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Visualizing Basic Accounting Flows: Does XBRL + Model + Animation = Understanding?

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Abstract: The usefulness of XBRL (eXtensible Business Reporting Language) in facilitating efficient data sharing is clear, but widespread use of XBRL also promises to support more effective analysis processes. This format should allow managers, investors, regulators, and students to aggregate, compare and analyze financial information. This study explores an XBRL-based visualization tool that maps the organization of financial statements captured in the XBRL formalism into a graphical representation that organizes, depicts, and animates financial data. We show that our tool integrates and presents profitability, liquidity, financing, and market value data in a manner recognizable to business students. Our findings suggest the promise of XBRL-based visualization tools both in helping students grasp basic accounting concepts and in facilitating financial analysis in general.

Key words: XBRL, Visualization, Financial Analysis, Accounting Education

1. INTRODUCTION

In today's global and interconnected economy, efficient and effective methodologies for communicating organizational financial information are increasingly important. Effective communication, in this context, means organizing useful data for a variety of stakeholders, and storing that data in an accessible location and format to support

[1] Data is available from the corresponding author upon request.

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regulation and shared analysis. Transparency in financial reporting is generally good for many stakeholders. Investors and regulators want to be able to accurately aggregate and analyze the financial position and operations of various organizations. While the wide-spread adoption of XBRL (eXtensible Business Reporting Language) has already shown itself useful in reducing the cost of sharing accounting data, its usefulness in supporting analysis is still more promise than fact.

XBRL is an XML (eXtensible Markup Language) standard developed by an international non-profit consortium of major companies, organizations and government agencies as a freely available, open standard for communicating financial and business information (XBRL International 2009a). XBRL uses XML 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 many or even 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 largely maintains the paradigms embedded in existing financial data but packages that data up to help organizations create and users leverage interoperable financial data.

Consolidated sets of financial statements such as those frequently presented in XBRL contain data relevant to several business issues including liquidity, profitability, financing, and valuation. To address this assortment of concerns, a variety of types of data are required including data representing financial position as of a particular moment, data summarizing the transactions during a period (sometimes matching revenues to expenses), data on operational vs. non-operational activities, and estimates for amounts that are not directly observable. Correctly interpreting traditional statements requires the reader to understand accounting principles and procedures in a context of fundamental business concepts.

Little work has been done to explore the construction and utility of generalizable visualizations of accounting flows even though vast experience with data visualization suggests that visually representing data can assist with some analysis tasks. Perhaps this is because of the complexity of the paradigms underlying modern financial statements or because of the historical difficulty of aggregating data generated by disparate systems. Adoption of the interoperable XBRL standard may represent an opportunity to deploy visualizations tools to help organizational stakeholders more quickly or effectively access, compare, and analyze financial data. It seems even more likely that a visualization tool could be helpful in teaching the substance and interaction of important accounting concepts to students.

Some business students learning accounting principles are taught the mechanics of journal entries with debits and credits, others are not. But in either case a general sense of the connection between accounting practice and business concept is important. Consider, for example the following list of the learning objectives from a representative course which does teach debits and credits, not just concepts.

1. Each student shall be able to *analyze basic business economic events* to determine their effect on accounts and financial statements.
2. Each student shall have a basic understanding of the accounting cycle, be able *analyze economic events* and prepare simple journal entries.
3. Each student shall be able to *interpret and analyze accrual and cash flow information* presented in accounts.
4. Each student shall be able *to interpret and analyze financial statements*.
5. Each student shall have a basic understanding the principles of internal control and be able to apply them to relatively straight forward situations to identify strengths and weaknesses.
6. Each student shall be able to *analyze issues relating to inventory, receivables, long-lived assets, liabilities and stockholders' equity* and recommend appropriate accounting treatment.

For five out of six of these objectives (italicized for emphasis), students are supposed to learn to connect the flow of funds as it relates to a business issue to financial statement components. A course which does NOT teach debits and credits might be expected to rely just as much or more on the connection between financial statement data and business processes. While the mechanics of the accounting cycle, journal entries, and studying financial statements are certainly important and valid as ways to make this connection clear, visualizing the flows may also be pedagogically useful.

This work seeks to explore the feasibility of an accounting flow visualizer (AFV). An effective AFV would need to have reasonable access to data sources (able to interpret XBRL in this case), express data related to important business issues, and be understood by users. The initial versions of the Accounting Flow Visualizer described in this article generates animated visualizations of accounting data using a model adapted from Torben

Thomsen's early work on the Business Instrument Panel. Tags found in the XBRL standard (and the source financial statements from which the XBRL is drawn) are mapped to the visualization's parameters. Finally, experimentation was conducted to see if students are able to accurately interpret the diagrammatic components and match them to key business issues.

2. BACKGROUND

An effective AFV will build on XBRL's strengths and model key business/accounting concepts.

XBRL: Efficiently Sharing Accounting Data

XML languages are a staple in distributed E-Commerce systems. Web services generally both describe themselves and provide data to clients using XML. Databases and office automation tools such as spreadsheets and word processers increasingly support XML to facilitate data sharing between platforms, locations, and organizations. Progress is being made in representing workflows in XRL (Exchangeable Routing Language) (Van der Aalast and Kumar 2003). XML is used to store web page contents for dynamic rendering based on contextual parameters. In the world of finance and accounting, the rise of XBRL is revolutionizing inter-organizational financial data sharing processes (XBRL International 2009a).

In general, an XBRL document includes context elements that identify reporting periods for income statements and cash flow statements, and points in time for balance sheets. Each context element is given an internal context id for use in the document, an external identifier to reference the financial entity to which this context applies, and appropriate dates (Garbellotto 2009). 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. There are thousands of pre-defined XBRL tags. While taxonomy definitions, link, and *tuple* tags delineate relationships between items, the underlying XML structure is essentially flat with no nesting of elements within other elements. In addition, users can extend XBRL, defining their own new tags for special circumstances.

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 demonstratively 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 (XBRL International 2009b). 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 et al 2004). But the cognitive burden associated with digesting printed financial statements may or may not be reduced by current tools for processing XBRL data.

Among the traits listed in its "Core Competency Framework" the American Institute of Certified Public Accountants (AICPA) has expressed a need for accountants to demonstrate an ability 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). Accounting researchers have long anticipated financial information visualization tools that help users develop a more comprehensive understanding of how changes in various financial items affect a company's overall operations (Wallman1997). But such tools have received little research attention.

Key Accounting Concepts to be Modeled

Helping students understand accounting procedures in light of underlying business concerns is a key goal for accounting courses. Topics covered in introductory financial accounting and financial statement analysis course materials relate to the students understanding of liquidity, profitability, financing, and valuation. Organizational accounting flows provide key information relevant to these generalizable business issues. However, an understanding of several more technical accounting concepts is needed to translate the data in traditional statements into information that helps a reader evaluate an organizations financial status. These concepts should have a strong influence on the nature of a useful visualization.

Important time-related issues include the matching principle and snapshot versus period-based reporting. The current value of assets, liabilities, and owners' equity are reported as end-of-period balances. In contrast, income statements and cash flow statements summarize the activities of the organization during a given time period. We might say that income statements generally reflect the expected financial effect of recent operations. Income statements match revenues to costs. Tabulating collections and purchases without matching could lead to incorrect profitability assessment. Including non-operational events in with current results might distort profitability analysis in a different way. To effectively communicate financial information a visual model of financial flows needs to allow for these and other issues.

Financial statement analysis depends to a large extent on comparative analysis, as in ratios. Pie charts and bar graphs are only two of many widely used visual devices for comparing the size of two numbers. Previous research has demonstrated that people are able to effectively evaluate data based on the size of elements in a drawing or picture although relative size judgments are subject to a number of possibly confounding factors (Croxton 1932, Kridder et al 2001). In any case it is clear that dashboards, graphs, and charts are useful in presenting and analyzing financial data. Notions such as liquidity (the availability of cash to meet current expenses), profitability (the portion of sales resulting in profit or the productivity of assets in generating profits), financing (the proportion of debt as compared to equity), and valuation (methods of establishing the economic value of a company) are key business concerns that are addressed by the data in financial statements. Such analysis tasks frequently require the integration and understanding of both accounting and business processes and the ability to integrate different types of data drawn from different statements.

Skilled accountants and others with appropriate training and experience can often distill both an overall notion and a number of details from a set of consolidated statements. But because of the complex and integrated nature of such analysis tasks, novice users (including students and many other stakeholders) may be able to benefit from a consolidated financial visualization.

Visually Modeling Financial Statement Data

Torben Thomsen proposed and performed some initial tests on the Business Instrument Panel, an integrated visual model of an organization's financial data (Thomsen 1990). The apparent goal of his line of work is 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, a depiction of paid in versus earned capital, and several other novel yet key notions from this work are relevant an integrated representation of accounting data. His notions include:

1. Incurred interest, taxes, and profit as a combined "Value Added" flow to express an organization's contribution to external stakeholders;

2. 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 rewarding stakeholders;

3. Deferred taxes as a stakeholder investment in the company; and

4. 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's model is complete in that it accounts for and balances all the economic flows of an organization. Some versions of his model have also depicted the market capitalization of firms as a contrast to balance sheet values to help the user quickly display the market's perception of the organization's tangible and intangible assets. In later work Thomsen develops some more complex variations of the visualization intending to account for varied business situations and to further develop his notion that accounting should move from fragmented lists to an integrated network model (Thomsen 2003). While such adaptations may yet prove valuable in developing a robust visualization model, the less complex early version described above was a good starting point for our development of a generalized yet useful XBRL-based visualization tool.

Figure 1 shows a static view of the animated AFV. It integrates readily available financial data in a simplified but analysis-oriented diagram. Selected flows of funds (generally from the income and cash flow statements) are displayed as circles and ending balances (generally from the balance sheet) are shown as rectangles. Wedges are used to overlay commonly compared amounts. The relative geometric areas of components depict the dollar amount of corresponding values. The AFV is markedly similar to Thomsen's original Business Instrument Panel despite some important differences. Perhaps the most fundamental variation is that the AFV does not attempt to be complete by modeling all economic events with their corresponding beginning and ending balances. Rather it seeks to understandably yet accurately depict data relevant to key financial issues. The diagram includes a number of visual components as explained in Table 1.

Both position and color connect related items. Dark green elements relate to ownership interests. Light green components relate to other financial stakeholders, i.e., taxing agencies and creditors. Positional clues include superimposed wedges on circles; the alignment of related market power elements supports comparison; and lines that divide related states within a single figure. These clues are intended to support comparison and ease the burden of analysis.

Like the current format of widely accepted financial statements in use today, this diagram represents a compromise between various possible utilities. Accruals and the matching principle influence some values (e.g., sales, purchases, and the profit wedge) while cash based notions drive the financing and distribution flows. Many non-operational flows are not directly depicted. Instead the results of these flows are expressed in the size of the state rectangles. Using circles for flows and rectangles for states provides potentially meaningful visual signals but may inordinately influence the ability of users to accurately compare magnitudes. This visual layout of the AFV reflects several incremental changes from previous diagrams aimed at verifying the basic notion that an integrated picture can recognizably map available financial statement data to important business issues.

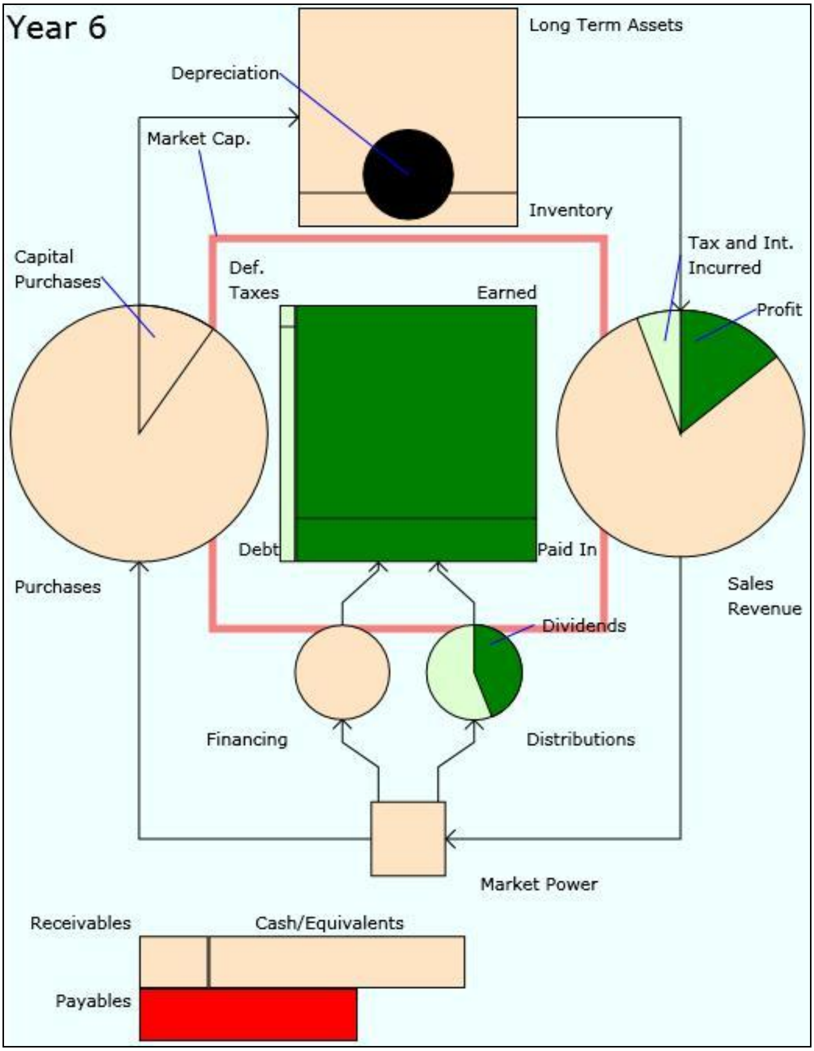

Figure 1. Accounting Animated Flow Visualizer Diagram

The visualization highlights data relevant to previously listed business issues addressed by standard financial statement data. Profitability can be assessed as it relates to *Sales Revenue* in the *Profit* wedge. The size of the wedge can also be visually compared to assets, debt, owners' equity, and market value. Liquidity information is displayed in the *Market Power* box and in the size difference between the *Receivables*, *Cash/Equivalents*, and *Payables* rectangles. The mix of sources of financing is presented in the central box. Other financing-related activities are also displayed in the *Financing* and *Distributions* flow circles. Valuation issues are addressed in part by the *Market Capitalization* rectangle shown as a thicker, colored square and also by the sizes of asset boxes.

While the visualizations presented in this study are all for a single company, it is likely that simultaneously displaying and animating several companies or a company and some sort of computed industry average proxy may well be the most important eventual application of this tool outside the educational sphere.

Transitions between periods are animated to help users more quickly identify trends or anomalous events. Although current reporting techniques provide data periodically (usually fiscal quarters and years) we developed animations that interpolate between periods. The idea is that relative changes may be more evident to users when they see elements shrink, grow, or remain the same over a number of periods. Users can control the animation by clicking on the period to which they want to move. If the visualization currently shows year one in a five year annually periodic data set, clicking year four animates how the data changes from year one to year two, then from two to three, and finally from three to four. The animations pause briefly when the actual sizes corresponding to a particular set of statements is reached. Each transition and each pause are allocated the same amount of time and text denotes the current period or transition periods as appropriate. Both forward and backward animations in the data set are possible. As with other parameters in the tool, these behaviors might be sub-optimal and therefore usefully altered in future versions.

The AFV uses linear animations. That is the length of a line, position of a point, radius of an ellipse, or height of a square changes by the same amount in any given second of an animation. Admittedly, this may or may not be optimal. When a circle's radius increases from one to two inches the area increases by much more than a factor of two. Naturally when a new period is reached, the areas correctly align with the data values. However, half way through the animation the proportion of change in area may not be exactly half and will vary for different shapes. Since the thrust of the visualization is more for comparing relative magnitudes and highlighting trends, this limitation may not have much practical significance.

Element	Shape	Comments
Sales Revenue	Tan circle	Accrual-based data from the income statement
- Profit	- Dark green wedge	
- Taxes and Interest Incurred	- Light green wedge	
Purchases	Tan circle	Labor costs and general and admin costs are included
- Capital Purchases	- Tan wedge	
Investor Box	Central Square	Investor claims – balance sheet data
- Deferred Taxes and Debt	- Light green rectangle	Lines divide then subdivide to distinguish portions
- Earned and Paid in Capital	- Dark green rectangle	
Market Capitalization	- Red rectangle	Share price times shares outstanding
Market Power	Tan square (lower)	Available funds to purchase goods and services
- Receivables and Cash	- Adjacent tan rectangles	
- Payables	- Red rectangle	
Goods	Tan box (top)	Indicates the ratio of long short term assets
- Long Term/Inventory	- Line on the goods box	Inventory is short term assets less Market Power
- Depreciation Flow	- Dark circle in top box	Long term assets are used up to generate sales
Financing	Tan circle lower left	Net movement of funds from financing activities
Distributions	Circle lower right	Funds paid out to investors - cash basis
- Taxes & Interest/ Dividends	- Dark green wedge	- Dividends, taxes, and interest to external stakeholders

Table 1. Accounting Flow Visualizer Elements Explained

An endless variety of business data visualizations are potentially useful. Our diagram is intended to focus specifically on accounting flow information available in standard XBRL documents. This makes some sense for students learning about accounting. It also makes sense as we explore the analysis utility of XBRL as opposed to its impact on reporting efficiency.

Mapping XBRL to the Diagram

Figure 2 highlights the AFV's design which aims to collect and visualize XBRL data. Nearly all of the data we use can be expressed in standard XBRL tags. The focus of this study is not the appropriateness of the existing XBRL taxonomies or the differences between available taxonomies or taxonomy components. Instead, we explore the feasibility of a useful analytical visualization drawn primarily from XBRL tags. To explore the format and content of XBRL as it relates to the previously described visualization, we first evaluated a dated but widely distributed Microsoft XBRL data set tabulating how it would be used to prepare a visualization. We also looked at a set of Adobe statements built using the current US-GAAP XBRL standards (Microsoft 2009). Although an older set of concepts are tagged in the Microsoft data, the distribution of tags is still of interest.

The key concepts/tags stored in the Microsoft dataset were codified by the US chapter of XBRL International as *United States Financial Reporting Primary Term Elements* or *usfr-pte*. Although the usfr-pte model is not included in the later version of XBRL, XBRL document analysis tools such as the AFV will naturally focus on fundamental accounting concepts that will be widely understood and, therefore, be included in the more general taxonomy specifications such as usfr-pte. Over time, it will be important to "map" our model concepts to other tag sources such as those for international data or those for specific industries.

XBRL also allows for extensions to report data that does not match up with standard tags. A company can make up its own tags (and should provide the corresponding definitions) to allow for such reporting. This poses an issue for developers of generalizable tools. To whatever degree such individualized tags include data relevant to an analysis task, tools will have to look for and report on the existence of custom tags. While this issue is pertinent to the AFV, pressure from regulators, analysts, investors, and accounting firms should keep the potential proliferation of tags somewhat in check (SEC 2009). Further, creators of XBRL documents are expected to use standardized tags from approved taxonomies whenever possible in creating data for public consumption. The commonly recognized business concepts included in our visualization are likely to be covered by the standardized tag sets.

As an early voluntary XBRL SEC filer, Microsoft has created XBRL documents for several years. XBRL documents and corresponding HTML financial statements are available at www.sec.gov for Microsoft (MSFT) annual reports for a several year period.

We considered the following questions as we compared the data available in the 2003-2004 Microsoft filings to both our model requirements and the tag set specified in the usfr-pte taxonomy.

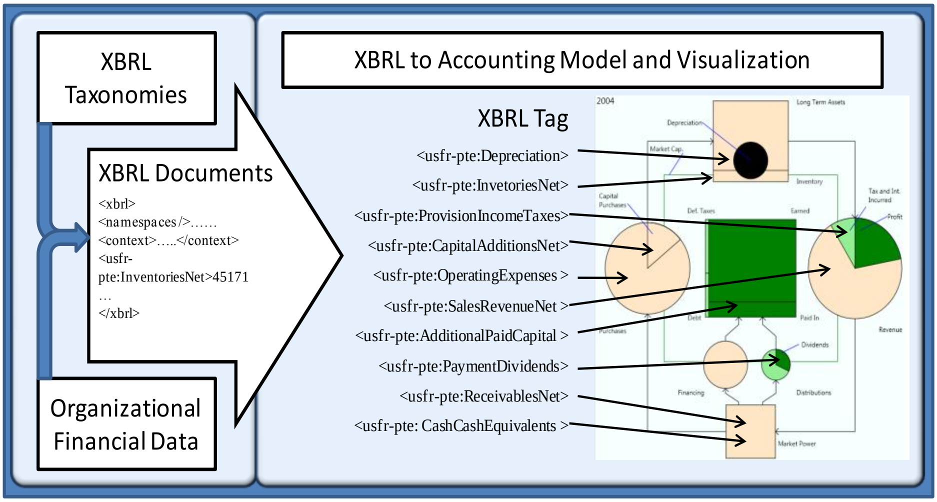

Figure 2. The Accounting Flow Visualizer processes financial data prepared by organizations in XBRL format, organizes it into an integrated model of financial performance, and depicts the results in an animated, colorful schematic.

- What is actually in the dataset?
- Is the data needed to support the model present?
- How much of the data in the XBRL filing is needed to populate the model?
- What impact do company specific tags have?
- What complicating issues arise in translating the Microsoft data into our model?

Table 2 characterizes the tags found in the Microsoft documents. We eliminated housekeeping tags such as the root and namespace declaration tags as well as tuple tags which link together facts in other tags, and tags from the usfr-mda taxonomy which specifies classes of items for Management's Discussion and Analysis. These did not report on values we depict. A quick counting of tags revealed 867 tag instances (items reported) including 200 different tag names. Of these 391 (91 unique names) were Microsoft extensions to the XBRL taxonomy. Fortunately, these extended tags were used to provide extra information that was not needed for our visualization model. The same financial data is also presented HTML form in the downloadable collection. Although the

XBRL data is labeled as belonging to 123 different context identifiers, it is summarized in only 7 html pages, several with columns for different reporting periods. For example, data for 4 different periods is presented in a columnar form for balance sheets and income statements. In all 19 different statement/period groupings were included in the data.

Item	Count	Comments
Tags	867	Excludes Tuples and usfr-mdr tags
Context Ids	123	
Statement/Periods	19	E.g., Four balance sheets presented on one html form = 4 Statement/Periods
Unique Tag Names	200	
Unique Usfr-pte	97	
Balance Sheet	36	Breakdown of unique usfr-pte tags
Income Stmt	18	
Cash Flow	29	
Stockholder Equity	3	
Notes	11	
Total Usfr-pte Items	476	
Balance Sheet	81	Counts actual number of tags
Income Stmt	259	
Cash Flow	113	
Stockholder Equity	12	
Notes	11	
Microsoft-Specific Names	91	
Microsoft Specific Tags	391	

Table 2. Categorizing Tags in the Microsoft Data

All the data needed to create an acceptable visualization was found in the XBRL documents except for the share price of the stock as of the closing date. This price is widely available for public companies and is used only in creating the Market Capitalization square. Table 3 identifies how many tagged entries from the collection were needed to create AFV style diagrams. We do not need all of the available data for several reasons.

Much of the data in an XBRL data set is redundant. Because one main focus of the XBRL tag structure is the printing of statements, subtotals are often stored in separate tagged entries. This means that some items are not used because they are components of included subtotals, for example, *usfr-pte:Accounts-ReceivableTradeGross* is ignored because it is included in *usfr-pte:ReceivablesNet*, and others are ignored because they are subtotals that summarize data we use in more detail e.g., *usfr-pte:StockHoldersEquity* which is broken down into paid in and earned capital in our visualization model.

Item	**Count**
Balance Sheet Items	
Unique Tag Names	52
Used	22
Unused	30
Components of Used Subtotals	8
Subtotals of Used Components	7
Items Not Relevant to AFV Diagrams	15
Income Statement Items	
Unique Tag Names	19
Used	8
Unused	11
Components of Used Subtotals	3
Subtotals of Used Components	2
Items Not Relevant to AFV Diagrams	6
Cash Flow Statement Items	
Unique Tag Names	18
Used	8
Unused	10
Components of Used Subtotals	8
Subtotals of Used Components	2
Items Not Relevant to AFV Diagrams	0
Statement of Stockholders' Equity Items	
Unique Tag Names	15
Used	0
Unused	15
Components of Used Subtotals	5
Subtotals of Used Components	0
Items Not Relevant to AFV Diagrams	10

Table 3. Usfr-pte Tags Used to Create AFV Diagrams for the Microsoft Data

In other cases, reported data is simply not included in our model. In particular, many reported values describe non-operational data flows. We show such data selectively. For example, we report cash financing flows to chart investment (debt or equity) in the company but we do not display flows for write-downs of assets that do not appropriately match with current sales. So, while we depict deprecation in a flow from long to short term assets we do not depict a non-operational journal entry such as the write down of goodwill in a declining, purchased subsidiary as a flow. Instead, the user would need to recognize the impact of significant events of that type in the change of the size of the earned capital or long term asset boxes. Future versions of the AFV could be customized to individual preferences, and will likely allow additional data to be displayed in response to mouseovers, button clicks, or other environmental conditions.

Microsoft's XBRL data provides a few specific challenges that are representative of problems that can arise with the mapping process. Microsoft's XBRL contains no tag for interest expense or a note in the footnotes about amount of interest paid, both of which are needed to correctly display the AFV. Further investigation into Microsoft's financial position revealed however, that this is because Microsoft has no long-term debt financing and thus owes no interest. While this is not an inherent problem, as any missing detail data is accounted for by usage of other summary tags, it could cause some confusion to a reader as to why a section of the standard visualization may not be present.

In January 2009, XBRL International (XBRL 2009c) released a new version of the us-gaap taxonomy to be used in SEC filings. It is extensive and, as with previous versions, includes many items not necessary for the AFV. Because the AFV does not depend on the same labels as the financial statements, the only us-gaap tags that need to be mapped are those expressing direct numerical data present on the financial statements; only tags of the "xbrli:monetaryItem" type are required. Thus the number of tags to consider in establishing a mapping from XBRL to the AFV is reduced from 13,452 (the number of tags found in the US_GAAP taxonomy) to 6,091. For example, we can safely ignore 2,706 abstract items and some 1,945 stringItem type tags which cannot contain numeric values.

To explore the viability of our mapping approach based on the latest US GAAP version of XBRL we successfully mapped a recent XBRL SEC submission for Adobe to the AFV. 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 prefix, all of which are unique tags; and twelve Adobe specific tags (prefix adbe) involved six unique tags names. 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.

As with the Microsoft data, few company-specific items needed to be considered although we did employ Adobe specific tags for PrepaidExpensesOtherAssets and InvestmentAndLeaseReceiveable. More investigation is needed to see if we could have avoided using these tags while still achieving an accurate depiction. 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)

Constructing the Accounting Flow Visualizer

The AFV was engineered for the internet. Some XBRL data is already available and as more companies are required to file, more will become available. These files will be available through the familiar http (hypertext transfer protocol) used by the AFV to access data. Xpath queries convert XML documents into systematically processable data. And the program will run in a client's browser through a Microsoft Silverlight plug-in.

Silverlight leverages Microsoft's Visual Studio .Net development tools to create sophisticated applications deployed to web browsers (Microsoft). Program codes are stored in a .xaml file specifying initial instructions for the browser and in .Net code pages. A compiled version is stored on a web server. An html (hypertext markup language) page provides needed instructions so the browser can download and execute the Silverlight application. The freely available Silverlight plug-in must be installed for the browser to run the application. This deployment structure is similar to that used with Flash or Realplayer applications. On the server side, little or no installation is required. Our implementation was simply copied to web-shared folder on an Apache web server with no additional configuration required.

A table matches recognized XBRL tags to modeled states and flows and groups them by period. So far, this mapping is relatively simple. However, because of issues discussed in the previous section, we expect that logic beyond simple mapping will be needed to account for data stored in extended tags, data available from multiple sources in an XBRL document, or data with other representational variations. XBRL documents generally refer to multiple statements and thus have multiple context ids. Additional user interactions will likely need to be developed in production-level software to select the context ids to be visualized, accept share price data, and account for conflicts or anomalies observed in an imported dataset.

The values are then translated into visualization parameters. Scaling factors are computed to represent values as circles, rectangles, or wedges while fitting into available screen space. While the current implementation does not allow the user to adjust the scale, that feature would be both desirable and technically possible.

3. EXPERIMENTAL DESIGN

To assess students' ability to interpret the AFV diagrams and map identifiable components to important business concepts, we tested the AFV on undergraduate students in an introductory financial accounting class at a major university. The presenter informed students that participation was voluntary, that answers would be kept anonymous, and that there was no extrinsic incentive (e.g., money, extra credit) to participate. Of the 45 students in class, 41 choose to participate to some extent. Of those 41, 34 provided answers to all questions (21 male and 13 female, all between the ages of 18 and 30).

The testing instrument consisted of printed instructions, figures, and questions. To enforce the idea that all students were being asked to evaluate the same information, the instructions and figures were projected on a screen at the front of the class. Students began by reading a brief one or two sentence summary of four accounting concepts: liquidity, financing, profitability, and market value. Students then answered questions designed to test their understanding of the four concepts.

The presenter then provided a 10 minute tutorial introducing the AFV and explaining what each component represented and which financial statement was the source for the data. Following the tutorial, students answered questions designed to test their understanding of the AFV and its components. Students were provided with a color AFV image representing one year of operations (representing data from Intel) and asked to answer questions by (1) estimating the relative magnitude between AFV components and (2) identifying the structure and flow of financing. Finally, students were provided with four equally scaled color AFV images representing four years of operations (based on Intel data) and asked to answer questions about trends and changes in AFV components. The images used are shown in Appendix A. Following the collection of data the presenters demonstrated the animated version of the tool and held a question answer session to gather feedback.

4. RESULTS

Results from the experiment are presented in Tables 4 to 7 and represent responses from 34 students. Table 4 presents the percentage of correct responses to questions about the four accounting concepts: liquidity, financing, profitability, and market value.

Question # / Concept	Mean Percentage of Correct Responses
1. Financing	94.12%
2. Liquidity †	83.82%
3. Market Value	94.12%
4. Profitability †	88.24%
† Two questions were averaged.	
Minimum and maximum correct response values are 76.47% and 100% respectively.	

Table 4. Understanding of Accounting Concepts

When more than one question tested the same concept the percentage of correct responses were averaged. Students correctly answered questions between 83% and 94% of the time indicating a reasonably good understanding of the four concepts.

Question # / Concept	Correct Response %
1. Boxes (States)	91.18%
2. Circles (Flows)	91.18%
3. Related Colors	100.00%
4.Balance Sheet as source for Boxes	90.91%
5. Income Statement or Statement of Cash Flows as source for Circles	94.12%
6. Wedges	91.18%
7. Market Value Line	91.18%

Table 5. Understanding the Accounting Flow Visualizer

Table 5 presents the percentage of correct responses to questions about the AFV. These questions were asked after the tutorial explaining the components and financial statement sources of the AFV. Students answered at least 90% of the questions about the shape and source of components correctly. Of particular interest is the perfect response rate when students were asked about the meaning and use of colors. As a whole, students demonstrated a solid overall understanding of the separate AFV components and sources. Tables 4 and 5 provided us with a reasonable degree of confidence that after a short tutorial the students were able to understand both the basic accounting concepts and the components of the AFV used to represent those concepts.

Table 6 presents student responses to questions requiring them to analyze the company's performance for one year. The first five questions in the table required students to provide a numerical estimate while the last three provided multiple choice answers. For questions 1, 2, and 5 the mean estimates provided were not significantly different from the actual values at the 95% level (p<=.05). The high percentages of correct responses to questions 7 (90.91%) and 8 (94.12%), which relate to the type and flow of financing, are similar to the response rate in related questions in Tables 4 and 5.

Question 6 asked students to compare the relative size of the purchases flow to the sales revenue flow. The sales revenue flow is actually 10% larger than the purchases flow, a value we (and 75% of students) did not think was distinguishable. This lower correct response rate may be an indicator that changes in circles may not be noticeable when the circle gets above a certain size (Kridder et al 2001).

Question # / Concept	**% Correct Responses**	**Actual Value**	**Mean Response (Standard Deviation)**	**z-score**
1. Estimate profit as a percentage of sale revenue	-	22.31%	22.89% (.046)	0.72 *
2. Estimate profit as a percentage of assets	-	27.39%	29.87% (.178)	0.78 *
3. Estimate profit as a percentage of retained earnings	-	28.94%	35.17% (.169)	2.02
4. Estimate dividend payout percentage	-	22.60%	35.69% (.112)	6.61
5. Estimate debt financing	-	7.33%	9.09% (.062)	1.57 *
6. Relative size of Purchases and Revenue Flows	75.00%	-	-	-
7. Primary source of financing (capital structure)	90.91%	-	-	-
8. Direction of Financing Flow	94.12%	-	-	-
* At the 95% significance level the mean student estimate is not significantly different from the actual value.				

Table 6. Correctness of Responses in Single-Year Analysis Tasks

Table 7 presents student responses to questions requiring them to analyze trends and changes in the firm's performance over four years. The percentage of correct responses for questions 1 thru 5 ranges from 79.41% to 97.06% indicating that students were able to correctly identify changes as well as trends in a company's performance across time using the AFV. Question 6 relates to trends in market value across four years and has the lowest correct response rate in the experiment, 48.48%. In years four, five, and seven the size of the market value is relatively unchanged and is slightly obscured behind the asset state box; however, in the sixth year market value decreases enough to create some visual white space between this asset state box and the market value box. This may explain the lower correct response if students primarily focus on year six when answering the question. When responses indicating a decrease or no change of market value are aggregated 81.81% of responses are accounted for.

Question # / Concept †	**% Correct Response**
1. Change in capital purchases	91.18%
2. Change in profitability	97.06%
3. Trend in liquidity	79.41%
4. Trend in financing (capital structure)	84.38%
5. Trend in dividend policy	94.12%
6. Trend in market value	48.48%
†"Change" refers to a comparison between two years. "Trend" refers to change over three or four years.	

Table 7. Correctness of Responses in Multi- Year Analysis Tasks

5. DISCUSSION

Tables 4 – 6 provide some evidence that students understood the concepts of liquidity, profitability, market value and the mix of financing for a company, were able to associate those concepts to the visualization, and estimated some relative proportions with surprising accuracy.

The primary purpose of the experiment was validation of students' ability to associate business concepts to recognizable components of the visualization. We are encouraged that, following a brief tutorial, students were able to correctly interpret the visual components used in the tool. That is, circles for flows, boxes for states, and colors that tied together related items. We are further encouraged that students were able to associate those components with financial statement sources, correctly mapping filled-in squares to the balance sheet and circles to income statements and cash flow statements. The results here were not all correct, but since this was during the first two weeks of an introductory accounting class, the students were likely still developing their conceptual understanding of the content and function of the statements. We believe these initial results are encouraging enough to warrant further development of the tool.

The size estimates were surprisingly accurate. While these numbers do not tell us much by themselves, they establish a basis for comparison as we experiment with different formats in future versions of the AFV. Students did well in estimating the percentage associated with a pie wedge (a familiar graphical metaphor) but less well in comparing wedges to each other or to other shapes. This is demonstrated in Table 6, questions 3 and 4 which asked students for estimates of dividends as a percentage of profit (one wedge compared to another wedge) and profit compared to assets (wedge vs. square). Improving the formulation of the diagrams will be an ongoing effort in our line of work.

We also noted encouraging anecdotal responses from students to the instructor after we left. Some students said they liked the visualizations, thought it showed things well, and that they wished they could use it at work.

6. CONCLUSION AND FUTURE WORK

This line of work aims to explore the feasibility of the AFV. Can XBRL data be meaningfully translated in a visual depiction? Can the available data be meaningfully integrated in so as to address key analysis questions? Can users correctly interpret the visualization? The results presented here are encouraging.

The basic visual metaphors were understandable as representing key business issues. This result is in line with less formal feedback received from accounting practitioners. The current experimentation is not of sufficient scope to draw broad conclusions but the results are promising enough to suggest that further exploration of integrated visualizations of financial statement data can be useful in presenting business/accounting concepts to students at least, to other less-savvy stakeholders probably, and perhaps also for more sophisticated analysts who want to quickly summarize or compare financial position of an organization of organizations.

The source data available in XBRL seems to be largely sufficient and appropriately organized to support potentially useful visualizations. Details described above deserve attention. For example, should multiple indicators of the same magnitude be tabulated and compared? What additional information (such as share price as of the end of the period) is needed to support useful analysis tools?

Visual details also need more exploration. Can people effectively compare the area of rectangles and circles? Would other shapes be more effective? Do the animations add value in helping users recognize trends or avoid missing key indicators? In short, these results are encouraging but ask a number of potentially interesting questions.

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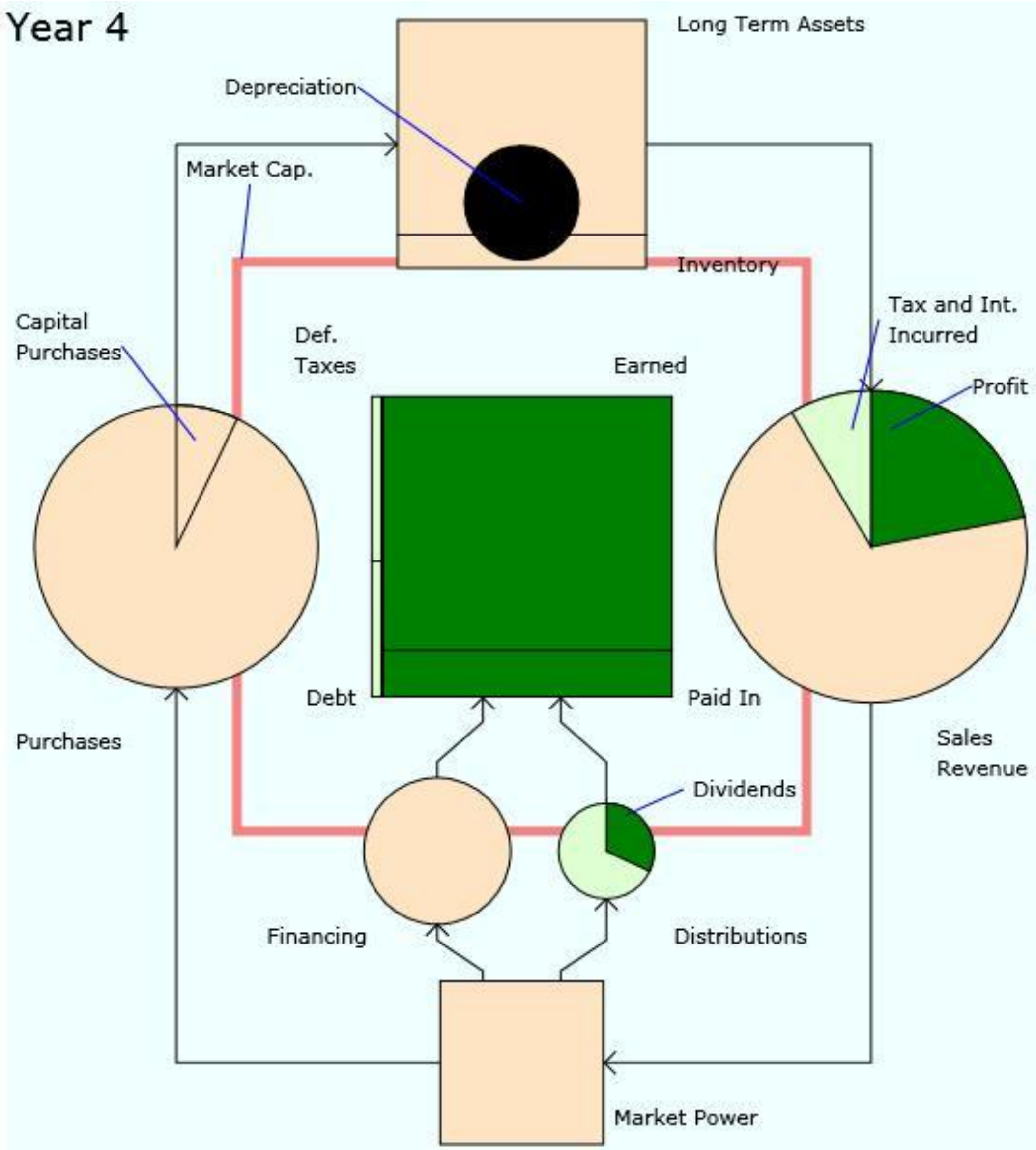
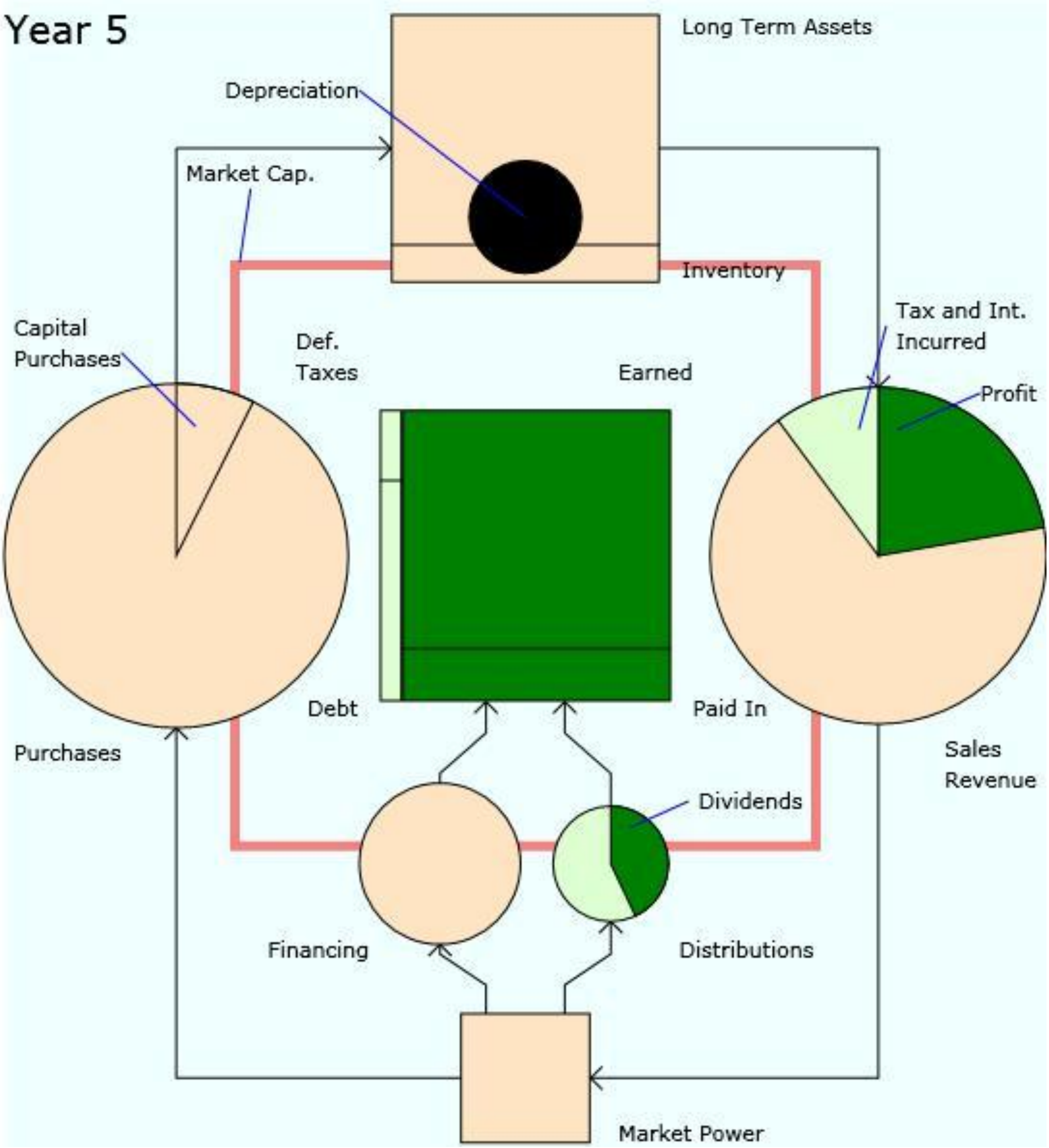
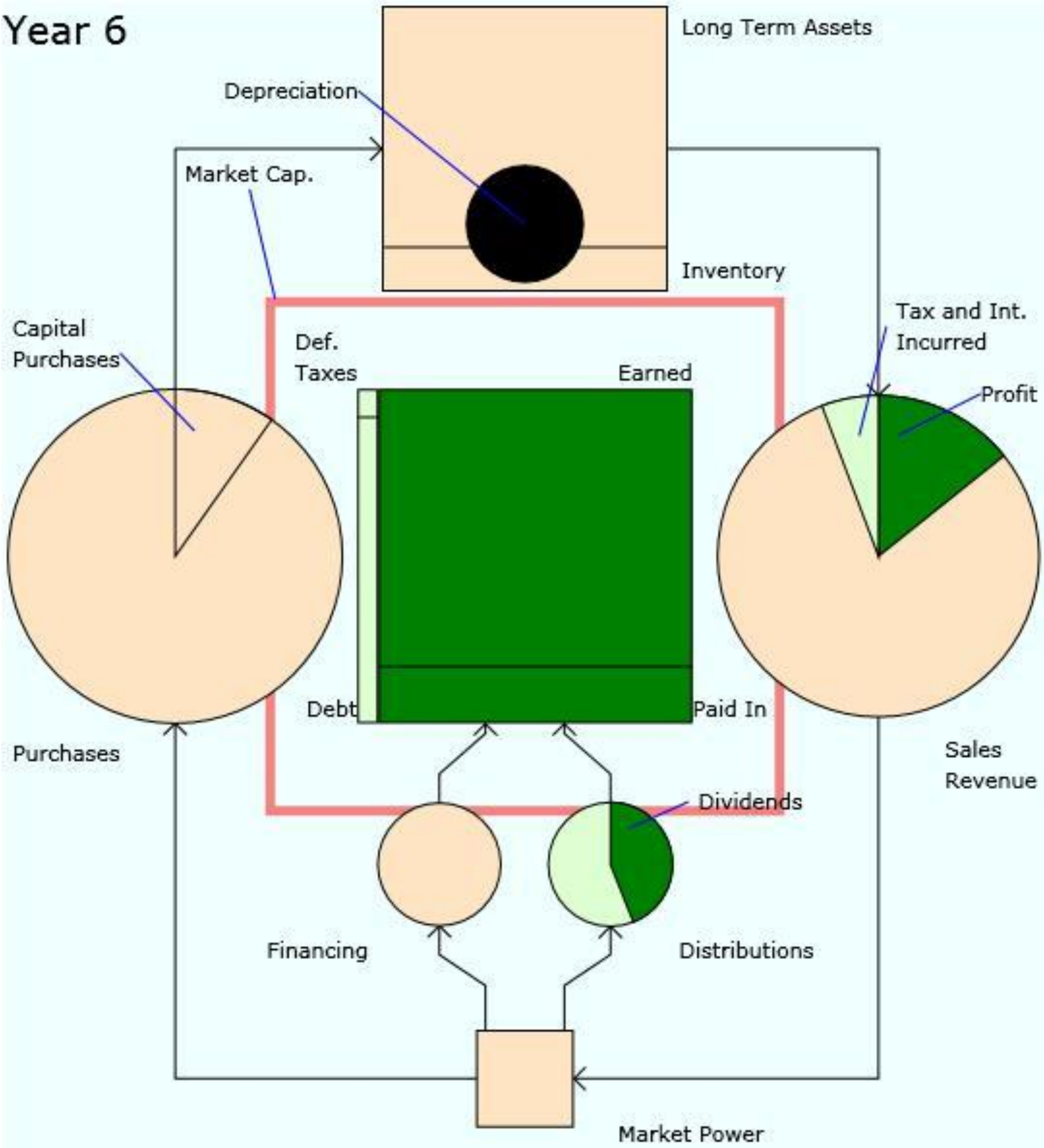
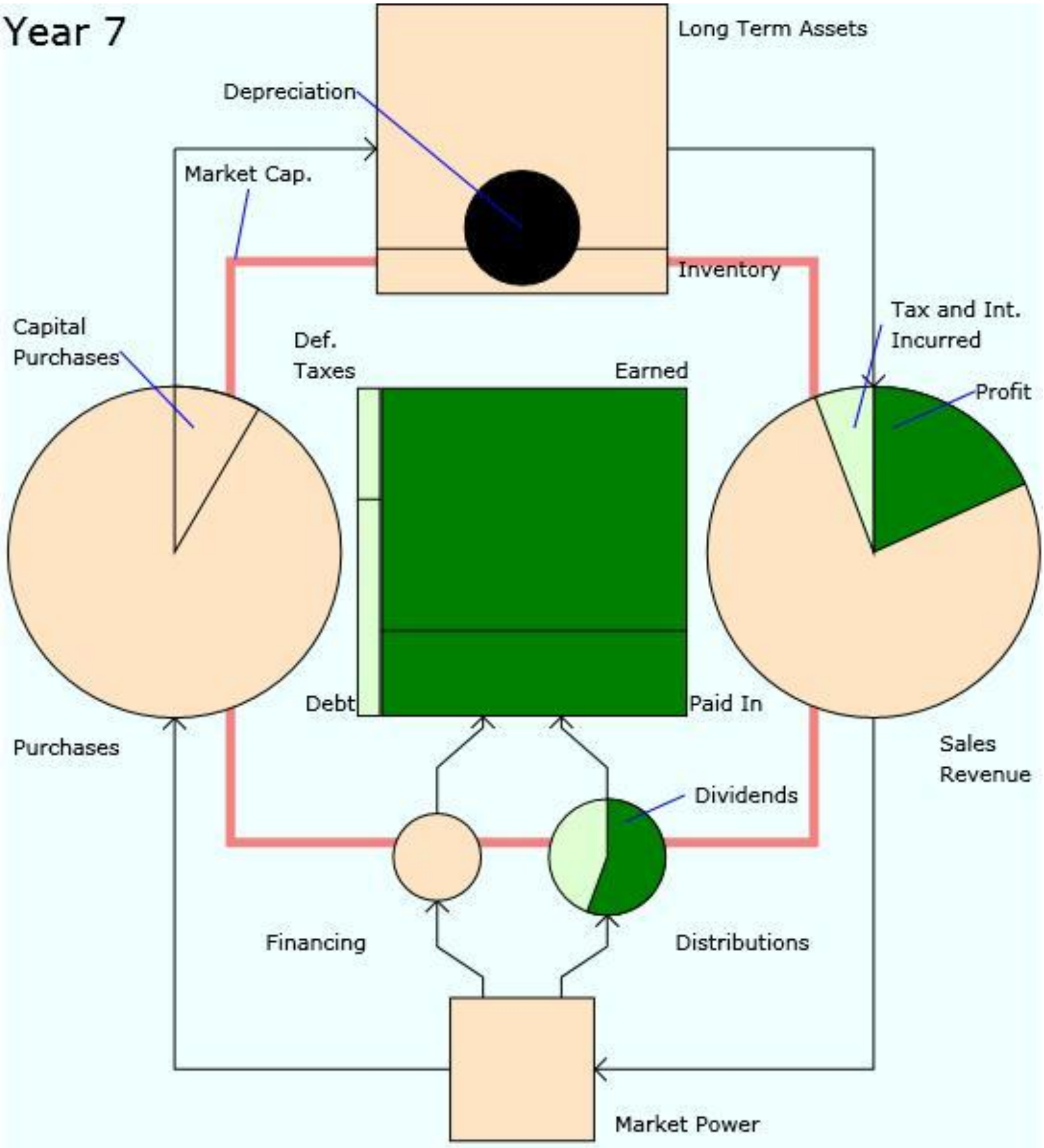
APPENDIX A: AFV Images Representing Four Years of Operations Data from Intel.

Four AFV diagrams based on Intel's annual reports used for the multi-year analysis tasks. Note the significant variation in market value and profitability and the depiction of an ongoing and extensive stock buyback program depicted in the financing flows.




Year 5
Long Term Assets
Depreciation
Market Cap.
Inventory
Capital
Purchases
Def.
Taxes
Earned
Tax and Int.
Incurred
Profit
Debt
Paid In
Purchases
Sales
Revenue
Dividends
Financing
Distributions
Market Power


Year 6
Long Term Assets
Depreciation
Market Cap.
Inventory
Capital
Purchases
Def.
Taxes
Earned
Tax and Int.
Incurred
Profit
Debt
Paid In
Purchases
Sales
Revenue
Dividends
Financing
Distributions
Market Power



Year 7
Long Term Assets
Depreciation
Market Cap.
Inventory
Capital Purchases
Def. Taxes
Earned
Tax and Int. Incurred
Profit
Debt
Paid In
Purchases
Sales Revenue
Dividends
Financing
Distributions
Market Power