Watch My Eyes
How Internet Shoppers Search Information

As more and more people make purchasing decisions using the Internet, academics have begun to focus research on how people make those decisions. Savannah Wei Shi, a new assistant professor of marketing, has been specializing in using eye-tracking equipment to better understand the workings of e-commerce.

Shi is lead author (with Michel Wedel of the University of Maryland and Rik Pieters of the University of Tilburg) of the paper, “Information Acquisition During Online Decision-Making: A Model-Based Exploration Using Eye-Tracking Data,” which is currently under consideration for publication.

THE EYES HAVE IT: Savannah Wei Shi used state-of-the-art eye-tracking technology to determine what works best on an Internet page layout.

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A NOTE FROM THE DEAN
Innovation. It’s the animating spirit behind Silicon Valley and the Leavey School of Business. Every day our faculty is inspired by the spirit of innovation in their classes and in their research. The five new professors who joined us this year embody the curiosity and original thinking that we celebrate in the business school. I am delighted to introduce them to you.

Whether it is a new way to analyze online investment discussions, or setting new standards for data security, our emerging scholars have connected with the business community of Silicon Valley and the world. Their transformative scholarship is changing the way we do business and the way we create prosperity here and abroad.

I am proud of the intellectual contributions of our faculty and I hope you’ll enjoy learning more about the inspirational work we are doing at Santa Clara.

Enjoy!

Drew Starbird
Dean and Professor of Operations Management and Information Systems
Finally, the raw data were subjected to a mathematical formula developed by Shi and the team to adjust for variables. For example, if a subject’s eye stops in one place for a few seconds, is it taking in information from that one place, or is the subject daydreaming about that night’s dinner? There’s no way to know for sure, but a good formula can assign probabilities that are likely to make the overall results more reliable.

How products are positioned on a comparison page will influence the customer’s decision-making strategies.

Data generated from the experiments showed that the decision-making process was faster, more complex, and less well-structured than previously believed. For example, one participant made a decision in 76 seconds, during which there were 140 combined eye fixations and saccades, nearly two per second.

The data showed that participants frequently switched strategies, often comparing two or three attributes or products before switching to another strategic approach.

One result that jumped out from the data was that people more consistently sampled information that was closely grouped on the page and moved their eyes horizontally, across rows rather than down columns, and that such a search pattern was present regardless of horizontal or vertical presentation format.

A practical implication of that finding, Shi says, is that a company that wants to nudge customers toward a certain product would do well to set up the comparison page so that the attributes run horizontally and the products run vertically in columns. That way a customer can easily select one attribute (for example, the capacity of the computer’s hard drive) and scan from left to right to see how the model the company wants to promote compares with the others.

“Customers are comparing different sets of products online all the time, and we assume the customers to be rational,” she says. “How the company places the product on a comparison web page can influence the strategies customers use to make decisions.”
Holding Up Production
Calculating Capacity When a Big Patent Expires

Businesses that hold lucrative patents face several tough decisions as those patents approach their expiration date. One consideration—particularly common in the pharmaceutical industry—is whether or not to try to “evergreen” the patent by applying for a new one or an improved version of the original product.

It’s a decision fraught with uncertainty on several fronts, including government regulation, market potential, and the need to ramp up production before the first two issues have been fully settled. Ram Bala, assistant professor of operations management and information systems (OMIS), and two colleagues have done a ground-breaking study of the production-capacity issues involved in such a decision.

“If you don’t have the production capacity, you can’t sell the product,” Bala says, “yet most of the research on evergreening has focused on marketing and economics. Up to now, no one has really studied the production-capacity question in this context.”

Bala, who joined the Leavey faculty in January 2012, is lead author on the paper “Competition, Capacity and Evergreening,” which has been submitted to a major journal of management. Sumit Kunnumkal and Milind G. Sohoni of the Indian School of Business in Hyderabad, are co-authors.

In the paper they look at several potential evergreening strategies and develop a model to help a business determine which is most likely to occur and what production capacity will be needed as a result. Bala says the underlying concepts can more easily be understood by considering the case of a pharmaceutical company that has a patent nearing expiration on a profitable prescription drug.

If a decision is made to evergreen the patent by developing a new and improved version of the drug, the path forward is obscured by a range of issues:

- Will the patent office consider the new version sufficiently different from the original to issue a patent for it?
- Will a new version pass clinical trials and win approval from federal regulators?
- Will a generic manufacturer enter the market with a clone of the original drug?
- If there is generic competition, should the drug company continue to sell the original as well as the improved version, or eliminate the original drug and sell only the new one?
“A company has to consider the tradeoffs involved in all these considerations as it tries to reach a decision,” Bala says. “What may seem like a straightforward decision really isn’t, and it’s complicated by the reality that firms often operate with separate departmental silos so that the research, marketing, and production people aren’t talking to each other as much as they should.”

Bala and his colleagues developed a model in their paper that can help businesses better weigh the factors involved in an evergreening decision and be better prepared with their production capacity. The model could help not only the company holding the original patent, but also a company planning to offer generic competition when the patent expires.

“We’ve talked with generic manufacturers, and they say production capacity is of immense importance to them,” Bala says. “They need to be able to decide when to invest in capacity and how much of it they’ll need to be ready on the day the patent expires.”

For both the original patent holder and the generic competitor, Bala says, the production-capacity gamble is a high-stakes affair. “If you don’t have enough capacity, you lose out on sales, on the ability to create market share, and on being able to lock in contracts with pharmacies and other distributors. With too much capacity you have waste and can’t sell your product at the price you want to get. Our model can help locate the point of tradeoff where a company can make a better decision.”

As economic theories go, the notion that feeling good can lead to better financial decisions might be categorized as a commonplace truism, but in reality, the premise hadn’t been subjected to much rigorous experimentation until John Ifcher, assistant professor of economics, came along.

Ifcher and his SCU colleague Homa Zarghamee conducted a carefully controlled experiment with a group of Santa Clara undergraduates to measure the relationship between mood and financial decisions. The results were reported in a paper, “Happiness and Time Preference: The Effect of Positive Affect in a Random-Assignment Experiment.” It was published in the December issue of the prestigious American Economic Review and its findings have been reported in the mainstream media, including The New York Times, The Wall Street Journal, and the CBS News business website.

“Happiness appears to drive decision-making in a fundamental way,” Ifcher says. “If you are in a better mood, you have more self-control, more willpower, and that’s important in financial and life decisions. It’s surprising that no one has examined this before.”
Ifcher says it was his interest in the relationship between happiness and self-control that drove him to conduct this experiment. He and Zarghamee, who has considerable experience in designing experiments, carefully established the protocols to stand up to scrutiny.

To enlist subjects who would be broadly representative of the student body, they recruited students taking a required English course at Santa Clara University. Participants filled out a questionnaire asking a series of questions about how much money they would accept today in lieu of waiting for a larger amount at some point in the future (from 1 to 56 days). To ensure honest answers, the students were told that they would be paid based on their answer to a randomly selected question from the questionnaire.

Before completing the questionnaire, students were randomly assigned to one of two groups—the control or treatment group—and shown different video clips. Half of the subjects saw excerpts from *Robin Williams Live on Broadway*, which has been identified by many psychologists as a clip that induces a positive mood. The other half were shown nature scenes from Denali National Park, which psychologists have found induces a neutral state of mind.

“The thing that surprised us was how clean the main result was,” Ifcher says. “We went in with a very specific research question, and there was clear evidence that those who were put in a good mood by the video were consistently more willing to wait for the money.”

Ifcher says there are numerous real-world applications for the findings of the experiment. For example, some companies appear to have already figured out that there is a relationship between being in a good mood and investment decisions, and have devoted considerable effort to creating pleasant offices (he cites Fidelity Investments as an example). Others may follow suit.

He can also envision companies using videos or other stimuli to create an upbeat mood among employees before the employees make a decision on their pension contributions, the idea being that they will wisely agree to make a larger contribution if they’re feeling good.

“The significance of this experiment is potentially very large,” Ifcher says. “Time preference, the ability to have patience or willpower in receiving money, is a really important part of who people are. Some psychologists even believe that the two most important predictors of success in life are intelligence and willpower.”
In the past decade many businesses and organizations that compile large amounts of data have used a “data cube” format for managing it. Different pieces of information are entered as separate cells or cubes within the larger cube, and the overall cube can be made available after screening out the separate cells with sensitive information.

The format has great practical utility, allowing, for example, the U.S. Census Bureau to aggregate massive amounts of data for public review without compromising personal information, or allowing a company in a joint venture with another firm to share necessary information without revealing proprietary data.

Underlying the data cube format is a critical security question: What are the boundaries of information that can be released without allowing a data snooper to get at the blocked-out sensitive information by drawing inferences from the data made available?

Haibing Lu, who joined the Leavey School of Business last fall as an assistant professor of operations management and information systems (OMIS), co-authored, with Yingjiu Li of Singapore, one of the pioneering papers in that area of inquiry. “Practical Inference Control for Data Cubes,” their study, was published by the IEEE Computer Society.

“It’s a very challenging problem,” Lu says, “and before our paper, the privacy issue with data cubes had not really been studied in depth.”

As a hypothetical example of how the problem works, Lu posits a health survey of a large employer. If the released data showed that five people in a firm of several thousand had been treated for an ailment, their privacy most likely wouldn’t be compromised. If it showed that five people in a smaller department within the organization had been treated, someone with knowledge of that department might be able to figure out who they were. The question then becomes where, between those two points, should the boundary be set for the data that will be made available?

Drawing that boundary line in the right place involves a two-step process. The first step is to define and clearly understand the standard of privacy that has to be maintained. The second is for people formatting the data cube to think like the bad guys.

Those formatting the data cube must think like the bad guys.

In their paper Lu and Li propose an improvement on those bounds, based on a complex formula. Their approach produces bounds at least as good as the Frechet system, but with less time complexity needed to reach a determination.

With the dramatic increase in computer power and data availability through the Internet, this research has substantive practical implications, particularly for larger firms and organizations, Lu says.

“AOL had a serious problem a while back when it posted information about user queries that allowed snoops to identify some users. It’s an issue that large government organizations have to deal with. And companies like Google and Yahoo are taking a hard look at these issues because they know that if there’s a serious privacy breach, there will be a big lawsuit.”
Guided by Chatter
Social Media Can Help Predict Stock Fluctuations

Investors are always looking for an edge, and good information at the right time can give them a considerable advantage. Recognizing this, researchers have looked at the connection between public information in the mainstream and social media, and shifts in stock prices—or the ability to predict those shifts.

David Zimbra, who became an assistant professor of operations management and information systems (OMIS) last fall, pushed that research to a more detailed level and found evidence that a careful and systematic analysis of online forum content can be used to predict stock prices with considerable success. His paper, “A Stakeholder Approach to Stock Prediction Using Finance Social Media,” co-authored by Hsinchun Chen, his graduate advisor, was just published in *IEEE Intelligence Systems*.

“Before this study most researchers in the field had been looking at social media forums as if the forum participants were all from one group with the same background and relationship with the firm,” Zimbra says. “My thought was that open social media spaces have a very diverse group of participants and draw a lot of different constituencies, or stakeholders, into the discussion. If you could break down the conversations by the groups they came from—for example, investors, activists, and employees—it would provide a more refined analysis of the forum discussion.”

It took Zimbra several years to develop an automated method of evaluating the comments, using artificial-intelligence methods. For the study, he chose the Yahoo Finance Wal-Mart forum as the information source; more recently he has applied the analysis to other arenas with similar success.

Zimbra used social network analysis techniques to identify members of stakeholder groups, and sentiment-analysis techniques to measure opinions conveyed in forum discussions. He then developed statistical models using historical information to determine the relationship between forum discussions and stock behavior over time. The model predictions were then utilized to perform daily trading of the Wal-Mart stock over a year based on observed forum discussions.

Using the approach of a predictive technician, who would respond quickly to capture profits before the market fully absorbs new information into stock prices, he began with a hypothetical investment of $10,000 in Wal-Mart stock. Every trading day for a year, his program tracked the comments on the forum, broke them down by stakeholder group, and at the end of the day, based on the comments, made a decision to buy, sell, or hold the stock.

At the end of the year Zimbra found that if he had bought the stock and held it for a year, he would have realized a one percent gain. Trading stock based on forum comments as a group would have yielded a return of 16 percent. Trading based on the forum comments, broken down by stakeholder group, would have brought a stunning 44 percent return.

“The impressive performance of the stakeholder-level model represented a statistically significant improvement in the accuracy of predictions,” Zimbra says. “To the degree that different constituencies were reflected in the analysis, there was a more accurate assessment of the forum discussions.”

Given the rapid growth of social media, there is more research to be done in the area, but Zimbra feels that the results of this experiment indicate a potential for much broader use of the techniques he developed.

“The implications of this research go beyond stock prediction,” he says. “It can help companies assess how people feel about their products and provide a wealth of information that has been drawn from focus groups up to this point. There are many ways in which businesses can maximize the value of social media.”
Five new instructors joined the ranks of tenure-track faculty in the Business School this year

**Ram Bala** joined the Operations Management and Information Systems (OMIS) in January 2012, from the Indian School of Business in Hyderabad (India), where he had taught in Operations Management since 2006. He earned his Ph.D. in Management Science from UCLA and received his bachelor’s degree in mechanical engineering from the Indian Institute of Technology. He has worked as a software consultant and as a strategic analyst in the private sector.

**John Ifcher** has become a tenure-track assistant professor in the department of Economics, where he previously served as an academic year lecturer. Ifcher received his Ph.D. in economics from the University of California at Berkeley. He also received a M.P.A. degree from the School of International and Public Affairs at Columbia University and a B.S. in computer science and psychology from the University of Michigan. He worked for the city of New York as the Senior Advisor to the Parks Commissioner between 1993 and 1998.

**Haibing Lu** joined OMIS from Rutgers University in New Jersey, where he was a teaching assistant as he completed his doctoral studies. He received a B.S. and M.S. in mathematics from Xi’an Jiaotong University (China), and received his Ph.D. in management of information technology from Rutgers University (New Jersey) in 2011.

**Savannah Wei Shi** became a member of the Marketing Department in Fall 2011. Shi earned a bachelor of science degree in marketing from Fudan University (China), and received her Ph.D. in marketing from the University of Maryland, College Park, in 2011.

**David Zimbra** is a new OMIS faculty member. He earned the BSC in Operations and Management Information Systems, and his MS in Management Information Systems from Santa Clara University, and received his Ph.D. in Management Information Systems from the University of Arizona in 2011. His private sector experience includes work at Ernst & Young and Network Appliance.