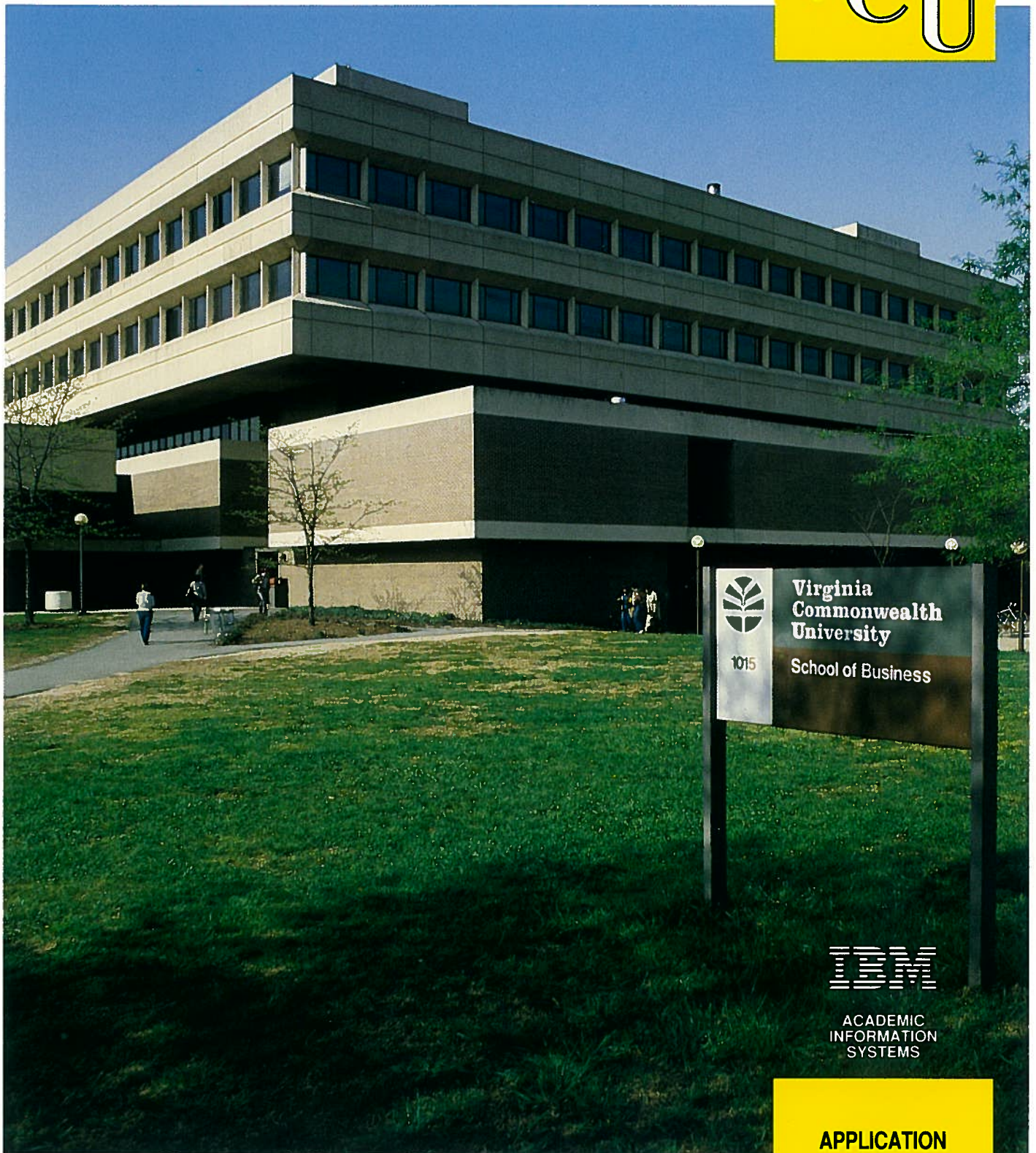


Virginia  
Commonwealth  
University

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## IBM PC Network Supports Experimental Economics Laboratory at VCU School of Business



ACADEMIC  
INFORMATION  
SYSTEMS

APPLICATION  
BRIEF

**A network of IBM Personal Computers forms the heart of a unique laboratory for research in the growing field of experimental economics at VCU's School of Business.**

**Officially known as the Laboratory for Experimental Research in Economics and Business, the facility is the first of its kind to employ the IBM PC Network as a tool for testing economic theory in a controlled setting. Experiments conducted in the lab are not simulations. Rather, they replicate actual market or business environments, enabling researchers to analyze the behavior of real people pursuing real profits.**

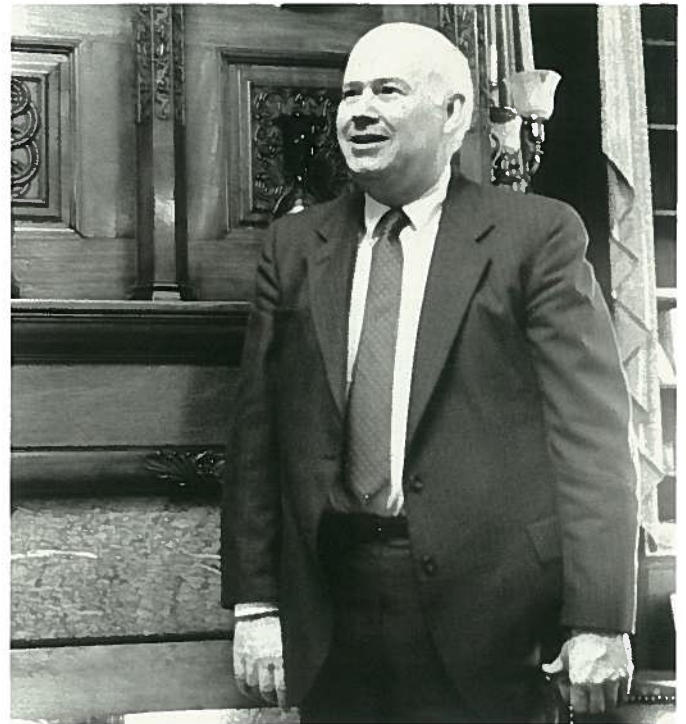
**The success of the VCU lab—which is serving as a model research facility—has drawn attention not only from the growing experimental economics community, but also from researchers in other behavioral disciplines.**

“The facility clearly demonstrates the potential of the interactive microcomputer lab as both a research and instructional tool,” says Charles P. Ruch, provost and vice president for academic affairs.

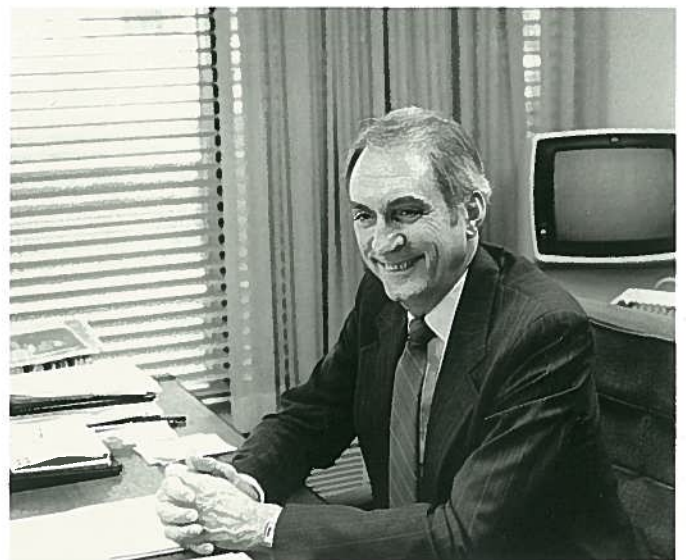
“This kind of technology is important to a professional institution like VCU,” says Ruch. “Since we don't have an engineering program, we have to depend on other academic areas to lead the way in computing technology. The lab is a good example of how the business school can play that role.”

According to J. Curtis Hall, dean of the School of Business, that role is taken very seriously. “We have an obligation to find new ways of using the computer technology that's available to us. We try to get as close to the cutting edge as possible in developing useful applications. This lab is one of our success stories.”

Hall adds that a prime aim of the business school is to sharpen student competency with those applications. “Today's business graduates really need to have solid computer skills. Without them, they are not fully prepared for the business world. We are addressing this need by integrating microcomputer applications into all of our upper-level courses.”



**CHARLES P. RUCH IS PROVOST AND VICE PRESIDENT FOR ACADEMIC AFFAIRS AT VIRGINIA COMMONWEALTH UNIVERSITY.**



**J. CURTIS HALL, DEAN OF THE SCHOOL OF BUSINESS, SAYS THE EXPERIMENTAL ECONOMICS LABORATORY IS ONE OF THE SCHOOL'S SUCCESS STORIES.**

**Economics  
Research:  
Out of the Field  
and Into the  
Laboratory**



**ROBERT J. REILLY, ASSOCIATE  
PROFESSOR OF ECONOMICS,  
IS DIRECTOR OF THE LABORATORY  
FOR EXPERIMENTAL  
RESEARCH IN ECONOMICS  
AND BUSINESS.**

Historically, research in economics and business has been a field science, which meant that researchers gathered data by observing the behavior of individuals and organizations in the real world. Unlike other scientific investigators, economists had no way to test theories under controlled conditions.

But during the past two decades, a community of researchers has developed ways of bringing economics into the laboratory. Experimental economics, as it is called, sets up simplified special cases that test the accuracy of general, complex theory.

One such study, considered a pioneering experimental economics effort, used as few as five students participating in a classroom bond auction to demonstrate the validity of the keystone theory behind laissez-faire capitalism—that the individual pursuit of profit determines prices that eventually reach a “competitive equilibrium.”

The impact of this type of research goes beyond simply proving or disproving theory. Experimental economics



**OPERATION OF ALL LABORATORY  
SOFTWARE—WORD  
PROCESSING, SPREADSHEET  
ANALYSIS, AND STATISTICAL  
PACKAGES—IS DIRECTED BY  
IBM'S FIXED-DISK ORGANIZER.**



MICHAEL D. PRATT, ASSOCIATE PROFESSOR OF ECONOMICS AND ASSOCIATE DIRECTOR OF THE LABORATORY, HAS WORKED TO DEVELOP A COMPUTER SETTING THAT REPLICATES ACTUAL MARKET AND BUSINESS ENVIRONMENTS.

offers government and business a valuable tool for shaping workable policy and practice.

“It’s clearly a research growth area now,” says Robert J. Reilly, associate professor of economics and director of the Laboratory for Experimental Research in Economics and Business. “During the early years, things were pretty slow-going, because everything was done manually. The computer is changing all of that.”

Even so, computer-based economics laboratories have been limited to a handful of universities with expensive mainframe environments. Reilly and Michael D. Pratt, also an associate professor of economics, saw the potential of a microcomputer network as a cost-effective way of extending research in experimental economics.

### **A Closer Look at the Lab**

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The laboratory Reilly and Pratt envisioned took shape in mid-1986, with the installation of 10 IBM PC/XTs and two IBM PC/ATs, all linked by IBM PC Network, along with several printers. The hardware and associated software, made available to VCU under an IBM equipment loan program, formed the heart of the only computer-based experimental economics lab in the eastern United States. It also was the first such facility anywhere built around an IBM PC Network.

The operation of all laboratory software—which includes various word processing, spreadsheet analysis, and statistical packages—is directed by IBM’s Fixed-Disk Organizer.

Says Pratt, who serves as associate director of the lab, “The network system readily accommodates complex processing of in-stream data at very fast speeds, so that information can be received from and transmitted to any specified combination of participants in an experiment.”

During a typical session, programs running on the microcomputers automatically direct the movement of data



over the network. At the end of the session, all participant responses entered on the IBM PC/XTs are transmitted to one of the IBM PC/ATs for processing and analysis.

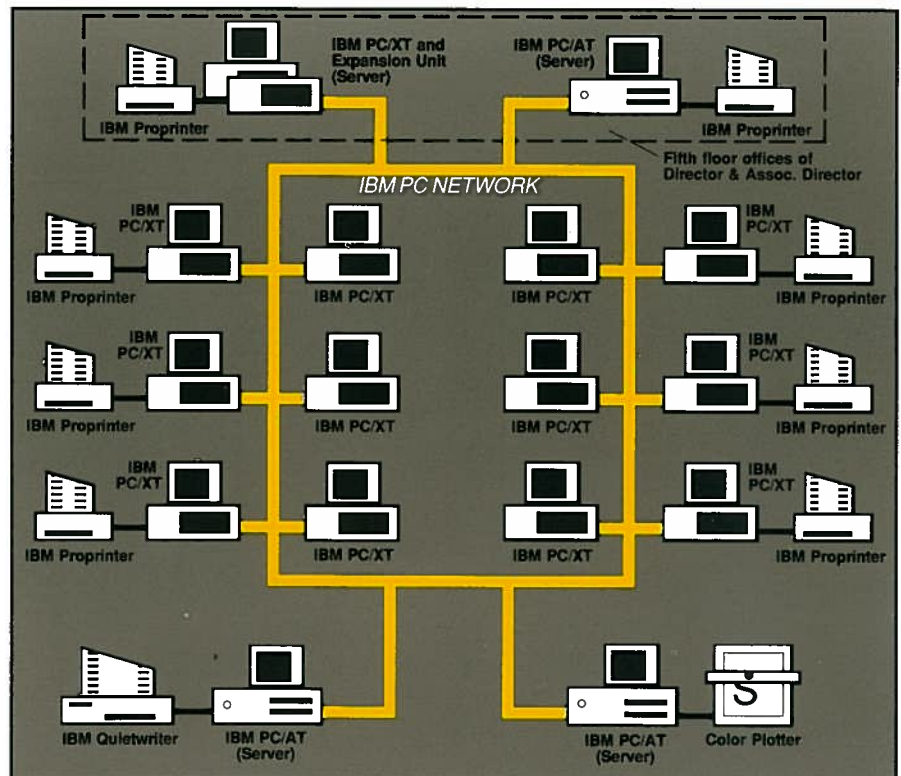
Pratt describes one 10-person experiment that requires the IBM PC/AT to make 40 draws to four probability distributions, store data, conduct all calculations, and distribute results to participants.

“The entire process only takes 13 seconds,” says Pratt. “Studies like this could never be done without the technology we have in the lab.”

Using BASIC, Reilly and Pratt programmed most of the software used in laboratory experiments. Their software, Pratt points out, is modular so other researchers can incorporate various programs into different experiments with little or no recoding.

The two VCU economists have developed several experiments that are being used not only to test theory, but also to demonstrate and refine the laboratory’s capabilities. These experiments deal with such subjects as product recall, seller behavior in a “posted offer” market, consumer quality perceptions, and lobbying characteristics.

WITH STUDENTS IN THE LABORATORY, REILLY AND PRATT DISCUSS A SESSION ABOUT TO BE RUN SIMULTANEOUSLY ON THE MICROCOMPUTERS. IBM PC/XTs FOR STUDENTS AND IBM PC/AT SERVERS ARE CONNECTED VIA IBM PC NETWORK (SEE SCHEMATIC DIAGRAM BELOW).





ED MILLNER, ASSISTANT PROFESSOR OF ECONOMICS, IS PREPARING AN EXPERIMENT THAT WILL TEST THE "CONTESTABLE MARKETS THEORY" IN THE LABORATORY.

The flexibility of the IBM PC Network accommodates experiments in areas other than economics. Business school faculty members representing such specialties as finance, management, industrial organization, and marketing have been quick to recognize the potential of the lab for advanced research.

Predictably, interest also has been high in departments outside the business school, such as psychology.

Pratt and Reilly welcome this cross-disciplinary interest. In fact, they have made an energetic effort to encourage it by conducting a series of seminars in which faculty are introduced to the capabilities of the IBM Personal Computer and the laboratory.

### Testing the Contestable Markets Theory

Ed Millner, assistant professor of economics, saw the potential of the lab for studies in industrial organization when he worked with Pratt and Reilly in programming the "rent-seeking" experiment (see page 9). Now he is conducting research that examines the "contestable markets theory." The theory suggests that the number of competitors in a given industry is a result, rather than a determinant, of that industry.

"The implications of the theory in the area of antitrust and regulatory policy are profound," says Millner. "In effect, the theory says that no strictures should be placed on a firm's ability to gain market share by merger or price manipulation, as long as there are no barriers to market entry or exit." An example can be found in advocates of airline deregulation supporting their position with the contestable markets theory.

Millner is designing a laboratory experiment in which participants, acting as business "owners," will take part in a series of market transactions. Some firms will operate as industry incumbents, and others will act as potential entrants.

Millner says his experiment will test the theory by determining whether an equilibrium develops over transaction periods, and by measuring the sensitivity of that equilibrium to such pressures as cost conditions, demand, and the number of new industry entrants.

### Studying Pieces of the "Dividend Puzzle"

Professor of Finance Tai S. Shin and colleague Seong C. Gweon are working with Pratt to design an experiment aimed at turning up some answers to what has become known as the "dividend puzzle."

"We want to find out why companies pay dividends at times when it really doesn't make sense to do so," says Shin. "It seems that announcements of stable or higher dividends send out positive signals to stockholders. At the same time, news of a cash in-flow, such as financing in the capital market, has a negative effect on stock prices."

Gweon, assistant professor of finance, adds that some companies announce dividends at the same time that they issue stocks or bonds. "Instead of raising external

## Designing Laboratory Experiments

Design is a critical phase of experimental economics. Each experiment must explicitly satisfy assumptions surrounding a theory being tested. The network configuration in the VCU laboratory makes design much easier.

"We've arranged the lab so researchers can use a fixed disk to aid in development work," Pratt explains. "At the end of each development session, the IBM Fixed-Disk Organizer takes a temporary directory off the fixed disk and puts it on the researcher's floppy diskette. They keep everything on the diskette until the experiment is completed and ready to run. Only then do we allocate permanent fixed-disk space for the experiment."

Pratt points out that the IBM PC Network accommodates simultaneous, multiple uses of the equipment. "We might be using one of the IBM PC/ATs as a file server for an experiment on one side of the room," he says. "At the same time, faculty members could be designing new experiments at terminals on the other side of the room."

Also important is the ability to modify experiments quickly and easily to alter research parameters.

Typically, experiments give participants a set of options and profit incentives. The idea, according to Pratt, is to create "real markets." Those markets are accurately replicated by offering student subjects the opportunity to earn real cash—usually at a ratio of "lab dollars" to actual dollars.

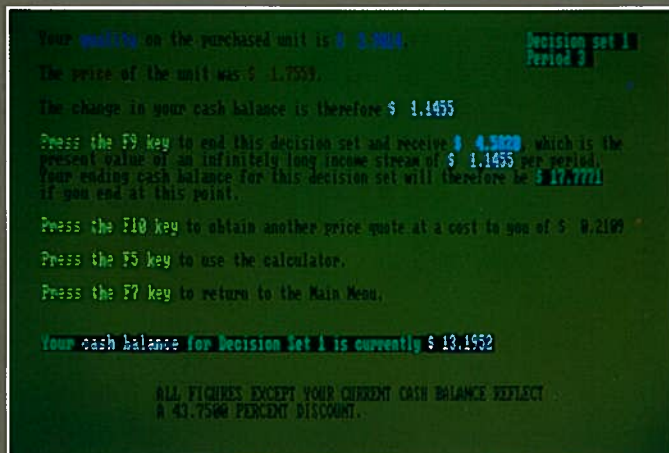
## The Consumer Search Experiment

One such experiment designed by Reilly and Pratt examines consumers' decisions when product is tied to price. The experiment comprises 20 decision sets, each one beginning with a cash balance of 15 lab dollars. Each decision set, in turn, is made up of periods during which participants can decide whether to purchase an item at a quoted price randomly drawn from between one and four dollars, or "pay" for another quote.

The value of an item purchased is determined by its quality, which also is randomly chosen from a range of zero to three times the price paid. Participants are not informed of the value of an item until after they have made a purchase.

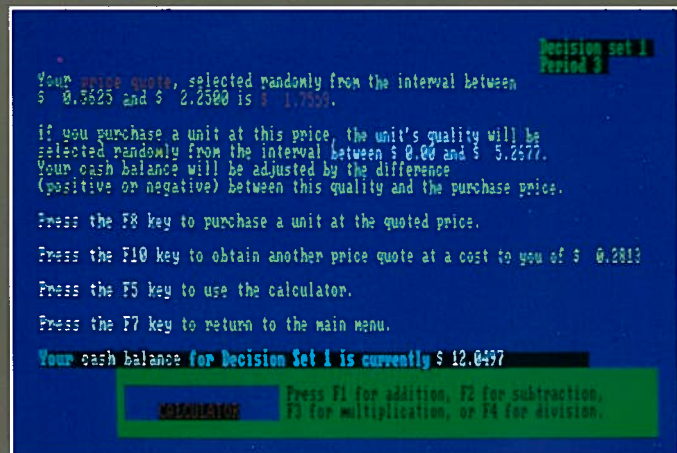
Upon completing a purchase transaction, a participant is given a choice: accept the present value of an associated income stream calculated and displayed by the computer or continue to the next period with the existing decision set and request new price quotes.

"This experiment eventually will produce results that can help business determine good pricing policy through an understanding of price/quality dependency when making purchase decisions," says Reilly.



IN THIS EXPERIMENT IN MARKET DECISION MAKING, STUDENTS USE LAB DOLLARS TO MAKE PURCHASES OF PRODUCTS WITH UNCERTAIN QUALITY. IN THIS CASE, THE STUDENT BUYER PAID \$1.76 FOR AN ITEM THAT TURNED

OUT TO BE WORTH \$2.90, WHICH RAISES HIS OR HER CASH BALANCE BY \$1.15. THE STUDENT HAS AN OPTION OF MORE "BUYS" IN THIS SET, OR MAY MOVE ON TO DECISION SET 2.



THE EXPERIMENT OFFERS EACH PARTICIPANT A BUY CHOICE (GIVEN PRICE) WHICH MAY BE DECLINED (F10 KEY) OR

ACCEPTED (F8 KEY). THIS SCREEN SHOWS THE CALCULATOR WINDOW OPEN, OFFERING MATHEMATICAL OPTIONS.

## The "Rent Seeking" Experiment

Another market decision-making experiment is based on economic theory suggesting that individuals will compete through lobbying to receive "protected profit," or rent, such as that generated by a cable television franchise.

"Specifically, we're interested in determining how much individuals are willing to pay to get at that profit," Pratt explains. "Lobbying really is nothing more than a lottery, whereby individuals spend time and money to influence legislative process. So we have come up with an experiment that is made up of 20 timed lotteries."

For each three-minute period, the computer randomly selects pairs of participants to compete against each other. Each period begins with a cash balance of 150 lab dollars per player and the chance to buy lottery tickets for one lab dollar apiece.

Players have a main menu option that figures the probability of winning a lottery—the ratio of the number of tickets purchased to the total sold. For example, if a player has purchased 15 tickets of a total 50 sold, the probability of that player winning is 0.3 (15/50), whereas the opponent's likelihood of winning is 0.7 (35/50).

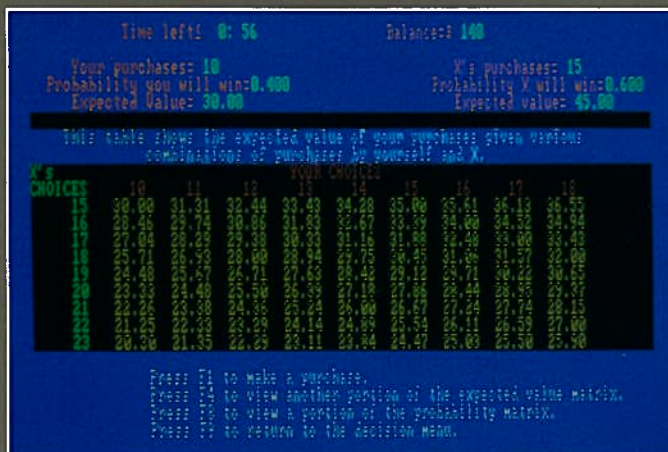
Players also can ask the computer to calculate "expected value"—the product of the probability of winning multiplied by the amount to be won, minus the amount spent on tickets.

After 20 lotteries are completed, the computer selects one of the lotteries to be played. Results are displayed on each participant's screen.

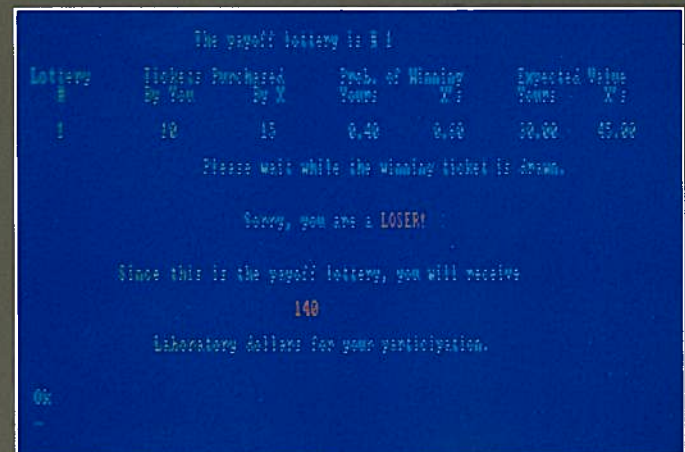
"We're detecting some interesting things with this experiment," says Pratt. "For example, there seems to be a tendency to pursue the prize even when the expected value is negative. We're confident the experiment will enable us to begin to quantify how much people will spend on opportunities to gain protected profit."



IN THE "RENT SEEKING" EXPERIMENT, RANDOMLY PAIRED STUDENTS COMPETE IN 20 TIMED LOTTERIES. THIS SCREEN SHOWS THE OPTIONS AVAILABLE TO ONE OF THE STUDENTS DURING A LOTTERY.



AN EXPECTED PROFIT MATRIX CAN BE CALLED UP AT ANY POINT DURING THE "RENT SEEKING" EXPERIMENT AS A REFERENCE FOR THE PARTICIPANT.



THE BAD NEWS IS GIVEN TO ONE OF THE LOSING STUDENTS IN THE LOTTERY AFTER THE WINNER HAS BEEN SELECTED.



(Continued from page 7)

money, they could simply reinvest the dollars paid in dividends," he notes. "Why do they do it? That's what we'd like to find out."

Gweon and Shin have mapped out a preliminary research strategy that calls for experiment participants to be investors. Their response to various company announcements and management actions will be studied in the controlled laboratory setting.

### **Studying Leadership With a Voice Synthesizer**

Randall G. Sleeth, associate professor of management, has found the laboratory environment ideal for conducting experiments using a voice synthesizer to study leadership behavior and human response to that behavior.

"We use synthesized voices to give instructions and then we watch to see how well subjects carry out those instructions," explains Sleeth. "Participants are instructed to do simple tasks, such as adding up numbers, over and over on the microcomputers."

The synthesizer is programmed to create voices that vary in degree of directness and warmth, qualities that appear to influence work effort.

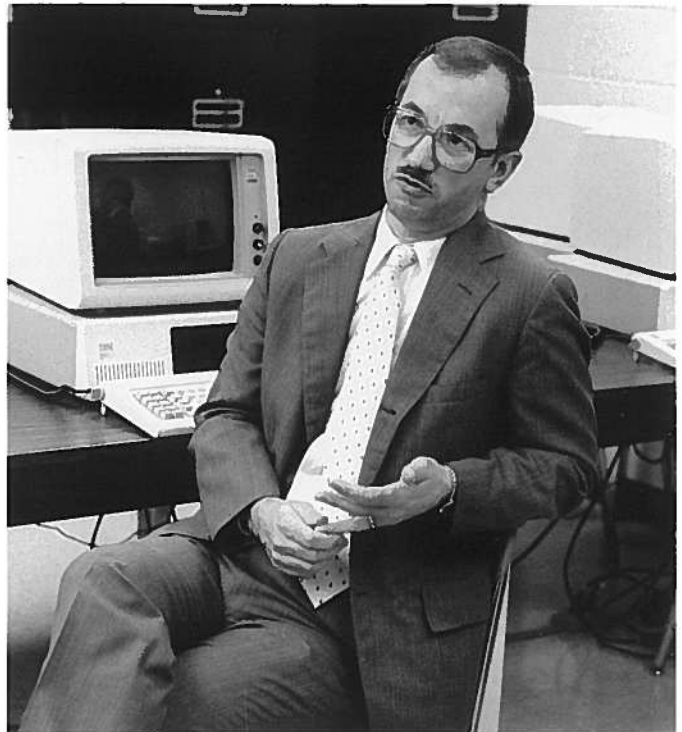
"Instructions delivered by a warm, direct voice produced the highest performance among subjects," says Sleeth. "A warm, non-direct voice drew the poorest performance, while a cold, direct voice got results somewhere in between."

He notes that certain personality traits of subjects also affected performance. For example, subjects reared in the "protestant work ethic" tend to respond most readily to criticism. "We have a feedback voice that tells off participants when they make mistakes," Sleeth explains. "Those subjects identified with a high protestant work ethic start working harder when the synthesizer tells them to shape up."

The IBM PC Network integrates programs for the experiment with instructions and feedback delivered by the synthesizer. "Much of what we've done so far is baseline work," says Sleeth, "but we wouldn't be able to do it without this technology."



TAI S. SHIN, PROFESSOR OF FINANCE (RIGHT), AND SEONG C. GWEON, ASSISTANT PROFESSOR OF FINANCE, ARE USING THE LABORATORY TO FIND OUT WHY COMPANIES PAY DIVIDENDS WHEN IT DOES NOT SEEM TO BE IN THEIR BEST INTEREST TO DO SO.



RANDALL G. SLEETH, ASSOCIATE PROFESSOR OF MANAGEMENT, IS USING A VOICE SYNTHESIZER IN A LABORATORY EXPERIMENT TO SEE HOW VOICE QUALITY AFFECTS LEADERSHIP.

These and other experiments are just the beginning of what Reilly and Pratt expect will be an on-going demand for the laboratory's capabilities to conduct research involving human behavior. "We want to be sure our lab facilities stay abreast of the demand for this research," says Reilly.

"We recognize that this lab and the IBM PC Network configuration are something that any university can duplicate," Pratt comments, "but we have the advantage of building the first lab of this kind, and we want to ensure that our facility continues to be a model in the future."

The lab signals what Provost Charles P. Ruch sees as a continuing proliferation of computer technology across virtually every academic discipline at VCU.

"In five years, we'll have a much more articulated computing environment," says Ruch. "I expect that students will see computing as an integral part of the learning experience—much the same as they view the library and other resources today."

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