Delivering Value Beyond Efficiency with Visualized XBRL

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abstract

The XBRL (eXtensible Business Reporting Language) data interoperability standard has been adopted by regulators worldwide, improving the efficiency, accuracy, and reliability of financial reporting systems. But XBRL also aims to support analysis by standardizing terminology and format across platforms. While XBRL clearly stores financial statements formatting instructions, it may or may not be well suited for analysis. Our Accounting Flow Visualizer (AFV) organizes selected XBRL data integrating profitability, liquidity, financing, and market value data from balance sheets, income statements, and cash flows using animated rectangles, circles, and wedges. This article includes initial analysis of XBRL filings (newly required in 2009) and describes an experiment designed to verify the AFV’s components. If key financial analysis data are readily available in XBRL and if the AFV’s visualization model effectively displays them, new analysis paradigms for investors and educators could emerge, demonstrating the value of XBRL and XML-based representational standards in general.

Keywords: XML, Accounting Information Systems, XBRL
Introduction

XBRL (eXtensible Business Reporting Language) is an XML (eXtensible Markup Language) standard developed by an international non-profit consortium of major companies, organisations and government agencies as a freely available, open standard for communicating financial and business information (XBRL International 2009a). XBRL International chose XML for its standard because XML was designed for cross-platform use and can be self-describing (World Wide Web Consortium 2008). Thus, it is the common denominator in most distributed systems. The rising use of XBRL promises increased efficiency in regulatory reporting processes, increased transparency in financial reporting for a wider audience, and improved support for 3rd party analysis. In short, XBRL is designed to help organizations create and users leverage interoperable financial data.

XBRL has been mandated for use in a variety of regulatory processes around the world. In the US, the FDIC has mandated XBRL for submission of regulatory data and the SEC (Securities Exchange Commission) and now requires submission of 10-K and other documents in XBRL format (SEC 2009). In the UK, Belgium, Japan and Singapore authoritative organizations are using XBRL for receiving and distributing financial reports (Garbellotto 2009). The Bank of Spain has developed a Financial Information Exchange system to support XBRL reporting by credit institutions. Australia and the Netherlands are working on initiatives to create a cross-government, multi-agency standard business reporting (SBR) project (XBRL International 2009b). Systematic evaluation of these efforts shows that these uses of interoperable data have increased the efficiency and the quality of the reporting process. XBRL data has fostered more timely submissions, cost savings in processing, more flexibility in adapting to new requests, faster report processing, and higher confidence in the accuracy and reliability of available data (XBRL International 2009b).

While the efficiency value of XBRL has been demonstrated, its usefulness in supporting analysis has not yet been widely reported. Some of the limitations and opportunities of XBRL are reflected in the RIXML Research Information Markup Language project which is building an XML-based open standard for representing investment research data (http://www.rixml.org/). The RIXML consortium includes both buy- and sell-side firms looking for an efficient way to share financial research data and merge that data with XBRL data. The steering committee includes investment firms (Fidelity Investments, Putnam Investments, and MFS Investment Management) and investment banking firms (e.g., UBS, Bank of America, and Citi). Commercial products are under development to leverage RIXML and/or XBRL as web services, for example, at IBM (http://www.ibm.com/developerworks/edu/x-dw-x-rixmltut.html). The willingness of organizations to invest in this kind of supplementary standard shows the importance of XBRL to the E-Commerce community and the need for additional, non-XBRL specifications of financial information suggests the value of both engineering efforts and academic investment in this important branch of the E-Commerce landscape. The academic community may be able to make a valuable contribution by identifying key goals of investors and other users of financial statements, mapping those needs to available XBRL data, and exploring the kinds of tools that may be useful in presenting such data.

In this research-in-process submission we (1) present a framework of key financial analysis concepts that might be of interest to users of XBRL data, (2) propose an initial model adapted from Torben Thompson’s early work for organizing balance sheet, income statement, and cash flow statement data into an integrated model, and (3) describe an early (but working) version of a tool that depicts the modeled information as account balances (from the balance sheet), operational and investment flows of funds (from income statements and cash flow statements), and proportions (with pie wedges and superimposed icons) to support overview analysis of the financial position of an organization. The work connects the reality of the presentation-focused XBRL terminology with user analysis needs and information-visualization technology. Intended contributions of the project include an increased understanding of the usefulness and limitations of XBRL technology, exploration of the usefulness of data interoperability standards such as XBRL in facilitating the reuse of stored data, and development and testing of an animated financial information tool that will have value in teaching accounting concepts, teaching XML technology, and helping investors quickly analyze standard financial data.

Background

XML languages are a staple in distributed E-Commerce systems. Web services generally both describe themselves and provide data to clients in XML form. Databases and office automation tools such as spreadsheets and word processors are increasingly building in XML support to facilitate data sharing across platforms and locations.
Progress is being made in representing workflows in XRL (Exchangeable Routing Language) (Van der Aalst and Kumar 2003). XML is used to store web page contents to be dynamically rendered based on a variety of contextual parameters. In the world of finance and accounting, the rise of XBRL is revolutionizing inter-organizational financial data sharing processes.

In general, an XBRL document begins with a set of context elements that identify the periods (for income statements and cash flow statements) and points (for balance sheets) in time reported within. Each context element is given an internal id for use in the document, an external identifier to reference the financial entity to which this context applies, and appropriate dates. Besides that, the remaining data is a long list of items that reference the context and the appropriate “tag” selected from an extensive list of defined terms spread across a collection of standardized taxonomies. Hierarchical structures within the data are delineated in separate linkbases. In addition, users can extend XBRL, defining their own new tags for special circumstances. In all there are thousands of pre-defined XBRL tags.

XBRL was developed with input from major companies, organizations, and government agencies who formed a non-profit consortium called XBRL International. They suggest that: XBRL is a language for the electronic communication of business and financial data which is revolutionising business reporting around the world. It provides major benefits in the preparation, analysis and communication of business information. It offers cost savings, greater efficiency and improved accuracy and reliability to all those involved in supplying or using financial data (XBRL International 2009a). While XBRL was created with the intention of facilitating data sharing, the tag taxonomies focus on representing data from traditional financial statements.

A variety of commercial tools are available to help organizations adapt to XBRL requirements. JustSystems’ xfy XBRL viewer is an application for rendering and viewing multidimensional XBRL statements used by the State of Oregon Controller’s Office (JustSystems 2008). Altova Missionkit 2009 for enterprise XML developers includes tools to render, edit, and validate XBRL, edit taxonomies using a graphical interface, and transform XBRL to and from databases, Excel 2007, and XML (Altova 2009). UBmatrix offers several tools for using XBRL, including a taxonomy designer, report builder, and its Enterprise Application Suite which is designed for the development of large-scale XBRL allocations (UBmatrix 2007). It includes a taxonomy manager and administrative controls to provide security. Allocation Solutions’ DataXchanger software is a user-friendly XBRL conversion and rendering software built for desktop and server environments (Allocation Solutions 2009). They have also released a “DX Express” version that can be used in global settings. These are only a few of the available tools. While such tools clearly have a market and provide value, they tend to support the creation of XBRL from existing financial statement data.

If XBRL is to fulfill its role as an interoperable data format that supports multiple users and various tasks, it must be demonstrably possible to repurpose the data for tasks other than printing traditional financial statements. XBRL was naturally developed based on the familiar financial statements as an organizational paradigm. This is clearly a strength for regulatory reporting and data sharing within and between accountants and financial professionals because the terminology is well understood. Some work has been done showing that financial statement search capabilities built on XBRL data do help people find key data in electronic statements (Hodge and Maines 2004). But the cognitive burden associated with digesting printed financial statements may or may not be reduced by current techniques for processing XBRL data.

Among the traits listed in its "Core Competency Framework" the American Institute of Certified Public Accountants (AICPA) identifies a need for accountants to see the "big picture" of a company’s operations (AICPA 2009). Yet less experienced users of financial statements have been shown to process financial information in an unstructured manner, demonstrating a lack of understanding among the relations of various financial statement items (Frederickson and Miller 2004, Hunton and McEwen 1997). To address the need of both accountants and other users for consolidated financial statement understanding, standardized and integrated representations are needed. Showing data from different companies or industries using a standardized financial statement paradigm is different from business intelligence and dashboard-based approaches that aim to display organization or process specific data as discussed in (Houghton et al. 2004, Nichols et al. 2009). Accounting researchers have long been anticipating the development of visualization tools to help users develop a more comprehensive understanding of how changes in various financial items affect a company's overall operations (Wallman 1997). But such tools have received little research attention.
Key financial analysis issues

Usefully digesting the data presented in traditional financial statements requires a significant amount of training. A reader needs to understand business concerns as well as the logic that presents that data in the three main financial statements. Balance sheets are a snapshot of the ending financial position of the entity, showing what is owed and what is owned as of the end of the period. Income statements match revenues and costs to help the reader understand the magnitude of profit or loss that results from operations. And while profitability, as demonstrated in the income statement, is of long term importance, liquidity (as reported in the statement of cash flows) helps stakeholders and potential stakeholders assess the organization’s ability to meet obligations. Business students are instructed (with varying degrees of success) in how to find such information in traditional, tabular financial statements. While savvy investors effectively reorganize statement data using ratios and other techniques, there is a significant cognitive burden associated with integrating multiple perspectives into an overall picture of an entity’s financial position. We propose that a model which integrates and visually summarizes capitalization (owned vs. owed), liquidity, and profitability of an entity’s financial operations would be useful for investors and also in business education.

The Business Instrument Panel

Torben Thomsen proposed and performed some initial tests on the Business Instrument Panel, a single and integrated visual model of an organization’s financial data (Thomsen 1990). The goal of his line of work was to “Reinvent Accounting” using a complete model of accounting expressed in a network paradigm of hills, holes, and flows. In addition to easily anticipated representations of purchases and sales as key operational flows, differentiation of long and short term assets, tracking of in and out flows of financing, and a depiction of paid in versus earned capital, several other novel yet key notions from this work are relevant to the integrated representation of accounting data. These include the presentation of:

- Incurred interest, taxes, and profit as a combined “Value Added” flow to express an organization’s contribution to external stakeholders;
- An organization’s total “Market Power” as the net of payables and receivables plus cash to depict the resources available for purchasing goods and services or repaying stakeholders;
- Deferred taxes as a stakeholder investment in the company; and
- Long and short term assets as “Goods” (breaking down the percentage of each) with depreciation depicted as a flow from long term goods into short term goods, denoting the use of assets in the production of saleable goods and services.

A thoughtful look at these notions shows how assets and liabilities (states – hills or holes in Thomsen’s terminology) can be meaningfully integrated with both profitability data (e.g., value added flows) and liquidity information (in the relative size of the organization’s market power). Thomsen also depicted the market capitalization of firms as a contrast to balance sheet values to quickly display the market’s perception of the organization’s tangible and intangible assets. This approach to organizing and presenting integrated financial data is a good starting point for development of a visualization tool intended to present key XBRL values for financial analysis.

XBRL + model + animation = understanding?

Our framework envisions the systematic processing of XBRL data into an integrated financial model displayed in an animated schematic adapted from Thomsen’s Business Instrument Panel. In the first panel of the process described by Figure 1, organizations prepare XBRL versions of their financial statements. Reporting periods, entities, and statements are identified in context elements, then numbers and notes are recorded in individual XBRL elements. At present, regulators are the primary consumers of the XBRL data. The middle of the figure depicts the mapping of XBRL vocabulary into a visualizable model which integrates accrual- and cash-based values as well as snapshot and period numbers. The visualization tool depicts these data in a colored, area-based representation.

The layout of the model closely tracks important business concepts and concerns. Figure 2 shows the current, under-development version of the OSU Accounting Flow Visualizer. Squares generally depict account balances or states at the end of a period while circles represent flows of funds from state to state. Selected items are superimposed to facilitate key comparisons such as wedges on a circle, concentric squares, or rectangles joined together to form a
As previously noted, profitability, liquidity, market value, and sources of financing are key issues for readers of financial statements. Profitability is explored in the size of the Profit wedge on the Revenue flow circle (return on sales) and in the area of the wedge as compared to the other icons such as the central investor box (return on investment or return on assets). Liquidity problems will make the Market Power box small. The market power box (Cash + Receivables less payables) is closely related to the familiar quick ratio (current assets less inventory, divided by current liabilities). Market value can be assessed by comparing the size of the Market Cap (capitalization) square (outstanding shares times ending share price) to the size of the central investor box. This box aggregates various sources of financing as found on the organization’s balance sheet and is broken down into Def. Taxes (Deferred), Debt (long term), Earned (Retained Earnings), and Paid In (Paid in capital). Financing cash flows from purchases/sales of stock, borrowing, and payments for taxes, interest and dividends are displayed in the Financing and Distribution flow circles.

The visualization tool ingests and animates data from multiple periods. Figure 3 shows the images as it pauses for years 2004, 2006, and 2008 in an animation of Intel’s annual reports. Effects of operations, financing activities, and stock price changes are marked even when viewed as still images. For example, between Quarter 1 of 2004 and Quarter 4 of 2008 Intel increased the number of shares it had repurchased from 1.9 billion to 3.2 billion, an increase of approximately 69%. This is reflected in the large financing flow from cash to investors and in substantial reductions in Earned capital, Paid In capital, and Market Power. Profitability and long term capital investments varied substantially in size and as a percentage of sales and total purchases. There was also a significant increase in dividends authorized and paid in this time period.

The icons and animation are intended to enhance the ability of a user to identify trends or changes. Once the data has been ingested by the program, the user can select to animate between periods. The periods are displayed as buttons on the right. When asked to move between a series of periods, the tool animates to the next period, changing labels as appropriate, and pauses for a moment before proceeding. The value of the motion (things growing, shrinking, and moving) is apparent but needs to be verified. The shapes and configuration of the schematic is largely drawn from Thomsen’s early work. Preliminary users have asked a variety of questions. They wonder if they can compare squares to circles accurately - so do we. They want to be able to compare two companies. This capability is definitely planned for development. One thing is consistent; experienced readers of financial statements can quickly identify important financial changes when looking either at animated or still versions of the diagram.

Investigational Approach and Early Observations

How effectively will XBRL serve as the basis of a tool able to visually summarize financial results? To address this question we are undertaking two main lines of investigation. First, how can we systematically extract data from
XBRL documents to support analysis of organizational profitability, liquidity, financing, and market value? Second, are these key analytic notions effectively communicated in the diagrams we propose? The balance of this section describes an investigational approach and briefly describes some initial results.

Figure 2. The OSU Accounting Flow Visualizer integrates and depicts financial data. Changes are animated over multiple years to highlight profitability, capitalization, liquidity, and market value information.

Figure 3. Animations highlight profitability (in the profit wedge as a proportion of sales), market value (in the size of the Market Cap square as compared to the central investor box), liquidity (in the size of the Market Power Box – Cash), and financing (in the size and direction of the financing flow, the relative area of debt and equity in the investor box, and the proportion of capital assets in the Goods box and purchases flow).

Because XBRL is mandated by many regulatory bodies it is likely to be used on a very large scale, both in the U.S. through the US-GAAP taxonomy and internationally in IFRS (International Financial Reporting Standards) XBRL
XBRL filings can be usefully repurposed for distributed, cross-platform analysis. The result of these explorations should be of both practical and theoretical interest in E-Commerce.

**Will publically available datasets support the intended analysis?**

XBRL usage patterns need to be documented to guide the efforts of analysis tool builders. Because SEC filings in XBRL have just become common in the summer of 2009 and because organizations can extend XBRL, it is not yet clear what will actually be included in publically available datasets. How many reporting entities (e.g., subsidiaries or divisions) and reporting contexts are included in a typical document? What proportion of the data reports numbers vs. notes? How much of the data is reported using company specific extended tags? For example, Adobe Systems Inc. filing in June of 2009 was among the first required interactive submissions. Of Adobe’s 269 lines of element data, 244 tags used the US-GAAP prefix including 96 unique tag names. Thirteen tags used the dei (document and entity information) prefix, all of which are unique tags; and twelve Adobe-specific tags (XBRL extensions with the prefix adbe) involved six unique tags names. Both tagged facts and specified relationships in actual filings should be categorized and counted. This kind of data will have implications as analysts and system builders seek to leverage XBRL filings. We are adapting AFV to help quickly categorize and tally the tags included in filings to help address the need for XBRL document metadata.

In addition to categorizing the content of filings, the data needs to be evaluated for its ability to meet the requirements of a generalizable visualization model. We plan to systematically map a number of actual SEC filings to our model. We expect that there will be some missing or ambiguous data but the areas of ambiguity must be documented before solutions can be developed. For example, we have already mapped the June Adobe submission to our model. Of the forty-three tags related to the Statement of Financial Position we used twenty-three. Seven were components of mapped values and five were subtotals. For the income statement, we used only seven out of twenty-seven, ignoring eleven components and five subtotals. For the Statement of Cash Flows we used twelve out of thirty-one tags, omitting eleven components and three subtotals. The rest of the numeric tags from these statements were not relevant to the visualization. By systematically associating standard XBRL tags to related analysis issues (e.g., liquidity, profitability, financing, and market value) and testing for the existence and consistency of these data in actual filings, we aim to assess which analysis questions are readily answerable in filed XBRL documents.

The use of XBRL extensions is an example of potential ambiguity. In mapping the Adobe data, only a few of the extended entries needed to be considered. Our expectation is that extended items will tend to appear at the detail level as part of a familiar subtotal. These subtotals are more likely to be used for the kind of high-level comparative analysis we envision for early XBRL-based financial analysis tools. Still, reporting anomalies or more complex relationships may require more nuanced interpretive functions. Adobe-specific tags for PrepaidExpensesOtherAssets and InvestmentAndLeaseReceiveable were needed to accurately depict Adobe’s financial activities in our diagram. More investigation is needed to see if we could have avoided using these tags while still achieving an accurate depiction, or if the link structures of the XBRL submission provided enough information to correctly handle the extended tag. We did not try to determine if Adobe’s use of these tags was contrary to best practices. The current version of the XBRL Preparers Guide recommends using an existing tag whenever possible. (XBRL 2009d, p. 28)

**Does the AFV diagram understandably address financial statement analysis concerns?**

The effectiveness of the AFV in expressing key business concepts was pilot tested by 34 introductory financial accounting students. After a 10 minute tutorial, the students were provided an AFV image representing one year of operations (based on financial data from Intel) and asked to answer questions about the financial concepts and about the meaning of the diagram. They were able to correctly answer basic questions regarding the financial concepts about 90% of the time and accurately interpret fundamental elements of the visualization, e.g., “do circles represent items from the income statement (flows) or balance sheet (states)?” more than 90% of the time.

Participants were also asked to estimate financial ratios (from the single image) and to identify trends using a series of four AFV images (similar to those in Figure 3) representing four years of operations. Students accurately (significant at the 95% level) estimated the percentages of the wedges in the circles but (not surprisingly) were less...
accurate in estimating the sizes of different shapes. For example, on average they estimated profit (a wedge) to be 35% of retained earnings (a rectangle) when it was actually 29%. They were generally able to correctly identify trends (increase/decrease/no change) for items over the four year period.

**Conclusion and future work**

As a first step, this approach to organizing and presenting basic accounting numbers appears to be promising for educational purposes. Business students often need to be convinced that information systems concepts matter for their education. Using this tool and its underlying architecture demonstrates how distributed processes, facilitated over the Internet, through XML-based standards can be leveraged to improve both communication/presentation of information and efficiency of operations. The integrated nature of the process makes for a potentially valuable case study in distributed system architecture and inter-organizational work flows. The tool also promises to be useful for accounting education. Key notions that have a direct and useful representation in the visual model include (1) converting goods into revenue, (2) the flow of profits to shareholders, (3) profit, taxes, and interest as a proportion of sales, (4) the purchase and depreciation of long term assets to create saleable goods, (5) the relationship of market and book value, and (6) financing options.

Given that key financial concepts are directly depicted, we anticipate that investors and other stakeholders will be able to usefully employ the tool. Only a few executives have been exposed to the tool as yet, but they recognized the power of the tool and thought it was promising for comparing companies, identifying trends, and showing the big picture. As XBRL data becomes more widely available over the next few years, Internet-based services should be able to summarize and depict that data, facilitating quick overviews of an organization’s financial position. These overviews may prove useful for at least three important classes of tasks: getting a general idea of an organization’s financial position, providing an additional view of available data to help avoid missing key information, and comparing the financial position of an organization to competitors. Specific experiments can be designed to test AFV for effectiveness in this area.

At present our tool only "understands" a limited set of XBRL tags. While our initial analysis suggests that the data needed to create each component of the visualization does map to XBRL tags, and that complete XBRL statements are likely to include enough data to support our model, significant work still needs to be done to map the thousands of standardized XBRL tags to the appropriate model transactions. As more data becomes available in XBRL format, we plan to undertake analysis of the content of actual statements as submitted by companies. Given that there is some latitude to express a single financial event in one of several ways in XBRL, a robust mapping may require the development of business rules to organize or re-factor available data. Analysis of the number and importance of custom tags added to the taxonomy by individual organizations will be of interest and may be an interesting point of reference in projecting the development of other interoperability standards.

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