REQUIRED COVER PAGE

APPLICATION FOR FACULTY RESEARCH GRANT

**All questions must be completed to be considered for grant award.

Choose one:	
[ ] Creative [X] Research	**Date of Last FRG Award** (Semester and Year awarded): _____ **Date of ATU Faculty Appointment** (Semester and Year): Fall, 2006

1. **Project Title:** A comparison of Information Representations of a Firm's Operating Activities
2. **Name of Principal Investigator/Project Director:** LIN ZHAO Dr
3. **School (abbrev):** Systems Sciences 4. **Department:** Computer and Information Science
5. **Campus Mail Address:** lin.zhao@atu.edu 6. **PI/PD Campus Phone:** 356-2161
7. **Amount Requested:** $ 2000 8. **Total Cost of Project:** $ 2050
9. **Does this project involve:** 10. **Duration of Project:** 10/2006 - 5/2007

Yes	No	
[X]	[ ]	human subjects?
[ ]	[X]	animals/animal care facility?
[ ]	[X]	radioactive materials?
[ ]	[X]	hazardous materials?
[ ]	[X]	biological agents or toxins restricted by the USA Patriot Act?
[ ]	[X]	copyright or patent potential?
[ ]	[X]	utilization of space **not** currently available to the PI/PD?
[ ]	[X]	the purchase of equipment/instrumentation/software currently **available** to the PI/PD?

NOTE: If the answer is "yes" to any of the above questions, the investigator must attach appropriate documentation of approval or justification for use/purchase.

SIGNATURES

Department Contribution (if applicable): $_____

Account Number: _____

Larry Morell — **Chairperson** — 10/10/06 **Date**

School Contribution (if applicable): $_____

Account Number: _____

Dean — 10/11/06 **Date**

This Section to be completed by the Office of Academic Affairs

FSBA Committee Award Recommendation: Yes____ No____
FSBA Committee Proposal Rank: _____ of _____ Total Proposals.
Recommendation of VPAA: Yes____ No _____
Recommendation of President: Yes____ No _____
Award Date: _____

A Comparison of Information Representations of a Firm's Operating Activities

Lin Zhao
Department of Computer and Information Science
Arkansas Tech University
lin.zhao@atu.edu

ABSTRACT

Information is often multidimensional, dynamic and difficult to communicate using traditional representations such as verbal descriptions or even graphics. With the development of advanced visualization technology, it is possible to create more effective representations. Taking a distributed cognition perspective and integrating several theories of visualization, we have formulated a theoretical model to examine the advantages of animated visualizations in representing dynamic information and in facilitating decision-making. Since interpretation and audit of financial information is a significant undertaking that must rest on a fuller understanding of the firm and its operations, we adopt Business Animator, a computer-based interactive animation, to empirically test the theoretical model using multidimensional accounting information in dynamic business environment.

Keywords

Animation, information representation, visualization, accounting information systems

Objectives

The purpose of this research is to study whether animated visualizations can improve multidimensional and dynamic information-based decision-making. We are using a cross-site lab experiment to compare animations with traditional static representations of a firm's financial health and to measure participants' perception of usefulness and ease of use of animated visualizations.

Theoretical Background

Little has changed in the graphics we use to represent key management data since William Playfair published his *Commercial and Political Atlas* in 1786. In a review, Tversky, *et al.* argued that empirical studies have not provided strong evidence that animated graphics outperform static graphics, but they are particularly promising in conveying real-time changes and temporal-spatial reorientations due to people's natural cognitive correspondences based on the congruence principle (Tversky, Morrison and Betrancourt, 2002). A basic principle of distributed cognition theory is that a cognitive task includes both internal and external representations, which together contain the abstract structure of the task (Zhang and Norman, 1994). In order to perform a cognitive task, such as making a business decision, people need to process information distributed across the internal mind and the external environment. Whatever external representations we create will have to link to the internal representations that people produce. Computational offloading, re-representation and graphical constraining are three characteristics that can be used to explain the connection between internal and external representations (Scaife and Rogers, 1996). According to visual computing and dual processing theory, a basic way to effectively facilitate the connection is to improve the visibility of the

information embedded in the data (Stanovich and West, 2000; Friedhoff and Peercy, 2000). A good external representation will be one that links naturally to the internal representations that people are capable of forming, thereby supporting their overall cognitive processes.

Based on the empirical evidence and the theories reviewed above, we believe that animated visualizations can enhance the understanding of multidimensional accounting information because they build a more effective connection to people's internal representations. So we adopt Business Animator (Lin Zhao, et al.) in a cross-site lab experiment to examine the efficacy of animated visualizations when compared with traditional financial statements or graphs.

Research Plan

Graduate and undergraduate students with accounting backgrounds will be recruited for a lab experiment to be conducted at two sites: Arkansas Tech University (ATU) and Case Western Reserve University (CASE). Flyers will be posted on campus and sent via student email lists and those teaching accounting classes will be asked to inform students of the experiment in October and November, 2006. This research has been reviewed and approved by human subjects committee at ATU (see the attached approval letter).

Experiment

Data will be collected through a lab experiment. In the pretest, participants need to respond on screen to questions about their ability to distinguish colors and questions about basic accounting concepts. If the results are satisfactory, participants will be provided with the experiment brochure and begin the formal experiment following the brochure. Time and accuracy of their task performance will be recorded as objective measures to compare their performance using

animations and using conventional static representations. After finishing the task, participants will be asked to fill in a demographic information sheet and a perception survey. All the items in this survey are adopted from prior research (Venkatesh, Morris, Davis & Davis, 2003). All the experiments are expected to be accomplished by December, 2006.

Data Analysis

Primary investigator and other group members will meet regularly to reflect upon the experimental data and utilizing appropriate statistical analysis tools (e.g. SPSS, Excel). The nature of the cross-site study generally enhances the validity and reliability of the experiment, and thus provides more powerful results. The analysis is expected to be finished by May, 2007.

Expected Contribution

This study integrates and tests several theories to better understand how animated visualizations affect decision making in a business context. It empirically compares animations with static graphs and with tables on a complex decision-making task involving multidimensional and dynamic accounting information.

References

Friedhoff, R. M., & Peercy, M. S. (2000). *Visual computing*. New York: WH Freeman & Co.

Scaife, M., & Rogers, Y. (1996). External Cognition: how do Graphical Representations Work? *International Journal of Human-Computer Studies, 45*, 185-213.

Stanovich, K. E., & West, R. F. (2000). Individual differences in reasoning: Implications for the rationality debate? *Behavioral and Brain Science*, 23(5), 645-726.

Tversky, B., Morrison, J. B., & Betrancourt, M. (2002). Animation: can it facilitate? *International Journal of Human-Computer Studies, 57*(4), 247-262.

Venkatesh, V., Morris, M., Davis, G. & Davis, F. (2003). User Acceptance of Information Technology: Toward a Unified View. *MIS Quarterly*, 27(3), 425-478.

Zhang, J., & Norman, D. A. (1994). Representations in distributed cognitive tasks. *Cognitive Science, 18*(1), 87-122.

Zhao, L., Grant, J., Collopy, F., & Boland, R. (2006). The Design of an Animated Representation of the Firm's Operating Activities. Proceedings of the Twelfth Americas Conference on Information Systems, Acapulco, Mexico.

PROPOSED BUDGET
FACULTY RESEARCH/DEVELOPMENT GRANT
(include budget categories as appropriate)

1. Graduate assistant stipend $_____
   Fringe benefits: salary X .0012 _____

2. Non-work study stipend _____
   Fringe benefits: salary X .0012 _____

3. *Supplies (please list items to be purchased and estimated price per item including taxes and shipping, if appropriate):

   Item No. 1 (e.g., software) Estimated Price _____
   Item No. 2 (e.g., copying costs) Estimated Price _____
   Item No. 3 participation reward Estimated Price $10 x 100 = $1000
   (additional lines as needed)

   Total estimated supplies _____

4. Travel (please list travel expenditures by date and estimated costs):

   Travel No. 1 Estimated Price 350
   Travel No. 2 Estimated Price 350
   Travel No. 3 Estimated Price 350
   (additional lines as needed)

   Total estimated travel 1050

5. *Capital Outlay (please list items to be purchased and estimated price per item including taxes and shipping, if appropriate):

   Item No. 1 Estimated Price _____
   Item No. 2 Estimated Price _____
   Item No. 3 Estimated Price _____
   (additional lines as needed)

   Total estimated capital outlay _____

TOTAL PROPOSED BUDGET $ 2050

*Items purchased under $2,500 (including taxes and shipping) are considered supply items. Capital Outlay items are those which cost $2,500 or more (including taxes and shipping).

OFFICE OF GRADUATE STUDIES

Tomlinson Building Room 113
1507 North Boulder Avenue
Russellville, AR 72801-2222

phone: 479-968-0398
fax: 479-964-0542

http://graduate.atu.edu

October 10, 2006

To Whom It May Concern:

The research proposal by Lin Zhao titled "A Comparison of Information Representations of a Firm's Operating Activities" has been approved by the Human Subjects Committee through an expedited review. The study presents limited risk to subjects, and the informed consent section is adequate.

Sincerely,

Eldon Clary, Jr.
Chair
Human Subjects Committee

LIN ZHAO
1008 North Sidney Ave, #D
Russellville, AR 72801
Tel: 518-364-8380 (M)
Email: lin.zhao@case.edu
Website: http://home.case.edu/~lxz34

EDUCATION

- Doctor of Philosophy in *Management Information Systems*, expected 2006
  Weatherhead School of Management, Case Western Reserve University, Cleveland, OH
  Minor: Compute Science
  Dissertation (Working Title): A Comparative Analysis of Dynamic Accounting Information Representations

- Master of Economics in *Econometrics*, 2001
  School of Management, Tianjin University, Tianjin, P. R. China
  Thesis: A study of Neural Networks & their Applications in Business Forecasting

- Bachelor of Engineering in *Systems Engineering*, 1999
  Tianjin University, Tianjin, P. R. China
  Thesis: A study of Intranet & its Application

PROFESSIONAL EXPERIENCE

- Assistant Professor, Department of Computer and Information Science, School of Systems Science, Arkansas Tech University, 2006-2007

- Instructor, Department of Information Systems, Weatherhead School of Management, Case Western Reserve University, 2005-2006

RESEARCH

Research Interests

- Design and use of dynamic visualization systems in business contexts
- Multidimensional information representation to support business decision-making
- User interface design and evaluations
- Cognitive aspects of Human-Computer Interaction
- Accounting information systems
- Time series forecasting using Neural Networks
- Knowledge-based expert systems and Artificial Intelligence

Published Review

- Zhao, L. (2004). Technical efficiency-based selection of learning cases to improve forecasting accuracy of neural networks under monotonicity assumption: Parag C. Pendharkar and James A. Rodger, Decision Support Systems (36). *International Journal of Forecasting*, *20*(4), 738-739.

Referred Proceedings

- Zhao, L., Grant, J., Collopy F. & Richard Boland, Jr. (2006). The Design of an Animated Representation of the Firm's Operating Activities. Proceedings of the Twelfth Americas Conference on Information Systems, Acapulco, Mexico.

- Zhao, L. (2006). A Comparative Analysis of Dynamic Representations of a Firm's Operating Activities. Proceedings of the Twelfth Americas Conference on Information Systems, Acapulco, Mexico.

- Zhao, L., Grant, J., & Collopy F. (2006). The Design of an Interactive and Dynamic Representation of the Firm. Proceedings of the SIGCHI conference on Human factors in computing systems (CHI '06), Montreal, Quebec, Canada.

- Zhao, L., Kennedy, M. and Collopy, F. (2003). *Neural Network Models for Time Series Forecasting: A Replication of the Hill, O'Connor and Remus Study.* Proceedings of the 23rd International Symposium on Forecasting (ISF 2003), Merida, Mexico.

Conference Presentations

- Zhao, L., Grant, J., Collopy F. & Richard Boland, Jr. (2006). *The Design of an Animated Representation of the Firm's Operating Activities.* Paper presented at the Twelfth Americas Conference on Information Systems, Acapulco, Mexico.

- Zhao, L. (2006). *A Comparative Analysis of Dynamic Representations of a Firm's Operating Activities.* Paper presented at the Twelfth Americas Conference on Information Systems, Acapulco, Mexico.

- Zhao, L., Grant, J., & Collopy F. (2006). *The Design of an Interactive and Dynamic Representation of the Firm.* Poster presented at the SIGCHI conference on Human factors in computing systems (CHI '06), Montreal, Quebec, Canada.

- Zhao, L. (2005). *Enhancing Decision-Making Using Animated Accounting Representations.* Paper presented at the 4th Big Ten Information Systems Research Symposium, Milwaukee, WI.

- Zhao, L. (2004). *Designing Playful Systems: An Experimental Study of Features that Enhance Learning Effectiveness.* Paper presented at the 3rd Big Ten Information Systems Research Symposium, Lansing, MI.

- Zhao, L., Kennedy, M. and Collopy, F. (2003). *Neural Network Models for Time Series Forecasting: A Replication of the Hill, O'Connor and Remus Study.* Paper presented at the 23rd International Symposium on Forecasting (ISF 2003), Merida, Mexico.

Work in Progress

- Zhao, L. (2005). Enhancing accounting information based decision making using animated visualizations: a distributed cognitive perspective. (theoretical part of Ph.D. dissertation)
- Grant, J., Zhao, L., & Collopy F. (2005). The Design of an Interactive and Dynamic Representation of the Firm. *Sprouts: Working Papers on Information Environments. Systems and Organizations*, *5*(9). (http://sprouts.case.edu/2005/050307.pdf)
- Zhao, L., Collopy F. & Kennedy M. (2003). The Problem of Neural Networks in Business Forecasting: An Attempt to Reproduce the Hill, O'Connor and Remus Study. *Sprouts: Working Papers on Information Environments. Systems and Organizations*, *3*(12). (http://sprouts.case.edu/2003/030412.pdf)
- Zhao, L. (2002). Under what conditions do neural networks produce improvements in business time-series forecasting?

Research Service

- Mini-track Chair, SIG: SIGHCI The Design of Online Environments, *Americas Conference on Information Systems*, 2006, Acapulco, México
- Reviewer, *International Conference on Information Systems*, 2006, Milwaukee, USA
- Reviewer, *Americas Conference on Information Systems*, 2006, Acapulco, México
- Reviewer, *European Conference on Information Systems*, 2006, Göteborg, Sweden
- Reviewer, *Information & Organization, IEEE Transactions on Neural Networks and International Journal of Forecasting*

Other Research Activities

- Research Assistant & Teaching Assistant (2001 – present)
  Weatherhead School of Management, Case Western Reserve University, USA
  Responsibility:
  - Conduct the Cycle model research project
  - Design a graphic interface for rule based forecasting (RBF) system
  - Design a meta model for MindDraw

- Research Assistant & Teaching Assistant (1999 – 2001)
  School of Management, Tianjin University, Tianjin, P. R. China
  Responsibility:
  - Build RBF Neural Network forecasting models using Matlab
  - Grade Neural Network Application course and supervise the lab section

- Internship – Programmer & Quality Manager Assistant (1999)
  Advanced System Development Company, Beijing, P. R. China
  Responsibility:
  - Conduct the IBM "JavaBeans Around World" project
  - Study and implement the Capability Maturity Model (CMM) to the software development process (the first company in China obtaining CMM certificate)