

A qualitative study of an animated representation of firms' operating health

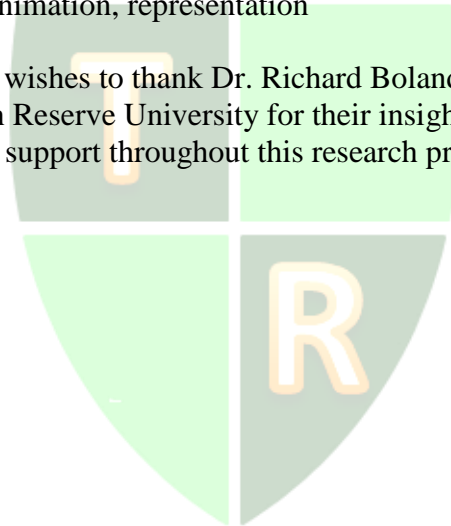
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ABSTRACT

In this research, we use a qualitative approach to study the efficiency and effectiveness of a new animation which is designed to represent critical financial ratios. We find that subjects perceive color and trend easily through animation. Animation also provides a holistic view of firms' operating activities, so subjects make more sense of the ratio data than traditional static representation: tables and graphs. These findings support the quantitative analysis in the previous research, and further imply that animation can help managers make more accurate decisions on operating health.

Keywords: thematic analysis, animation, representation

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INTRODUCTION

Information is often multidimensional and dynamic, which makes it difficult to communicate using traditional representations such as verbal descriptions or even graphics. However, the development of advanced visualization technology allows the creation of more effective representations. By taking a distributed cognition perspective and integrating several theories of visualization, we designed an animated system to represent dynamic information, Business Animator. The laboratory experiment results showed that animated representations were more accurate than static representations; however, they were not significantly superior in terms of speed (Zhao, Grant, Collopy & Boland Jr., 2008). To better analyze the underlying advantages of dynamic representation and interpret the results, we conduct this qualitative study.

Qualitative modes of data analysis provide ways of discerning, examining, comparing, contrasting, and interpreting meaningful patterns or themes. Among many qualitative research methods, we chose thematic analysis as it offered an accessible and theoretically flexible approach to analyze qualitative data within psychology (Braun & Clarke, 2006).

Thematic analysis is a method for identifying, analyzing, and reporting patterns (themes) within data. Boyatzis (1998) argued that thematic analysis can serve five different purposes as: “a way of seeing, a way of making sense out of seemingly unrelated material, a way of analyzing qualitative information, a way of systematically observing a person, an interaction, a group, a situation, an organization, or a culture, and a way of converting qualitative information into quantitative data.” In this study, we seek to achieve the first three goals following the six phases suggested by Braun and Clarke (2006): familiarizing data, generating initial codes, searching for themes, reviewing themes, defining and naming themes, and producing the report.

BACKGROUND

Research in information systems and cognitive science has indicated that diagrams can improve decision making or problem solving as compared to texts or tables (Boyatzis, 1998; Benbasat, Dexter & Todd, 1986; Dennis & Carte, 1998; DeSanctis & Jarvenpaa, 1989; Larkin & Simon, 1987; Umanath & Vessey, 1994). With the rise of computer-based visualization systems, animation and 3D modeling seem to be useful in enhancing the effectiveness and efficiency of information representation (Vessey & Galletta, 1991; Large, Beheshti & Renaud, 1996; Mayer & Sims, 1994; Rieber, 1990; Sukel, Catrambone, Essa & Brostow, 2003) and (Tegarden, 1999) although some researchers warn that most of these optimistic results are not reliable (Tversky, Morrison & Betrancourt, 2002). The results and the lessons from these studies provide us with an empirical base to design the system and the experiment.

With the advent of more powerful and accessible computer animation, Business Animator enables managers and analysts to develop an intuitive sense about the cycle model itself while exploring and visualizing how firms at various stages of growth, sustenance, and decay are affected by specific operating, financing, and investing decisions. The animation portrays temporality, allowing the theoretical construct momentum to be captured and depicted as the cycles change at differing rates.

Version 1

The major interface of Business Animator on the computer screen has two parts as Figure 1 shows. At the left is a matrix of buttons that allows the user to choose which firm and which year is being viewed. Pressing on one of these allows the user to view that particular firm for the specified year. Ordinarily the user will move from year to year to examine the changes in a particular firm. At the right of the display is the visual representation of Business Animator with the color scale shown on the right. The features of the model are summarized in Table 1.

Version 2

Based on the pilot study, subjects using Business Animator 1 did not feel satisfied with the color scaled used. Most of the subjects thought the contrast on the color scale were not clear. For example, it was hard for them to notice the change from light orange and dark orange. Furthermore, some subjects could not compare each firm's performance across different years effectively, since they had to click the button on the left panel for each firm, which distracted their attention. On the other hand, it blocked the way of continuously thinking the changes over years. All these feedbacks motivated us to revise the Business Animator into a newer version.

In this version, as Figure 2 and Table 2 describe, we simplified the graphic features of Business Animator by removing the brightness dimension and making the color and movement speed of small circles on the operating cycles represent consistent turnover ratios. Furthermore, we set the color scale from red at the bottom to green at the top. The colors close to red are negative indicators while the colors close to green are positive indicators. This modification should have helped subjects more easily perceive the information from color as the red-green color scheme follows the traditional standard in business presentation (e.g., stock price and index reports, accounting and financial reports).

Animated effects are also enhanced by automatically showing the change of each firm over five years. On the left of the interface shown in Figure 2 is a vertical list of buttons (ranging from "A" to "M") that allows the user to choose which firm to view. Pressing on one of these allows the user to view the smooth changes (trends) of that particular firm from the first year to the fifth year. The two textboxes to the right show the user which year and which firm is being viewed. The example in Figure 2 shows Firm K in the second year.

Data Collection

Research in visualization-based decision making often uses a comparative approach to study the differences among representations. The design of this study followed the tradition. We employed a holistic task—bankruptcy prediction. To succeed at this task, people need to process many ratios and temporal factors as a whole to assess the financial situation of a company (Vessey, et. al, 1991). Seven critical financial indicators (capital, total assets, current ratio, receivables turnover, inventory turnover, self-financing, and debt service) of thirteen firms adapted from previous research (Vessey, et. al, 1991) were evaluated by subjects over five time periods. In order to show a more complete structure of the organization's operational flows and shareholder equity and liabilities, an additional four indicators (debt, paid-in capital, retained earnings, and payables turnover) were also included. The dependent variable was judgmental accuracy. The independent variable was the type of representation (tables vs. graphs vs. Business

Animator v. 1 vs. Business Animator v. 2). Static graphical representations were based on conventional financial market practice (NYSE: Daily Graphics) with financial statement balances as column graphs and financial ratios as line graphs. We include them here to compare the performance of Business Animator with classic benchmark.

The experiment was conducted in three rounds at two universities following the same procedure. Of the 57 subjects who participated in the experiment, six did not complete the tasks successfully, so their inputs with missing values were deleted. The statistical analysis reveals that subjects using Business Animator v. 2 made significantly more accurate judgment than graphs, but not Business Animator v.1 (Zhao, et. al, 2008). To interpret these quantitative findings, we selected thirty subjects randomly and interviewed them after the experiment. The interviewer was the author or the author's colleague who was working on the same research project and who was familiar with the experiment's context. All the conversations from the interviews were recorded and then transcribed into verbal data by an experienced native English speaker to ensure the transcription was "true" to its original nature. The author further checked the transcripts back against the original audio recordings for accuracy and simultaneously became familiar with the data.

RESULTS AND DISCUSSIONS

Codes identify a feature of the data that appears interesting to the analyst; they refer to "the most basic segment, or element, of the raw data or information that can be assessed in a meaningful way regarding the phenomenon" (Boyatzis, 1998). We used a theory-driven one to code the contents of the entire data set with specific questions as follows:

What is your experience with Business Animator, particularly compared to tables and graphs?

What do you feel about the color scale? Does it make sense to you?

What do you feel about the movement speed? Does it make sense to you?

Which graphic element caught more attention from you, color or movement speed?

What procedure did you follow to make bankruptcy prediction using Business Animator?

What different procedure did you follow to complete the task using Business Animator as compared to tables and graphs?

Did you view Business Animator as a whole or as many small graphic elements?

Based on a long list of different codes across the data set, units of text dealing with the same issue were grouped together in the following four analytic categories (themes):

First, the color scale played an important role in supporting the subjects' predictions, as color was easier to observe than movement speed. For example:

"Color (attracts more attention). It was easier to read than the movement speed because you can't really tell between medium and extremely fast, and stuff like that." (ID: 050407101)

"(Movement speed) was a little harder to focus on but it was easy to understand.... I generally look at mostly the color." (ID: 050407403)

From this point of view, a clear contrast in the color scale was the most powerful tool to guide subjects in identifying the problems quickly and easily, and vice versa. Most complaints regarding Business Animator Version 1 pointed to the color scale. For example:

- “Graphic color is too close to each other so it’s a little hard to differentiate.” (ID: 30207401)
- “The color scheme used in the first exercise should not be green to dark green. I had to go back and forth to see what meant better and worse. It should be from green to yellow to orange, basically different colors.” (ID: 30207406)
- “The worst now is red color but the blue and green is difficult to judge.”
- “Degree of color is so hard to tell for human eye.”
- “I would use a greater spectrum in terms of color. Maybe a little darker. Sometimes it was hard for me to differentiate the color tones because there were such slight differences.”

The bad performance in time and accuracy also reflected the problem of the color scale used in Business Animator Version 1. With some modifications, the color scale in Version 2 seemed to be clearer and more useful as reflected in user feedback. Among fifteen random selected interviewees who used Business Animator Version 2, eleven used positive words to describe their overall perception of using animations. The most commonly used adjectives were “good,” “interesting,” “easy,” “clear,” and “fun”; the verbs used were “enjoy” and “like.” Furthermore, all the interviewees admitted that color as one of the key graphic features in Business Animator was useful (clear), and that the red–green scheme provided a good contrast as the following examples indicate. It was obvious that the big shift in subjects’ perceptions of the color scale was a primary factor in producing better task performance.

- “The colors helped a lot with the understanding, I think.” (ID: 42707401)
- “I feel the color scale is very clear.” (ID: 050407102)
- “It (color scale) was a good contrast.” (ID: 050407201)
- “(Color scale is) very clear and easy to understand.” (ID: 050407301)
- “I really like the colors a lot. It was easy to follow what was happening when you could see how the colors change.” (ID: 050407403)

Second, animations led subjects to easily perceive the trend. In Business Animator Version 2, we added this function to show the trend via automatic changes of color and movement speed over the years. Subjects stated that this animation feature helped them identify the trend that was one of the key criteria in evaluating bankruptcy predication tasks. For example:

- “I found that Business Animator made it a little bit easier to determine trends in those businesses because I could see it speed up, I kind of had the tendency that I wanted to make the judgment that the company was going to have to file bankruptcy than if I was just using a plain graph because I could see it speed up. But, it’s a little easier to determine trends, especially if you don’t have a whole lot of experience.” (ID: 050407102)

Third, subjects perceived Business Animator holistically. From a cognitive fit perspective, better performance was achieved if the representation fitted the task type. As bankruptcy prediction was defined as a holistic task, subjects should make better judgments when using a holistic representation. Business Animator showed the complete picture of a firm's financial status in one single display, which allowed subjects to perceive information holistically instead of digging into the ratios individually, as some interviewees mentioned:

“Well, the movement helps you see it better than just looking at still pictures, I mean you can see where it's going but that's more like a path thing. It's not so much as a movement, it's like all combined at one time, it's like okay. It's happening in real time and I am right there with it and you can see all the little pieces at once.” (ID: 050407401)

“I like the Business Animator because it showed everything all at once, it was clearer. I like the visual. I like the colors because it showed not just bad, but how bad and I compared that to the expense, it showed that.” (ID: 42707402)

“It (Business Animator) is better from a complete view (than seeing individual elements).” (ID: 42707301)

Fourth, subjects made more sense of the data through using Business Animator. Although we represented the same financial indicators in tables, graphs, and Business Animator, people gained more underlying insights regarding a firm's financial status by watching the changes of movements, colors, and proportion:

“Animator, it was, everything moved you, I mean, (and) you could tell the difference if the turnover ratio was slow, then it would go slower or faster. I mean everything made sense to me.” (ID: 050407101).

These four themes provided many insights underlying the statistical analyses presented in the previous research (Zhao, et. al, 2008). The red–green color scale helped the subjects to see the contrast clearly in the animated movement across five years, thus allowing the subjects to easily detect the trend. Representation of all the indicators through a single interface (Business Animator) encouraged the subjects to perform tasks holistically. With all the graphic features embedded, subjects could think more about the company's overall operations instead of the meaning of a single ratio. In summary, these four aspects systematically explained the striking performance of Business Animator Version 2. It can be applied to ex post financial information to aid in the interpretation of ratios. It can quickly highlight areas in which the firm's operations were not as efficient or as effective as possible. It can also be applied ex ante as a planning tool to identify potential pitfalls in operations, such as bankruptcy prediction, which has been empirically demonstrated. Overall, it has the potential to aid in understanding financial data in a way not formerly available. The use of design principles can be used to substantially improve performance achievable with dynamic representations.

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Figure 1 - The Interface of Business Animator Version 1

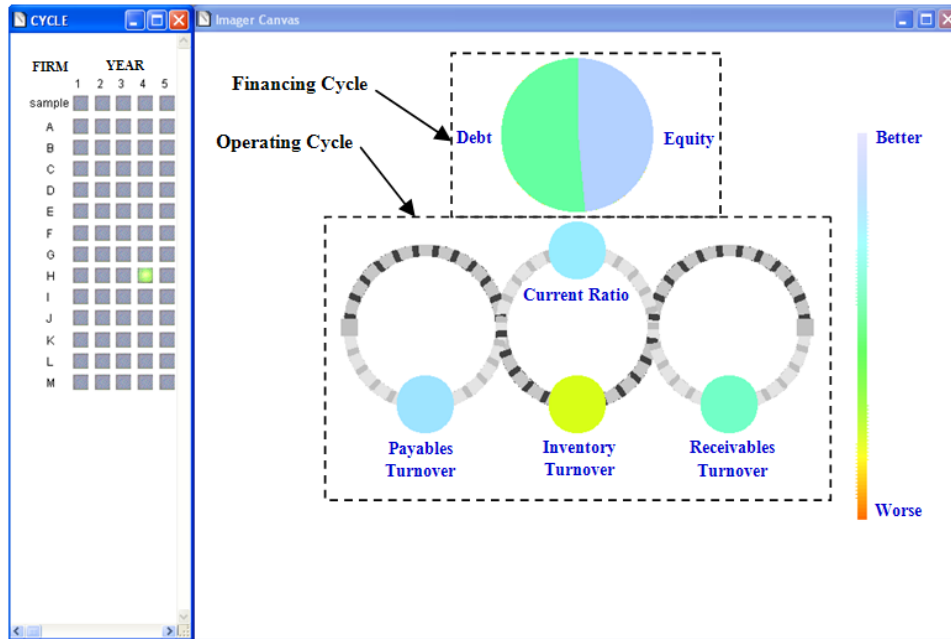


Figure 2 - The Interface of Business Animator Version 2

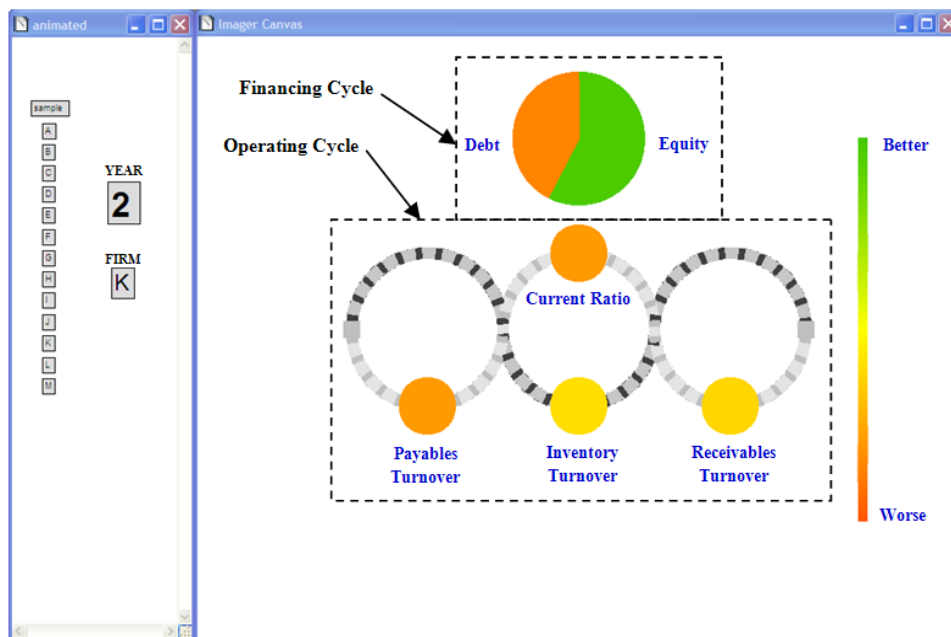


Table 1: Summary of the Graphic Features of Business Animator Version 1

Financing Cycle	Size	Hue & Brightness
Left slice	Share of total assets financed by total debt the firm carries	Interest incurred on the firm's debt
Right slice	Share of total assets financed by earnings from the firm's operations (retained earnings) and stockholders	Proportion of total assets financed by earnings from the firm's operations (retained earnings)
Operating Cycles	Speed of Path	Hue & Brightness
Middle circle on the top		Current assets on hand after current liabilities are covered
Middle circle on the bottom	Speed of selling inventory relative to all the firms	How quickly acquired products are sold
Right circle on the bottom	Speed of collecting from customers relative to all the firms	How quickly customers pay for products
Left circle on the bottom	Speed of paying suppliers relative to all the firms	How quickly suppliers are paid

Table 2: Summary of the Graphic Features of Business Animator Version 2

Financing Cycle	Size	Color
Left slice	Share of total assets financed by total debt the firm carries	Interest incurred on the firm's debt, namely, debt service
Right slice	Share of total assets financed by earnings from the firm's operations (retained earnings) and stockholders	Proportion of total assets financed by earnings from the firm's operations (retained earnings), namely, self-financing
Operating Cycles	Speed of Path	Color of Circle
Middle circle on the top		Current assets on hand after current liabilities are covered
Middle circle on the bottom	How quickly acquired products are sold	
Right circle on the bottom	How quickly customers pay for products	
Left circle on the bottom	How quickly suppliers are paid	