INDIANA UNIVERSITY

MTC

Supported by NSF

MATHEMATICS THROUGHOUT THE CURRICULUM

PROJECT NEWSLETTER

▸ Winter 1997/98 ▸ Volume 1, No. 2

Mathematics in Action

BUSINESS AND MATH COMBINE TO SOLVE SOCIAL AND INDUSTRIAL PROBLEMS

When Cathy Romano, a student at IU South Bend, sat down to help her 16-year-old son figure out a math problem about the chances of high school kids passing a math course, she was confident she could tackle the probability question.

"I don't have a fear of math now," said Ms. Romano. "I understand where you can utilize it in everyday life." Ms. Romano, 46, got the chance to use math in everyday life, and conquer her fear of math, when she took the course *Mathematics in Action: Social and Industrial Problems* last spring.

Team-taught by business professor Paul Kochanowski and mathematics professor Morteza Shafii-Mousavi at IU South Bend, the course was developed for the Mathematics Throughout the Curriculum project and introduced mathematics to students in a way they could understand and benefit.

"Our objective was to create an appreciation for mathematics," said Dr. Kochanowski. "We wanted to show students that these basic tools are powerful for solving problems."

The professors recruited projects from six local businesses and organizations, and each student worked on a team assigned one of these projects. The students needed to learn new mathematics to solve the problems presented to them. In particular, they studied probability theory, linear systems and optimization theory, including the traveling salesman problem.

We actually got to use things like probability and frequency tables and see that it worked. We were not just taking a test.

Cathy Romano, *class participant*

Ms. Romano and her team analyzed advertisements for the *South Bend Times*, a small publisher of weekly papers. The students conducted surveys to determine readership and perceptions of the *Times-Penny Saver* publication and compared them with the *South Bend Tribune*, the major newspaper in the area, to evaluate the cost-effectiveness of advertising in the two publications.

They showed that it was cheaper to advertise in the smaller newspaper, as companies reached more people who bought their specific products.

The Romano team documented its findings in a 47-page report and presented it to Penny Saver.

"We actually got to use things like probability and frequency tables and see that it worked," said Ms. Romano. "We were not just taking a test."

This kind of practical experience is just what Professors Shafii-Mousavi and Kochanowski had in mind when they developed this mathematics/business course.

"These industry projects are so comprehensive," said Dr. Shafii-Mousavi. "The students learn how to deal with clients, with computers, with group projects, how to present the project, etc."

Finding the six companies involved a

PAGE 3 / A **'WIN-WIN'** PERSPECTIVE FROM INDUSTRY

ACTION *cont. on page three*

A Good Start

SOLID FALL FOR COURSES, EVALUATION

We are now well into our second year of the "Mathematics Throughout the Curriculum" project. There is still much to be done in curriculum development and implementation, but we have also begun the important steps of dissemination and evaluation.

In this issue we are highlighting two of our courses which are actively involved in dissemination.

"Mathematics in Action" was successfully developed and introduced at Indiana University South Bend during the 1996/1997 academic year by business professor Paul Kochanowski and mathematics professor Morteza Shafii-Mousavi.

In order to share what they have learned, the professors sponsored a regional dissemination workshop at IU South Bend for those who were interested in the MTC concept. Participants included faculty from other colleges and universities in Indiana and IU faculty who have not yet become involved in the MTC project.

The IU South Bend story begins on page one and continues on page three where Tom Heeter, General Manager of Ashley Ward's Elkhart, Ind., division, discusses his company's extremely positive collaboration with the MTC course.

"Mathematics and Art" was developed with a national focus by professor Marc Frantz of Indiana University-Purdue University Indianapolis and professor Annalisa Crannell of Franklin & Marshall College in Lancaster, Pa. By piloting the course at Franklin & Marshall and subsequently at IUPUI, the interdisciplinary course is receiving broad attention through a variety of articles and presentations.

Frantz shares his experience with the course on page four of this publication, while Crannell's preceptor, undergraduate assistant, Bonnie Valiente, shares her own perspective of the course on page five.

One of the key activities this fall was hosting the on-site visit by an external evaluation team hired by NSF.

The team was Tania Madfes of WestEd Corp., in San Francisco, Susan Millar of the University of Wisconsin and Bill Velez of the University of Arizona. The three evaluators arrived in Bloomington on Monday, Sept. 22, and prepared for two full days of meetings in Bloomington and at the IUPUI campus in Indianapolis.

IU math Professors Daniel Maki and Bart Ng

During their visit the trio met with students in MTC classes, departmental and campus administrators and course development teams.

Some members of the IU South East development teams met with the visitors by conference call, while one IU South Bend member traveled to Bloomington for the meeting. The IU South Bend team, together with two students from their class, came to Indianapolis for a session.

We have just recently received the extensive evaluation report the team produced. The care and effort that went into the visit and report was impressive. Generally, we are pleased with the team's response to our project and its suggestions.

Our upcoming newsletters will include discussion of the visiting team's observations and the recommendations they provided, including a suggestion that a greater focus be put on pedagogy and materials development for the purposes of dissemination.

We welcome people to contact us for more information or with suggestions for new courses.

Please see the back page for our mailing address, phone number, web address and our e-mail addresses.

We look forward to your comments.

other
MATHEMATICS IN ACTION
student projects

- **American Diabetes Association**
  Students obtained conditional probabilities showing the incidence of diabetes as related to age, gender and race. In combination with neighborhood demographics, students were able to determine areas with the largest potential concentration of diabetes.
- **Penn-Harris-Madison School Corporation**
  Students investigated the cost efficiency of the school corporation's policy of maintaining its 3/4 ton pick-up trucks until they're inoperable.
- **South Bend Community School Corporation**
  Students studied the efficiency of the school corporation's current internal delivery system. Proposed new routes were compared to current routes. The mathematics of the traveling salesman were used.
- **South Bend Times**
  Students measured readership and advertiser perceptions of a Times' publication, the *Times Pennysaver* vs. the major newspaper in the area, the *South Bend Tribune* with surveys. The group evaluated the cost-effectiveness of advertising in the two publications.
- **Teachers Credit Union**
  Students used several months of bank loan data classified by account, product type, and days delinquent to calculate conditional probabilities then scrutinized the data to identify high risk product types.

A Win-Win Situation

SUCCESS FOR SOUTH BEND STUDENTS *AND* INDUSTRY

Ashley F. Ward, Inc., a producer of precision machine parts in Elkhart, Ind., asked students to examine company production and shipping data to identify those parts and those customers with the highest probability of late shipments.

Professors Shafii-Mousavi and Kochanowski contacted Tom Heeter, the General Manager of Ashley Ward's Elkhart, Ind., division to supervise the students.

Heeter believed involvement in the course was a win-win situation for both students and his company, while serving one of his personal interests.

"(We) thought 'what could we give back to the educational community here in South Bend?'" said Mr. Heeter, whose seats on the Mishawaka Indiana School Board, Elkhart Area Career Center Advisory Board and his current position on the advisory board of the IU South Bend Business and Economics Division proved he would be a perfect match for the instructors.

"We need students well prepared before they enter business, and we run into difficulty finding this in post-grads," said Mr. Heeter.

"Most difficult is the 'reality problem,' where students struggle to understand how to use the wonderful education they have."

On the other hand, post-grads often feel disadvantaged in the job market because the experience they so desperately seek seems impossible to get without a job.

Mathematics in Action helped solve these problems for both employer and student by providing opportunity.

Mr. Heeter arrived at the "real life" problems that Professors Shafii-Mousavi and Kochanowski's students would face. While Heeter conceded that the students didn't arrive at conclusions Ashley Ward hadn't already realized, he found the information collected by the students validated the company's current data.

"The work done by our group of students confirmed that our scheduling is antiquated," said Mr. Heeter. "We've recognized this for a number of years, but this (student work) was a final indication that we better add new computer software very rapidly."

Any concerns Mr. Heeter had about working with students, whether with confidentiality or with the student's ability to deal with job complexities were quickly assauged.

"Our challenge to the students was for them to work on their own, set their own appointments and gather their own information without the structure of the classroom," said Mr. Heeter.

"I saw more information on their final report than I thought I would, which was a key dimension to this experience.

"It wasn't just a math course; it was a communications class. 'Could they convert their knowledge of the math and data and explain it to us to make it useful?' Overall, they did a superb job.," said Mr. Heeter.

ACTION

cont. from page one

great deal of work on the part of Kochanowski and Shafii-Mousavi.

"I've always thought that if you want to show students that what you teach is powerful and valuable, you have to show them that it's relevant," Dr. Kochanowski said.

"I'm excited about what I teach because I know that it's useful," Dr. Shafii-Mousavi added.

"You cannot make learning effective unless you put the students in the right context for learning,"

For Ms. Romano, context was everything.

"I was never really good in math," said Ms. Romano.

"This course gave me courage; I'm not afraid of math anymore. This type of class would have a whole generation of people loving math."

Mathematics and Art

UNFORESEEN 'PERKS' EXIST FOR MTC COURSE DEVELOPERS

by Marc Frantz
Research Associate in Mathematics, IUPUI

If you're an MTC course developer, I assume the "perks" in the title got your attention. The perks I'm talking about are not the monetary kind, but don't stop reading yet!

I've found that there are benefits to interdisciplinary course development that aren't part of any written guarantee, but nonetheless seem likely to be experienced by most of us sooner or later.

My success with an MTC course serves as a good predictor of the bonuses you might expect to receive, in addition to the obvious rewards we all desire for our students and ourselves as a result of our curriculum restructuring efforts.

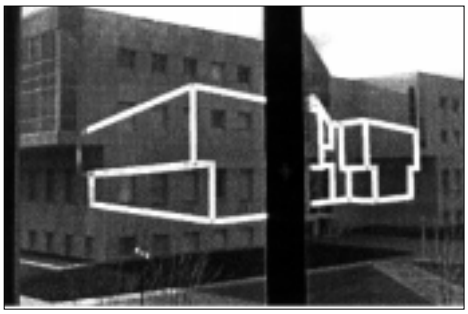
My good luck has been associated with the "Mathematics and Art" course I developed with Dr. Annalisa Crannell of Franklin & Marshall College, in Lancaster, Pa. The typical course development team for the MTC project consists of a mathematician and a specialist from another discipline, but ours consisted of two mathematicians, both very interested in art.

While visiting my mathematics department at IUPUI, Dr. Crannell expressed an interest in teaching a mathematics and art course, and I was also enthusiastic about the idea. Since my undergraduate degree is in fine arts with a major in painting, we saw this as an opportunity for interdisciplinary work.

I'm teaching the course for the first time at IUPUI, with a group of students whose math backgrounds vary widely. I'm faced with the task of making sure the students are interested and challenged, without overwhelming them. This is possible by selecting a set of relatively simple mathematical tools that can be applied to a wide range of interesting topics in art, and with a wide range of difficulty. In fact, while searching for these interesting problems for my students, I have come across some results that were apparently unknown. This is the good luck I referred to earlier.

The two main topics in my course at IUPUI are mathematical perspective and fractal geometry. Although it somehow escaped me in art school, perspective is simply the result of projecting points from an object in three dimensional space along straight lines (light rays) that strike one eye of an observer. The points where these lines pierce a "picture plane" constitute the perspective image of the object.

(Above) I was the observer (left) and my student, Pat Sullivan, (right) was the projection function. The window was the picture plane.



By following my directions, Pat used strips of masking tape to make a fairly decent perspective drawing of the IUPUI Library.

We did this exercise in "Mathematics and Art" because from this simple concept we obtain a mathematic description of perspective. In turn, this perspective allowed us to derive, and more importantly understand, the perspective drawing tricks commonly used by artists. We also drew using a coordinate transformation approach and, of all things, Microsoft Excel. (see: http://www.math.iupui.edu/m190/house-www/house.html).

Fractal geometry is fairly well-known, at least in name. For us the important thing was that trees, bushes, clouds, mountains, rivers, lightning, galaxies, snowflakes and a host of other natural forms could be drawn convincingly using fractal geometry.

Through our work in Mathematics and Art we were able to present strong circumstantial evidence that Japanese woodblock artists of the 19th century routinely incorporated fractal shapes in their work.

I recently investigated certain properties of a function commonly used as a "counterexample" in real analysis courses.

I realized that its graph had a kind of self-similarity connected with fractal geometry. The results are detailed in an article titled, "Two Functions Whose Powers Make Fractals," which will appear in the *American Mathematical Monthly*.

ART *cont. on page five*

ART

cont. from page four

After submitting this article, I realized further that the graph was an authentic example of anamorphic art, a type of perspective trickery introduced by painters near the end of the 15th Century. I detail this discovery in an article titled, "When Real Analysis Meets Anamorphic Art," and presented it in a multimedia talk to our graduate students.

Again I realized the value of the "Mathematics and Art" course to my own work after staring up at telephone poles one day and thinking about their perspective representations.

There is a surprising link between the way we see the world and the famous infinite series. This resulted in "Visualizing the Telescoping Series," an article submitted to *Mathematics Magazine*.

This is the kind of "perk" I'm talking about.

Many of us bring an interdisciplinary slant to our courses that aids our research, while it enhances our students' educational experiences.

(Co-Mathematics and Art developer, Dr. Crannell, is currently teaching Mathematics and Art for the second time at Franklin & Marshall.

Her preceptor is Bonnie Valiente. Ms. Valiente's article on mathematics and art course appears on this page.)

Perspective

UNDERSTANDING WHAT LIES BEYOND THE WALL OF GLASS

by Bonnie Valiente
Preceptor, Mathematics and Art
Franklin & Marshall College

Art has a transparent layer to it. While the initial layer is like a piece of glass you can see through, it is often difficult to get students to see through the window of a page. On the other side of an art piece lies another world, often filled with fantasy or a hidden story.

Beyond the glass, there are many hours of thought that create the skeleton of the art work. The skeleton is then often decorated with the flesh of texture, color, pencil or other surfacing. Art is a poetry of images.

And, like poetry, the deeper meaning of the images becomes lost without the tools of vocabulary.

How do we learn to speak what we see and visualize what we speak? How do we learn to create what we visualized and recreate forms or techniques that already exist? Most people will say, "I can't draw, so how can I make art?"

But what are the things that make us capable of visual expression? Once we begin to search for some of the answers to these questions we can begin to see beyond the wall of glass.

We become capable of describing what comes into focus and begin to approach an understanding of how to duplicate some of the things we see.

Many people are attracted to a piece of art because of its coloring or subject matter. However, are these the only two elements of the art work that attract us? In the vaults of the subconscious, there are other things that cause us to gaze into a painting or a sculpture in a gallery. How can we begin to understand what thought went into the work of M.C. Escher? How can such complicated art pieces as interlocking repeat patterns of fractals be produced?

One of the answers to these questions lies in the tool of mathematics. Mathematics can often be the mechanics of how art work is produced or what allows it to be possible.

In Mathematics and Art we discussed some mathematical techniques that allow the production of art work. We were challenged to understand what lies beyond the glass window and what would aid us in ordering the creative thinking process.

Mathematics can often be the mechanics of how art work is produced or what allows it to be possible.

We also explored how to describe art and mathematics. Many of the skills learned from speaking the language of art and mathematics then transformed into written papers.

As students pick up more and more vocabulary from class lecture, homework assignments, frequent art critiques and revision of written work, they become more and more fluent in the language.

Thus, at the end of the semester a great deal of improvement was seen in the final product of the students' work: their portfolio.

For more information about MTC

Contact:

MTC Project Office
c/o Pam Harnett
Department of Mathematics
Indiana University
Bloomington, IN 47405
(812) 855-7073
MTC@indiana.edu
http://www.math.iupui.edu/mtc/

Directors

Daniel Maki
maki@indiana.edu

Bart Ng
bng@indiana.edu

Editors

Karen Lanning
William Toelke

PROJECT UPDATE

Seven new MTC courses were taught during 1996-97:

- Art and mathematics
- Criminal justice and statistics
- Economics and game theory
- Economics and statistics
- First-year biology and mathematics
- Mathematics for industry
- Physics and mathematics

Nine additional courses will be taught during 1997-98:

- Chemistry and mathematics
- Finance and mathematics
- History and mathematics
- Intermediate biology
- Linguistics
- Mathematics for liberal arts
- Mathematics for social sciences
- Nursing and mathematics
- Speech and hearing

Additional courses will be developed during 1997-98.

INDIANA UNIVERSITY

MTC Project
Department of Mathematics
Indiana University
Bloomington, Indiana 47405

Supported by NSF