

Director: Jennifer Snyder

Associate Director: Richard Delaware

April 1, 2001

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### OUR 17<sup>TH</sup> YEAR

As spring arrives and our spirits lift, we end this long cold winter with a few items of note. This 2000-2001 MPI year saw our first students from the Blue Springs District, and our first Calculus-based Physics course. We also welcome our new MPI secretary, Donna Dilse, who lives in Blue Springs, and comes to us after having worked as an administrative assistant for the Alpha Phi Omega National Service Fraternity in Independence. Finally, thanks to all of you, parents, teachers, administrators, and others who support the MPI program entering its 18<sup>th</sup> year in Fall 2001. We'll be back with another intensive year of Calculus, Physics, and college-bound study habits. Until then, enjoy the warmth of the summer.

### CALCULUS READINESS EXAMS

During the last week of April and the first week of May, the Associate Director will travel to most of the high schools participating in the MPI to administer the MAA Calculus Readiness Test, a 25 question diagnostic test designed to determine roughly how prepared a student is to take calculus. It covers analytic geometry, algebra and some trigonometry. A score of 12 or above is required to attend the MPI, although occasionally lower scores are accepted, provided a transcript and two recommendations are received, and a personal letter is written to the MPI Director, all by May 10. this year. (Details will be discussed when the Associate Director makes his visit.)

Of course, this little test is by no means definitive, and in fact, a student's commitment more often determines his or her success at the MPI than a score on one introductory test. However, this test has proved to be effective as long as it is complimented by CAREFUL SCREENING done at individual high schools by counselors and teachers who know the students in question. Let us be clear on this: Students who have all the prerequisite classes and score 12 or more on the test, but who possess no maturity or commitment to hard work will not succeed at the MPI.

### TO ALL MPI ALUMNI:

### HAVE YOU GRADUATED FROM COLLEGE?

IF SO:

PLEASE CONSIDER BEING AN

- ENRICHMENT SPEAKER -

CALL (816) 235-1272

or contact us at [mpi@umkc.edu](mailto:mpi@umkc.edu)

MPI Alumni who have spoken:

Doug Bullock	(84-85)
Brent Harding	(84-85)
Pam Deters/Stephen Koop	(84-85)
Seth McMenemy	(88-89)
Tony Thornton	(88-89)
Mitch Dobson	(89-90)
Rachel Allen	(92-93)

### ODDS AND ENDS

On February 5 and 6, our two Recruitment Days, we hosted approximately 126 high school juniors and several teachers and counselors, from 8 different schools: Center, Center Place Restoration, Englewood Christian, Ft. Osage, Northeast, St. Mary's, Truman, and William Chrisman.

On March 6, four of our MPI students, Mike Bowerman, Kevin Canning, Billy Gooch, and Laura Hajj, representing Ft. Osage High School, participated in the first UMKC Mathematics Competition. We are happy to say that the team of Bowerman, Canning, and Hajj won the 2<sup>nd</sup> Place trophy in Calculus. Richard Delaware also participated in the competition as both a moderator and a judge.

April 5-8, Libbi Sparks will attend the Annual NCTM (National Council of Teachers of Mathematics) Conference in Orlando, FL.

On April 13, Richard Delaware will speak in the *UMKC Writing Across the Curriculum Faculty Forum* about his Writing Intensive History of Mathematics course, Math 464.

On April 20, Richard Delaware will speak in the UMKC Department of Mathematics and Statistics Expository Talks Series on: *Arrow's Impossibility Theorem: Is the Only Fair Voting System a Dictatorship?*

May 7 & 8, Sheri Adams and Libbi Sparks will attend a State of Missouri Mathematics Institute Grant review session in Springfield, MO, to show their progress in the implementation of the grant at Truman and William Chrisman high schools.

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### THE AUGUST 2001 ISSUE

The August 1 M $\pi$  Newsletter will list the top ten MPI students for 2000-01 and all those receiving awards at our May 10<sup>th</sup> Awards Presentation.

There will also be **IMPORTANT INFORMATION** and advice for the YEAR 18 class of 2001-2002. TAKE NOTE!

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### ENRICHMENTS

#### FOLLOW UP

On Friday, March 9, Eddie Burris, UMKC Computer Science & Telecommunications, spoke on "CAN YOU PUT THE INTERNET ON YOUR CELL PHONE?"

Students responded:

■ The question persists: "Can the Internet be accessed through a cellular phone?" Such access would carry limitations. A transportable screen is too small to display in a full browser size. A cell phone must have high bandwidth and low battery consumption. Frequency "cells" or such areas help increase bandwidth, but cellular Internet will still lack certain advantages. Protocol and HTML/HTTP languages will make cellular Internet difficult to achieve. Cellular Internet is a flawed, but promising, technology.

■ This was an excellent and intriguing topic and speaker.

■ I would have really liked to see and touch some of these PDA's and cell phones that are being developed.

■ It was an interesting topic for a generation that has grown up with cell phones and other mobile devices. It's always fun to see where the future may lead.

■ Good topic; good, current info.

■ This enrichment was good, but it should be more interactive. He did a good job of associating with us by mentioning things like Napster.

On Friday, March 23, we made a **FIELD TRIP TO THE WORLD-CLASS LINDA HALL LIBRARY OF SCIENCE, ENGINEERING & TECHNOLOGY** located at the center of the UMKC campus (though independent of it), and to some **UMKC PHYSICS DEPARTMENT LABS**. At the Library we visited the Rare Book Room to view rare and historically significant mathematics books. At UMKC, in Physics we toured laboratories in Atomic Force Microscopy (Da Ming Zhu), Photoelectron Spectroscopy (David Wieliczka), Photo-Luminescence (Jerry Wrobel), and participated in a liquid nitrogen demonstration with Dr. Snyder. Finally, we ate lunch together. After the trip, students were required to complete a Calculus Writing Assignment, typing a paper about the mathematics books they personally examined. Among the rare books (in English, Latin, and other languages) we viewed, were the following:

◆ Books by Newton and Leibniz, the co-inventors of Calculus.

◆ Several versions of Euclid's Elements, including the first printed edition of 1482, the first English translation in 1570, and a completely visual version in color created by Oliver Byrne in 1847.

◆ Descartes' book (1637) in which he invented Analytic Geometry.

◆ The 1670 edition of Diophantus in which Fermat's Last Theorem was first printed.

Students responded:

■ First of all we visited Dr. Snyder's lab at UMKC where she showed us some awesome demonstrations with liquid nitrogen. We watched as she froze stuff in it and then broke things like racquetballs and flowers. I even got to break the racquetball. That was awesome. After that we went to another lab where we learned about vortices, circles, and copper plating. The physicist let me copper plate a quarter. Afterwards we trekked to another lab where we learned about light. Once we were finished at the physics labs we walked to Linda Hall Library where we took a tour and researched rare books for our writing assignment. Then we had

lunch and ice cream made with liquid nitrogen. It was real good!

■ Went to Rare Book Room in Linda Hall Library. Saw books from 14<sup>th</sup> – 20<sup>th</sup> centuries. Most in old English, French, Latin, Greek, and Arabic. Then off to the Physics lab to study liquid nitrogen, light properties, and atomic studies. And finally lunch with liquid nitrogen ice cream and caramel topping, yum!

■ At first, I did not want to go on this field trip. It sounded rather boring. But now, I am glad that we went. It was very informative and fun.

■ Wrobel was the coolest ever.

■ I want to go back to the Rare Book Room to look at old butterfly & insect books.

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## UPCOMING

On April 6, Tina Niemi, UMKC Geosciences, will speak on "PALEOSEISMOLOGY AND PROBABILITIES OF FUTURE EARTHQUAKES."

On April 27, Brent Harding (MPI 1984-85), Engineer Specialist, will speak on "APPLICATIONS OF SATELLITE TECHNOLOGY."

Sunday, April 29, will be our annual **WORLDS OF FUN PHYSICS DAY**.

Finally, we'll hold our annual **BREAKFAST** on Wednesday, May 9, and our **AWARDS PRESENTATION** on Thursday, May 10, the last day of MPI classes this year.

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**MPI E-MAIL ADDRESS:**

[mpi@umkc.edu](mailto:mpi@umkc.edu)

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## FINAL 2000-2001 STUDENT IMPRESSIONS

"Some of my friends in college complain because their 9:30 a.m. Calculus class is too early. In college, I won't have to get up as early as they do. The real irony is that I will be used to the earlier start

time and will have nothing better to do than volumes of Calculus problems at 7 am bright and early."

**Mike Bowerman**  
Fort Osage High School  
Fort Osage School District

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"MPI is a great opportunity to meet new people. Classes are pretty tough first semester, especially if you haven't already taken Calculus and Physics in high school, but by second semester it doesn't seem as hard. If you take the opportunity to form study groups with people you didn't know when you came, you'll do better in class and enjoy MPI more."

**Aaron Ballantyne**  
Center Place Restoration School  
Independence School District

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"MPI was one of the greatest challenges I have ever faced. I have learned so much about life and myself. Now that the year is ending, I am glad to say that I met the feat and survived."

**Nina LanFranca**  
Truman High School  
Independence School District

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"The MPI is one of our first true college classes; studying, paying attention, and showing up on time are necessities. These are points we are not accustomed to. You must achieve these points, or the MPI will burn you!"

**John Waldman**  
Fort Osage High School  
Fort Osage School District

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"This month is my birthday month (it's the 11<sup>th</sup>), so I begged to write a second impression for this issue of the newsletter. (My first was in the October issue.) I just wanted to say MPI is the greatest. (No, I'm not lying, or trying to get a better grade.) This is probably the best thing that I have ever done, and the most worthwhile, not to mention the fact that this college credits will actually transfer to college. <gasp>.

Thank you all for making this program happen. And thank you, Mr. Delaware, for making Calculus worth getting up at 6 a.m."

**Laura Hajj**  
Fort Osage High School  
Fort Osage School District

“As the year is coming to an end, I am finding it harder to stay focused on my homework. We were told that the beginning of the year would be the hardest time at MPI, but I believe that now is the most challenging time.”

**Jamie Chapman**  
Truman High School  
Independence School District

“MPI is the coolest. You’re not cool unless you go to MPI. Seriously, MPI is really fun and it’s been such a great experience this year. It’s really not as bad as you’re thinking. You’ll probably really enjoy it. I did. Plus, you will be so much more prepared for college than everyone else.”

**Megan Roney**  
Truman High School  
Independence School District

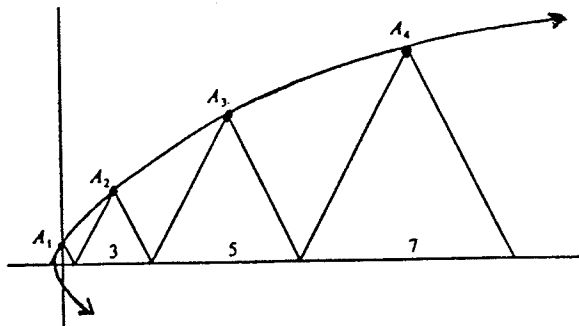
“MPI is a great experience. It is also very challenging and takes a lot of time and hard work. Besides the early mornings, MPI is lots of fun and homework. You have to be very prepared and awake during class to make any progress.”

**Tim Fortner**  
William Chrisman High School  
Independence School District

**A SOLUTION TO  
MATHEMATICS CHALLENGE #67**

Recall the problem statement:

Equilateral triangles of side lengths 1, 3, 5, ..., 2n-1, ..., are placed end-to-end along the x-axis, as shown below.



Show that the vertices,  $A_1, A_2, \dots$ , which do not lie on the x-axis, all lie on a parabola.

[From: Mathematical Morsels, by Ross Honsberger, 1978, Problem #64, p. 167.]

**SOLUTION:**

The vertex  $A_1$  of the first triangle in the sketch above is the top of an equilateral triangle of side 1. Using the Pythagorean Theorem, it is easy to calculate its height to be  $\frac{\sqrt{3}}{2}$ . So,  $A_1$  has coordinates  $(0, \frac{\sqrt{3}}{2})$ .

Let the coordinates of  $A_n$  be  $(x, y)$ . We hope to show that  $x$  and  $y$  are related by the equation of a parabola. On the one hand, since the base of the  $n^{\text{th}}$  triangle is of length  $2n-1$ , we see from the sketch above that the x-coordinate of  $A_n$  is

$$x = \frac{1}{2} + 3 + 5 + \dots + (2n-3) + (\frac{1}{2})(2n-1).$$

It is well known that the sum of the first  $k$  odd positive integers is  $k^2$ , that is,

$$1 + 3 + 5 + \dots + (2k-1) = k^2.$$

So, noting that  $2n-3 = 2(n-1) - 1$ , we can simplify  $x$  as follows:

$$\begin{aligned} x &= \frac{1}{2} + 3 + 5 + \dots + (2n-3) + (\frac{1}{2})(2n-1) \\ &= \frac{1}{2} + [(n-1)^2 - 1] + n - \frac{1}{2} \\ &= n^2 - 2n + 1 - 1 + n = n^2 - n \\ &= n(n-1). \end{aligned}$$

On the other hand, the y-coordinate of  $A_n$ , the top vertex of the  $n^{\text{th}}$  equilateral triangle of side  $(2n-1)$ , is just

$$y = (2n-1) \left( \frac{\sqrt{3}}{2} \right)$$

Solving for  $n$  in terms of  $y$ , we deduce

$$\begin{aligned} n &= \left( \frac{y}{\sqrt{3}} \right) \left[ \frac{2y}{\sqrt{3} + 1} \right], \text{ and therefore} \\ n-1 &= \left( \frac{y}{\sqrt{3}} \right) \left[ \frac{2y}{\sqrt{3} - 1} \right] \end{aligned}$$

So, we can write  $x$  as

$$\begin{aligned} x &= n(n-1) \\ &= \left( \frac{y}{\sqrt{3}} \right) \left[ \frac{2y}{\sqrt{3} + 1} \right] \left( \frac{y}{\sqrt{3}} \right) \left[ \frac{2y}{\sqrt{3} - 1} \right] \\ &= (1/4) [(4y^2)/3 - 1]. \end{aligned}$$

Multiplying by 12 and rearranging the equation, we have

$$\begin{aligned} 12x &= 4y^2 - 3 \\ 4y^2 &= 12x + 3, \end{aligned}$$

which is the equation of a parabola, as desired.

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**A SOLUTION TO  
PHYSICS CHALLENGE #58**

Recall the problem statement:

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A rubber bullet and an aluminum bullet both have the same size, speed, and mass. They are both fired at a block of wood. Which is most likely to knock the block over?

- a) The rubber bullet
  - b) The aluminum bullet
  - c) Both the same
- 

**SOLUTION:**

The rubber bullet is more likely to knock the block over than the aluminum bullet. You can think about this problem in a number of ways, but let's consider it here in terms of impulse and momentum. Initially, both bullets have the same mass and speed and therefore the same initial momentum. Let's assume that the rubber bullet collides with the block and then rebounds with an equal momentum, but in the opposite direction. Let's also assume that the block stops the aluminum bullet during the collision. The Impulse/Momentum Theorem states:  $F\Delta t = \vec{p}_f - \vec{p}_o$ . Using our assumptions, for the rubber bullet,  $\vec{p}_f = -\vec{p}_o$  and for the aluminum bullet,  $\vec{p}_f = 0$ . If we put this information into the Impulse/Momentum Theorem for both the rubber and aluminum bullets, we can see what kind of force the block must provide.

$$\text{Rubber: } F\Delta t = -\vec{p}_o - \vec{p}_o = -2\vec{p}_o$$

$$\text{Aluminum: } F\Delta t = 0 - \vec{p}_o = -\vec{p}_o$$

If we assume that both collisions take the same amount of time then we can see that that block has to provide twice as much force to change the momentum of the rubber bullet than it does for the aluminum bullet. From Newton's Third Law, this means that the rubber bullet puts twice as much force onto the block as the aluminum bullet does. Therefore, the rubber bullet is more likely to knock the block over.

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**MATHEMATICS CHALLENGE #68**

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The arms of an equal-length balance are never exactly the same length. To eliminate the error due to this unavoidable fact, someone proposes that objects be weighed twice, once on each side of the

balance, and then the average used as the correct weight of the object.

However, show that in fact the average of these weighings *never* gives the correct weight, unless the arms are exactly the same length! In view of this, determine how the weighings ought to be treated in order to truly give the correct weight.

[From : Pi Mu Epsilon Journal, 1950, vol. 52, #2, as quoted in Mathematical Chestnuts from Around the World, by Ross Honsberger, MAA, 2001, section 6, problem #1.]

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**PHYSICS CHALLENGE #59**

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Continuing on this same theme of Impulse and Momentum, consider this problem from one of our exams: Two boys in a canoe toss a baseball back and forth. What effect will this have on the canoe?

- a. None, because the ball remains in the canoe.
  - b. The canoe will drift in the direction of the boy who throws the ball harder each time.
  - c. The canoe will drift in the direction of the boy who throws the ball with less force each time.
  - d. The canoe will oscillate back and forth always moving opposite to the ball's motion.
  - e. The canoe will oscillate back and forth in the direction of the ball's motion.
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**Do you have a physics problem that you'd like to challenge the MPI students and alumni with? Send your question (with solution!) to the MPI address or e-mail to: [jdiscenna@umkc.edu](mailto:jdiscenna@umkc.edu).**

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**Editor/Writer:**

**Richard Delaware**

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