applying good data management to this industry. A more promising tack is to take the business as the given, clarify and accommodate its particular needs based upon deep subject matter understanding and experience, and adapt well-known sound data management principles to serve the industry on its own terms.

<sup>1</sup> "Making Data Management Easier for the Financial Management Industry" (October 2010), co-authored by Marc Firenze, Chief Technology Officer of Eagle Investment Systems and Jeff Shortis, Chief Data Officer of Pioneer Investments. Eagle Investment Systems white paper, April 2011.

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