Corporate Reporting Using Graphs: A Review and Synthesis

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Draft date: November 2008

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Acknowledgements: We would like to thank participants at the British Accounting Association Conference in Blackpool (April 2008) and the European Accounting Association Conference (April 2008) for their helpful comments on an earlier draft of this paper, especially Niamh Brennan, Doris Merkl-Davies, Sayjda Talib and Pauline Weetman. We would particularly like to thank the anonymous referee.

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1.0 INTRODUCTION

Increasingly, the annual reports of public companies use visual representation to communicate financial information. These companies augment the financial statements and related notes with a variety of additional material, normally located at the front of the annual report. A variety of formats are used, in particular, text (accounting narratives, including the MD&A), graphs and photographs. While there is now a sizeable body of research on different aspects of accounting narratives [for reviews see Jones and Shoemaker, 1994; Cole and Jones, 2005; and, most recently, Merkl-Davies and Brennan, 2007], graphs in corporate reports have received rather less attention. Yet graphs represent an integral part of a company's overall disclosure strategy. The purpose of the present paper is to review and synthesize the extant literature on graphs, and to identify fruitful directions for future research. This paper, therefore, complements the review by Merkl-Davies and Brennan [2007].

The comparatively recent introduction of graphs into corporate reports reflects the changing role of the annual corporate report. It has been transformed from a primarily formal, legal document into a major public relations document [e.g., Squiers, 1989; Lee, 1994; and Hopwood, 1996]. In turn, this development partly arises from wider societal transformations, particularly the pervasive television epistemology of the late twentieth-century English speaking world. In this world, television, which is "at once kaleidoscopic, glamorous, and entertaining", serves to frame and drive other communicational media (Graves, Flesher and Jordan, 1996, p.59). Graphs are now used extensively, at least in the developed Western world. For example, Beattie and Jones [2001] demonstrate that 92% of Australian, 88% of French, 84% of German, 90% of Dutch, 82% of UK and 90% of US top companies use

graphs in their annual reports. This high incidence is confirmed by many other research studies.

Companies seek to communicate using financial graphs rather than tables or narratives for six main reasons.[1] First, graphs allow management to present information in a flexible way. Most of the information in annual reports is constrained by a regulatory framework. For example, in the US there are regulatory requirements from the Securities and Exchange Commission (SEC) and the Financial Accounting Standards Board. Graphs, however, typically fall outside the regulatory remit of accounting standards. Companies, therefore, have discretion to summarize, distil and express the information in whatever way they choose. Second, graphs are eye-catching. The visual saliency of graphs is enhanced by the use of color [Leivian, 1980]. In effect, graphs become oases of color and interest within rather formal and forbidding statutory documents. Graphs become "graphical sound bites" [Henry, 1995, p.35] reflecting the wider sound bite culture of television epistemology. Third, graphs are excellent at summarising, distilling and communicating financial information. They are particularly good at conveying trend information, patterns and highlighting anomalies [Korol, 1986; Harris, 1996]. In financial reporting, graphs can capture a company's performance by highlighting a few key performance indicators such as sales and earnings per share, over time. Fourth, graphs tap into a highly developed human cognitive skill, spatial intelligence. In essence, graphs being visual allow spatial rather than linguistic decoding. We can, therefore, use 'sight' (the dominant visual sense) to 'see' the data more directly and clearly [Kosslyn, 1989; Lewandowsky and Spence, 1989; Ackerman, 1991]. Pinker [1990, p.73] comments that a "striking fact about human cognition is that we like to process information in graphic form". Fifth, graphs are memorable. We retain pictorial and graphical representations much better than numbers [Leivian, 1980]). This data is capable of being readily retrieved. Finally, graphs are egalitarian. Not only can unsophisticated users

digest graphs as well as sophisticated users, but graphs are in many ways independent of language and therefore are international. Following the terminology of Merkl-Davies and Brennan [2007], this set of reasons would underpin what can be described as the altruistic motivation for graph use and design choices by preparers.

The use of graphs in annual reports is not, however, problem free. The communicative effectiveness of graphs is contingent upon the graphical competency of both the preparer and the user. There are many specific aspects of graph construction and design that can be varied and which have the potential to affect users' perceptions. Besides issues of basic graphical competency, another concern is the use of financial information, including graphs, to serve managerial interests rather than user interests. This has been well-documented (see, for example, Beattie and Jones [1992, a,b]). Gibbins et al. [1992, p.22] note that the use of graphs to disclose financial information in annual reports represents a significant dimension in financial disclosure management. In the wider research domain, innumerable studies document the incentives for, and ways in which, management seeks to create a more favorable view of the company's performance than is warranted. This is a self-serving motivation for graph use and design choices by preparers. This body of research includes: Clatworthy and Jones [2003]; Llewellyn et al. [1996] (self-serving behavior); Murphy and Zimmerman [1993] (the cover up hypothesis); Preston et al. [1996] (images); Revsine [1991] (the selective financial misrepresentation hypothesis); Schipper [1989] (earnings management); Stanton and Stanton [2002] (impression management); Tweedie and Whittington [1990] (financial reporting abuses); and Watts and Zimmerman [1996] (positive accounting theory). Collectively, these studies can be termed impression management studies. A possible outcome of such impression management behavior is that the message conveyed is no longer neutral and unbiased.

It is possible that these two motivations(altruistic and self-serving) co-exist to some degree. Preparers have generic incentives arising from agency theory to communicate performance effectively. In the absence of specific circumstances that could result in an adverse impact (or a reduced beneficial impact) arising from such communication, this motivation is likely to determine behaviour. However, in certain circumstances, the impression management motivation may dominate the altruistic motive. Indeed, it is possible that these motivations may even overlap In the annual report of a single company for a single year, several graphs often appear. Some may serve fully altruistic motives, while the existence and design of specific others may be driven by self-serving motives. Empirically, it is easier to identify instances of impression management than it is to identify instances of altruism. For this reason, research to date has focussed on the self-serving motive.

Specifically, in relation to graphs, Beattie and Jones [1992a, p.1] outline three commonly found forms of graphical infidelity, which they term selectivity, measurement distortion and presentational enhancement. Beattie and Jones [2000a] refer to selectivity as the *primary graphical choice*; the other two forms of graphical infidelity are *secondary graphical choices* as they are contingent upon a graph being used. All three may result from either preparers' lack of competency or deliberate manipulation. Selectivity concerns bias in the selection of only favorable items [Birnberg et al., 1983]. In financial graphs, selectivity occurs when a company graphs variables where there is a favorable trend line (e.g., rising earnings) and elects not to graph variables with unfavorable trend lines (e.g., falling earnings per share .

Measurement distortion occurs where the physical representation of the numbers on a graph is not proportionate to the underlying numbers. Measurement distortion thus violates the fundamental principle of graph construction. In financial graphs, measurement distortion may occur through the use of a non-zero axis or because the graphical specifiers (i.e., the

symbol used to represent specific numerical values) are simply not drawn to scale. Measurement distortion is commonly measured using a graph discrepancy index developed by Tufte [1983] and refined by Taylor and Anderson [1986].

Finally, presentational enhancement occurs when the design of one or more of the graphical components enhances or degrades certain features of the graph. Examples include the use of graph shape, the use of inappropriate three-dimensional specifiers, and the inconsistent use of color. Birnberg et al. [1983] term such presentational enhancement "focusing". Gibbins et al. [1990, p.129] classify such practices as interpretation and presentation management. Framing effects of this nature have been shown to alter the meaning attributed by users [Tversky and Kahneman, 1981; Bazerman, 1990].

Perhaps surprisingly, graphs are currently unaudited and unregulated in most Western countries.[2] In both the US and the UK, for example, regulatory pronouncements merely state that auditors should 'review' additional sections of the annual report (which would include financial graphs) for material inconsistencies with the audited financial statements [American Institute of Certified Public Accountants, 1975; Auditing Practices Board, 2006]. This enables management to innovate, experiment and use such sections flexibly. However, the opportunity for impression management and graphical infidelity is consequently increased.

There have, however, been proposals to improve the regulation of financial graphs. [Canadian Institute of Chartered Accountants, 1993, p.147; Accounting Standards Board, 2000]. In a discussion paper concerned with improving communication in annual reports, the UK standard-setting body not only stressed the advantages of graphical presentation to private shareholders, but also recommended a series of five specific guidelines for graph presentation [Accounting Standards Board, 2000].[3]

The body of academic research which has grown up to investigate the nature and extent of graph usage in external reporting has a relatively recent origin. The first systematic study was published in the US by Johnston, Rice and Roemmich [1980]. However, by the end of 2006, over 20 academic studies looking at financial graphs in seven countries had been published. As with any emerging research area, the literature is currently somewhat fragmented and disorganized. We offer a simple framework in which to view and organize the various studies. This framework identifies three major issues relating to graphical reporting, as shown in Figure 1 and described below.

1. The Theory

What theoretical development underpins research into graphical reporting research? (This provides an underlying theoretical conceptualization).

2. The Practice

a, What graphical reporting practices do organizations adopt? (This provides a baseline, descriptive overview).

b, What is the overall environment in which financial graphs are prepared and used? (This provides a contextualization of graphical practices).

c, Are graphical reporting practices systematically associated with organizational and country characteristics? (This provides explanatory factors for graphical usage).

3. The Consequences

What impact do specific graph features have on users' perceptions and, hence, decisions? (This concerns the consequences of graph use).

[Figure 1 about here]

To date, there has been only a limited theorization of graphical practice, chiefly employing an impression management perspective. The other perspective adopted (often implicitly) in relation to management incentives is the altruistic motive, which assumes that management uses graphs altruistically to communicate more effectively, thereby improving the decision-making of investors (and other stakeholders). Graphical practice has been uncovered through extensive archival work, principally the study of financial graphs in annual reports. The descriptive study of practice has been underpinned by the statistical graphs literature which has provided a normative framework and an embryonic theory of graph understanding. By contrast, the consequences of graphical practices research have been addressed using an experimental empirical approach and is in its infancy.

The remainder of the paper is presented in three sections, followed by a conclusion. In section 2, we introduce the key components of the graph type most commonly found in corporate reports (the column graph) and discuss relevant concepts and theory from the statistical graphics literature. Section 3 presents a critical review of extant studies, synthesizing this literature across key issues. In section 4, we discuss the main issues arising from our literature review and develop policy implications and research opportunities.

2.0 GRAPHS AND STATISTICAL GRAPHICS

2.1 The nature of graphs

Graphs have been commonly used since their creation by William Playfair over 200 years ago. Graphs are symbolic displays requiring interpretation according to certain conventions [Kosslyn, 1989]. The distinguishing feature of a graph is that the representation of quantitative information, as physically measured on the surface of the graph, should be directly proportional to the underlying numerical values [Tufte, 1983]. There is general agreement that graphs are used for two purposes: to explore/analyse data and to present/communicate information to an audience. The type of graph used generally depends upon its underlying purpose. Graphs in annual reports are typically used to present and communicate financial data. The most common generic graph form is the rectilinear coordinate graph. Several types of graph are of this form - column graphs (i.e. vertically presented columns), bar graphs (i.e. horizontally presented columns) and line graphs. Column and line graphs are particularly suited to the display of time series data. Variants of the column graph that are commonly encountered are the segmented column graph (where each column is divided into several sections) and the grouped column graph (a series of grouped, side-by-side columns). The other graph type found with any frequency in annual reports is the pie chart, which is suited to the display of a single categorical variable.

2.2 Structural components of column graph and principles of good practice

Statistical graphics is a relatively new research area that draws upon the statistics, cognitive psychology and human information processing literatures. The initial achievement of this field was the establishment of a set of construction and design principles based on best practice [Schmid and Schmid, 1979; Schmid, 1983; Tufte, 1983; Kosslyn, 1994].

The basic rectilinear coordinate graph, such as the column graph, has four primary structural components: background, framework, specifier and labels. These components and their sub-components are shown in Figure 2.

[Figure 2 about here]

The background is the pattern against which the other graph components are displayed. It serves no essential purpose. It can be plain white, colored, patterned or include pictorial decoration and often extends beyond the boundaries of the framework. Although it can have a neutral impact or generate interest, it can be distracting and potentially interfere with the effective communication of the graphical financial information from preparer to user. Thus, the background should not be too prominent and should reinforce the graphical message [Jarett, 1983; Kosslyn, 1989].

The full outer framework comprises two intersecting perpendicular lines. Often all measurements are positive and so only the upper right quadrant of the potential graphical framework is shown. The axes are each marked off in equal units, with tick marks showing the scale divisions. Typically, the horizontal or x-axis represents time (shown in years from left to right) while the y-axis represents a financial variable such as sales or earnings per share. In general, it is considered poor practice to use a non-zero scale or unequal divisions as this runs counter to the basic graphic convention that the specifier should vary in direct proportion to the numerical values being portrayed [Tufte, 1983; Schmid, 1983]. Unskilled graph readers could easily be misled by a non-zero or non-arithmetic scale if they rely only on perceptual processing and do not read and cognitively process the labels. Some writers, however, argue that the display of extreme, outlying values using a zero-based, arithmetic scale can degrade the resolution of the graph, making it difficult to 'see' differences between data points [Cleveland, 1994]. The inner framework comprises horizontal gridlines across the area formed by the framework assist in the judgment of position and length. Gridlines should be thin and lie behind the specifiers [Kosslyn, 1994]. In practice, many graphs in

annual reports are drawn in outline, showing only an explicit x-axis, an implicit y-axis and no gridlines.

The key component of a column graph is the specifier, which is the graphical element used to represent the quantitative information. In column graphs, the specifier is the length of the column. The width of the specifiers and the interspaces should be uniform and evenly spaced [Jarett, 1983]. Column specifiers can have a number of attributes, such as cross-hatching, color and dimensionality. The use of cross-hatching, unfilled, outline specifiers and three-dimensional specifiers is not advised, as they can produce distortive visual effects.

Three types of label are essential to all graphs [Schmid, 1983; Kosslyn, 1989]. First, a meaningful title should exist, generally located at the top of the graph. Second, the scale on each axis should be given an alpha label, normally to the left for the vertical axis and to the bottom of the horizontal axis. Third, numeric labels are required to indicate values of each scale, normally located close to the axis. In some cases (e.g., years) the numeric values make the descriptive axis label obvious and it can be omitted.

In general, effective graphic communication requires that these graphic components are present *and* that they are arranged in a balanced way. Critical to this balance is the choice of axes scales that produce a "well-proportioned" graph that permits efficient visual decoding. This is known as a graph's shape parameter. Effectively, this is the ratio of a graph's height to its width. In addition, the subsidiary nature of certain graphic components should be conveyed by means of lighter weight lines and smaller typefaces.

2.3 Towards a theory of graph understanding

During the last 20 years, developments in computer graphics have contributed to further theoretical development. While a complete theory of graph understanding does not yet exist, certain elements of such a theory are in place and combine insights from both the statistical graphics and human information processing literatures. Graph readers employ two processing activities – *perceptual* and *cognitive*.[4] The initial processing activity is perceptual. In a series of experimental studies, Cleveland and McGill [1984; 1985; 1986; 1987] investigate graphical perception drawing upon sensory psychophysics. It has been found that the accuracy of the geometric judgments made depends upon the visual dimension employed by the graph.[5] The judgment of position along a common scale has been found to produce the most accurate judgments, this being the dominant dimension in column graphs (length and area are secondary dimensions). These judgments involve four distinct visual routines: find an anchor point; scan from that point; mentally project a reference line; and superimpose a mental image of one specifier on another [Simkin and Hastie, 1987]. Graph readers may (or may not) move beyond perceptual processing to engage in cognitive activities such as scale/label reading. There is widespread recognition that both perceptual and cognitive processing activities are contingent upon the specific nature of the task and on user characteristics.

3.0 LITERATURE REVIEW

3.1 Scope/boundaries

The scope of this review comprises all the systematic, published studies into the use of financial graphs in external financial communication of which we are aware. In all, we review 25 articles uncovered via a comprehensive literature search and review of known studies.

3.2 General Details

Table 1 lists 15 archival studies and Table 2 lists 4 experimental studies, giving a combined total of 19 studies.[6] However, 25 distinct articles are listed as in some cases the results of a single study produced more than one published article/research report. The studies were published from 1980 to 2008. Sixteen of the studies were based on a single country: three Australian, one Canadian, one Hong Kong, six UK and five US. Of the remaining studies, one was a bilateral UK-US comparison, one compared the US and 12 other countries, and one was a six-country comparison. The main focus of the 15 archival studies was the corporate annual report (12 studies), one study looked at charity annual reports, one looked at both corporate annual reports and at not-for-profit organisations' annual reports and one looked at IPO prospectuses. Below, we discuss the 15 archival-based studies first, followed by the four experimental studies.

[Table 1 about here]

3.3 Theorization

To date, there has been little overt theorization of graphical practice. A common implicit, and sometimes explicit, framework is that of impression management. This framework derives from social psychology, and particularly from the work of Schlenker (1980). In effect, it is a theory of corporate presentation and suggests that management seek to use graphs opportunistically to present a favorable view of corporate performance and, indeed, by extension to create a more favorable view of a company's performance than is warranted by the actual performance. Thus, management are likely to include graphs of favorable performance but exclude those where performance is unfavourable, to distort graphs in their favor and to use creative construction and design techniques. This framework is used to underpin the collective work of Beattie and Jones either implicitly or more explicitly. Several other researchers into this area also adopt this broad theoretical approach. The altruistic communication enhancement motive is less commonly adopted by researchers. In

their excellent review of discretionary narratives, Merkl-Davies and Brennan [2007] also identify the impression management and incremental information perspectives as being those adopted by researchers in that area.

It is worth considering how these two perspectives fit with the semi-strong form of the efficient market hypothesis, which states that public information is immediately and unbiasedly impounded into share prices. An implication of the efficient market hypothesis is that the annual report contains very limited 'new' information and so there is no significant share price reaction to it. Yet shareholder surveys indicate that shareholders do use annual reports. Hines [1982, p.297] resolves this apparent paradox by arguing that a market reaction definition of information usefulness is overly narrow and that 'usage' of annual reports by shareholders may not produce a short-term market reaction. She notes that the audited annual reports fulfil an important information confirmatory role and act as a useful summary of company performance and financial position, assisting of the evaluation of the company. For this reason, the efficient market hypothesis does not negate management incentives to use graphs (under either the altruistic or impression management perspective).

3.4 The Practice: Archival Studies

a, Frequency of Graph Usage

Graph usage in annual reports (i.e. whether or not an annual report contains *at least one* graph) has remained consistently high at the levels reported in early studies. Steinbart [1989] in the US and Beattie and Jones [1992b] in the UK reported that 79% of companies used graphs in 1986 and 1989, respectively. More recently, Frownfelter and Fulkerson's [1998; 2001] international study shows that 89% of US companies and 86% of non-US companies use graphs. In general, graph usage in the 1990s stabilized between 80-90% of companies across western developed countries. This finding appears remarkably robust. At this general

level of usage, it is not possible to make inferences regarding the incentives underlying graph use. One company may produce well-constructed graphs for the same set of topics each year (consistent with the altruistic motive), whereas another may switch the topics graphed each year and/or flaunt the principles of good graph construction to impression manage. Both, however, are observed to use graphs. More detailed analysis of graph use is required to explore such motivational issues.

Interestingly, however, Beattie and Jones [1998, p.24] show that frequency of graph usage falls in the UK from 80% in 1988 to 69% in 1992. This reflects the course of a downturn in the UK economy and suggests a connection between economic prosperity and presentational format choices. By 2004, Beattie, Dhanani and Jones [2008] find the use of graphs to be almost universal (99%).

Outside western developed countries, a different pattern of graph usage in annual reports is detected in three studies. First, Courtis [1997] reports comparatively low graph usage in Hong Kong annual reports (38% in 1992-3; 35% in 1994-95). This finding raises the interesting question of whether graphical usage has a cultural component, as this is the only non-western study. Second, Mather et al. [2000] find that only 28% of companies use graphs in IPO company prospectuses. This finding suggests that, in financial documentation other than the annual reports, graphical usage may be much lower. Finally, Beattie and Jones [1994a] in the UK and Mather et al. [1996] in Australia report usage of 74% and 73% in charity and not-for-profit annual reports, respectively. This indicates that non-corporate annual reports may have a lower incidence of graphical usage.

b, Topics Graphed

The four most popular financial variables graphed in annual reports are sales, earnings, earnings per share (EPS) and dividends per share (DPS). However, distinct national patterns are evident. Typically, in Australia, the UK and the Netherlands profit is the most popular variable. By contrast, in the US and Hong Kong sales is more frequently graphed in annual reports than profit/earnings. Germany's results are anomalous. Of the four variables frequently graphed by other countries, only sales is graphed by more than a quarter of companies [Beattie and Jones, 1996]. For charities, whereas Beattie and Jones [1994a] find total income and total expenditure graphs to be most popular; Mather et al. [1996] find Australian not-for-profit organisations reporting patterns resemble those of Australian companies. In Australian IPO prospectuses, Mather et al. [2000] find market-based graphs to be most important.

c, Selectivity

A key research question is whether graphs are used selectively by companies. Steinbart [1989] in the US finds that 74% of companies with increases in annual net income use graphs of sales, income or dividends, while only 53% of companies use them where annual net income decreased (significant at the 0.01 level). This basic idea that companies use significantly more graphs which show favorable, rather than unfavorable, performance was refined, developed and tested by Beattie and Jones [1992a,b] on 240 annual reports in the UK. The UK results confirmed Steinbart's selectivity findings. These findings have been further supported in a number of other contexts using a cross-sectional research design: in a six-country international study [Beattie and Jones, 1996, 2000b, 2001]; in Australian companies [Mather et al. 1996; Beattie and Jones 1999]; in a US/non-US international comparison [Frownfelter and Fulkerson, 1998]; and in a study of IPO prospectuses [Mather et al. 2000].

The graph use decision has a status quo option, i.e., include the same graphs as in last year's annual report. Due to inherent inertia, this option is selected disproportionately, a psychological effect known as status quo bias (Samuelson and Zeckhauser, 1988]. It follows that management incentives may have to meet a threshold level before an "active" decision to change graph use is made. In a more powerful research design using time-series data, Beattie and Jones [1998; 2000] matched company graph start/stop decisions with the direction of change for the year in the variable being graphed. They found strong evidence of selectivity. Overall, however, the capital market countries (Australia, UK and US) appear more selective than France, Germany and the Netherlands.

d, Measurement Distortion

Studies of measurement distortion seek to establish how accurately the graph represents the underlying data. All published studies to date have used a Graph Discrepancy Index (GDI), which is a variation of Tufte's [1983] 'lie factor' proposed by Taylor and Anderson [1986]:

$$\text{Graph Discrepancy Index (GDI)} = [(a/b)-1] \times 100\%$$

where

a = percentage change (in cms) depicted in graph, i.e.,

$$\frac{\text{height of last column} - \text{height of first column}}{\text{height of first column}} \times 100\%$$

b = percentage change in data

If, for example, a company's sales increased from \$10 to \$20 over five years and this is shown in a column graph in which the specifier increases from 10 cms in year 1 to 21 cms in year 5, then the graph discrepancy index is 10%, viz.

$$GDI = [(110/100) - 1] \times 100\%$$

where

$$a = \frac{21-10}{10} \times 100\% = 110$$

and

$$b = \frac{20-10}{10} \times 100\% = 100$$

Where the graph is correctly represented, the Graph Discrepancy Index (GDI) is zero. Positive (negative) values indicate the percentage by which a trend is exaggerated (understated). To determine whether or not a distortion gives a more favorable or less favourable impression of a company's performance than is justified from the data, the nature of the variable and trend must be examined. In most cases, the Graph Discrepancy Index has been used to examine four key financial variables (KFVs) (as identified by Beattie and Jones [1992a,b]): sales, profits, EPS and DPS. For these variables, higher values indicate "better" performance than lower ones. The interpretation of Graph Discrepancy Index (GDI) values for these variables is as shown in Figure 3. The exaggeration of an upward trend and the understatement of a declining trend both give more favorable impressions of a company's performance than is warranted.

[Figure 3 about here]

Unfortunately, not all studies discuss favorable/unfavorable GDIs as well as positive/negative GDIs. While positive/negative GDIs are evidence of low preparer competency, the interpretation of findings in relation to preparer incentives requires observed GDIs to be classified as favorable/unfavorable.

Eleven studies investigate measurement distortion. To date, all studies have used the graph Graph Discrepancy Index (GDI). All the studies approach the subject in slightly different ways, but overall their results are indicative of systematic bias in a company's favour. It is possible to isolate three aggregate distortion statistics: mean measurement distortion/mean *material* measurement distortion; favorable vs. unfavorable distortions; and significance test statistics.

Most of the studies report mean measurement distortions. Of the 23 reported mean measurement distortions in Table 1, 21 are positive (i.e., broadly favorable to the company assuming a predominance of upward trends), while only 2 are negative (Germany, key financial variables in Beattie and Jones [1996] and key financial variables in Mather et al.'s [2000] Australian study).[7]

All those studies which report the frequency distribution of Graph Discrepancy Indices (except for Steinbart [1989]) showed more overstatements of trends than understatements. Beattie and Jones's [1992a] findings are typical, showing 22 material exaggerations and 8 material understatements.

Finally, in four studies statistical tests were conducted to see whether favorable discrepancies outweighed unfavorable discrepancies. In three studies, they did (Steinbart, 1989; Mather et al., 1996; and Beattie and Jones, 1999). Mather et al. [1996] is illustrative. They found in

their study of 143 Australian companies that distorted graphs of any of the KFVs are significantly more likely to present performance favourably than unfavourable (performance being measured as the change in the graphed variable over the period of the graph). Interestingly, Mather et al. [2002] found contrary results for Australian companies issuing IPO prospectuses. In this study, unfavorable distortions of KFVs were significantly more likely than favorable distortions. This appears to reflect caution by companies raising new funds.

The GDI is a simple and intuitive measure. Although universally used to date, it does however suffer from a number of faults. Mather et al. [2005] provide a useful discussion and illustration of the problems. In particular, there are instances where spuriously high Graph Discrepancy Indices (GDIs) can result unless the researcher takes care to discount them.[8] In particular, very minor inaccuracies can be difficult to measure accurately; in the particular case of no change in the height of the first and last columns produces a spurious GDI of -100% if the change in the data is marginal. A further problem is that the GDI is undefined if there is no change in the data (as the denominator is zero). This situation is most likely to occur for a few DPS graphs.

Mather et al. [2005] propose the Relative Graph Discrepancy Index (RGDI) as an alternative measure. This measure is a function of the height of the last column as it is plotted and the height at which it *should* have been plotted. Specifically, it is calculated as:

$$RGD = \frac{g2 - g3}{g3}$$

where

g2 = height of last column

g3 = correct height of last column, i.e. (g1/d1) × d2, and

d1 = value of first data point

d2 = value of last data point

The RGDI overcomes potential problem situations that arise if the GDI is used. However, to date no study has yet used the RGDI.

e, Construction and Design Issues

A frequent finding has been that graphical construction and design that does not adhere to the generally accepted normative principles. In some cases, such as Beattie and Jones (1992a; 1999), there was strong evidence that this was associated with presentational enhancement. In the seminal study by Johnson et al., [1980, p.56], the authors conclude, after finding 125 out of 423 incorrectly constructed graphs, that "the use of misleading or potentially misleading graphs appears to be widespread". Beattie and Jones [1992a,b; 1994b] find frequent instances of inaccurate design, including 17 cases of non-zero axes. The CICA study [1993] identified 15 ways that graphs can potentially be misleading. Meanwhile, Beattie and Jones [1994a] document many instances where pie graphs breach good design rules. Courtis [1997] and Beattie and Jones [1996, 2000b, 2001] document instances of misleading graphs including, manipulated baselines, absent gridlines, unsuitable graph types, and unconventional presentation of trends. Finally, Beattie and Jones [1997] show non-compliance with 20 narrative graph design and construction principles for the US and the UK.

f, Type of Graph

Those five studies that report the graph type used in annual reports showed that the column graph was by far the most popular graphical format used by companies for KFVs. However, for charities, pie graphs were the most popular [Beattie and Jones, 1994a]. Whereas for-profit organisations focused on showing the time trend of key financial performance variables (for which column graphs are most suitable), not-for-profit organisations were more concerned to show, for the most recent year, ”where the money comes from and where it goes” (i.e. categorical data well-suited to display using pie graphs).

g, Length of Time Series

Those studies reporting the length of time series graphed by companies indicate that five-year time series were the most popular. However, Beattie and Jones [1996; 2000b; 2001] document significant numbers of ten-year graphs.

h, Slope Parameter

The angle of a graph’s trend line in relation to the horizontal is termed a graph’s slope parameter or aspect ratio. A graph’s slope parameter is intimately connected to its shape parameter (defined as the height of the tallest specifier divided by the total width of all the specifiers). Research has shown that we “mentally construct lines between the tops of the columns in order to judge change” [Hollands and Spence, 1992, p.321). The shape and slope parameters are important as they affect the user’s ability to accurately decode a slope and this, in turn, may affect the user’s perception of a graph. Put simply, graphs of financial variables drawn with steeper slopes are likely to be attributed as having better financial performance than those with gentler slopes. Prior statistical graphics research has determined an optimal graph slope for judging graphs generally to be 45° [Cleveland and McGill, 1987; Cleveland et al., 1988; Hollands and Spence, 1992; Cleveland, 1993, 1994].

Displays which diverge significantly from 45° are described as exhibiting *orientation distortion* [Cleveland et al., 1988, p.293].

Several studies by Beattie and Jones [1996, 1997, 1998, 1999, 2000b, 2001] provide descriptive data about the slope parameter. In all cases, they find that the mean slope parameter in financial graphs is significantly lower than the theoretical optimum of 45°. For example, Beattie and Jones [1997] find that the mean slope parameter for US and UK companies is, respectively, 33.5° and 34.5°. This suggests that many graphs will be perceived as portraying poorer financial performance than would be the case with a higher slope parameter. While this finding may appear surprising, it may be the case that tall, narrow graphs (which favourably emphasize a rising trend) are simply not considered acceptable; most graphs being rather squarer in shape. The mean deviation from the 45° optimum, in either direction, is 16.4°.

3.5 The Consequences: Experimental Studies of User Impact

a, Nature of Experiments

The four laboratory studies (see Table 2) each look at different aspects of graph construction and design. The earliest such study, Taylor and Anderson [1986], investigated a range of 7 graphical improprieties using bank loan officers. Beattie and Jones [2002a] investigate the slope parameter, while Beattie and Jones [2002b] look at measurement distortion. Finally, Arunachalam et al. [2002] investigate four types of improperly constructed graphs. The three most recent studies use the earlier empirical studies which document graphical improprieties as the motivation for their research. The aim is to establish whether these graphical infidelities do, in practice, have any effect on users' perceptions/decisions.

[Table 2 about here]

b, Subjects

With the exception of Taylor and Anderson [1986], accounting and business students are used as subjects acting as surrogates for annual report users. The average number of subjects ranges from 35 to 53.

c, Research Instrument

In each case, a set of graphs was prepared by the researchers. Some of the graphs (the control graphs) were left unaffected. The others were altered. The subjects were then tested to see if their perceptions were affected by the experimental graphical impropriety.

d, Findings

In all four studies, there was evidence that distorted graphs did affect the graph readers' *perceptions* of company performance. As a result, investors' *decision making* is assumed to also be affected.

Taylor and Anderson [1986] find all seven graphical improprieties to have the expected impact on bank loan officers' perceptions of the company. The improprieties were: omission of zero baseline; use of logarithmic rate-of-change graphs; use of multiple y-axis scales; placement of most irregular stratum in segmented column graphs other than at or near the top; choice of time series length to exclude decline in performance; showing time series reversed from the norm of left to right; and scale extended far beyond the highest or lowest plotted points.

Beattie and Jones [2002a] find that the slope parameter affected judgments of financial performance. Graphs with greater slope parameters (i.e., with steeper trend lines) were

perceived as more favorable than graphs with shallower slope parameters, even though the underlying data was the same. Given the large number of graphs with slope parameters that do not approximate to 45° (the optimum for perceptual judgments) Beattie and Jones [2002a] argue that misperceptions of financial performance may be common.

Beattie and Jones [2002b] focus on measurement distortion. Using a range of distorted graphs, they find that at low levels of distortion, students perceive no difference. However, above 10% students increasingly perceive the differences. Consequently, as large numbers of graphs in corporate annual reports show such distortions then users' perceptions will be affected.

Arunachalam et al. [2002] investigate four types of improper graph design: proportionality distortion (i.e. the use of a non-zero or broken axis); year reversal; masking (e.g. by graphing two variables that differ greatly in magnitude on the same y-axis scale); and omission of negative values. They used three experimental groups of accounting students. In their first experiment, they investigate all four types of improper graph design; in the next two experiments they focus on proportionality distortion. Across all three experiments, they find evidence that graphical impropriety affects subjects' decisions. Thus, by implication, improper design affects impressions of company performance.

4. DISCUSSION

As set out above (and summarized in Figure 1), there are three main issues addressed by graphical research in accounting settings:

1. Theorization of graphical practices
2. Graphical practices, including description, contextualization and explanation
3. Consequences of graphical practices

In this section, the current state of knowledge in relation to each main issue is evaluated and then the directions for future research are discussed. Figure 4 summarizes the extant research while Figure 5 summarizes avenues for future research.

[Insert Figure 4 and 5 about here]

1. Theorization of Graphical Practices

i, Extant research

In relation to the general issue of graphical practice determinants, there is a critical need for further theorizing regarding management incentives. The impression management framework, the dominant current paradigm, is a fairly loose framework – it merely suggests that management will seek to portray themselves and their organization in a favorable light. Thus, management are expected to want to emphasize increasing profits.

ii, Future research

In accounting, a range of overlapping theoretical frameworks has been employed to study different aspects of corporate reporting, such as social and environmental reporting and intellectual capital reporting. These theories draw upon foundation disciplines such as economics, psychology and organizational behaviour. It is to be expected that some of these alternative theoretical frameworks will be able to predict more precisely the nature of graph use and the graphic portrayal that will be viewed favorably. The theories discussed below are not necessarily mutually exclusive, and a full understanding of graph use is likely to involve the application of multiple theoretical lenses. Moreover, in many cases it may not be possible to distinguish empirically between the theoretical antecedents of graphical practices.

Apply impression management into new area

So far the impression management framework has been used primarily to explore use of graphs in Western Developed countries' annual report. However, there are many other fruitful areas for research both geographically and by documentation. For example, developing countries and other financial documentation such as earnings releases. A particular interesting new area would be to explore impression management in companies sustainability reports.

Other theoretical models

Generic disclosure theory, which draws on, *inter alia*, agency theory and signalling behavior, identifies the costs and benefits of informative business disclosure for listed companies. The first main benefit arises from a reduction in the cost of capital. By helping investors and creditors better understand the company's economic risk, the information risk premium (a component of the cost of capital) is reduced. Agency theory ties into impression management as there may be incentives for the preparers to use graphs in their own interests rather than in those of the users. Signalling theory, tries to signal the true quality of a company's performance. However, Signalling theory would suggest that, where performance variables are highlighted using graphs, management believes that this performance will persist. This theory could be tested by examining the relationship between graph usage and the persistence of performance.

Positive accounting theory predicts that companies with high potential political costs will make accounting choices that reduce reported earnings, to reduce these costs [Watts and Zimmerman, 1986]. Such companies will *not* want to emphasize high profits. In this situation, the political cost incentive to downplay high profits may outweigh the general desire to emphasise good profit performance. Future research can usefully investigate

whether an association exists between the level of political costs and performance graphs. For example, one might hypothesise that high visibility companies may seek to use less graphs.

As the annual report is recognised to be a general audience document, stakeholder theory (which extends agency theory to multiple stakeholder groups) may also be a suitable lens through which to seek to understand graphical reporting behaviour. Stakeholder theory, developed by Freeman [1984], argues that other groups (for example, employees, suppliers, customers and the public) can affect the success of an organization (see Friedman and Miles [2006] for a recent review of this area). Investors, particularly institutional investors, bring a different set of skills and expertise to annual reports and to financial graphs than other stakeholders. Therefore, it would be useful to investigate how investors and other stakeholders use financial graphs. Recent research also suggests that management do consider a range of stakeholder groups in their communication decisions [McInnes et al., 2007]. Research, therefore, is required into whether management specifically target graphs at stakeholder groups other than shareholders.

Legitimacy theory is concerned with the need for organizations, if they are to be successful, to 'establish congruence between the social values associated with or implied by their activities and the norms of acceptable behaviour in the larger social system' [Mathews, 1993, p.350; Suchman, 1995]. In common with stakeholder theory, a number of constituencies are recognised. External reporting is one mechanism that can be used strategically to achieve legitimacy. To date, legitimacy theory has mainly been used to explain voluntary environmental and social disclosures (see, for example, Milne and Patten, 2002). Disclosure is directed at legitimacy-threatening issues and contains messages that seek to restore legitimacy. In this context, graphs would be used to enhance the communicative

effectiveness of these messages. Graphs research based on this theoretical lens would, therefore, examine graph use in relation to topics identified as pertaining to key legitimacy issues.

Finally, institutional theory, which posits that organisations must conform to the rules and norms of behaviour in their environment in order to survive, suggests that graphic practices reflect an element of imitation and institutional isomorphism. In particular, organizations may feel external authoritative pressures or expectations to use graphs to improve communication or their use may be a response to uncertainty [DiMaggio and Powell, 1983]. This homogeneity across organizations is distinct from the homogeneity often observed in practice for individual organizations over time (the latter being attributable, at least in part, to the status quo bias). Empirically, a reduction in the variation and diversity of graph use over time is consistent with coercive and mimetic forms of isomorphism. An interesting research question could be to track the diffusion of graphs over time, for example, from higher status to lower status organisations (Jones, 2008).

2. Graphical Practices

a, Description of graphical practices

i, Extant research

Many studies have documented graphical reporting practices. The major focus of research effort has been on the annual reports of listed companies in a single, developed, country (especially the US, the UK and Australia using an impression management framework. For such organisations, we know that graph use is widespread, especially graphs of key financial variables, and that the five-year, column graph is the norm. However, even among developed countries, significant country differences have been observed (for example,

German companies infrequently graph earnings, EPS and DPS). We also know that selectivity, measurement and orientation distortion are prevalent amongst these countries.

ii, Future research

Non-Western countries

There has been an almost complete focus on graphs in Western developed countries. Very little is known about graphical practices in either the non-Western developed world or in emerging economies. There is thus a nich arena for study in countries such as China, India and the Middle East. Studies of graph usage in such countries should yield interesting insights into managerial preferences in such countries as well as potential cultural differences.

Non-annual report documentation

There is also virtually no research on the annual reports of not-for-profit organizations. In addition to country coverage and organization type, a further dimension where research could usefully be extended is in relation to the documentary source. Annual reports are only one (although a key) document type. Extant research includes a single study of graphs in IPO prospectuses and no research on other information sources produced by the organization (such as websites; analyst presentations; podcasts, newsletters; environmental reports). Further, the use of graphs in secondary information sources has not been addressed at all. Analysts' reports represent one possible source of secondary graphs. In addition, large companies often now offer website viewers of their corporate reports the option to produce graphs of key data series. This follows the 'point and click for a graph of this data' function developed in the American Institute of Certified Public Accountants FauxCom project (a fully integrated web presentation of a business reporting package [package can be viewed at http://ciberconta.unizar.es/LECCION/INTRODUC/fauxcom/inicio.html].

Drill-down studies

The existing studies have severe weaknesses in both scope and in theorization. In terms of scope, there is a need for more fine-grained analysis such as Bannister and Newman [2006] who focus on graphs of a single variable and one construction attribute. There is also scope for extending the range of graphical attributes examined. For example, most graphs use color. Different colors are known to have different emotive associations (e.g., red signals danger in many cultures). Courtis [2004] finds that color use in annual reports generally is associated with perception formation. Is color being used in graphs as an impression management device?

Construction and design issues

When observed graphical practices have been compared against the principles of graph construction and design, frequent departures from these principles are noted. In particular, measurement distortion (deviation from the fundamental principle of graph construction) has been examined. Other construction and design features have received limited attention. These graphical infidelities can arise from a lack of graphical competency on the part of the preparer or active impression management.

b, Contextualization of graphical practices

i, Extant research

We categorize this area into two broad strands: authorship and graphical competency of the preparer; and the integration of graphical choice within the broad framework of accounting choice. Unfortunately, to date, we know of no extant studies into these aspects of graphical practice.

ii, Future research

Authorship and graphical competency of preparer

Who actually is the preparer? At present, we know very little about the process by which graphs appear in organizational documents. Are they prepared internally or externally? Internally, they could be prepared by various parties, such as the organization's accounting and finance department or the public relations department. Externally, they could be prepared by the design consultants. Alternatively, are several parties involved? Research into this area (i.e., into the authorship of graphs) would be very valuable, not least because it would offer an insight into the motives of preparers as well as their likely level of graphical competency.

Graphical and reporting choices

Extant studies that examine a range of graphical infidelities look at them separately and sequentially. More powerful research designs might emerge if observed graphical choices were combined in some way (e.g., an index of graphical distortion could be constructed). In common with all indices, the weighting of individual factors would have to be considered. This index of graphical distortion could be used as the dependent variable in studies of the determinants of graphical practices.

Graphical and reporting choices

So far graphical practice has been studied in isolation. The use and abuse of graphs has been a discrete topic. However, in reality clearly this is not the case. The management choice of graphs and the associated construction and design issues are part of a wider set of financial reporting policy choices and presentational choices. These concern accounting numbers, accounting narratives, graphs and pictures. There is thus a clear need to adopt a more holistic approach to graph research and to see how it fits into the broader financial reporting

agenda. We suggest that some degree of cross-fertilization between these current research "silos" could prove to be productive. Researchers could look at the portfolio of choices made and explore interaction effects.

c. Explanation of graphical practices

i, Extant research

The general nature and extent of graph use as well as the incentives to engage in impression management are likely to be affected by specific organizational characteristics. The extant research into graphical practices has almost solely focused on the effect of earnings (i.e. profitability performance). There is a significant body of evidence that profitability (in the case of for-profit organizations) is associated with selectivity (the primary graphical choice) and graphical improprieties. In particular, there has been a link established between corporate performance and the use of graphs. In other words, companies are more likely to include graphs in their annual reports when earnings have increased rather than decreased. This finding is robust holding across countries and across time. In addition to the effect of profitability there is a suspicion that at the aggregate level of graphical practice, there is a country effect stemming from the underlying economic, institutional and cultural setting.

ii, Future research

Why do management use graphs?

There is a clear need to extend our research in this area. Why do management use graphs? Surprisingly, we have little knowledge of why management actually usually voluntarily choose to use graphs in their annual reports. It has been conjectured that this is because of the possibilities that graphical presentation allow management to influence the financial reporting agenda or that graphs are a useful communicational tool. Or it may be speculated that, given the typical human herding instinct graph usage may nowadays be perceived as the

norm. However, in truth, we do not know. It would be useful to conduct an interview or questionnaire study to investigate this aspect.

Organisational influences

It would be particularly useful to explore other potential determinants of graphical practice. What is the impact, if any, of other organizational characteristics commonly found to be associated with disclosure (e.g., organization type, industry, listing status, ownership structure, and the effectiveness of corporate governance)? In particular, company size(e.g.,capitalization) has been singled out as a crucial unexplained variable.

Country effect

In addition, systematic research is now required to follow up the country effect with international comparative studies. Comparisons between practices in the developed and developing countries would be particularly useful. These would help to identify graphical continuities and discontinuities across countries caused by culture.

Longitudinal studies

Another fruitful avenue for future research is longitudinal studies, of which there are, to date very few. Longitudinal studies such as Beattie and Jones [2000] which examine the *changes* in graph use made by individual companies are particularly useful for investigating the influence of organizational characteristics on graphical practices. By contrast, longitudinal studies such as Beattie, Dhanani and Jones [2008] that focus on change at the aggregate population level are particularly good at investigating the impact of external factors.

3. Consequences of graphical practices

i, Extant research

The few experimental studies that have been undertaken to date offer strong evidence that users' perceptions are affected by graphical infidelities such as measurement distortion and selection of slope parameter.

ii, Future research

Students as surrogates

A key methodological issue for experimental graphical research is whether students are acceptable surrogates. Beattie and Jones [2002a, p.185] argue that the graph-reading skills of students and real-life users are unlikely to differ, and so students are acceptable surrogates for experiments that investigate perceptions. The subsequent decision-making behaviour of the two groups may, however, differ.

Decision-making and share price

A fundamental issue to be addressed by future research is whether an impact on a user's perceptions of the organization carries through to an impact on their decision. For example, are investment decisions affected by graphical presentation choices? We need, therefore, to carry out research into the effect, if any, of financial graphs on analysts' earnings forecasts and stock prices. Identifying suitable research designs is, however, problematic. As far as we are aware, there are no published share price reaction studies where the event of interest is the disclosure of graphs. We believe that the reason for this lies in the difficulty of isolating the disclosure of the graphs from the other disclosures made alongside the graphs in the annual report. Research that examines the decisions of other key stakeholder groups such as employees, customers and suppliers is also required.

Search strategies

We know practically nothing, however, about how graphs are actually used in various human data processing contexts – this is an issue that could perhaps be explored using eye-movement retinal imaging (an innovative method first used in the accounting discipline by Hunton and McEwan [1997] to explore the information search strategies of financial analysts using annual reports). Furthermore, how does the attention paid to graphs vary with user characteristics, such as stakeholder role and level of accounting sophistication and level of graphical competency?

Conclusions

Graphs are a commonly found feature of corporate reporting. As such, a body of academic research has grown up to investigate this reporting phenomenon. This paper reviews 25 articles uncovered by a comprehensive literature search.

In particular, the paper investigates (i) the theorization of graphical practice, (ii) graphical practice itself (including description, contextualization and explanation) and (iii) the consequences of graphical practices. We establish the current state of knowledge and explore directions for future research.

Currently, the main theory used to motivate financial graphs research has been impression management. This framework has most commonly been used on the annual reports of listed companies in developed countries such as the UK, US and Australia. The studies have typically found that graph usage is widespread, especially graphs of key financial variables (such as sales, earnings, EPS and DPS). The studies have also generally found that graphs are used to give a more favorable view of the company than is actually warranted. They have

thus documented frequent instances of selectivity, measurement distortion, orientation distortion and presentational enhancement. Profitability is found to be the main explanator of financial graphs. The experimental studies offer strong evidence that users' perceptions are affected by graphical infidelities such as measurement distortion and selection of the slope parameter.

However, the current research provides only a limited picture of graphical practices. Impression management yields an important, but limited insight, into the use and abuse of financial graphs. There is an urgent need to adopt alternative theorizations. There is also a need to expand the scope of financial graphs research to other information sources (e.g., prospectuses, websites, analysts presentations, environmental reports), to other organizations (e.g., not-for-profit organizations, governmental organizations) and to other countries (e.g., developing world). More in depth studies and longitudinal studies would also be beneficial.

A particularly neglected area that warrants future research is into the contextualization and explanation of graphical practices. We know practically nothing of why management use graphs, the graphical competency of the preparers or how graphical choice fits in to the wider financial reporting literature. There is thus a clear need to widen the nature of graphical research to embed it within the financial choice literature and financial disclosure literature more generally. For example, we need to look at the impact of organization characteristics (such as size, industry, listing status, ownership structure and the effectiveness of corporate governance).

Finally, we know practically nothing of how graphs are used in various human data processing contexts. In particular, although we know that human perceptions are affected by graphical attributes such as measurement distortion and orientation distortion, we do not

know if these perceptual changes are carried through to users' decision making. Put simply, if graphs are distorted does this affect a shareholder's investment decisions or an employee's decision to stay with the company.

Collectively, therefore, the extant research does give us a good idea of how financial graphs are used and abused in corporate reporting. However, although we know a great deal, there is still a great deal of which we are ignorant. Clearly, there is much research still to do.

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Figure 1: Main Issues and Research Questions in Graphical Reporting Research

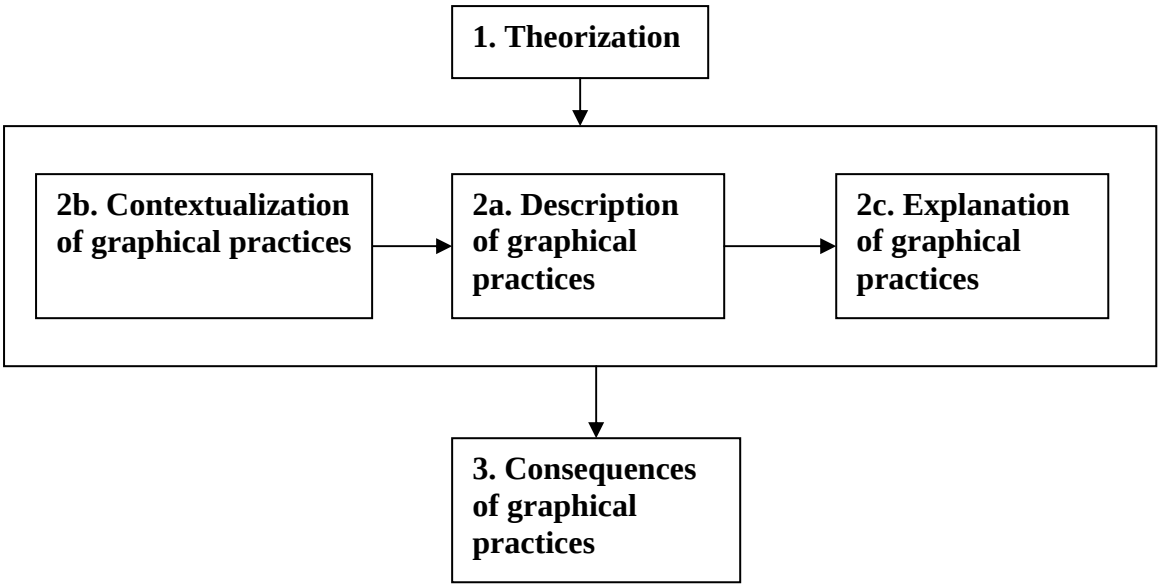

Figure 2: Illustration of Graphic Components using a Typical Five-year Column Graph

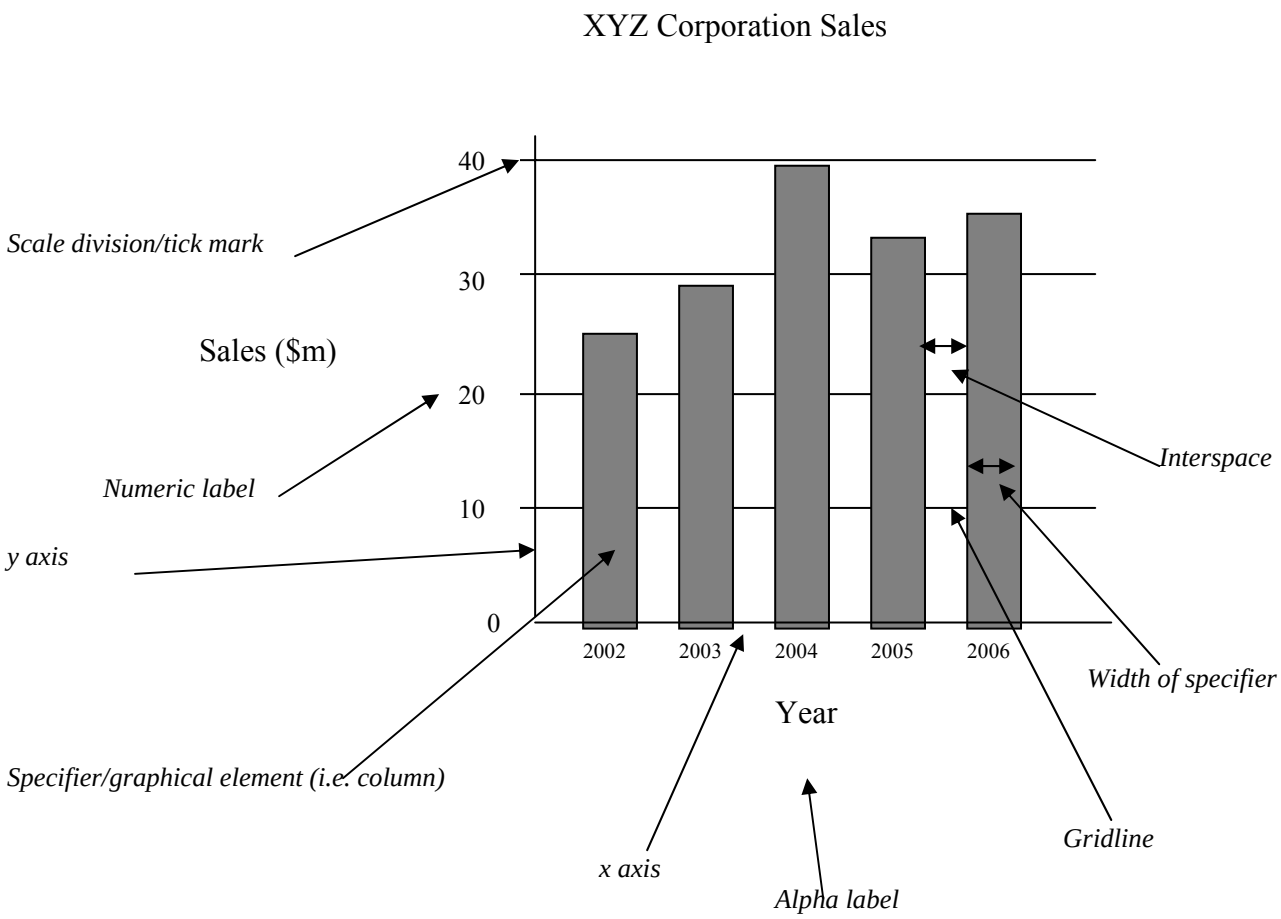

Figure 3: Interpretation of Graph Discrepancy Index (GDI) Measures for Key Financial Variable (KFV) Graphs

	Trend	
	Rising	**Falling**
Exaggeration	+ve GDI Favorable	+ve GDI Unfavorable
Understatement	-ve GDI Unfavorable	-ve GDI Favorable

Notes to table:

1. The exaggeration of an upward trend and the understatement of a declining trend both give more favorable impressions of a company's performance than is warranted in the case of KFV graphs.
2. Key financial variables are sales, earnings, earnings per share (EPS) and dividends per share (DPS).

Figure 4: Extant Research into Graphical Reporting Research

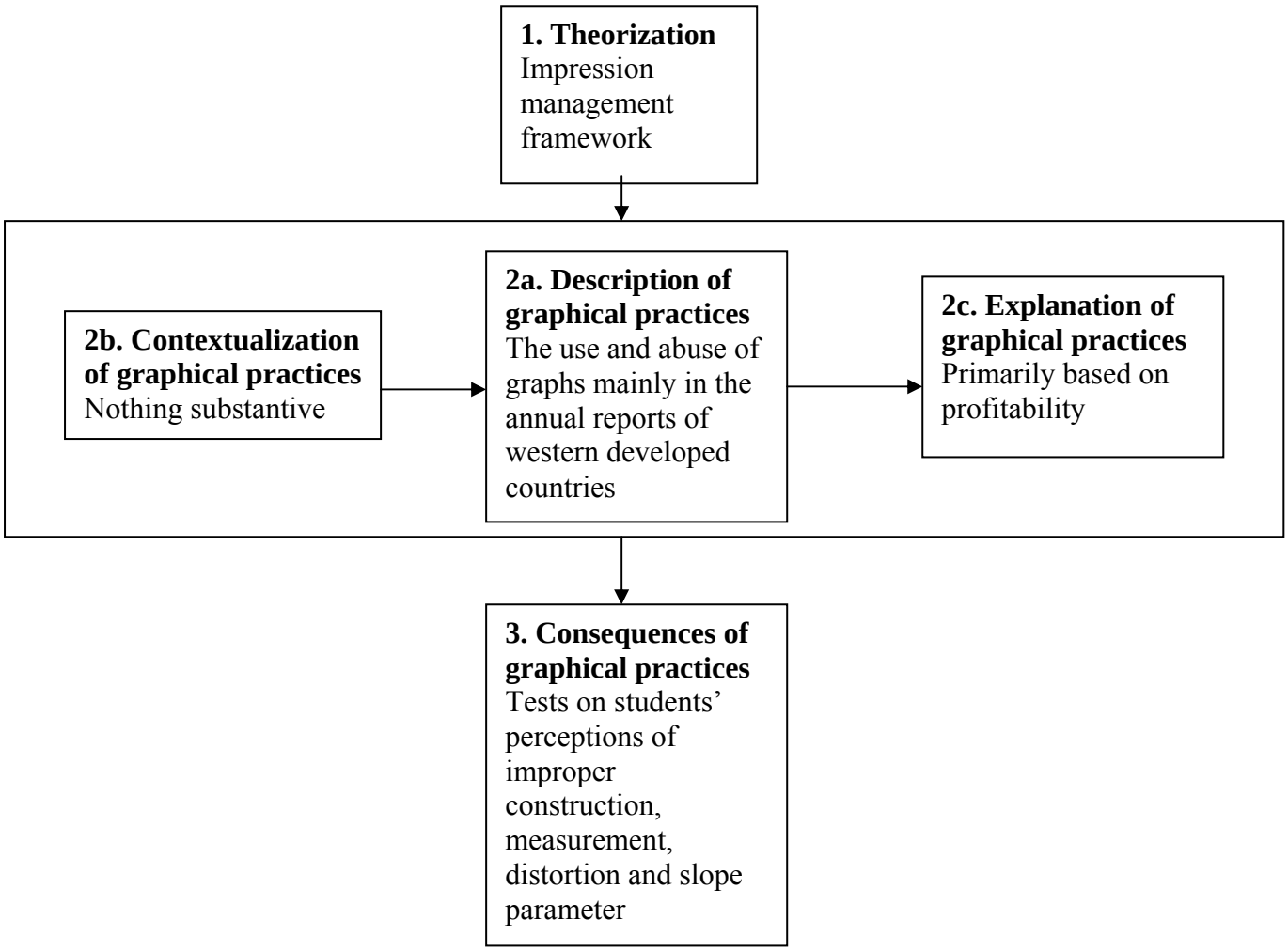

Figure 5: Future Research Required into Graphical Reporting Research

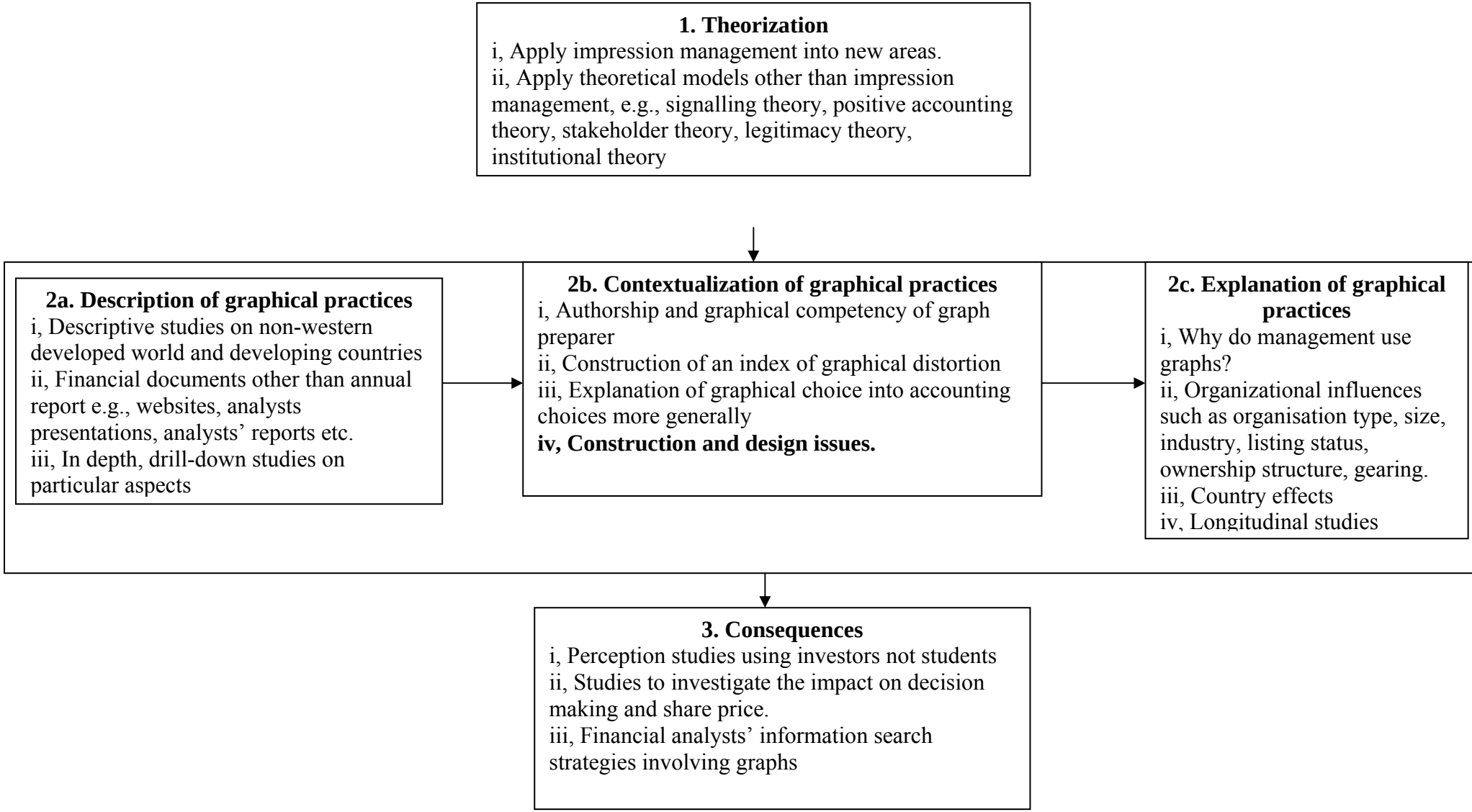

Table 1: Empirical Archival Studies of Graphs in Annual Reports

Study ID. Researchers (Publication Date), Country Studied, Publication ID(s)	*Data Studied*	*Frequency of Graph Usage*	*Topics Graphed (KFV: Key Financial Variables)*	*Selectivity in Graph Usage (KFV=Key Financial Variables)*	*Measurement Distortion in Graphs (GDI = Graph Discrepancy Index) Materiality level 5% unless stated*	*Other Important Findings*
1. Johnston, Rice and Roemmich (1980), US, 1	50 graphs from Fortune 500 companies annual reports for 1977/78	Not reported	423 graphs	Not covered	Not covered	125 of 423 graphs incorrectly constructed e.g. multiple scaling, non-zero axes. Conclude "the use of misleading or potentially misleading graphs appears to be widespread" (p.56)
2. Steinbart (1989), US,2	319 graphs from Fortune 500 companies annual reports for 1986	79% use graphs	217 sales, 350 profit and 131 DPS graphs	Yes, 150 (74%) of 222 companies with increase in annual net income include graphs of sales, income or dividends, while 62 (53%) of 117 where annual net income decreased included them (sig.0.001)	Average mean measurement distortion +11%, 26% graphs distort data by >10%. 30.8% of materially discrepant graphs unfavorable, 20.8% favorable. Discrepant graphs more likely to occur where net income had declined (sig. .05)	41 instances of discrepant graphs. "This study found examples of annual reports of major corporations that contained graphs that significantly distorted trends in the financial data" (p.70)
3. Beattie and Jones (1992a,b) (1994b). UK, 3-5	240 large listed company 1989 annual reports	79% use graphs	65% at least one KFV, 38% sales, 55% profit, 53% EPS and 48% DPS graphs	Yes, at least one KFV, sales, profit before tax, EPS and DPS all significantly associated with EPS trend over current and five years (sig.0.01), profit before tax, EPS and DPS (but not sales) all significantly associated with matched trend (sig.0.01). EPS (sig. 0.01 level), profit before tax and turnover (sig.0.05) and DPS (sig.0.10) significantly associated with matched trend (over 5 years or current)	Average mean measurement distortion +10.7%. Mean material distortion +34.3%. 22 material exaggerations c.f. 8 material understatements	64% of all graphs column graphs. 17 cases of non-zero axes
4. Canadian Institute of Chartered Accountants (1993), Canada, 6	200 companies annual reports for 1991	83% use graphs	75% sales, 74% earnings, 52% shareholders' equity and 48% assets graphs of companies	Not covered	Average mean measurement distortion +10.7%. Mean material distortion +34.3%. 22 material exaggerations c.f. 8 material understatements	Identifies 15 ways graphs can potentially be misleading
5. Beattie and Jones (1994a), UK, 7	50 charity annual reports for 1990	74% use graphs	43 total income; 51 total expenditure graphs	No relationship between use of graphs and surplus/deficit or level of administrative expenses	Average mean measurement distortion +8.4%. A significant number of pie graph individual segments materially distorted. No systematic bias	Pie graph was the commonest graph type (54% of all graphs). Many of the 40 pie graphs breached good design rules

Table 1 (Cont'd): Empirical Archival Studies of Graphs in Annual Reports

Study ID. Researchers (Publication Date), Country Studied, Publication ID(s)	*Data Studied*	*Frequency of Graph Usage*	*Topics Graphed (KFV: Key Financial Variables)*	*Selectivity in Graph Usage (KFV=Key Financial Variables)*	*Measurement Distortion in Graphs (GDI = Graph Discrepancy Index) Materiality level 5% unless stated*	*Other Important Findings*
6. Beattie and Jones (1996), (2000), (2001), Australia (Aus), France (Fr), Germany (Ger), Netherlands (NL), UK and US, 8-10	50 top listed company annual reports for 1991 (Aus) and 1992 for the other five countries	92% Aus, 88% Fr, 84% Ger, 90% NL, 82% UK and 90% US companies use graphs	Aus: Sales 38%, Profit 66%, EPS 40%, DPS 34% France: Sales 68%, Profit 68%, EPS 34%, DPS 32% Ger: Sales 28%, Profit <25%, EPS <25%, DPS <25% NL: Sales 64%, Profit 70%, EPS 34%, DPS - UK: Sales 40%, Profit 44%, EPS 32%, DPS 34% US: Sales 54%, Profit 49%, EPS 54%, DPS 48%	Yes. Significant associations between including at least one KPV and trends in: five year profit (Aus), prior and five year profit (US) and prior year EPS (US). Aus EPS and DPS graphs associated with five year trends in EPS and profit, and five year trends in DPS and EPS, respectively. UK profit associated with 5 year trends in profit and EPS, EPS with 5 year EPS trend. Overall, Aus, UK and US more selective than France, Germany and Netherlands.	Average mean measurement distortion: Aus +1.2%, Fr +36.4%, Ger -13.4%, NL +3.3%, UK +85.7%, US +29.9%. Overall, 174 out of 513 KPV time trends were materially distorted (59 under and 115 over). Mean material discrepancies always in companies favour, except Germany. Most likely in company's favour in France, UK and US	Column graphs most common presentational format. French most prolific graph users, UK most frugal. Majority of KPV graphs in first five pages. Overall, 5-year graphs most popular. In UK and US significant numbers of 10-year graphs. Many instances of improper graphical design and construction techniques. e.g., unsuitable graph types, unconventional presentation of the trends. Many graphs depart significantly from theoretical optimum of 45° for slope parameter
7. Mather, Ramsay and Serry (1996), Australia, 11	143 company annual reports for 1992; 44 not-for-profit, organisations annual reports for 1991	83% companies and 73% not-for-profit use graphs	For companies, 41% sales, 52% profit, 27% EPS and 34% DPS graphs; for not-for-profit, 59% sales; 75% profit; 39% EPS and 48% DPS graphs	Yes. For top 50 companies across any KFV and individual KFVs. For next 100 companies (i) profit in current year associated with any KFV, sales, profit (sig.0.05), but not EPS, DPS; (ii) variable associated with current year variable trend for profit (sig. 0.05), and DPS (sig. 0.10), but not sales or EPS.	For companies, 30% distorted; for non-for-profit 51% distorted. Mean GDIs +16.4% for companies; +105.6% for not-for-profit. For all companies, graph distortion associated with performance for all KFVs (sig. 0.10), sales (sig. 0.05), profit (sig. 0.04). Less prevalent for top 50 than next 100	None
8. Beattie and Jones (1997), UK and US, 12	85 US companies and 91 UK companies from top 100 US and UK companies 1990 annual reports	92% US companies and 80% UK companies use graphs (sig. 0.05)	For US, 66% sales, 49% earnings, 56% EPS and 42% DPS; For UK, 37% sales, 45% earnings, 51 EPS and 49% DPS	Yes. For UK and US, use of at least one of four KFVs associated with increase in EPS over current or 5 years (sig. 0.05). For UK, earnings, EPS and DPS (but not sales) graphs generally associated with current or 5 year increase in EPS (sig. 0.05). For US, these variables not significant at 0.05 (except EPS/DPS over 5 years). When KFVs matched against current year and five year trends, only earnings (current year, sig. 0.05) for US and earnings and DPS (sig. 0.05) for UK significant.	24% of UK and US graphs materially distorted. 34 US and 29 UK graphs materially exaggerated against 9 and 11 understatements, respectively. US mean discrepancy +15.6; UK +6.9	Bar/column graphs most frequent (79% US, 62% UK). 5 year time-trend most often graphed. Mean slope parameter 33.5° US and 34.5° UK. Mean deviation from 45° optimum is 16.4°. Non-compliance with 20 normative graph construction and design principles common in both countries

Table 1 (Cont'd): Empirical Archival Studies of Graphs in Annual Reports

Study ID. Researchers (Publication Date), Country Studied, Publication ID(s)	*Data Studied*	*Frequency of Graph Usage*	*Topics Graphed (KFV: Key Financial Variables)*	*Selectivity in Graph Usage (KFV=Key Financial Variables)*	*Measurement Distortion in Graphs (GDI = Graph Discrepancy Index) Materiality level 5% unless stated*	*Other Important Findings*
9. Courtis (1997), Hong Kong, 13	For 1992-3, 364 company annual reports. For 1994-5, 327 company annual reports	1992-93: 38% companies use graphs; 1994-95: 35% companies use graphs	In 1992/3, 100 sales, 85 profit, 44 EPS and 31 DPS graphs out of 745	Not covered	Not covered	Column graphs commonest (67% for 1992/3 and 58% for 1994/95). In 1994/5, 301 of 578 graphs misleading. 72% of companies include at least one misleading graph, e.g. manipulated baselines, absent gridlines. Graph usage varies across industry.
10. Beattie and Jones (1998), (2000), UK, 14 & 15	137 company annual reports for 1990-92	Frequency falls 80% 1988, 79% 1989, 76% 1990, 71% 1991 and 69% 1992.	1988 sales 34%, Profit 53%, EPS 57%, DPS 49% 1989 sales 34%, Profit 53%, EPS 57%, DPS 53% 1990 sales 30%, Profit 49%, EPS 52%, DPS 50% 1991 sales 21%, Profit 39%, EPS 41%, DPS 42% 1992 sales 22%, Profit 34%, EPS 41%, DPS 39%	Using pooled graph data, decision to start/stop graphs of each of sales, profit, EPS and DPS was associated with specific variables, profit and EPS at 0.000 level in 11 out 12 cases. Graph use also associated magnitude of prior year change in 11 out 12 cases at 0.000 level.	Average mean measurement distorition across five years: sales +78%, Profit +15%, EPS +9%, DPS +11%, across all +23%. 10% graphs materially understated, 20% materially overstated, 30% materially distorted, mean measurement distoriton +74%.	As performance declines, changes in graph construction and design occur consistent with impression management, e.g., decline in prominence (locational and size), a marked shift from creative graph types to simpler types, 5-year graphs decline, mean asset ratio 38.4%, with nearly half diverging more than 15˚from 45˚, use of design features declines.
11. Frownfelter and Fulkerson (1998), (2001) US and non-US countries, 16 & 17	English language company annual reports of non-US companies listed on the NYSE or AMEX, matched with US companies (12 countries and 74 annual reports in total); annual reports spanned the years 1984-1994	89% US companies and 86% non-US companies use graphs	For US, 68% sales, 54% profit, 51% EPS and 41% DPS graphs; for non-US companies, 59% sales, 59% profit, 41% EPS and 43% DPS+D15. Non-financial variables (23% total), financial (20%).	Yes. For prior year, association between EPS and (i) at least one KFV (total and non-US at 0.05 level), (ii) profit (total and non-US at 0.05 level), (iii) EPS (total 0.10 level), (iv) DPS (total 0.05, US 0.10). No associations for EPS and (i) sales, (ii) net income (for US only) and (iii) the remaining cases	Mean absolute GDI +1.61 for US and +1.42 for non-US. For whole sample 869 material exaggerations of financial (503 instances) and non-financial (211) instances c.f. 497 material understatements (271 financial and 260 non-financial). Spanish, Dutch, Australian, UK and especially Danish graphs have highest GDIs. Overall mean GDIs are higher with good news than bad news for profit, but not EPS.	Dichotomous classification (I.e., US and non-US) and English language samples impedes interpretation. Column graphs most commonly used.
12. Beattie and Jones (1999), Australia, 18	89 large company annual reports for 1991	89% companies use graphs	36% sales, 63% profit, 38% EPS and 37% DPS graphs	Yes. Presence of at least one of 4 KFV and of sales, profit, EPS or DPS wqas tested. Over current year's and 5-year sales, EPS and profit trends. Only one result significant at 0.01 (at least one KPV and 5-year profit).	31 material favorable discrepancies and 13 material unfavorable discrepancies. 34% material distortions. Mean GDI +3.5% and +10.5% mean material GDI. Profit material distortion and total pooled (across all variables distortion) were significant (sig. 001).	117 positive KFV graph shape parameters widely dispersed. Mean overall positive slope 31.2°. Slope parameter not systematically biased. Diversified companies use most graphs followed by financial services. 26 departures from

recommended construction and design techniques. Examples of presentational enhancement.

Table 1 (Cont'd): Empirical Archival Studies of Graphs in Annual Reports

Study ID. Researchers (Publication Date), Country Studied, Publication ID(s)	*Data Studied*	*Frequency of Graph Usage*	*Topics Graphed (KFV: Key Financial Variables)*	*Selectivity in Graph Usage (KFV=Key Financial Variables)*	*Measurement Distortion in Graphs (GDI = Graph Discrepancy Index) Materiality level 5% unless stated*	*Other Important Findings*
13. Mather, Ramsay and Serry (2000), Australia, 19	484 IPO company prospectuses. 163 pre-1991 (Corporations Law); 90 post-1991	28% companies use graphs	Market 44.8%, sales 18%, profit 10%, price/values 9%	Yes. Any graph use associated with trend in profitability (0.05 level). Graphs of KFVs associated with profit trend (0.01 level). Results contradict text, but it appears only KFVs associated with profit trend for pre 1991 (at 0.05 level).	Mean GDI overall for all variables +55.5%. For KFV -2; for other +86.4. 88 material (over 5%) positive distortions and 100 negative distortions. Unfavorable distortion of KFVs significantly more likely than favorable distortion (sig. 0.01)	Mining companies did not include graphs. Regulatory change appears to markedly reduce selectivity.
14. Bannister and Newman (2006), US,20	141 proxy performance graphs in 1993 annual report of Fortune 250 companies	Not covered	Not covered	Not covered – graph mandated by SEC	Not covered	Reporting discretion (in relation to amount of numerical disclosure and variable definition (i.e. choice of peer group benchmark return)) exercised for management's benefit.
15. Beattie, Dhanani and Jones (2008), UK, 21	94 annual large listed company 2004 annual reports	99% use graphs	62% at least one KFV, 35% sales, 52% profit, 45% EPS and 40% DPS graphs	Yes. Significance of association with EPS trend over current year: at least one KFV (sig.0.01), profit before tax and DPS (sig.0.05), EPS (sig.0.10), sales not sig. Similar results for matched variable trend over current year: profit before tax and DPS (sig.0.01), EPS (sig.0.05), sales not sig.	32% material exaggerations c.f. 28% material understatements	97% of all graphs column/bar graphs. Evidence that shorter time series (rather than no graph) being used to mask adverse financial trends. No cases of non-zero axes

Note to table: EPS is earnings per share and DPS is dividends per share.

Table 2: Experimental Studies of Financial Graphs in Annual Reports

Study ID. Researchers (Publication Date), Country Studied, Publication ID(s)	*Nature of Experiment*	*Subjects*	*Research Instrument*	*Main Findings*	*Other Findings*
16. Taylor and Anderson (1986), US, 22	Subjects sent 7 graphs and asked for perceptions of company performance in each case.	Undisclosed number of bank commercial loan officers.	Seven pairs of graphs drawn (A & B); each B graph created a visual illusion;	Perceptions of company performance judged (no statistical tests) more favourable for graphs with visual effect that disregarded a graphical guideline.	
17. Beattie and Jones (2002a), UK, 23	Subjects review a set of nine graphs with slope parameter and data increase as independent variables. Students perform categorisation and comparison tasks.	53 sophomore business studies students.	A set of nine graphs drawn with three levels of data change (50%, 100% and 200%) and three levels of slope parameter (30°, 45° and 70°).	Experiment 1 students perceived that graphs with larger slope parameter showed greater data increases. Trends with greater slope parameters (e.g., 70° rather than 30°) are perceived as more favorable even though the underlying graphed data was the same.	1989 Annual reports of 240 large UK companies, reviewed to collect data on slope parameters. Mean overall slope parameter of 364 graphs 42.3° (close to 45° optimum). Dispersion wide 174 graphs deviate more than 15°.
18. Beattie and Jones (2002b), UK, 24	Twelve trials were conducted to investigate which levels of measurement distortion affected subjects' perceptions of financial performance. Students shown paired graphs.	52 sophomore business studies students	A set of graphs drawn with 6 levels of distortion (5%, 10%, 20%, 30%, 40% and 50%).	At low levels of distortion (5% and 10%) students perceive no difference. However, at levels of distortion of 10% or more, students increasingly perceive differences.	
19. Arunachalam, Pei and Steinbart (2002), US, 25	Three experiments. Subjects made decisions choosing between investing in one of three companies (medium, high, low growth rate), on the basis of correctly and incorrectly graphed data. In experiment 1 27 decisions, in experiment 2 12 decisions and in experiment 3 24 decisions were made.	i, 49 undergraduate accounting majors ii, 42 undergraduate accounting majors iii, 35 undergraduate accounting majors	i, Four different types of improperly constructed graphs involved proportionality distortion, masking, year reversal and omission of negative values. ii, Proportionality distorted graphs constructed in experiments 2 and 3.	i, All four types of improperly designed graphs significantly affected subject's decisions for companies with lowest growth rate. Year reversal and omission of negative numbers significantly affected subjects' decisions for companies with medium growth rate. ii) Subjects' investment decisions affected by graphical distortion for low growth, but not medium growth companies. iii) Subjects graphical decisions affected by improper graph design for lowest growth rate companies.	

ANNOTATED BIBLIOGRAPHY

1. Taylor, B.G. and L.K. Anderson. 1986. Misleading graphs: guidelines for the accountant. *Journal of Accountancy*. October: 126-135.

This was the first experimental study conducted into user's perceptions of graphs contained in the annual report. The objective was to test the impact of graphic formatting choices on users of financial data. Seven pairs of graphs were sent to bank commercial loan officers in the US (number of subjects not reported). For each graph pair, the same data were accurately plotted, but one graph violated a principle of graph construction and design. The issues covered were: non-zero axis; rate-of-change graph; use of multiple scales; placement of irregular stratum; choice of time period; ordering of time values; excessive extension of scale range. Subjects saw one graph in each pair, and their perception of company performance was elicited. Although no quantitative results or statistical tests are reported, it is stated that perceptions based on graphs that violated a principle were strikingly different.

2. Steinbart, P.J. 1989. The auditor's responsibility for the accuracy of graphs in annual reports: some evidence of the need for additional guidance. *Accounting Horizons*. 3 (3): 60-70.

This paper was the first academic study of graph reporting practice to be published. The 1986 annual reports of 319 Fortune 500 US companies were examined to identify cases where graphs were presented in a manner likely to create a more favorable impression of corporate performance than warranted. In all cases, the numerical values presented in graphs matched the financial statements. Using the GDI, 26% of sales, earnings and dividends graphs displayed a distortion greater that ±10%, with an average of +11%. Discrepant graphs were more likely to occur in situations where the company had experienced a decline in earnings. Other format choices that hid trends were documented (e.g. excessive extension of scale range). Steinbart questions the auditor's responsibility in relation to distorted graphs, given the auditing requirement to ensure the consistency of material presented in documents containing audited financial statements.

3. Beattie, V.A. and M.J. Jones. 2000a. Changing graph use in corporate annual reports: A time-series analysis. *Contemporary Accounting Research*. 17 (2): 213-226.

This study was the first time series study undertaken. The objective was to conduct a more powerful test of the graph selectivity hypothesis by focussing on *changes* in the graph use decision and their association with changes in company performance. The analysis is based on the annual reports of 137 listed UK companies over the five-year period 1988 to 1992. Four

KFVs are examined across four decision years for each company, giving 2,192 graphical choices, with changes in the graph use decision occurring in 319 cases. These cases were related to three performance proxies (the specific KFV graphed; earnings and EPS), each measured as (i) direction of change in latest year and (ii) magnitude of change in latest year. Strong evidence consistent with impression management is found, especially for earnings and ES, measured as direction of change.

4. Mather, P., A. Ramsay and A. Steen. 2000. The use and representational faithfulness of graphs in Australian IPO prospectuses. *Accounting, Auditing and Accountability Journal*. 13 (1): 65-83.

This was the first study to investigate the use of financial graphs in a document other than the annual report. 484 Australian initial public offering (IPO) prospectuses are examined to investigate the issues of selectivity and measurement in graphs. The sample covers periods before and after a change in the regulation of prospectuses in 1991 (there was a move from rules-based to principles-based regulation, although no specific mention of graphs is made under either regulatory regime). Graph usage in prospectuses (28%) is substantially less than found in top Australian company annual reports (83%), (although the incidence of graphs was higher for the post 1991 sub-sample). Significant industry differences in graph usage were identified between industrial and mining companies (mining companies less frequently included graphs). Evidence of selectivity was found, with companies showing increasing profits being significantly more likely to include graphs. The level and direction of distortion in KFV graphs was, however, *not* in the direction predicted by impression management incentives.

5. Beattie, V. A. and M.J. Jones, 2002a. The impact of graph slope on rate of change judgments in corporate reports, *Abacus*. 38 (2): 177-199.

Along with Beattie and Jones (2002b), this was the first academic, experimental study into financial graphs. The aim was to investigate whether sub-optimal slope parameters (optimum = 45º) distorted users' judgments of corporate performance. A set of nine graphs was constructed to reflect each of three levels of two independent variables: slope parameter (30º, 45º and 70º) and data increase (50%, 100%, and 200%). The data change effect primarily acts as a 'distractor' in the experiment, to minimize learning effects. In the first task (categorization) each graph was shown in turn to subjects for 3 seconds. Subjects (52 sophomore business studies students) selected one of five response categories in relation to the performance of the company: very slightly increasing; slightly increasing, moderately increasing; sharply increasing and very sharply increasing. ANOVA showed that better perceptions of performance were associated with higher slope parameters. In the second task

(comparison), the nine graphs were shown in pairs (A and B), generating 36 trials. The five response categories in relation to the performance of the companies were: A much more favourable than B; A more favourable than B; A and B equally favourable; B more favourable than A; B much more favourable than A. As expected, a significant graph slope effect was found. In addition, archival research into the slope parameters in 240 large UK companies' annual reports revealed extensive departure from the optimum.

6. Beattie, V. A. and M.J. Jones. 2002b. Measurement distortion of graphs in corporate reports: An experimental study, *Accounting Auditing and Accountability Journal*. 15 (4): 546-564.

Along with Beattie and Jones (2002a), this was the first academic, experimental study into financial graphs. The aim was to establish a materiality threshold for graph distortion, i.e. the level of graph distortion that resulted in a change in users' perceptions of company performance. An initial base EPS graph was constructed showing a steady 100% increase over a five-year period; axes and scale values were omitted to avoid cognitive (rather than perceptual) processing. Six pairs of graphs (X and Y; one with distortion) are shown to subjects for 3 seconds. Both orders of presentation were shown, giving 12 trials. The distortion investigated ranged from 5% to 50%. Subjects (52 sophomore business studies students) selected one of three response categories in relation to the performance of both companies: X more favourable than Y; no difference; Y more favourable than X. Distortion of 5% had no significant effect while distortion at 10% impacted perceptions at the 5% level of significance and levels beyond 10% impacted perceptions at the 5% level of significance. Users with lower levels of financial understanding appeared to be at most risk of being misled.

7. Arunachalam, V., B.K.W. Pei and P.J. Steinbart. 2002. Impression management with graphs: Effects on choices, *Journal of Information Systems*. 16 (2):183-202.

This experimental study investigates the impact on subjects' choices of four types of improper graph design: proportionality distortion (i.e. the use of a non-zero or broken axis); year reversal; masking (e.g. by graphing two variables that differ greatly in magnitude on the same y-axis scale); and omission of negative values. Subjects received five years of data in the form of graphs that included precise numbers) on four KFVs for each of three companies. Subjects were asked to select one company for investment (this experiment therefore involved a decision task rather than eliciting perceptions). The three companies included a high, medium and low in terms of growth rates for each KFV; the graphs for one company were distorted to give a more favourable growth rate. As subjects should select the company

with the highest growth rate, only the graphs for the companies showing medium or low growth were distorted. 49 accounting majors took part in experiment one comprising 27 trials and all four types of improper graph design. Two further experiments focused on proportionality distortion (a different group of 42 accounting majors). Evidence that graphical impropriety affects subjects' decisions is found across all three experiments.

8. Beattie, V., A. Dhanani and M.J. Jones. 2008. Investigating presentational change in UK annual reports: A longitudinal study. *Journal of Business Communication*. Forthcoming.

This longitudinal study examines change in the structure and form of annual reports produced by UK listed companies from 1965 to 2004 and has a particular focus on a comparison with the findings (based on 1989 annual reports) of Beattie and Jones (1992). Data is based on the 2003/04 annual reports of a sample of 100 companies randomly selected from the FSTE 500 list, of which six were subsequently eliminated. Although graphs usage is found to be universal in the 2003/04 sample, the incidence of KFV graphs had declined slightly, being replaced by graphs depicting other operating issues. Impression management through selectivity, measurement distortion of graphs and manipulation of the length of time series graphed is common. Evidence is found of a 'normalization' process in relation to many aspects of the annual report, which conforms to the generic pattern of diffusion of new ideas.

Endnotes

[1] The statistical graphics literature distinguishes between graphs used for communication (i.e. presentation) purposes and those used for data analysis purposes.

[2] The main exception to this is the performance graph which is now mandated in the UK and the US. In the UK, schedule 7A of the Companies Act (as amended) requires the historical time series of a company's total shareholder return to be displayed graphically against an appropriate benchmark market index. In the US, a performance graph is required under item 201(E) of Regulation S-K.

[3] These guidelines were derived from academic research [Beattie and Jones, 1998].

[4] In addition, there is also a preliminary stage of 'pre-attentive vision', which refers to the effortless perception which occurs during the first one or two seconds that the graph is looked at, when color and texture are discriminated [Julesz, 1981]. Perceptual processing involves eye movement and attentive search.

[5] There are seven-dimensions used in graphs (position along a common scale; position along identical, but non-aligned scales; length; area; volume; angle; and slope), with different graph types utilising combinations of these dimensions.

[6] In total, 25 articles are listed. However, four studies comprised ten published articles/research reports.

[7] We can offer no rational explanation for these two anomalous results.

[8] Spurious results such as these would be obvious to the thoughtful researcher and it may be assumed that such instances have been discounted in most prior studies.