Mixed Reality Visualization of Financial Accounting Data

Uthai Tanlamai* · Phannaphatr Savetpanuvong** · Wisit Kunarittipol***

Abstract

Mixed reality (MR) representation of accounting numbers is used as an alternative way of virtually engaging users of real three dimensional graphics of financialdata. An experiment was conducted to compare the usability and knowledge drawn from utilizing a table of numbers versus MR representations. The results showed that when MR was used, the participants'ratings of the firm's financial status and performance were more congruent with those of experts than when a table was employed. Also, MR was seen as providing less complex information with a shorter amount of time being spent and was perceived as being easyanduseful.

Keywords : Financial Accounting Data Visualization, Mixed Reality, Usability of 3D Graphics with 3D Reality.

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* Department of Accountancy, Chulalongkorn Business School Chulalongkorn University, e-mail : uthai@acc.chula.ac.th
** Technopreneurship and Innovation Management Program, Graduate School, Chulalongkorn University, e-mail : phannaphatr@gmail.com
*** LarnGear Technology, Production Manager, e-mail : wisit@LarnGearTech.com

1. Introduction

Although three dimensional (3D) graphs are available in spreadsheets and Business Intelligence tools, their usage appears to be less than desired. Previous studies found 3D graphs to be associated with slower decision times and reliable performance decrements [Fischer, 2000; Carswell, 1991]. However, 3D rotational visuals were found to make the best prediction in terms of decision accuracy by novice users who dealt with complex, multidimensional accounting data [Brath and Peters, 2005; Dull and Tegarden, 1999; Helweg-Larsen and Helweg-Larsen, 2007]. Also, when three and more variables were used in graphic representations, 3D line graphs consistently outperformed their equivalent 2D graphs [Kumar and Benbasat, 2004]. Note that the 3D graphs that were used in many of the 2D versus 3D studies were actually static 3D graphs or the 3D on a 2D view. Thus, it is possible that the findings might differ if the 3D graphs could really be a 3D object to the user. With Mixed Reality (MR) technology, a 3D graph can be constructed and viewed as a real 3D object.

The typical 3D objects in the majority of MR applications can easily be represented with day-to-day images such as living creatures, buildings, and other familiar forms. Imaginary 3D objects, such as fancy castles, cartoon figures, chemical structure, and even DNA, can also be developed easily because there exist some kinds of physical or agreed upon 3D visual representations.

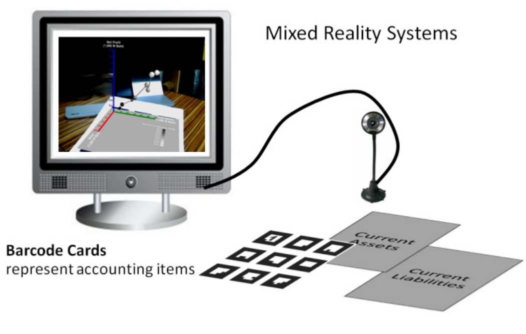
In accounting and financial data, there is no standard representation of 3D objects for accounting numbers. Some use stacks of bills, coins, or gold bars to represent accounting items like revenues and expenses. However, there are no agreed upon (or de facto standard) 3D object representations that the authors know of to represent balance sheet items such as assets, liabilities, owner equity and so on. Neither are there any typical visual metaphors to be used to represent various financial ratios, such as Return on Assets (ROA), Return on Equity (ROE), and Debt to Equity (D/E). One of the most seen representations is a square or circular cylinder produced by a spreadsheet application. Nevertheless, whether or not 3D bar-charts and line graphs are most appropriate representations of accounting numbers has yet to be determined.

While there is much research examining 2D versus 3D data representationas decision aids, there are as many studies focusing on the effective use of tables versus graphical displays of finance and accounting information. As finance and accounting numbers are abstract in themselves, their corresponding displays whether they are 2D, 3D, or MR will inevitably take on additional level of abstraction. This is especially true with MR since one of the most challenging tasks for a system designer or developer of this type of application is to come up with a real 3D object that can represent the abstract idea of accounting numbers. Beside the difficulty of the abstraction issue, these 3D objects must be accepted by various financial report users as well.

2. Mixed Reality (MR)

The thrust of mixed reality (MR) is to merge real images with virtual images. Introduced by Paul Milgram [Milgram and Kishino, 1994] in order to combine real and virtual worlds through the use of computer technology, the concept of mixed reality has been evolved and changed to encompass its utility and usefulness. To date, the more generalized term being used is Augmented Reality (AR).

There are increasing numbers of mixed reality applications in the areas of entertainment, gaming, training and education, architecture, industrial applications, and so on. These applications capture one of the strengths of the mixed reality mode of data presentation, specifically the virtual 3D environment that allows users to interact, visualize and perhaps feel the reality of simulated objects more vividly.



<Figure 1> Hardware, Software, and MR Accessories

As depicted in <Figure 1> a MR application requires the use of computer hardware with a webcam and markers or barcode cards that will be detected by the systems and eventually project the 3D images on a computer screen. The MR feature being employed in this study is the use of a marker on a printed page. Once this marker is read by a webcam-enabled personal computer, a 3D virtual object will appear on the screen in the form of a hologram look alike on the page image. Although paper-based markers are most typical in MR and AR applications, the recent development in mobile and multi-touch technology has helped MR and AR to enter into other mainstream applications. More and more MR applications can be seen on smart phones like the iPhone to replace paper-based markers and to show augmented reality images on the go(technology/special_reports/20091103ceo_guide_to_augmented_reality.htm).

3. Financial Report Visualization

Reporting of business information, especially financial figures, has utilized spreadsheet graphs extensively. Previous studies found limited types of graphs being used in the annual reports of public companies [Tanlamai and Tangsiri, 2010]. Financial data users appear to have mixed learning outcomes from their exposure to spatial graphs or spatial tables and symbolic tables [Tanlamai and Soongswang, 2009, 2011]. To extract accurate information by decision makers, previous research has focused on what is the proper presentation of quantitative information [Kirner and Kirner, 2006; Tufte, 2001]. Visual illusion of graphical representations (2D and 3D) can be mitigated and provide less bias decisions by introducing proper gridlines [Amer and Ravindran, 2010].

Amer used the Latency-Correction theory that had beenoffered by Changizi and colleagues to explain why 3D graphs (especially those being produced in traditional spreadsheet software) would create a cognitive illusion with a split-second of real world object deception [Amer and Ravindran, 2010, pp. 25-26]. They hypothesized that although the observer was not actually moving and the figure was static, the observer could misperceive a geometric figure like the 3D graph as a real 3D object for a tenth of a second before the reality set in. With MR technology, it is expected that the misperception willbe less and the latency correction time may even be shorter since a 3D graph will be projected like a real 3D object on a computer screen. Following this line of research, we argue that MR graphs should be able to mitigate decision biases as well. However, before any of thesearguments can be tested, it is imperative to examine whether a novelty like the MR graph representations of financial data will be usable and accepted by a financial data user.

4. Study Objective

The objective of the study is to examine the acceptance and usability of MR visuals and whether they will outperform the table of numbers in representing financial accounting data.

4.1 Study Constructs

As summarized by Chang et al., as "learning in visualization use is learning about the dataset being visualized" [Chang et al., 2010, p. 2], the present study relies on learner's self-reported assessment on the following constructs :

1. Cognitive processing measures (the amount of time spent and the complexity of information).
2. Perception measures of the interface system (ease of use and usefulness).
3. Knowledge drawn from the data representation measures (congruence between participants's rating versus expert's rating on the financial status and performance of the experimental data set).

A general hypothesis for this study is, all other things being equal, information and cognitive load will be less, system perception in terms of ease of use and usefulness will be higher, and knowledge drawn will be better for the mixed reality interface system than the traditional table presentation system.

4.2 User Experiment

Using a similar method as the Learning-based evaluation methodology as described in Chang et al., an experiment with pre-test questionnaire, training, post-test questionnaire as well as subjective preference was utilized [Chang et al., 2010]. Although a more rigorous experiment using qualitative, individual observational subject technique might have been better in capturing and analyzing user interaction with this new MR interface system (similar to the one employed in Jeong et al. [2008], the present experimentuses a more quasi-experimental approachby collecting data in small groups with two conditions.

At the beginning of study, a pre-test questionnaire was used to obtain demographic data and user experience of financial accounting data and MR technology. Each participant was then trained on the use of MR tools for 20 minutes. We used one hospital data set to walk the participant through both ways of presenting data, tables and MR. We informed the subject that they would be asked to assess the financial status (solvency) and performance of the hospital afterward. Following the training, the user was asked to use two different hospital datasets to assess their financial standing. See questionnaire segment of task related outcomes and usability issues in Appendix A. A post-test questionnaire was also included to capture the user's relative preference between the two methods of data representation.

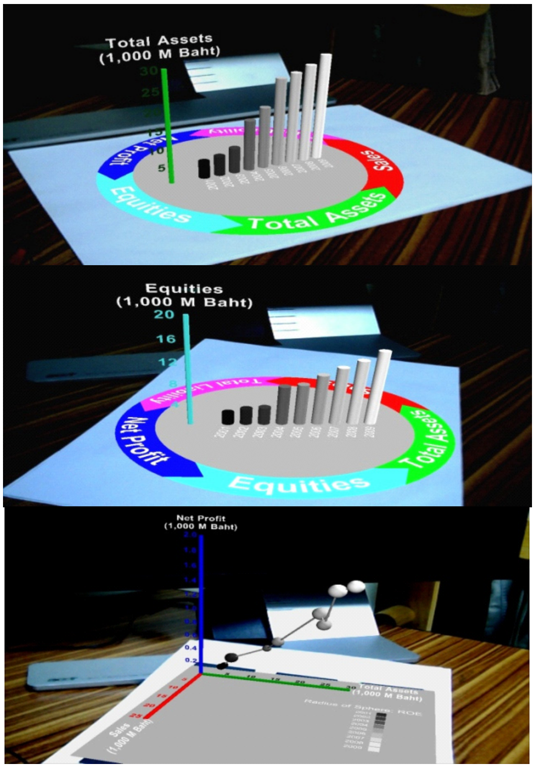
The experimental data was presented in both spreadsheet and MR formats. Equal data items were given in an Excel table and mixed reality image projection. As shown in <Figure 2> ten years of data was shown in one table. The only financial ratio being included was ROE.

For the MR interface, paper-based markers were developed by one of the authors from the same sets of data [Larngear Technology, www.larngeartech.com]. As shown in <Figure 3> a 3D bar-graph on a 3D plane was used to represent the five financial accounting items, Sales, Net profit, Total assets, Total Liability, and Equities. Subjects were able to rotate the markers so as to view the graphs from every angle. These 3D-MR graphs were based on the same 10 years of financial data as well.

As discussed earlier, it is very difficult to come up with a visual representation for financial ratio, ROE, in this case. After several rounds of trial and errors, ROE was visualized as a pin-head. The radius of the pin represents the

Company Highlight																				
Symbol	Train																			
Period	Yearly	Year	To																	
Account Period	Fiscal Year																			
		2009		2008		2007		2006		2005		2004		2003		2002		2001		
ITEMS		Jan - Dec	%Chg	an - Dec	%Chg	Jan - Dec	Chg	Jan - Dec	%Chg	Jan - Dec	%Chg	Jan - Dec	%Chg	Jan - Dec	%Chg	Jan - Dec	%Chg	Jan - Dec	%Chg	
Total Assets	('000 Baht)	1,052,870.00	-3.41	1,090,052.00	11.34	979,043.	23.29	794,111.00	12.61	705,203.00	4.48	674,995.00	6.67	632,788.00	7.41	589,108.00	3.9	567,015.00	0.63	
Total Liabilities	('000 Baht)	136,908.00	-44.49	246,618.00	13.3	217,673.00	118.21	99,756.00	20.99	82,448.00	5.38	78,238.00	29.76	60,294.00	13.09	53,315.00	17.65	45,316.00	-45.23	
Equities	('000 Baht)	915,962.00	8.6	843,434.00	10.78	761,370.00	9.65	694,355.00	11.5	622,755.00	4.36	596,757.00	4.24	572,494.00	6.85	535,793.00	2.7	521,699.00	8.53	
Sales	('000 Baht)	1,318,992.00	3.1	1,279,321.00	12	1,142,219.00	12.73	1,013,216.00	20.04	844,065.00	14.68	736,009.00	20.79	609,335.00	16.87	521,378.00	9.37	476,729.00	13.48	
Net Profit	('000 Baht)	176,948.00	1.61	174,149.00	13.73	153,126.00	7.03	143,070.00	48.65	96,248.00	12.22	85,767.00	12.28	76,384.00	52.96	49,938.00	10.99	44,992.00	18.32	
vol: ROE = Net Profit / Equities		19.32%		20.65%		20.11%		20.60%		15.46%		14.37%		13.34%		9.32%		8.62%		

〈Figure 2〉 Financial Data in Spreadsheet Table magnitude of the ratio in a given time frame. ROEs of ten years were strung on a single line floating among 3 accounting items. The participant can rotate the MR visual in order to see these ROEs in relation to any two or three dimensions at a time.



<Figure 3> Financial Data in Mixed Reality Visuals

4.3 Experimental Subjects

In order to comparethe user's learning experience of traditional tables of numbers versus the mixed reality system interface developed for financial accounting data, we conducted a within-subject experimentalstudy. 58 participants (9males and 49 females) performed two sets of tasks, one for each interface. All participants were students in the third or fourth year of the Bachelor of Accountancy program taking a software package in accounting course. The participantsreceiveda class credit and a small souvenir for their participation. None of the participants self-reported that they were familiar with MR technology. A few (12.1%) indicated that they had never had any experience with assessing the financial status of a firm before.

4.4 Data Collection

Data from two hospitals with two methods of data representations wasemployedin the experiment. Each participantexamined the data of both hospitals using both data representation methods. Since there were two hospital cases (H1 = Hospital#1, H2 = Hospital#2) being used and two ways of presenting financial accounting data (T = Table, MR = Mixed Reality), four conditions (as shown in <Table 1> below) were identified for the randomized assignment of participants. Booklets containing detailed instructions and questionnaires were created with distinct color coding for each condition. Participants were asked to record the beginning and ending time of each task. Research assistants distributed and collected the designated and color-coded markers on an individual basis. These research assistances were trained to be able to monitor the process correctly.

Prior to exposure to the experimental data, all participants were trained with data from another hospital in both table and MR formats. The training included how to record the time spent on a give a task and the explanation of any unclear concepts or questions being asked. Two expert financial analysts were asked to use the same hospital data and gave their ratings. Neither of these experts had ever had experience with MR before. Their ratings were used to compare with those rated by the participants. Absolute different scores were used as congruence measures.

〈Table 1〉 Booklet Conditions and Number of Usable Data

Booklet Condition	Task#1	Task#2	Number of Usable Subjects
A	T-H1	MR-H2	14(24.1%)
B	T-H2	MR-H1	14(24.1%)
C	MR-H1	T-H2	15(25.9%)
D	MR-H2	T-H1	15(25.9%)
			58

5. Analyses and Results

In performing the tasks using data from two hospitals, the experts took a longer time than the participants. As shown in <Table 2> the first expert took almost double the amount of time compared to the second expert for both spreadsheet and MR tasks. On average, there was no difference between participants doing the two tasks. Neither was there any difference in the average time spent when different hospital data was examined.

〈Table 2〉 Time Spent (minutes)

Dataset/ Format	Table By Expert	MR By Expert	Average Time by Participants
H1	6(Exp#1)	4(Exp#2)	3.47
H2	3(Exp#2)	7(Exp#1)	3.45
Average Time by Participants	3.52	3.40	3.46 (Exp's Avg. = 5)

The means and standard deviations of knowledge drawn from the spreadsheet table and MR are shown in <Table 3>. When a spreadsheet table was used, the participants rated the solvency and performance of H1 higher than H2 (4.90 > 4.28; 4.66 > 3.97) but both experts rated them equallyhigh at 6 out of 7point scale. However, when MR was used, the participants rated H2 to be better than H1 (5.17 > 4.90; 5.48 > 4.17).

〈Table 3〉 Means (Std. Dev.) of the Firm's Assessment by Participants and Experts

Data set	Spreadsheet (N = 29)		MR (N = 29)	
	Solv.	Perf.	Solv.	Perf.
H1	4.90(1.5) 6(Exp#1)	4.66(1.5) 6(Exp#1)	4.90(1.5) 5(Exp#2)	4.17(1.3) 5(Exp#2)
H2	4.28(1.4) 6(Exp#2)	3.97(1.4) 6(Exp#2)	5.17(1.3) 6(Exp#1)	5.48(1.1) 6(Exp#1)

It should be noted that each expert had seen the data of both hospitals but with each in a different mode of representation. While Expert#1 saw only the spreadsheet data of H1 and MR of H2, Expert#2 saw the spreadsheet of H2 and MR of H1. Both experts rated the solvency and performance of H2 to be either better to or equal to that of H1. Since both experts are compatible in their expertise, their individual ratings were used for each individual mode of representation separately.

To assess whether there was any difference of knowledge being drawn from different modes of financial data representations, congruency measures were calculated as the absolute differences between the participant's and expert's rating scores. As shown in <Table 4> the disparity ratings were greater when a Table of Numbers was used (1.55 for Solvency and 1.76 for Performance) than when MR was used (1.19 for Solvency and 0.98 for Performance). The mean differences of congruence ratings differed significantly at .05 and .01 levels. Thus, the results support the general hypothesis that knowledge learned will be higher for the mixed reality interface system than the traditional table presentation system. The extent of participant-expert rating differences was lower when MR was employed.

〈Table 4〉 Mean Differences between Table and MR Interfaces of the Congruency Rating of Participant-Expert (N = 57)

Expert-ParticipantCongruent Rating	
Congruence of solvency ratings	1.55, 1.19 ($t = 2.047^{*}$)
Congruence of performance ratings	1.76, 0.98 ($t = 4.140^{***}$)

*** $p <= .001$, ** $p <= .01$, * $p < .05$.

Also, the two methods of representing financial accounting data affected the participant's information processing process differently. The differences were at .001 levels of statistical significance. For cognitive and perception measures <Table 5>, participants rated Table to be more complex and required more time to process than MR representations. In terms of perceived ease of use and usefulness, participants found MR to be easier to use (Mean = 5.59), less frustrating (Mean = 3.05), and less complicate (Mean = 3.16). They consistently perceived MR to be more useful. The mean differences between table and MR were statistically significant at .000 levels.

〈Table 5〉 Mean Differences between Table and MR Interfaces (N = 58)

Cognition	
Information Complexity	4.56, 3.41 ($t = 4.56^{***}$)
Amount of Time Spent	5.03, 3.17 ($t = 6.98^{***}$)
Perception	
Ease of Use	3.64, 5.59 ($t = -7.87^{***}$)
Frustrating to Use	4.83, 3.05 ($t = 5.73^{***}$)
Complicate to Use	4.59, 3.16 ($t = 5.16^{***}$)
Useful format for showing data	4.91, 6.38 ($t = -9.06^{***}$)
Useful format for assessment	4.60, 6.17 ($t = 7.46^{***}$)

*** $p <= .001$, ** $p <= .01$, * $p < .05$.

In the post-test questionnaire, participants were asked about their overall perception and preference between these two modes of presentation of accounting data. The result is shown in <Table 6>. The percentage of participants was higher for those who found MR to be easier to use, more useful, less complex, faster and better liked. These responses were shared by the experts but not in unison. Although both said that MR was easy to use and useful, one expert thought Table was more complex than MR. This expert thought MR to be faster than Table and he liked to use MRto assess the standing of a company better. This expert took a longer time when doing the tasks. The other expert, on the other hand, noted MR to be more complex and thought Table to be faster and preferred to use table of numbers for financial assessment.

〈Table 6〉 Percentage of Participant's Selection

Responses	Table	MR
Ease of Use	22.4%	77.6%
Usefulness	20.7%	79.3%
Complexity	60.3%	39.7%
Faster to Use	6.9%	93.1%
Preference for Assessment	15.5%	84.5%

6. Discussion and Conclusion

Numerous accounting numbers are used to represent the abstraction of reality of a firm financial status, performance and value. These numbers are typically presented in the form of tables of numbers and 2D and 3D graphs. Deriving numbers into various ratios has led to greater complexity and abstraction for financial data users. Many studies have found 3D graphs to be less useful as compared to 2D graphs or a table with numbers. The present research proposes an alternative way of presenting financial accounting data by using mixed reality technology which effectively augments 3D graphics with 3D reality.

An experiment was conducted to examinethe usability of MR in representing financial accounting numbers. Knowledge drawn from MR versus table representations was compared. The results showed that MR outperformed tables in almost all cases. By using MR, participants who are accounting students were able to have a closer rating to that of the experts. Similar to previous studies that compared tables with graphs [Benbasat and Dexter, 1986], the 3D-MR graphs were accepted by all participants aseasy and useful. The added value of realism promised by AR and VR as found in Maad et al. [2008], was not embraced entirely by financial analyst experts in the present study. The two analysts would have preferred to have had different data dimensions presented, for example, sales growth shown in Quarter over Quarter and Year over Year instead of sales value for ten years. They also liked to have other financial data items such as P/E, Book Value, Dividend Yield, GDP, competitor's and industrial data.

The main thrust of this research deals with providing an easy contextual mechanism at the time that a person is learning and absorbing the amalgamation of financial data. By adding a mix-reality layer to the 3D graphs, the present research found novice user sable to comprehend the abstractions of financial data faster and to be able to assess the information more closely to what an expert may have done.

It should be noted that although MR was wholeheartedly accepted by most users and experts, its acceptance might be explained by the novelty of the technology itself. Using MR in financial reporting is still very new. Thus, the findings may be confounded by the perceived innovativeness of the technology itself.

6.1 Limitationand Future Research

One notable limitation of the present MR reporting tool has to do with the inflexibility of the hardware and software components that were used to develop the present application. At times, hard codes were needed during application development, especially for the interfaces between the data layer and 3D model builder as well as between 3D model rendering and AR processing displays. Data with different scales needs to be adjusted continually until the final 3D projection quality looks realistic. The size of markers and the distance between webcam and where the markers will be handled by a user also affects the projection angle and the quality of the 3D objects. Continual refinements to ensure that the visual representations are as real as possible have taken up an enormous amount of development time for our research instrument. However, this noted limitation might be resolved soon since the field of data visualization and AR interaction has advanced a great deal toad dress a wider range of applications with complex data similar to that in business setting [Tanlamai and Tangsiri, 2010].

Another more challenging task before MR applications can be used asan effective accounting and financial reporting tool ishow to come up with an acceptable 3D model/representation for the number that can represent various accounting concepts. What picture(s) could be more parsimonious than the existing accounting numbers that can readily tell the story of a company's financial standing? For example, a sales amount of 10 million dollars has already given a sense of volume with which a bar graph or stacks of goal coins cannot compete.

Although it is mindboggling to represent the abstract concept of accounting numbers in a real 3D object, the landscape of Mixed Reality applications is changing rapidly. Also, the technological advancement in various areas such as the gesture control of interactive interface systems, camera with projection unit, holographic technology, etc. willresult in an increase in research using MR applications in a real business setting. Thus, it is expected that more research using AR and MR in financial and accounting disciplines willmaterialize in the near future [Kirner and Kirner, 2006].

In regard to the user experiment, the present result might not be applicable to real userssuch as management, audit committees, financial analystsand investors. Different stakeholder groups using accounting and financial data should be tested [Tanlamai, 2009] in future research. Both novice and experts should also be examined. Furthermore, alternative data collection techniques, such as the think-aloud method, are recommended so that details of user interaction processes can becaptured more effectively.

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Appendix A : Example of Task-related Questionnaire Segment

Beginning Time of Task#1 : ________________

Task#1 : Glance through the financial data of Hospital 1 and please answer all 9 questions below.

Task#1 : Hospital 1 data in table format

What is your rating of the financial status of this hospital?	Very Secure	□ □ □ □ □ □ □	Not secure
What is your rating of the financial performance of this hospital?	Excellent	□ □ □ □ □ □ □	Very poor
How complex do you think the information has been presented?	Extremely complex	□ □ □ □ □ □ □	Not at all complex
How much time do you think you have spent in reading and evaluating these financial data?	A lot of time	□ □ □ □ □ □ □	Very little time
Financial data shown in table format was easy to use.	Strongly agree	□ □ □ □ □ □ □	Strongly disagree
Financial data shown in table format is frustrating to use.	Strongly agree	□ □ □ □ □ □ □	Strongly disagree
Financial data shown in table format was more complicated than you would like it to be.	Strongly agree	□ □ □ □ □ □ □	Strongly disagree
Table was a useful way to show financial data.	Strongly agree	□ □ □ □ □ □ □	Strongly disagree
Table was a useful way to present financial data that is used in assessing the company's status and performance.	Strongly agree	□ □ □ □ □ □ □	Strongly disagree

Ending Time of Task#1 : ________________

Raise your hand when you are done!

Task#2 : Glance through the financial data of Hospital 2 and please answer all 9 questions below.

Beginning Time of Task#2 : ________________

Task#2 : Hospital 2 Data in Mixed Reality format

What is your rating of the financial status of this hospital?	Very Secure	□ □ □ □ □ □ □	Not secure
What is your rating of the financial performance of this hospital?	Excellent	□ □ □ □ □ □ □	Very poor
How complex do you think the information has been presented?	Extremely complex	□ □ □ □ □ □ □	Not at all complex
How much time do you think you have spent in reading and evaluating these financial data?	A lot of time	□ □ □ □ □ □ □	Very little time
Financial data shown in Mixed Reality format was easy to use.	Strongly agree	□ □ □ □ □ □ □	Strongly disagree
Financial data shown in Mixed Reality format is frustrating to use.	Strongly agree	□ □ □ □ □ □ □	Strongly disagree
Financial data shown in Mixed Reality format was more complicated than you would like it to be.	Strongly agree	□ □ □ □ □ □ □	Strongly disagree
Mixed Reality was a useful way to show financial data.	Strongly agree	□ □ □ □ □ □ □	Strongly disagree
Mixed Reality was a useful way to present financial data that is used in assessing the company's status and performance.	Strongly agree	□ □ □ □ □ □ □	Strongly disagree

Ending Time of Task#2 : ________________

Author Profile

Uthai Tanlamai

Uthai Tanlamai is a professor of information systems at Chulalongkorn University. She received her Ph.D. in Management Information Systems from the University of Illinois at Urbana-Champaign. Prior to joining the Faculty, she was a tenured faculty member at California State University at Fresno and taught at Bentley College in Waltham, Massachusetts for a year. Most of her research interests deal with the behavior aspects of information systems implementation. Her current research interests include risk management, ERP implementation, visualization of business reports, augmented reality of financial data,

Phannaphatr Savetpanuvong

Phannaphatr Savetpanuvong is a PhD candidate at Chulalongkorn University in Thailand. He has more than 14 years of experience in transnational IT and management consulting firms, including Hewlett-Packard, Ericsson, Microsoft and IBM. His research focuses on applying artificial intelligence techniques to manage innovation and strategic planning. He has published a number of articles in conference proceedings such as the 4th IEEE International Conference in Management of Innovation and Technology; the Strategic Management Society 29th Annual International Conference; and the International Conference on e-Commerce, e-Administration, e-Society, e-Education, and e-Technology 2010 and 2011.

Wisit Kunarittipol

Wisit Kunarittipol graduated from Chulalongkorn University with a bachelor degree in engineering. He has an extensive knowledge in three-dimensional imagery development and CAD software for more than 7 years. Wisit is also a co-founder and works with Larngear Technology Company Limited, a multiple award-winning company that specialized in Mixed Reality Technology development. His company has won Asia Pacific ICT Alliance Awards in Research and Development in 2007 as well as E-Learning Applications in 2010. Larngear Technology's recent works include science education kits and experiential media for museums and tourism promotions.

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