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Quantitative Data Graphics: Best Practices of Designing Tables and Graphs for Use in Not-for-Profit Evaluation Reports

CAPSTONE REPORT

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Abstract

for

Quantitative Data Graphics: Best Practices of Designing Tables and Graphs for Use in Not-for-Profit Evaluation Reports

Graphical presentation of quantitative data greatly improves information perception, absorption, and retention. This literature review study analyzed 16 sources published between 1990 and 2005, addressing the three most frequently used quantitative business data presentation types: tables, graphs, and charts (Tufte, 2001) and graphics design. Results are presented in four tables, providing a set of factors for consideration by not-for-profit organization program managers when creating quantitative graphical data visualizations for use in program evaluation reports.

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CHAPTER I

PURPOSE OF STUDY

Brief Purpose

The purpose of this study is to provide program managers of educational not-for-profit organizations (Werther & Berman, 2001) with a set of factors to consider regarding the graphical display of quantitative data (Tufte, 2001), for use in program evaluation reports (McNamara, 1999; O'Neill, 2002). This study is intended to assist program managers who lack graphic design training to make educated choices concerning the application of graphical display for reporting program evaluation data.

One of the responsibilities of not-for-profit organization program managers (Administration for Children and Families, 2005) is to provide stakeholders (Werther & Berman, 2001) with program evaluation reports in order to fulfill accountability requirements (Dees, Emerson & Economy, 2001; McNamara, 2003). Stakeholders must be able to perceive information and draw conclusions upon activities which may impact the future of the program (Brinckerhoff, 2000; The Program Manager's Guide to Evaluation, 2005). According to Werther & Berman (2001), the most important components of program evaluation reports are quantitative information reflecting program outcomes and financial analyses.

Tufte (2001) states that "Using graphics in displaying quantitative data is often the most effective way to describe, explore, and summarize a set of numbers." The most widely used types of graphical quantitative data display are tables, charts, and graphs (Harris, 1999; Zelazny, 1996). Creation of graphical display of

quantitative data involves not only understanding data, but also identifying the most suitable methods of display (Few, 2004; Tufte, 1997).

This study is designed as a literature review (Leedy & Ormrod, 2001) in which literature is collected, assessed, and organized for further evaluation. Twenty chosen resources published between 1987 and 2005 are analyzed using conceptual content analysis method (Palmquist, et al., 2005) in order to address (1) types of graphical display methods of quantitative data (Few, 2004; Bounford, 2000) and (2) program evaluation and accountability practices of educational not-for-profit organizations (Dees, Emerson & Economy, 2001).

The results of the content analysis are compiled into four distinct lists of terms and phrases addressing such graphical display types as (1) tables, (2) bar graphs, (3) line graphs, (4) pie graphs, and their elements. Then these four lists are framed into a set of factors for consideration for use by not-for-profit program managers on application of graphical data display methods (Few, 2004; Bounford, 2000) in presenting financial and program outcome evaluation data (The Program Manager's Guide to Evaluation, 2005; Seubert, ND).

Full Purpose

The purpose of this study is to develop a set of factors for consideration for use of graphical data display methods in presenting quantitative data (Tufte, 2001, Bigwood & Spore, 2003) in not-for-profit organization program reports (McNamara, 1999; O'Neill, 2002). The study is designed as a literature review (Leedy & Ormrod, 2001) and aligns information pertaining to (1) types of quantitative data graphical display methods and (2) practices of educational not-for-profit organizational accountability and program evaluation reporting.

The research is conducted by analyzing selected sources published between 1990 and 2005, addressing the fields of graphics design and public sector management (Werther, Berman, 2001; Brinckerhoff, 2000). The data related to the two main topics are identified using conceptual content analysis methodology (Palmquist, et al., 2005). The outcome, a set of factors for consideration, is designed to aid program managers in choosing the most suitable data visualization methods in their effort to increase effectiveness of the program accountability documentation. The factors are presented in a concise, clearly documented fashion, in order to alleviate the efforts of canvassing volumes of graphics design literature in the search of suitable and easily applicable visualization solutions.

The literature for this study is collected by searching library resources, electronic databases, and the World Wide Web. Literature sources are determined to be suitable for the study based on the following relevance criteria: (1) the source addresses the topics of types and methods of quantitative data display, (2) the source evaluates data visualization methods in the context of their applicability in displaying of various types of quantitative data, (3) the source covers the topics of management, accountability, evaluation practices and strategies of not-for-profit organizations, (4) the source has been quoted and/or referenced in a number of publications covering the subject matters directly related to the research topic.

During the initial search process to identify the appropriate literature for this study, the obtained sources are categorized by their relevancy to the research topic, publication date, and credibility record. The research focuses on the literature sources addressing two key areas: (1) graphics design principles and (2) organizational aspects of not-for-profit company management. The graphics design related literature is focused on three types of graphical presentation of quantitative data: (1) tables, (2) graphs, and (3) charts, as well as their attributes. These are the

most commonly used types of business data display and are designed to graphically represent specific data sets (Bigwood & Spore, 2003; Few, 2004, Tufte, 2001).

Once collected, the chosen material is reviewed and analyzed using the data analysis strategy known as conceptual analysis (Palmquist et al., 2005), in the search for patterns, consistencies, and internal trends. This approach to data analysis is selected as most appropriate for this study because it enables the researcher to establish presence and frequency of occurrence of selected terms and concepts in a chosen body of literature (Palmquist et al., 2005).

This research is designed to assist program managers who do not have graphics design training in choosing graphical methods that are the most suitable for displaying certain types of data. The study provides program managers with a set of factors for consideration containing specific data visualization techniques that can be applied in order to communicate the program evaluation information effectively. The main task of not-for-profit organization program managers when gathering data and preparing program evaluation reports is to provide stakeholders with systematic, objective, and verifiable information concerning program activities, outcomes, and financial analysis (McNamara, 1999; O'Neill, 2002; Werther & Berman, 2001). Information presented in program evaluation reports must demonstrate to stakeholders that the program goals are achieved and the resources are spent in accordance with contractual agreements, particularly if the reports are prepared for submission to program funders (O'Neill, 2002; Werther & Berman, 2001). In an environment where competition for funding is growing, in order to secure future support, it is crucial to present stakeholders with measurable program evaluation results focusing on beneficial outcomes (O'Neill, 2002).

Horton (1991) states that the contextual and visual quality of documents impact the way they are perceived. The most effective way to communicate findings containing quantitative information is to display the data graphically (Tufte, 2001). Graphical representation of data serves as a tool to make the information easier to process and comprehend (Few, 2004; Horton, 1991; Tufte, 2001). According to Horton (1991), well-designed graphics help to structure data and enable the readers to grasp and process information more quickly and efficiently which leads to increased information retention and improved decision making.

Graphical data display methods have been successfully used for centuries to visualize data (Few, 2004, Tufte, 1997). Tufte (2001) explains the meaning of data graphics in the following statement:

> … graphics are instruments for reasoning about quantitative information. Often the most effective way to describe, explore, and summarize a set of numbers — even a very large set — is to look at pictures of those numbers.

Tables, graphs, and charts today are the most widely used types of graphical representation of quantitative data (Few, 2004; Harris, 1999; Zelazny, 1996). Tables are designed to display numbers in a methodical fashion and are effective for the purposes of structuring and presenting concentrated written material, and a series of small data sets (Bigwood & Spore, 2003; Tufte, 2001). Data are arranged in table format, categorized, and displayed in textual and numerical form, which allows for fast overview and discrimination (Bounford, 2000; Few, 2004). Graphs and charts present quantitative information in the form of visual objects and are intended to represent patterns and communicate a specific message (Bigwood & Spore, 2003; Few, 2004). Few (2004) states that the data presented in the form of objects help the readers to perceive information by distinguishing various shapes of data and its

aspects, and: "The data patterns revealed by graphs enable readers to detect numerous points of interest from a single collection of information."

Introduction of software applications designed to graphically represent data has made visualization possible to those who have access to such software and have mastered the available visualization techniques. But in order to produce quality data graphics it is not enough to be merely a skillful software user (Bounford, 2000; Few, 2004; Zelazny, 1996). The knowledge of the data visualization principles and ability to distinguish the most suitable data display methods are essential in creating informative and visually appealing graphics (Few, 2004; Tufte, 2001), no matter what tools are employed in the process (Horton, 1991). The importance of design simplicity and the role that it plays in data visualization is also widely recognized and discussed by such authors as Few (2004), Horton (1999) and Tufte (1990, 1997, 2001). In his book The Visual Display of Quantitative Information (2001), Tufte emphasizes the issue in the following statement:

> Furthermore, of all methods for analyzing and communicating statistical information, well-designed data graphics are usually the simplest and at the same time the most powerful (p.9)

Few (2004) reinforces this point of view by stating:

> The purpose of quantitative tables and graphs in business communication is to reveal important information effectively. That's it. Not to entertain, not to indulge in self-expression, not to make numbers interesting through flash-and-dazzle that you would otherwise deem boring. (p.10)

Significance

Building mutually beneficial relationships with stakeholders is the key to success in operating a not-for-profit organization (McNamara, 1999; O'Neill, 2002; Werther & Berman, 2001). According to Werther & Berman (2001, p.142) stakeholders expect to be presented with evidence of program implementation results, which makes outcome based evaluation and accountability the cornerstones of professionally managed not-for-profit organizations. With accountability being a mandatory element of not-for-profit program management (O'Neill, 2002; Werther & Berman, 2001), program evaluation reports play a vital role in ensuring that information reflecting program outcomes reaches the audience and communicates the intended message (Horton & Horton, 1999). The program evaluation information delivery methods, including graphical presentation of data, must be chosen in order to present results to stakeholders in a comprehensive manner that promotes perception and positively influences decision making (Brinckerhoff, 2000; The Program Manager's Guide to Evaluation, 2005).

The evaluation process is a fundamental part of any program lifecycle and is essential in attaining high quality performance standards (McNamara, 2003; The Program Manager's Guide to Evaluation, 2005). Accountability and program evaluation reporting are vital components of not-for-profit organizational activity, and are crucial in forming successful working relationships with stakeholders and fulfilling their accountability requirements (Dees, Emerson & Economy, 2001; O'Neill, 2002; McNamara, 2003). Stakeholders, depending on the individual organization and its structure, expect a certain level and frequency of outcome reporting from program managers (Brinckerhoff, 2000; O'Neill, 2002; The Program Manager's Guide to Evaluation, 2005). Program evaluations are designed to provide stakeholders with information regarding implementation of program components, cost-benefit analysis,

short and long-term results, as well as planning and budgeting efforts in order to make objective assessments concerning the program execution process (Brinckerhoff, 2000; McNamara, 1999; Werther, Berman, 2001).

The issues of accountability and program evaluation reporting are especially significant when viewed from the standpoint of the funder requirements (Brinckerhoff, 2000). According to Brinckerhoff (2000), a large number of organizations are competing for the same funds. The funders are willing to invest in causes that are able to demonstrate significant and measurable impact, and produce the most considerable change (Brinckerhoff, 2000; O'Neill, 2002). Under these circumstances, in order to secure funding, it is essential that not-for-profit organizations demonstrate the program impact and positive outcomes by presenting evaluation data in a clear and comprehensive manner (O'Neill, 2002; Seubert, ND).

This set of factors addresses these needs in the following ways: (1) underscore the importance of specific data visualization techniques, including tables, graphs, and charts, in presenting program evaluation results and show how these techniques can positively influence the evaluation outcomes; (2) help program managers identify the most suitable graphical data display methods and to encourage them to employ these methods when creating program evaluation reports, while advising that poorly designed graphics may distort information and damage data integrity (Davis, 1999; Few, 2004); and (3) reassure program managers who do not have graphics design training that it is possible to create highly effective data visualization graphics using the most commonly used design tools and techniques (Bounford, 2000; Few, 2004; Tufte, 2001; Zelazny, 1996).

Limitations

The literature collected for this study represents instruction and research materials published between 1990 and 2005. This time frame was chosen due to the following considerations: (1) although the basic approaches to graphical display of quantitative data have remained unchanged for decades (Few, 2004, Tufte, 1997), there have been significant developments in the study of human perception that led to new discoveries and re-examination of the best information presentation methods (Craig, 2000; Few, 2004;); and (2) in the past decade the not-for-profit sector has gone through significant transformations resulting from changes in economic, political, technological, and other environments (Brinckerhoff, 2000). As a result, accountability and program outcome evaluation have become mandatory elements of program planning and execution (Brinckerhoff, 2000; O'Neill, 2002; Seubert, ND). Based on these trends, the review of literature concerning not-for-profit organizations excludes material published before 1998.

The graphics design related literature is focused on three types of graphical presentation of quantitative data: (1) tables, (2) graphs, and (3) charts, as well as their attributes. These are the most commonly used types of business data display and are designed to graphically represent specific data sets (Bigwood & Spore, 2003; Few, 2004, Tufte, 2001).

Analysis of the collected sources reveals lack of universal definitions of *graphs* and *charts,* two fundamental graphical data display types, and confirms that these two terms are used interchangeably throughout literature. For the purposes of this study a coding rule is created that makes it possible during the analysis of literature to code occurrences of the graphical data presentation concepts into two main categories: (1) tables and (2) graphs*.* In order to achieve this, concepts of *graphs*

and *charts* are grouped into a single category named *graphs. Note:* Information about pie graphs is taken from sources that promote or tolerate usage of pie graphs, thus reflecting views of a small fraction of selected authors; the information can be classified as incomplete.

Skillfully planned and designed data graphics improve the chances of information being perceived and processed more efficiently (Few, 2004; Horton, 1991, Tufte, 2001). At the same time, well designed graphics alone cannot serve as a guarantee of successful data presentation (Bigwood & Spore, 2003; cite). Data graphics must be designed based on the thorough knowledge of the audience, its needs, expectations, and requirements (Bigwood & Spore, 2003; Puett, 2000), only then can the information reach the intended audience, communicate the message, and facilitate the building of favorable relationships (O'Neill, 2002; Seubert, ND). While not part of the primary focus of this study, in order to cover these aspects, the not-for-profit related sources are focused on such topics as: (1) development of mutually beneficial relationships with stakeholders through fulfilling contractual accountability requirements; (2) program outcome evaluation reporting practices; and (3) components and structure of program evaluation reports.

This research is not designed to address the data rendering software tools used in creation of data graphics. Rather, it addresses the general understanding of quantitative data graphical presentation methods. For the purpose of this study it is assumed that similar data visualization results can be achieved by means of a variety of data visualization tools such as Microsoft Excel, PowerPoint, Word, Visio, and other specialized design software. Thus the literature chosen for this study does not include software tutorials and publications intended to help readers in developing specific software user skills.

This research does not provide not-for-profit organization program managers with recommendations on how to form relationships with stakeholders, how to plan and conduct program outcome evaluations, how to develop policies concerning project evaluation report submission standards and practices, and how to collect the data and prepare content for the program evaluation reports. According to Few (2004) and Horton (1999), while graphical display of program evaluation data can help to communicate the message and increase its impact, it can not make up for inadequately developed document content.

Problem Area

Not-for-profit organizations play a unique role in society. As such, they have become virtually irreplaceable, and often fill niches that do not receive adequate attention from government and for-profit sectors (Berry, 2003; Werther & Berman, 2001). Werther & Berman (2001) describe the not-for-profit sector in this manner:

> Organizations in the third sector often pursue educational, health, cultural, religious, artistic, political, charitable, philanthropic, or other social goals. They seek to serve the public at large or the public good of a narrowly defined membership. Their aims often support the noblest features of society (p.3).

According to Berry (2003) the number of not-for-profit organizations in the United States has tripled in the past 25 years. As of 2003 there are more than 900,000 not-for-profit organizations registered with the Internal Revenue Service (Berry, 2003). Berry & Arons (2003) state that:

> The growth of nonprofits did not just happen because funds were available and needs became more evident. This growth reflects an intellectual ferment about the substance of domestic policy and the process by which it is made (p.10).

In the past several decades, a number of significant changes occurred in not-for-profit organization status, with two of the most important changes being (1) development of market-based tactics in structuring and managing not-for-profit organizations and (2) a move from a needs-based to outcomes-based approach to funding (Dees, Emerson & Economy, 2001). Under these circumstances not-for-profit program managers are faced with the need to conduct program outcome evaluation using more business-oriented strategies (O'Neill, 2002; Werther & Berman, 2001). Such an approach requires program managers to keep stakeholders informed about the program implementation results by delivering detailed evaluation and accountability reports, including both program outcome and financial information (McNamara, 1999; O'Neill, 2002; Werther & Berman, 2001). Effective information delivery methods, now more than ever, are one of the key elements of program management success (McNamara, 1999; O'Neill, 2002; The Program Manager's Guide to Evaluation, 2005).

Graphical presentation of information, if used skillfully, tends to deliver certain types of information more successfully, and especially applies to the graphical presentation of quantitative data (Few, 2004; Tufte, 1997). Tufte (2001) says that "Graphics *reveal* data", and states further that "Data graphics should draw the viewer's attention to the sense and substance of the data…" (p.91). He continues with the idea that "… much of the world these days is observed and assessed quantitatively — and well-designed graphics are far more effective than words in showing such observations" (p.87).

The field of data visualization has been evolving and developing rapidly, with new tools, techniques, and methods emerging continuously (Few, 2004). Technological advancement has contributed to production of much higher quality data graphics, but it has not provided users with the basic understanding of graphical display types and design principles (Bounford, 2000; Few, 2004). Few (2004) supports this notion by stating:

> Something produced with a computer, however, acquires an air of authenticity and quality that it doesn't necessarily deserve. In our excitement to produce what we could only make before with great effort, many of us have lost sight of the real purpose of quantitative displays — *to provide the reader with important, meaningful, and useful insight.* To communicate quantitative information effectively first requires an understanding of the numbers, then the ability to display their message for accurate and efficient interpretation by the reader (p.9)

An assumption underlying this paper is that an understanding of graphical data display principles can help not-for-profit organization program managers to present program evaluation data by supporting the outcomes with accurately chosen data graphics types. This not only makes the information easier to communicate and perceive, but also ensures preservation of data integrity and avoids misrepresentation (Few, 2004; Horton, 1991; Tufte, 1997, 2001).

CHAPTER II

REVIEW OF REFERENCES

This chapter provides a review of primary references that were instrumental in building the study framework and conducting the research. The references are presented in three sections: (1) resources addressing organizational issues of not-for-profit organizations, (2) resources presenting methodology used in conducting the study, (3) resources examining graphical data presentation.

Each reference annotation provides a brief content overview and a description of why the source was selected and how it is relevant to the study.

Section 1: Not-for-profit organization management references

Dees, J. G., Emerson, J. & Economy, P. (2001). *Enterprising nonprofits: a toolkit for social entrepreneurs.* New York, NY: John Wiley and Sons, Inc.

This book focuses on how the changing socio-economical environment impacts third sector management by creating the necessity to employ more business-oriented methods to operate a successful not-for-profit organization and to secure funding. The authors offer practical advice on how to apply core business concepts to managing not-for-profit organizations, including identification and mobilization of resources, planning, financial management and accountability, risk management, customer relations, and other components.

This book examines the entrepreneurial aspects of not-for-profit organization management, it is recommended as a suggested reading by a number of not-for-profit resource centers, and is referenced in public sector-related literature. The book provides support for the study by validating the notion that in order to succeed and

be competitive, not-for-profit organizations have to employ entrepreneurial management approaches and be aware of the existing societal, economical, and political trends and tendencies. This information was instrumental in defining the significance of the study.

McNamara, C. (1999). Basic guide to program evaluation. *Free Management Library*. Retrieved April 4, 2005 from http://www.mapnp.org/library/evaluatn/fnl_eval.htm

This article discusses the processes, methods, and benefits of program evaluation planning and execution, and also addresses key considerations, characteristics, and practical applications of program evaluation. The author reviews different types of program evaluation and analyzes information collection, analysis, and interpretation methods. This resource was key to structuring the study, framing the topic, and identifying the research audience.

This article was selected because it offers insight into program evaluation practices and provides a broad range of information on evaluation structure, requirements, procedures, and analysis. This publication serves as a theoretical support to numerous not-for-profit and for-profit texts examining the subject of program evaluation.

McNamara, C. (1999). Basic guide to outcomes-based evaluation for nonprofit organizations with very limited resources. *Free Management Library*. Retrieved April 4, 2005 from http://www.mapnp.org/library/evaluatn/outcomes.htm

This article reviews outcome-based program evaluation process and explains the reasons why and how not-for-profit organizations benefit by choosing this

particular approach to program evaluation. The author explains how, in the environment of intensifying competition for funding, outcome-based evaluation is becoming the preferred and often required method of program accountability. The reader is guided through logical steps of outcome-based evaluation planning and execution, with an emphasis on the importance of a methodical approach to program evaluation data gathering and analysis.

This article was selected because it offers a systematic in-depth description of outcome-based program evaluation and, in combination with *Basic guide to program evaluation* (McNamara, 1999), provides a perspective necessary to frame the research topic and develop the Full Purpose of this study. The author is cited and referenced in a majority of identified not-for-profit related sources, which adds to the credibility of the source.

Werther, B. W., & Berman, E. M. (2001). *Third sector management: the art of managing nonprofit organizations.* Washington, DC: Georgetown University Press.

This book presents a detailed analysis of all basic elements of not-for-profit sector management. The authors discuss the importance of a strategic approach to not-for-profit management by identifying company vision, mission, strategy, and program execution as key elements to long-term organizational success. Special attention is paid to the issues of fundraising, its effectiveness and direct dependency on organizational positioning and performance record.

This text serves as a key source for framing the research topic. It proved to be especially valuable in narrowing down the research audience by providing an insight into program management component and formation of relationships with program funders and other stakeholders. William Werther and Evan Berman are

award-winning authors of numerous publications, as well as acclaimed practitioners and scholars in the fields of not-for-profit management, human resources management, and public administration.

Section 2: Research method and content analysis references

Leedy, P. D. & Ormrod, J. A. (2001). *Practical research: planning and design.* Upper Saddle River, NJ: Prentice-Hall, Inc.

This textbook provides comprehensive guidance on basic research methodology. The topic of literature review presented in chapter four was used extensively in choosing the most appropriate research method.

Palmquist, M. et al. (2005). *Content Analysis*. Writing@CSU. Colorado State University Department of English. Retrieved April 10, 2005 from http://writing.colostate.edu/references/research/content

This source provides fundamental information and practical advice on how to plan and conduct content analysis. This web site was chosen to be the primary resource used for developing and conducting content analysis for this research, because it thoroughly describes conceptual analysis and offers an integral eight-step method designed to break down and structure the coding process.

Section 3: Graphical data visualization references

Bigwood, S. & Spore, M. (2003). *Presenting numbers, tables, and charts*. New York, NY: Oxford University Press Inc.

This manual-style book offers a concentrated overview on how to graphically present information, and focuses specifically on organization and display of

quantitative data. In a very concise manner, using simple yet very effective illustrations, the authors examine each type of data graphics and explain their purpose, functionality, and basic design principles.

This book was chosen because it provides well-organized information that can be easily located, and serves as a reference and data source for the research. This text was identified as one of the recommended data visualization resources on the website of the world-famous author Edward Tufte. Sally Bigwood and Melissa Spore are UK-based information design, corporate planning, and instructional design specialists with over twenty years of experience in these fields.

Bounford, T. (2000). *Digital diagrams: effective design and presentation of statistical information*. New York, NY: Watson-Guptill Publications.

Although this book largely covers development of skills necessary to create visually attractive and effective graphics, Chapters 1 and 2 are solely dedicated to types of statistical data display and practical application of tables and graphs. This text explores in great detail data graphics attributes, design elements, and their usage, including use of color and visual effects.

Some graphical data presentation solutions offered in this book are entirely opposite from those expressed by the widely acclaimed author Edward Tufte and his supporters. Nevertheless, due to its extensive coverage of the topic and broad variety of offered graphical elements and design approaches, this text was chosen as a solid base for performing data gathering and content analysis.

Few, S. (2004). *Show me the numbers: designing tables and graphs to enlighten*. Oakland, CA: Analytic Press.

This book is designed to introduce readers to practical data visualization methods for everyday business needs. The author presents hundreds of graphic examples and, in order to prove the point that effective data presentation can be achieved using commonly available tools, stresses that all graphics for this text are created using Microsoft Excel.

This text was chosen to be one of the primary data collection sources due to its extensive coverage of the topic and its logically organized approach to data presentation in business environment. Being a follower of Tufte's ideas, the author not only explores data visualization techniques, but also pays special attention to examining humans perception of and its influence on information comprehension and retention.

Harris, R. L. (1999). *Information graphics: a comprehensive illustrated reference: visual tools for analyzing, managing, and communicating.* New York, NY: Oxford University Press.

Among all the literature sources collected for this study, this encyclopedia-style textbook offers the most extensive compilation of qualitative and quantitative graphical data presentation methods, addressing a majority of data display types. The text consists of over 4000 graphics illustrations accompanied by detailed explanations.

This text serves solely as a resource for data collection and analysis in this paper.

Horton, W. (1991). *Illustrating computer documentation: the art of presenting information graphically on paper and online.* New York, NY: John Wiley & Sons, Inc.

This book is designed to provide documentation specialists with a set of tools necessary to graphically communicate difficult technical information in a clear and comprehensible manner. The author addresses a broad spectrum of topics including psychology of visual perception, color theory, information visualization techniques, illustration, and document layout.

Although the text touches only briefly on the topic of table and graph design using it mostly to illustrate the greater information visualization ideas, the content proved to be very useful in the framing of the study. The text is well-cited and its bibliography offers a broad range of additional resources.

Tufte, E. (1990). *Envisioning Information*. Cheshire, CT: Graphics Press.

In this book the author, who is famed for his contributions to the field of contemporary information design (Few, 2004), discusses universal information design principles and offers complex data presentation strategies. The author's views and ideas are cited in a majority of graphic design-related literature gathered for this study. This text was used to frame the research topic and define the significance of the study.

Edward Tufte is the author of some of the most highly acclaimed contemporary publications on information design and his teachings resonate in publications of numerous authors world-wide. This book was selected because it skillfully balances information design theory and practice.

Tufte, E. (2001). *Visual display of quantitative information.* Cheshire, CT: Graphics Press.

This work offers a thorough analysis of fundamental quantitative information visualization principles. The award-winning author exemplifies the meaning of data

graphics and demonstrates that graphical form is the best mechanism to convey quantitative information. He reviews contemporary and century-old graphical traditions and emphasizes the role of graphics in conveying information.

This book serves as a solid theoretical base for this study supporting the important role of visual communications addressed in the Full Purpose and Significance sections of this research paper, and is a source for data collection and analysis.

Zelazny, G. (1996). *Say it with charts: the executive's guide to visual communication*. Burr Ridge, IL: Irwin Professional Publishing.

This text focuses specifically on design and use of graphs as means of quantitative data communication, and takes a broad look at graph design principles and elements. Gene Zelazny, the Director of Visual Communications for McKinsey & Company and a regular lecturer at the top business schools in the United States and Europe, offers expert advice on the topics of information delivery and visual communications methods. The author guides the reader through all stages of graph creation starting with concept ideas and ending with lessons on graphical element creation using software applications.

This book was selected for the study because it offers practical design recommendations and addresses individual graph design elements in great detail, thus providing the study with essential research material. This text serves primarily as a source for data collection and analysis.

CHAPTER III

METHOD

The research method selected for use in this study was literature review. Literature review enables the researcher to collect, evaluate, analyze, and organize literature in order to conduct the study (Leedy & Ormrod, 2001). A qualitative approach was found to be the most suitable for this study because it allowed for the collection of data and analysis of the phenomena form a particular perspective. Leedy & Ormrod (2001) emphasize that unlike quantitative study that is designed to present measurable variables and confirm or disconfirm the theory, qualitative study describes and presents the observations from the author's point of view.

Data Collection

The literature search for this study was conducted in several steps. Initially it was necessary to determine the presence of literature sources essential to planning and conducting the research on the chosen topic. Early investigative Internet searches identified the existence of literature in such categories as graphical data presentation methods and not-for-profit management. After availability of such material was determined, a more thorough literature search was conducted in the category of graphical data presentation. The search was directed towards finding sources addressing visualization of quantitative data, and specifically focusing on such types of business data visualization as tables, charts, and graphs. The not-for-profit related literature category was secondary to this study, and the search was aimed at finding sources covering general aspects of managerial, accountability, and program evaluation issues.

The search for graphics design literature was limited to include publications ranging from 1990 through 2005, and was aimed at identifying sources covering the following topics:

- Types of quantitative data
- Definitions and attributes of tables, graphs, and charts
- Methods of graphical data presentation
- Advantages of visualizing data
- Human perception of graphical vs. verbal information
- General rules on selecting adequate data presentation methods
- Principles of designing effective documentation and presentations

During the preliminary search it was determined that highly regarded graphic and information design literature sources were available in book format and these sources were acquired through Multnomah County Library and from the researcher's personal collection, totaling 12 texts.

Further search was conducted to identify articles, conference proceedings, and instructional materials to supplement the texts. The search of the following databases was conducted using the UO Library online information system resources:

- Academic Search Premier
- Article First
- ECO: Academic Collections Online

- JSTOR: Electronic Journal Archive

The database search yielded 5 articles that were classified as supplementary to the already collected texts.

Finally, Google (www.google.com) and Profusion (www.profusion.com) search engines were used to identify additional sources available on the Internet. The key search terms included the following:

- "Data presentation" + graphics +graphs +tables
- "Business data" + graphs +charts
- Design + graphs +charts +tables
- "Quantitative data" +visualization
- "Information graphics" + presentation
- "Data graphics" + display + visualization
- "Corporate reporting"

This search produced 35 web sites addressing content applicable to the research study. Overall the search process of the University of Oregon Library online data bases and the Internet revealed that the resources acquired through these searches were secondary in relevance to the information presented in the textbooks. Authors of these textbooks were cited, referenced, and quoted in the majority of the acquired online literature sources. Additionally several acquired articles were written by the same book authors. As a result it was decided that the primary literature sources for this study are textbooks supplemented by 13 selected articles.

Data Analysis

The collected literature was examined using a content analysis strategy. The particular strategy selected was conceptual analysis, as presented by Palmquist et al. (2005) on the Colorado State University Writing Center website. This strategy was chosen because it provided the researcher with the tools to analyze the sources by recording the frequency and occurrence of certain concepts, both of explicit and implicit nature, in search for internal trends and patterns (Palmquist et al., 2005). According to Palmquist et al. (2005) "In conceptual analysis, a concept is chosen for examination, and the analysis involves quantifying and tallying its presence." The data analysis was performed following the eight-step approach described by Palmquist et al. (2005).

In order to perform coding, the graphics design texts were first classified into categories addressing the three most frequently used quantitative business data presentation types: (1) tables, (2) graphs, and (3) charts (Bigwood & Spore, 2003; Few, 2004, Tufte, 2001). These design elements were formulated as a set of fixed concepts and the texts were coded for the existence of these categories.

In order to conduct content analysis, a set of rules was developed to establish the levels of generalization, as explained by Palmquist et al. (2005). Special attention was paid to "… whether concepts are to be coded exactly as they appear, or if they can be recoded as the same even when they appear in different forms" (Palmquist et al., 2005). The determination was based on the definitions and usage of the chosen concepts in selected texts.

While there was no debate as to the definition of *table*, the concepts of *graph* and *chart* were used throughout the literature interchangeably, and there were conflicting definitions concerning the origins and the actual meanings of these terms.

Several sources noted a level of confusion in the usage of these terms in the literature. For example, the same graphical data visualizations in some sources were defined as *charts* (Bigwood & Spore, 2003; Horton, 1991; Zelazny, 1996), and in others referred to as *graphs* (Few, 2004; Harris, 1999; Bounford, 2000). Tufte (2001, 1997, 1990) mostly referred to all graphical representation simply as *data graphics.*

For the purposes of this study, following the definition given by Few (2004) stating that "*Tables* and *graphs* are two members of a larger family of display methods known as *charts*", it was assumed that (1) tables and (2) graphs are two major quantitative data display categories. Analysis was performed by coding concepts into these two categories, where concepts of *graphs* and *charts,* including their elements, were consolidated into a single category called *graphs*.

These coding rules enabled the researcher to systematically analyze the texts for occurrence of these chosen concepts and disregard others as irrelevant. This approach provided flexibility, while maintaining integrity of the data and focusing on the purpose of the study (Palmquist et al., 2005). The coding of the texts was performed manually by recording the occurrence of select concepts following the established rules discussed above.

Data Presentation

The data analysis results drawn form the literature review of 16 selected sources are presented in a form of a set of factors for consideration organized into a series of tables. Tables include: *Table 1*: Factors to Consider Regarding the Use of Tables to Present Graphical Data; *Table 2*: Factors to Consider Regarding the Use of Graphs to Present Graphical Data; Table 3: Factors to Consider Regarding the Use of

Graphs — Data Elements; Table 4: Factors to Consider Regarding the Use of Graphs — Non-data Elements. Tables are designed to present findings in the field of quantitative data visualization. Factors presented in these tables provide not-for-profit organization program managers with practical information concerning general graphical data presentation types, principles, elements, and methods in visualizing quantitative program evaluation data.

The factors are intended to assist not-for-profit organization program managers in developing a basic understanding of graphical data presentation methods and address the needs of not-for-profit program managers in their efforts to design effective documentation. Documents presented in well organized and a graphically cohesive manner are not only visually attractive but, most importantly, communicate the information more successfully (Few, 2004, Tufte, 1990, 2001). Understanding these issues is essential in preparing program outcome and evaluation reports to stakeholders as a part of specifically established not-for-profit accountability requirements (Dees, Emerson & Economy, 2001; McNamara, 2003; Werther & Berman, 2001).

CHAPTER IV

ANALYSIS OF DATA

This chapter introduces the results of conceptual content analysis of 16 selected literature sources on the subjects of graphical data visualization methods and graphics design. The list of references forming the data analysis set follows:

1. Bigwood, S. & Spore, M. (2003). *Presenting numbers, tables, and charts*. New York, NY: Oxford University Press Inc.
2. Bounford, T. (2000). *Digital diagrams: effective design and presentation of statistical information*. New York, NY: Watson-Guptill Publications.
3. Few, S. (2004). *Show me the numbers: designing tables and graphs to enlighten*. Oakland, CA: Analytic Press.
4. Few, S. (2005). Data visualization: grid lines in graphs are rarely useful. *DM Review magazine*. Retrieved March 28, 2005, from http://www.dmreview.com/article_sub.cfm?articleId=1018118
5. Few, S. (2004, July). The information cannot speak for itself. *Intelligent Enterprise*. Retrieved March 30, 2005, from http://www.intelligententerprise.com/showArticle.jhtml?articleID=49400920
6. Few, S. (2004, September). Enie, meenie, minie, moe: selecting the right graph for your message. *Intelligent Enterprise*. Retrieved March 30, 2005, from http://www.intelligententerprise.com/showArticle.jhtml?articleID=46800517
7. Few, S. (2004, October). Elegance through simplicity. *Intelligent Enterprise*. Retrieved March 30, 2005, from http://www.intelligententerprise.com/showArticle.jhtml?articleID=49400920

8. Harris, R. L. (1999). *Information graphics: a comprehensive illustrated reference: visual tools for analyzing, managing, and communicating.* New York, NY: Oxford University Press.

9. Horton, W. (1991). *Illustrating computer documentation: the art of presenting information graphically on paper and online.* New York, NY: John Wiley & Sons, Inc.

10. Horton, W. & Horton, K. (1999). Picture-perfect proposals: putting visual literacy to work. Association of Proposal Management Professionals. Retrieved March 29, 2005 from http://www.apmp.org/docs/fall99/19pictureperfect.pdf

11. Klass, G. (2002). Presenting data: tabular and graphical display of social indicators. Illinois State University. Retrieved April 2, 2005, from http://lilt.ilstu.edu/gmklass/pos138/datadisplay/

12. Parker, R. (2003). Looking good in print, fifth edition. Scottsdale, AZ: Paraglyph Press, Inc.

13. *Style guide for business and technical communication.* (2000). Salt Lake City, UT: Franklin Covey Co.

14. Tufte, E. (1990). *Envisioning Information*. Cheshire, CT: Graphics Press.

15. Tufte, E. (2001). *Visual display of quantitative information.* Cheshire, CT: Graphics Press.

16. Zelazny, G. (1996). *Say it with charts: the executive's guide to visual communication*. Burr Ridge, IL: Irwin Professional Publishing.

The references are subjected to conceptual analysis (Palmquist, et al., 2005) and coded using two main data graphics categories: (1) tables and (2) graphs. Several sub-categories are used relative to the graph category in order to perform more in-depth data analysis. The sub-categories include: (1) bar graphs, (2) line graphs, and (3) pie graphs. Analysis of each category is followed by a table

presenting a concentrated version of data analysis results. The goal of this coding process is to identify pervading perspectives in the field of graphical data presentation and to demonstrate a variety of approaches used to produce high quality information graphics.

Results of the conceptual analysis are presented in a series of tables, organized for convenient reference, designed to provide not-for-profit organization program managers with a set of factors for consideration when choosing graphical visualization methods to display program outcome evaluation data.

Few (2001) states that "Words, graphics, and tables are different mechanisms with but a single purpose — the presentation of information". Graphics should communicate information in the most efficient and simplest way possible, determined by the data presentation goals and the audience (Horton & Horton, 1999).

All graphical display elements can be divided into two categories: (1) *data elements* — those that communicate the actual information (numbers, bars, lines, wedges, etc.) and (2) *non-data elements* — those that do not communicate information but rather play a supporting role (axis, grid, legends, colors, fills, etc.) (Few, 2004).

Tables

Tables are one of the oldest methods employed to classify, organize, and present quantitative and qualitative information (Tufte, 2001), and have been used for these purposes for over five thousand years (Horton, 1991). One purpose of the table is to display quantitative data by showing "…simple relationships between quantitative values and the categorical subdivisions to which these values are

related, so that the values can be individually located and related" (Few, 2004). Tables support presentation of large amount of data in a compact space, allowing viewers to quickly scan large volumes of data. Tables also promote comparison and improve information absorption (Horton, 1991). Some basic concepts of table design are:

- Relationships displayed in tables are divided into two categories: (1) quantitative-to-categorical, designed to look up one quantitative value at a time, and (2) quantitative-to-quantitative, designed to show relationships between values (Few, 4004, p.47)

- Tables can be designed as (1) unidirectional, where categories appear only in rows or in columns, but not in both directions, and (2) bidirectional (Few, 2004, p.52), also called multidirectional, where there is more than one set of categories (Harris, 1999, p.389).

- Table gridlines, whose purpose is to separate data categories, are considered distracting and unnecessary by most authors, and should be used with caution. Majority hold the opinion that the white spaces between the rows and columns create a natural grid and do not create visual clutter. Light shading is claimed to be an effective substitute for gridlines and is more effective at delineating rows and columns (Few, 2004), although a small number of sources support the use of gridlines as a suitable delineation method.

- All text in tables should be arranged horizontally. Column headings should be repeated at the beginning of each new group and, in cases when tables run across pages, at the beginning of each new page (Few, 2004, p,154). Text alignment in numerical tables must be consistent in order to present data clearly (Bigwood & Spore, 2003).

Table 1: Factors to Consider Regarding the Use of Tables

Factors to Consider	Graphical Data Presentation Concepts	Reference Number
Purpose of Tables – or When to use a Table	To list exact values.	1, 2, 3, 4, 9, 12, 13
	To provide precise information and ease of reference.	3, 4, 9, 12, 14
	To compare numbers in the same and different categories.	3, 4, 9,
	To simplify data presentation.	3, 9
Data Arrangement and Organization Principles	Use a unidirectional information arrangement method to display single set of values.	3, 4
	Use a bidirectional (multidirectional) information method to display multiple sets of values.	3, 4
	Split large and complicated tables into few smaller tables.	2, 3, 9
	Align numbers and text consistently.	2, 3, 4
	Arrange data in a specific order i.e. alphabetical, chronological, etc., depending on the presentation goal.	1, 8, 9, 13
	Place tables immediately after the text they are designed to illustrate.	1, 3, 9, 15
Design Principles	Repeat column headings at the beginning of each new group and at each new page.	3
	Arrange all text and headings in tables only horizontally.	1, 3, 11
	Arrange heading text vertically or on an angle to accommodate long names.	2
	Mute or omit gridlines as they create clutter and distract from the actual data.	1, 3, 4, 8, 9, 12, 14
	Use gridlines to delineate rows and columns.	2, 13
	Use white spaces to delineate rows and columns.	1, 3, 12, 14
	Use very light shading to delineate rows and columns.	1, 2, 3, 8

Graphs

Graphs translate data into visual objects and are powerful tools of communicating quantitative information (Few, 2004, p.162). Graphs should be used when it is difficult to present pattern, trend, or relationship information in a verbal or table form (Bigwood & Spore, 2003). In order to communicate information effectively, these visual objects "must be prominent, accurate, and clear" (Few, 2004).

Graphs: General Use

The three most commonly used types of graphs are bar, line, and pie graphs (Bigwood & Spore, 2003; Few, 2004; Tufte, 2001).

- *Bar graphs* represent information in the form of columns or bars that are arranged vertically or horizontally, and are designed to present visual data relationships between two or more sets of values (Bigwood & Spore, 2003);
- *Line graphs* represent information in the form of lines, and excel at visualizing how values change over time, display continuity, flow, and value fluctuations (Few, 2004);
- *Pie graphs* are designed to visualize proportions, but their usage and effectiveness has been greatly criticized in the past few decades (Klass, 2002). Pie graphs are still popular due to their pleasing appearance (Bigwood & Spore, 2003), but the overwhelming majority of sources agree that this is the least effective data presentation method. One of the most famous quotes often used in graphics design literature belongs to

Edward Tufte (2001, p.178): "… the only worse design than a pie chart is several of them…" and continues " Given their low data-density and failure to order numbers along a visual dimension, pie charts should never be used."

Table 2: Factors to Consider Regarding General Use of Graphs

Factors	Graphical Data Presentation Concepts	Reference Number
Purpose of Graphs – or When to Use a Graph	To show trends, relationships, and exact values.	1, 3, 10, 11, 12, 13, 15, 16
	To substitute for text or tables to present data more effectively.	1, 2, 3, 10, 11, 12, 15, 16
	To tell a story.	1, 3, 14, 15,
	To present quantitative data in an attractive manner.	1, 2, 10, 12, 13
	Place graphs immediately after the text they illustrate.	1, 3, 10, 11
Bar Graphs	To display changes over time, comparisons, deviations, parts of the whole, rankings, time series.	1, 2, 3, 6, 8, 9, 11, 12, 13, 15, 16
Line Graphs	To display changes over time, comparisons, deviations, frequency distributions, time series trends.	1, 2, 3, 6, 7, 8, 9, 12, 13, 15
Pie Graphs	To display part of the whole or proportions.	1, 2, 3, 5, 6, 8, 11, 12, 13, 15, 16
	Avoid use of pie graphs due to their ineffectiveness.	1, 3, 5, 6, 8, 11, 12, 13, 15, 16
	Use pie graphs to effectively display parts of the whole or proportions.	2, 8

Graphs: Data Elements

The main consideration when designing graphical data presentation is to follow the basic principles of quantitative communication: "clarity, consistence, and

efficiency … and … telling the truth about the data" (Tufte, 2001). Disobeying these principles, accidentally or purposely, may lead to creation of graphics that distort information and mislead the viewer (Few, 2004). The majority of sources reviewed in this study share the perspective that the most important task in creating successful graphical data visualizations is to choose appropriate data elements (bars, lines, slices, points, values), and present them using general data organization principles. Basic data display elements and principles for data organization using graphs include:

- *Bar graphs* display information effectively when values to be presented in bars differ significantly; an appropriate bar orientation is chosen (horizontal or vertical); balanced data proximity (distance between bars and width of bars) is maintained; and an appropriate order of data is applied (Bigwood & Spore, 2003; Few, 2004);

- *Line graphs* display information clearly when there a sufficient number of values is present (three or more data points); a restricted number of data sets is used (five or fewer) in order to avoid the "spaghetti effect"; and lines are distinguished by the means of color or pattern coding (Parker, 2003; Tufte, 2001);

- Pie graphs display information successfully when there is a limited number of data sets (five, six, or fewer); slices are arranged by size (bigger to smaller); and a total value of every graph is clearly indicated (Bounford, 2000; Harris, 1999).

Table 3:	**Factors to Consider Regarding the Use of Graphs — Data Elements**	
Factors	Graphical Data Presentation Concept	**Reference Number**
Bar Graphs	Use bars when quantities differ significantly.	1, 3, 11, 13
	Order bars by value (size) not alphabetically or otherwise.	1, 3, 8, 10, 11
	Use horizontal bars when data label text is long.	1, 3, 13, 15, 16
	Bars must have equal width and should not overlap.	1, 3
Line Graphs	Use 3 or more data points to illustrate the pattern.	1, 3
	Limit number of lines to 5 or fewer. If more limes are necessary split the graph into several smaller graphs.	1, 3, 11, 16
	Distinguish lines by color or patterns. Take into account that the differences may diminish with reproduction.	3, 9, 11, 13, 16
	Do not layer line graphs.	1, 3, 9, 13, 16
Pie Graphs	Limit number of slices to 5-6 or fewer.	1, 12, 13, 16
	Arrange slices from large to small.	1, 12, 13, 16
	Indicate total value.	1, 8, 9, 13, 16
	Never compare two or more pie charts side to side.	1, 3, 11, 12, 15

Graphs: Non-data Elements

This subcategory addresses graph design elements used in presenting data. Edward Tufte, who is famous for coining such widely used terms as "chartjunk", "data ink", and "non-data ink" characterizing the overuse of non-data elements, states:

> The interior decoration of graphics generates a lot of ink that does not tell the viewer anything new. The purpose of the decoration varies — to make the graphic appear more scientific and precise, to enliven the display, to give the designer an opportunity to exercise artistic skills. Regardless of the cause, it is all non-data-ink or redundant data-ink, and it is often chartjunk (Tufte, 2001, p.107).

The majority of the authors reviewed in this study agree that if not approached with caution, these helpful non-data elements can easily turn into the infamous "chartjunk." The following are several overarching principles that have to be considered when planning and designing graphs:

- Such elements as axis and grids serve as supporting structures and "… rather than encoding data [they] define the space in which the data is displayed. … As such, they should be visually muted to the point where they are just visible enough to do their job, no longer competing with data for attention. " (Few, 2004)

- Special attention must be paid to the negative effects of three-dimensional (3-D) data presentation methods that became widely spread and popular with the availability of data visualization software (Few, 2004; Tufte, 2001). The majority of the authors agree that three dimensional data presentation must be avoided at all costs. Klass (2002) states: "The primary causes of extraneous lines in charting graphics today are the 3-D option offered by conventional spreadsheet charting software. These 3-D options serve no useful purpose; they add only ink to the chart, and more often than not make it more difficult to estimate the values."

- Fills and patterns have to be chosen carefully as they also, if not applied carefully, can cause distractions or even data misrepresentations (Bigwood & Spore, 2003). Use of these various elements (stripes, weaves, checkers, dots, etc.) create an illusion of shimmer, the so called *fabric effect* (Tufte, 2001) [Tufte also describes this as the "moiré" effect]. Edward Tufte states: "This moiré vibration, probably the most common form of graphical clutter, is inevitably bad art and bad data graphics. The noise clouds the flow of information and contaminates the entire graphic. It has no place in data graphical design."

- Proper data labeling plays a crucial role in graphical data presentation, and aspects such as close proximity to the graphical data element, horizontal text orientation, use of succinct language are essential in presenting information accurately (Bigwood & Spore, 2003). Appropriate use of legends must also be considered. A majority of authors hold to the opinion that legends should be used only in cases when data label text is too long to fit next to the graphical element, or to eliminate repetition due to the grouping of data subdivisions. They also agree that if used, the legends must be located as close to the graphic as possible "…the closer the legend is to the data values, the easier it is to read the graph" (Few, 2004).

Table 4: Factors to Consider Regarding the Use of Graphs — Non-data Elements

Factors	Graphical Data Presentation Concepts	**Reference Number**
Axis	Include 4-6 numbers on the axis to avoid overcrowding.	1, 3, 9, 11
	Axis elements are secondary — mute or in some cases omit.	1, 3, 7, 15

Table 4: Factors to Consider Regarding the Use of Graphs — Non-data Elements

Factors	Graphical Data Presentation Concepts	Reference Number
Data Labels and Legends	Arrange data label text horizontally and locate directly next to data items.	1, 3, 10, 13, 15
	Legends tend to create distraction. Use legends only if data label text is too long or to avoid repetition.	1, 3, 8, 11, 12, 13, 15
	Locate legends as close to the graphic as possible, preferably inside of the graphic border.	1, 3, 8, 9, 11, 12, 13, 15
Fills and Patterns	Use fills to differentiate, encode and emphasize values.	2, 8, 13
	Use distinct fill colors and tints. Take into account that the differences may diminish with reproduction.	1, 3, 8, 9, 12, 13, 14, 15
	Patterns create visual clutter. Avoid use of patterns or use them with caution.	1, 3, 7, 8, 9, 11, 15
Grids and Backgrounds	Grids create visual clutter — mute or omit.	1, 3, 4, 6, 7, 11 15, 16
	Grids serve as visual aid.	2, 8, 12, 13
	Backgrounds create distractions and harsh appearance.	1, 3, 7, 10, 11 15
	Backgrounds improve appearance and enhance material.	2, 8
Three Dimensional (3-D) Effects	3-D effects create confusion and are hard to interpret.	1, 3, 6, 7, 8, 11, 15
	3-D effects enhance data graphics.	2, 8

CHAPTER V

CONCLUSIONS

This study is intended to present not-for-profit organization program managers with a set of factors for consideration for use in creation of graphical visualizations of quantitative program evaluation data. The study addresses the two most often used types of graphical data presentation: (1) tables and (2) graphs, and related elements and design principles (Bigwood & Spore, 2003; Few, 2004, Tufte, 2001).

The outcome of this study consists of four tables presenting a selected number of graphical data visualization concepts, discovered during data analysis. Sixteen references published between 1990 to 2005, covering topics directly related to graphics design, were chosen as a foundation for this literature review study (Leedy, Ormrod, 2001). Data was collected and analyzed using the conceptual content analysis method (Palmquist et al., 2005).

Information offered in these four tables is intended to familiarize not-for-profit organization program managers with the basic quantitative data visualization concepts. This knowledge is necessary to portray program evaluation data accurately and comprehensibly. The concepts are organized to ensure easy reference and are listed by the frequency of occurrence in the selected literature.

According to Werther & Berman (2001), in order to secure a stable position in the contemporary business environment and effectively compete for funding, not-for profit organizations are increasingly adopting market-based management approaches. As a result, in similar fashion to for-profit companies, not-for-profits are required to fulfill specific contractual obligations and comply with stakeholder

reporting policies through the regular delivery of measurable program evaluation data (O'Neill, 2002; Werther & Berman, 2001).

In order to effectively present program evaluation data, it is essential that the content of the reports is well-written and the information is thoroughly prepared and verified (McNamara, 1999; O'Neill, 2002; Werther & Berman, 2001). At the same time, all authors agree that inadequate graphical data visualizations most often result from the lack of understanding of data presentation principles. The conclusion is that even the most skillfully created graphics will fail to communicate a poorly framed message (Bigwood & Spore, 2003; Few, 2004; Tufte, 2001).

Rapid advancement in the field of graphical data visualization software offers seemingly endless information presentation options but it by no means guarantees creation of quality data graphics (Bounford, 2000; Few, 2004; Tufte, 2001; Zelazny, 1996). The authors agree that elaborate visual effects offered by software applications and employed by users who do not have understanding of basic data visualization principles, result in poor data graphics that, while looking visually attractive, may fail to communicate the message and may distort the content. Few (2004) states:

> … many of us … suddenly became Rembrandts of the X and Y axes, or so we thought. Like kids in a toy store, we went wild over the available colors and cool effects, thrilled with the new means for techno-artistic expression. Through the magic of computers, the creation of tables and graphs became easy – perhaps too easy.

Edward Tufte, whose writings provided rich material used to frame the research question and to collect and analyze information visualization-related data presented in this study, insists that the most important principle in designing data graphics is to be responsible and preserve data integrity, not to demonstrate designer's artistic originality. According to Tufte (1990) the mission of data graphics is to make the viewers pay attention and think about the information, not the design. His opinions are supported and by majority of the authors who's works were selected for this study.

One of the most important findings of this research is the existence of a clear differentiation between graphical *data* and *non-data* elements. It is important to realize that in order to design successful data graphics, the emphasis must be placed on *data elements* (Tufte, 2001). Although there is a minor disagreement among authors on the topic of full elimination of non-data elements, all authors agree that non-data elements serve a secondary role and should not distract the viewer from perceiving the actual information. A majority of the sources reviewed for this study share an opinion that such secondary elements as busy patterns, three-dimensional effects, imposing fills, grids, backgrounds, and other non-data components should be used with utmost caution or preferably not at all.

On the topic of data graphics design methods, the most valuable information was presented by Stephen Few in his widely acclaimed book "Show me the numbers" (2004) as well as series of on-line articles. In comparison with Tufte's work which offers more theoretical and scientific approach to data graphic design, Few provides insights into practical and business applications of information visualization theory.

The main conclusion drawn from this literature review is that simplicity and putting emphasis on *data* elements, as opposed to *non-data* elements, is the key to

delivering graphics that stand for data integrity and respect for the viewer. Few (2004) reminds managers that "the real purpose of quantitative displays [is] to provide our readers with important, meaningful, and actionable insight – in other words, to communicate the data simply and clearly", only then the skills of choosing the right graphical solution will produce positive results.

APPENDIX A

TABLE DESIGN IMPROVEMENT EXAMPLES

Initial table design

This table is designed using:

- Black, point 1 weight gridlines and 1,5 point line for the outer border;
- 35% gray header shading, and boldfaced header, side and last row text;
- Centered alignment for text and data.

Results — poor information perception:

- Visually heavy appearance, gridlines and header row attract main attention. Grid lines are supportive elements and should not dominate the table;
- Text on dark background is poorly legible;
- Excessive use of boldface text creates unnecessary emphasis;
- Centered alignment distracts from perceiving and comparing data.

Month	Program 1	Program 2	Program 3	Program 4
January	20,000	15,000	10,000	50,000
February	15,000	13,000	25,000	15,000
March	10,000	25,000	75,000	30,000
April	30,000	10,000	30,000	25,000
May	25,000	50,000	18,000	10,000
June	75,000	20,000	20,000	30,000
July	13,000	18,000	50,000	75,000
August	20,000	25,000	25,000	13,000
September	50,000	30,000	10,000	15,000
October	18,000	15,000	75,000	25,000
November	50,000	75,000	30,000	50,000
December	25,000	10,000	13,000	18,000
Total	**351,000**	**306,000**	**381,000**	**356,000**

Figure A1: Initial Table Design

Table design improvements — Option 1

This table is designed using:

- 25% gray, point 1 weight vertical gridlines;
- 10% gray header shading, and boldface header and last row text;
- Left alignment for row header and categories, right alignment for columns, including values and data labels.

Results — improved information perception:

- Removing some gridlines (horizontal or vertical) and using lighter line colors create fewer distractions and allow for better information perception;
- Use of lighter header shading improves legibility;
- Left alignment of row categories helps with legibility, and right alignment of values and their labels creates consistency;
- Removing some boldface text effects brings out the data.

Month	Program 1	Program 2	Program 3	Program 4
January	20,000	15,000	10,000	50,000
February	15,000	13,000	25,000	15,000
March	10,000	25,000	75,000	30,000
April	30,000	10,000	30,000	25,000
May	25,000	50,000	18,000	10,000
June	75,000	20,000	20,000	30,000
July	13,000	18,000	50,000	75,000
August	20,000	25,000	25,000	13,000
September	50,000	30,000	10,000	15,000
October	18,000	15,000	75,000	25,000
November	50,000	75,000	30,000	50,000
December	25,000	10,000	13,000	18,000
Total	**351,000**	**306,000**	**381,000**	**356,000**

Figure A2: Table Design Improvements — Option 1

Table Design Improvements — Option 2

This table is designed using:

- 5% gray horizontal row shading;
- 10% gray header shading;;
- Boldfaced text to emphasize categories and total values.

Results — improved information perception:

- Light shading (horizontal or vertical) can be used to separate values and acts as effective delineator. Shading should be used only when large amounts of data are presented.
- Boldfaced text emphasizes categories and values, but should be used cautiously as it may distract from perceiving the actual data.

Month	Program 1	Program 2	Program 3	Program 4
January	20,000	15,000	10,000	50,000
February	15,000	13,000	25,000	15,000
March	10,000	25,000	75,000	30,000
April	30,000	10,000	30,000	25,000
May	25,000	50,000	18,000	10,000
June	75,000	20,000	20,000	30,000
July	13,000	18,000	50,000	75,000
August	20,000	25,000	25,000	13,000
September	50,000	30,000	10,000	15,000
October	18,000	15,000	75,000	25,000
November	50,000	75,000	30,000	50,000
December	25,000	10,000	13,000	18,000
Total	**351,000**	**306,000**	**381,000**	**356,000**

Figure A3: Table Design Improvements — Option 2

Table Design Improvements — Option 3

This table is designed using:

- 25% gray horizontal rules below header and above final row;
- Boldfaced text to emphasize categories and total values.

Results — improved information perception:

- Removing all grid (horizontal or vertical) brings out the data. White spaces between rows and columns serve as natural grid;
- Removing all shading helps to emphasize data;
- Boldfaced text emphasizes categories and values, but should be used cautiously as it may distract from perceiving the actual data.

Month	Program 1	Program 2	Program 3	Program 4
January	20,000	15,000	10,000	50,000
February	15,000	13,000	25,000	15,000
March	10,000	25,000	75,000	30,000
April	30,000	10,000	30,000	25,000
May	25,000	50,000	18,000	10,000
June	75,000	20,000	20,000	30,000
July	13,000	18,000	50,000	75,000
August	20,000	25,000	25,000	13,000
September	50,000	30,000	10,000	15,000
October	18,000	15,000	75,000	25,000
November	50,000	75,000	30,000	50,000
December	25,000	10,000	13,000	18,000
Total	**351,000**	**306,000**	**381,000**	**356,000**

Figure A4: Table Design Improvements — Option 3

Table Design Improvements — Option 4

This table is designed using:

- 25% gray horizontal rules below header and above final row;
- 5% gray shading to emphasize a specific data set;

Results — improved information perception:

- Removing all grid (horizontal or vertical) brings out the data. White spaces between rows and columns serve as natural grid;
- Applying light shading is helpful in bringing attention to specific data sets;
- Removing boldfaced text can be helpful if the goal is to emphasize a specific data set.

Month	Program 1	Program 2	Program 3	Program 4
January	20,000	15,000	10,000	50,000
February	15,000	13,000	25,000	15,000
March	10,000	25,000	75,000	30,000
April	30,000	10,000	30,000	25,000
May	25,000	50,000	18,000	10,000
June	75,000	20,000	20,000	30,000
July	13,000	18,000	50,000	75,000
August	20,000	25,000	25,000	13,000
September	50,000	30,000	10,000	15,000
October	18,000	15,000	75,000	25,000
November	50,000	75,000	30,000	50,000
December	25,000	10,000	13,000	18,000
Total	351,000	306,000	381,000	356,000

Figure A5: Table Design Improvements — Option 4

APPENDIX B

DEFINITIONS

Term	Definition
Accountability	Accountability means being held to account, scrutinized, and being required to give an account or explanation. Wikipedia, http://en.wikipedia.org/wiki/Data
	Accountability is the aspects of responsibility involving giving a statistical or judicial explanation for events. Judgment may follow. Dictionary.LaborLawTalk.com, http://encyclopedia.laborlawtalk.com/index.php
Chart	A graphic representation of selected worksheet information. Types include 2-D and 3-D column, bar, pie, area and line charts. Seattle Community Colleges, dept.seattlecolleges.com/ssccwrite/pickups/gloss~1.htm
Content Analysis	Content analysis is a research tool used to determine the presence of certain words or concepts within texts or sets of texts. Researchers quantify and analyze the presence, meanings and relationships of such words and concepts, then make inferences about the messages within the texts, the writer(s), the audience, and even the culture and time of which these are a part. Palmquist, et al., 2005
Data	1: factual information (as measurements or statistics) used as a basis for reasoning, discussion, or calculation Merriam-Webster OnLine, http://www.m-w.com/
Data Visualization	The set of techniques used to turn a set of data into visual insight. It aims to give the data a meaningful representation by exploiting the powerful discerning capabilities of the human eye. Edinburgh Online Graphics Dictionary, http://homepages.inf.ed.ac.uk/rbf/GRDICT/grdict.htm

Term	Definition
	Meaning of data and information
Data vs. Information	Data on its own has no meaning, only when interpreted by some kind of data processing system does it take on meaning and become information. People or computers can find patterns in data to perceive information, and information can be used to enhance knowledge. Since knowledge is prerequisite to wisdom, we always want more data and information. But, as modern societies verge on information overload, we especially need better ways to find patterns. Wikipedia, http://en.wikipedia.org/wiki/Data
Data Visualization	The method or end result of transforming numeric and textual information into a graphic format. Visualizations are used to explore large quantities of data holistically in order to understand trends or principles. McGraw-Hill, Higher Education Online Learning Center, Fundamentals of Graphics Communication Glossary, http://highered.mcgraw-hill.com/sites/0072322098/student_view0/glossary_i.html
Data, Quantitative	Information presented in numerical form. The Measurement Excellence and Training Resource Information Center http://www.measurementexperts.org/instrument/term_pocket_terms.asp
Evaluation report	Evaluation report involves collecting information about a program or some aspect of a program to make necessary decisions about the program. Program evaluation may include a variety of evaluations: needs assessments, cost/benefit analysis, effectiveness, efficiency, formative, summative, goal-based, process, outcomes, etc. Carter McNamara, Free Management Library, 1999 http://www.mapnp.org/library/evaluatn/fnl_eval.htm
	The systematic collection of information about the activities, characteristics, and outcomes of programs to make judgments about the program, improve program effectiveness, and/or inform decisions about future program development. CDC, http://www.cdc.gov/tobacco/evaluation_manual/glossary.html
Funder	A person or organization, which provides grants for non-profit organizations. The National Results Council, http://www.nationalresultscouncil.org/glossary.htm

Term	Definition
Graph	A graph is a visual representation of data that displays the relationship among variables, usually cast along x and y axes. Graphs are especially useful in showing the broader trends in the data. North Carolina State University, www.ncsu.edu/labwrite/res/res-glossary.html
	1: the collection of all points whose coordinates satisfy a given relation (as a function) 2: a diagram (as a series of one or more points, lines, line segments, curves, or areas) that represents the variation of a variable in comparison with that of one or more other variables Merriam-Webster OnLine, http://www.m-w.com/
Information	Any communication or representation of knowledge such as facts, data, or opinions, in any medium or form, including textual, numerical, graphic, cartographic, narrative, or audio-visual forms. The Open Group, www.opengroup.org/togaf/p4/glossary/glossary.htm
	Information is the result of processing, manipulating and organizing data in a way that adds to the knowledge of the person receiving it. Oracle FAQ, www.orafaq.com/glossary/faqglosi.htm
Literature Review	The review describes theoretical perspectives and previous research findings related to the problem at hand. Its function is to "look again" (re + view) at what others have done in areas that are similar, though not necessarily identical, to one's own area of investigation. Leedy & Ormrod, 2001
Method	A structured organization of tasks, estimates, and guidelines that provide a systematic approach or discipline. University Information Services (UIS), Georgetown University, www.georgetown.edu/uis/ia/dw/GLOSSARY0816.html
Not-for-profit Organization	An entity with the following characteristics that distinguish it from a business enterprise: (a) contributions of significant amounts of resources from providers who do not expect proportionate return, (b) operating purposes other than to provide goods or services at a profit, and (c) absence of ownership interests like those of business enterprises. PSU Foundation Services, http://foundation.pdx.edu/fs/glossary.jsp

Term	Definition
	Non-profit means not conducted or maintained for the purpose of making a profit. Instead, it operates to serve a public good. Any net earnings by a non-profit organization are used by the organization for the purposes of which it was established. Community Services Council Virtual Resource Center, http://envision.ca/templates/profile.asp?ID=56
	A non-profit organization (often called "non-profit org" or simply "non-profit" or "not-for-profit") can be seen as an organization that doesn't have a goal to make a profit. It may be entirely funded by voluntary donations. Wikipedia, http://en.wikipedia.org/wiki/Non_profit
Outcome	A description of the intended result, effect, or consequence that will occur from carrying out a program or activity. Balanced Scorecard Institute, http://www.balancedscorecard.org/basics/definitions.html
Program	A program (in management) has at least two senses: 1. A collection of projects that are directed toward a common goal, e.g., the NASA space program 2. A broad framework of goals to be achieved, serving as a basis to define and plan specific projects, e.g. the EU's SAPARD program Wikipedia, http://en.wikipedia.org/wiki/Program_%28management%29
Program Evaluation	Evaluation is the systematic application of scientific methods to assess the design, implementation, improvement or outcomes of a program. Rossi, P.H., et al (2003). *Evaluation: A systematic approach (7th edition)*. Newbury Park, CA: Sage Publications, Inc.
Program Manager	The individual responsible for overseeing and controlling a function, component, project, etc., and may include research leaders, scientists, engineers, project officers, administrative officers and other individuals. Sometimes a person in this role is referred to as a PM. Knowledge Net, 2005, http://www.knownet.hhs.gov/
Report	A narrative, statistical, graphic, or other account of operations, conditions, or plans that is recorded on any medium for submission by one person, office, or organization to another. Unites States Environmental Protection Agency, http://www.epa.gov/records/gloss/gloss07.htm

Term	Definition
Stakeholder	A person, group, or business unit that has a share or an interest in a particular activity or set of activities. University Information Services (UIS), Georgetown University, www.georgetown.edu/uis/ia/dw/GLOSSARY0816.html
	A person or group impacted by the performance of a program. Includes, but is not limited to funders, persons in the program, and employees of the facility. The National Results Council, http://www.nationalresultscouncil.org/glossary.htm
Table	A tabular view of data, on a relational database management system, defined by one or more columns of data and a primary key. A table populated by rows of data. University Information Services (UIS), Georgetown University, www.georgetown.edu/uis/ia/dw/GLOSSARY0816.html
	5 a: a systematic arrangement of data usually in rows and columns for ready reference. Merriam-Webster OnLine, http://www.m-w.com/
Technique	A specific approach to performing a task. A methodical means of handling and communicating complex details. University Information Services (UIS), Georgetown University, www.georgetown.edu/uis/ia/dw/GLOSSARY0816.html
Type	d: a particular kind, class, or group <oranges of the seedless *type*> <leaders of the new *type*... did England yeoman's service -- G. M. Trevelyan> e: something distinguishable as a variety: SORT <what *type* of food do you like?> Merriam-Webster OnLine, http://www.m-w.com/
	Factual information used as a basis for reasoning, discussion, or calculation; a collection of numerical facts. International Literacy Institute, www.literacyonline.org/explorer/stats_glossary.html
Visualization (Graphic)	Visualization is any technique for creating images, diagrams, or animations to communicate a message. Visualization through visual imagery has been an effective way to communicate both abstract and concrete ideas since the dawn of man. Wikipedia, http://en.wikipedia.org/wiki/Visualization_%28graphic%29

Term	Definition
Visualization (Information)	As a subject in computer science, information visualization is the use of interactive, sensory representations, typically visual, of abstract data to reinforce cognition. Information visualization is a complex research area. It builds on theory in information design, computer graphics, human-computer interaction and cognitive science. Wikipedia, http://en.wikipedia.org/wiki/Information_visualization

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