



Director: Richard Waring  
Mathematics Coordinator: Richard Delaware

December 1, 1993

Vol. 8, No. 3

**OPEN HOUSE THANK-YOU LETTER**

A total of 80 people attended our 1993-94 Open House on November 7, 1993. A special thanks goes out to all the parents, friends, and school administrators who took time from their busy schedules to take part in this event. Not only did you contribute to the success of our Open House, but more importantly your presence demonstrates the support and encouragement you give to your children and our students. I strongly believe a quality education is the key to a successful and productive future for our young people. The encouragement and support of parents along with the priorities and values you help establish are essential for their success.

I hope you enjoyed seeing our demonstrations, videos, and calculus and physics laboratories. Few students across the country have the opportunity to use computers as both an integral part of calculus classes and to collect and analyze data in physics laboratories.

Finally, I want to thank our students who did such a great job of interacting with our visitors and in explaining the various demonstrations.

Richard Waring  
Director

**SHARP EL-9300C GRAPHICS  
CALCULATORS DISTRIBUTED TO ALL**

For the first time this year, the MPI has decided to require all students to have and use a graphics calculator in both physics and calculus, and for our purposes the mathematics coordinator selected the Sharp EL-9300C. Although it is not the most powerful such graphics calculator on the market, it is

ideally suited to the MPI, and its selection of students. Five particular Sharp attributes settled the decision: The ability to graph; the Solver function; the ability to enter mathematical expressions exactly as you would write them, rather than being restricted to one line; 32 KB of memory; and the very low educational cost to us of approximately \$70.00 each. No other graphics calculator on the market could provide all five attributes.

All MPI students are required either to rent a Sharp from us (a \$10.00 one-time, non-refundable fee for the entire academic year, with an option to buy the calculator outright at any time), or to provide themselves an equal or better graphics calculator. When we began distribution on Oct. 5, only 10 out of 51 students possessed graphics calculators: 7 had Casios, and 3 had TI-85's. Eventually, 5 of the Casio owners decided to rent our Sharps. By the end of distribution on Oct. 26, 49 Sharp graphics calculators had been rented, 3 purchased outright, and 6 were on free loan to the MPI faculty (1 faculty member had previously bought one of his own).

**TO ALL MPI ALUMNI:**

**HAVE YOU GRADUATED  
FROM COLLEGE?**

**IF SO:**

**PLEASE CONSIDER JOINING OUR  
PANEL DISCUSSION THIS YEAR!  
(Wed. Jan. 5, 1994)**

**ALSO, PLEASE CONSIDER BEING  
AN ENRICHMENT SPEAKER!**

**CALL (816) 235-1272**

## AN EXPO, A FAIR, AND A CONFERENCE

On Oct. 1-2, the mathematics coordinator attended the 3rd Annual Greater Kansas City Mathematics Technology Expo at Kansas City, KS Community College, as its Planning Committee Chairman.

Tuesday evening, Nov. 16, from 6-8 pm, Richard Waring, the mathematics coordinator and Larry Harding, our MPI physics teacher from Fort Osage High School, manned a display of 2 MPI computers, and 7 physics experiment set-ups at the Fort Osage Technology Fair. Over 750 people appeared. In addition this year, in order to increase the number of potential MPI students attending, the MPI printed and distributed a flyer announcing our attendance at the Fair to EVERY Fort Osage High School sophomore and junior.

Finally, during the same period of time, Nov. 15-17, Sheri Adams attended the Fall Conference for Implementing Technology Preparation.

### 'LOST' MPI ALUMNI CAN YOU HELP US?

Can you provide ANY information about the following former MPI students? We particularly need to know whether they have graduated from college, which college, and with what degree. Any hint (phone number, address, college, parents' address, etc.) will be appreciated. We use this data to report to our sponsors on the impact of the MPI. Call our secretary Doris at (816) 235-1272 if you can help, or drop us a note.

#### Year 1, 84-85:

Paul Eaton	Russell Franks
Michael Herman	Ken Hylton
Lori Lindsey McCane	Neal Malbaff
Brian Marriott	Phil Mendenhall
Tim Merkel	Frank Milliren
Rick Mosley	Melissa Nevin
Thong Than Nguyen	Dan Norris
Hung Pham	Kevin Prosser
Gaylord Salisbury	Tim Sartain
Todd Schannuth	Stephen Schultz
James Sharp	Carla Shivers
Eugene Tiebout	Curt Wilson

#### Year 2, 85-86:

Sam Accurso	Rolando Aguilera
David Amadio	Rickey Black

Robert Chow	Stacey Evans
Gladys Gilford	John Ha
Antoinette Hill	Twana Jenkins
Felicia Knowles	Minh Chi Ngo
Christine Mazurkewycz	Scott Qualls
Robert Quillen	Mark Stinson
Sol Thongkham	Bob Weinman
LaTrice Williams	Paul Williamson

#### Year 3, 86-87:

David Chancellor	Amy Modrell
Caroline Noah McBride	Linh Phan
John Pritchett	Cong Tran
Hoang Tran	Marci Wegener

#### Year 4, 87-88:

Jim Brown	Carl Bryant
Eric Butcher	John Carmack
Gary Carty	Gerald Cloe
Mike Doss	Jesse Goyette
Kim Greathouse	Mike Horak
Michele Kliebert	Dana Meade
Zina Mickles	Kelly Nance Johnson
Jamie Ryan	Keith Smith
Jason Stabenow	Dinh Tran
Jeremy White	Kevin White
Vanessa White Kemper	Desmond Wilkins
Lloyd Williamson	

#### Year 5, 88-89:

Michael Atty	Russell Browning
Melissa Chance	Sean Combs
Kevin Crosby	Tho Doan
Hang Du	Brian Edgar
Jay Eifler	Jesse Hafemeister
Lyle Harris	Angel Kelly
Brian Kelsay	Steve Kuhn
Brian Lacher	Andrea Linville
Rachel Mack	Jon Morgan
Chad Morley	Todd Myers
Huong Nguyen	Loan Nguyen
Tang Nguyen	Tuan Nguyen
Cameron Perkins	Van Phung
Cindy Roby	David Roller
Mike Schmidt	Candi Smith
Anthony Thornton	Thaison Tran
Patrick Windes	Stephanie Young
Rafael Zarate	

#### Year 6, 89-90:

Chris Harder	Tu Viet Nguyen
Thuy Phan	Efaramia Vele, Jr.
Chris Walker	

#### Year 8, 91-92:

Dung Dang

### ENRICHMENTS

#### FOLLOW UP

On Oct. 15, Bill Fields, Director of Chemical, Biological and Radiation Safety at UMKC spoke on **RADIOACTIVITY AND ITS EFFECT ON HUMANS**. He discussed alpha, beta,

and gamma rays, radon in houses, the effect radium had on the bones of young high school girls working as radium dial painters earlier in this century, and that the maximum suggested whole-body annual radiation exposure is 5000 milli-rems. [The average exposure from all sources in Kansas City, MO is about 200 milli-rems per year.]

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On Oct. 29, although Larry Deaton was ill and unable to give his very popular talk on BIRTH ORDER, we were pleased, and lucky, to find Pam Deters [BS Computer Science] and her husband Steve Koop [BS Aeronautical Engineering] (both MPI 84-85), momentarily back in this region before continuing on to Japan (!) for 3 years, available to informally discuss with our current MPI class their **COLLEGE YEARS AND CAREERS**.

Some student comments were:

--Mostly they talked about whatever we wanted. They told us about their jobs and how they got where they are. Each attended college for five years, and Pam did a lot of co-oping. Now they are getting ready to move to Japan for three years. Both changed their career choice since starting college. Having it so informal was great.

--We learned about choosing a major and that it's okay to change your major.

--The three things the work world will look at are your college GPA, your work experience, and the activities you have participated in. I feel like their talk was beneficial. I learned more about requirements for the work world. I also enjoyed the informal setting.

--This was wonderful. The speakers were really informative. They were believable because of their experience.

--We talked about life after MPI and how MPI helps you for the future. Get involved in college. Don't just sit around your dorm watching cartoons. If your plans for life suddenly change, let it happen. You'll be much happier. I loved Steve's point about going over all his classes every day, every week, until test time, then he didn't have

to study. The most important lesson I'm learning is to study a little every day because in college you can't cram the night before.

--They gave us a good idea of what life is really like in college and in your life afterwards. They said some things that were really helpful to know and that I hadn't heard before. It was nice to get a perspective from someone other than teachers and parents.

--College isn't there to just study, it's to gain a better focus of what you want to do.

--I liked the moral ethics that they stressed, like never jeopardizing my integrity. I agree so much with this.

--I enjoyed the blunt honesty of both of the speakers. I enjoyed this week's enrichment because I could relate to everything that was said. I found it fascinating how they met later in life (after MPI) and fell in love, and also the frequency of their travelling.

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Finally, Nov. 12, on a rainy, gray day, we made our annual 8-hour field trip to the **NUCLEAR RESEARCH REACTOR** at the University of Missouri-Columbia (MU) campus, where in addition to seeing the reactor and hearing about its operation, we ran into Chris Pickens (MPI 86-87) now employed there. We then toured the MU Engineering Dept., briefly seeing, among other sights, the Sun Tiger, MU's solar car, which placed 19th overall in the June 20-26, 1993 Sunrayce from Dallas to Minneapolis, a distance of 1055 miles, and placed 3rd among first-generation entries.

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#### UPCOMING

On Dec. 10, Frank Booth, a forensic chemist with the Kansas City Regional Crime Center will speak on **SCIENCE IN THE CRIME LAB**, as he has done for us for several years. His scientific approach to the detection of crime always appeals to our students.

Wed. Jan. 5 will see our 9th Annual **PANEL DISCUSSION AND REUNION**, when former MPI students return and share their experience and advice

with this year's class. We expect to have on the panel both an MPI medical doctor, and a student currently in her 2nd year at MIT.

On Jan. 14, 1994, Dave Weiliczka, a UMKC physicist, will once again bring his presentation on **LASERS AND HOLOGRAMS**.

Finally, on Jan. 28, Ed Kiker, who spoke Oct. 1 on LUNAR MINING AND SPACE TRANSPORTATION, will return for a 2 hour discussion of **THE DESIGN PROCESS IN CYBERNETIC SYSTEMS**.

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### **WE HEAR FROM PAST STUDENTS**

**PAT LIANG (86-87)**  
(Univ. of Indiana Medical School)

10-20-93 e-mail:

"As I read the recent (MPI) e-mail message ... and see some addresses of familiar persons, I can't help but recall the friendships I made through MPI. Not only did I learn survival skills vital to college and graduate school, but I gained a great deal in the way of interpersonal relations.

I am currently in the eighth week of my twelve week internal medicine clinical rotation as a third year medical student at Indiana University Medical Center. Everything is going very well and I am keeping extremely busy... twelve hour shifts daily with every fourth day on night call. I have not really had a day to myself in nearly six weeks and am looking to be off in mid-November. I have finished a rotation in psychiatry and will proceed to pediatrics in December and January.

Looking back, I am astounded at the amount I really learned at MPI. I do not mean just the academic challenge, but the chance to interact daily with persons from other schools in the area. It taught me how, on a basic level, to mold the manner in which I approach others. I have found this to be extremely important to clinical medicine and (it) has made this phase of medical school all the more enjoyable."

**EUGENE BAE (86-87)**  
(BS Electrical Engineering)

10-20-93 e-mail:

"It's good to hear from you and MPI again. The first item of business concerns my new e-mail address. I have since graduated from MIT with my M.S. in Technology and Policy and currently find myself working in Washington, DC for the US Department of Defense.

I have joined the Pentagon in the Office of the Deputy Under Secretary of Defense for Environment Security as a Clinton Appointee. Yes, that would make me a full-fledged supporting Democrat! My responsibilities focus on identifying and implementing innovative technologies to execute the Department's environment goals. Furthermore, my duties include activities in international programs, dual-use technologies, and defense conversion.

After some period of time (to be determined), I plan to return to school to complete my doctoral studies in a technology policy field, utilizing this as well as other related experiences.

Unfortunately, I am going to have to pass on the January 5 invitation to attend the MPI reunion. As a dedicated government employee, I will be hard at work while my old friends gather together and reminisce the good ol' days. Say hello to all, and may MPI continue to train young minds in the fortunes of math and science!"

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**TODD JOHANN (92-93)**  
(History, English Major)

9-19-93 e-mail:

"If possible will you please send a copy of the newsletter to my box at Dartmouth..."

Also please pass on a word of "Hi" from me to all the instructors. Finally, I have just finished a placement exam for math. It was tough. I recommend that all students enrolled at the MPI that are going to private schools take the AP examination. A score of 2 on the BC will place one out of the first math course at an Ivy League college! I'll e-mail where I have placed when I find out."

10-31-93 e-mail:

"I need your help, please. I am trying to decide which math I am ready for. These are my choices: Math 3: Introduction to Calculus, Math 8: Calculus and Linear Algebra, Math 13: Multivariable Calculus.

I am trying to figure out my (times) for winter term, but more importantly I must show proof for credits before the end of the fall term.

On the basis of my work at MPI should I be entitled to credit for any of these courses (Math 3?) if you believe so and I were to give you the name of a Professor to e-mail, would you?

Thank you for taking the time to read these course descriptions. Please send a warm 'Hi' to all the great teachers back at MPI. None of the Professors here in the IVY come even close to matching the quality and commitment of the MPI staff!"

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**LAURA DILLEY (91-92)**  
(Linguistics, Brain and Cognitive Sciences Major)

11-22-93 e-mail:

"Yes, life here is intense. I won't kid you about that. But to sort of ease you in to MIT life, freshman year is entirely pass/no record. So frosh year, an A or B or C equals a P for "pass." To give you an idea, I took calculus 1 and 2, physics 1 and 2, Intro to Solid State Chemistry, German III, 6.001 (structure and Interp. of Computer Programs) and Philosophy of Language last year, and passed everything. I had a social life - I went out to see my boyfriend (Jason Anderson - do you remember him?) every other weekend and was in the MIT Symphony, etc. In addition, I got a job in November of last year working for a speech researcher. I will talk about this more a little later. So as you can see, I had my share of activities outside of normal, day-to-day classes.

In general, I think I've gotten an excellent education here so far. The teaching ranges from good to very good to excellent, mostly centered around very good to excellent. The

professors they get to teach intro undergrad courses at MIT are generally extremely well-screened, so not only are they experts in their fields, but they know how to teach, as well. Their involvement in research usually does not, in my opinion, cause them to be a less effective teacher. It does sometimes limit their availability outside of class, but that's what TA's are for. TA's hold "recitation sections" of about 30 people, so there is a more one-on-one variety of instruction. (Lectures to intro calc & physics, in contrast, can have 400-500 people). Many of the TA's are grad students, so it's a mixed bag whether you'll get a good one or not. But it's easy to switch sections, so it's not a big deal. Oh, also, tutoring is available in just about any subject you can think of through the office of Minority Education (not just limited to minorities). I got tutoring last year in physics - lots of people do it. Oh, and by the way, the MPI did a great job of preparing me for 18.01 (Calculus I). I took Calc I at the MPI and most of 18.01 was a relaxing review for me. The other versions, you may have read, are 18.011 and 18.012, which roughly correspond to "calculus with a strenuous amount of theory" and "calculus from hell with a butt-load of theory." I have friends who took these courses and spent most of the semester pulling out their hair. Another option (if I would have taken the placement exam) would have been to take Calculus II (18.02). I think I could have managed in here first semester, but it would have been rough. There is some stuff that they expect you to know which the MPI teaches (only) in Calc II.

About MIT's emphasis on research - having been here a year now, I can't think of it as anything but a GOOD thing, because opportunities to get involved in research carry over to the undergrads. There is a program called UROP (Undergraduate Research Opportunities Project), which you may have seen in the mailers. This program is set up to make it extremely easy for undergrads to get involved in the real goings-on of the Institute. You can get paid (\$6.90+ an hour) or you can get credit for working at a UROP. I have heard it said that 80% of MIT students have a UROP at some point in their MIT careers. Anyway, I've had a UROP now

for about a year; I work for a speech researcher. Over the summer I got to go to a linguistics conference with her at Ohio State U. I may be writing a paper soon. Oh, and I make \$9/hr.) That's nice dough for a college student.

Boston, Boston..what to say about Boston except, I love it!? There is sooo much to do. There's Harvard Square, where all the hip college people hang out, street musicians, tourists, you name it...there's Faneuil Hall, great historic place and shopping area...there's the North End, authentic Italian section with TONS of great restaurants. You can get just about anywhere by the T, Boston's subway system. It costs \$.85. Plus, there's a ton of other colleges in Boston. What's the estimate I heard..500 in a five-mile radius? Something amazing like that. Other stuff...every major music group comes through Boston, whether your tastes are classical or alternative, or whatever... There are an amazing number of great concerts (if you have the time and money). There's also quite a few 18/19+ clubs. I don't follow that though.

Just the fact that there are so many college people around in such a happening city is very invigorating. But realistically, there aren't that many people that go off campus every weekend. This is partly because of the work (already discussed) and partly because many people (sadly) just don't take advantage of Boston/Cambridge. What people DO do: sports, club activities, fraternity/sorority activities (I almost joined a sorority), music groups, etc. It's one of those deals where you are as active as you want to be, and have time for. There is no lack of activities, but a scarcity of time to do them all.

But all in all, MIT's great. I know I made the right choice for me."

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**ERIC SWEARINGEN (92-93)**  
(Bio. Chem. Engineering Major)

10-11-93 e-mail:

"Hola! How are you doing? This is Eric Swearingen if you haven't figured it out yet, and I thought that I would give you a

letter just telling you how things have been going during my first months of college. To put it plainly, this whole idea of college really came as a surprise to me because the work that I do is just like that of MPI, but it is away from home and a lot of my friends. Calc II for instance was a bit harder for me to grasp, because I usually worked the mysteries of Calculus with many of my friends. But they're all gone right now. Don't worry, though, I've made many more here at the Fraternity. Speaking of Fraternity, I joined Lambda Chi Alpha at the end of last summer, and right now I'm going through the stages of being a pledge, which is a new concept for me, but I grabbed on quickly to our traditions and ideals, and after initiation in a few weeks, it will all be over. Well, back to Calc III, because I'm sure you are interested in how I am doing in that. First test was over vectors in two and three and four dimensions, along with a little on surface areas and planes... I got a 78, but on the curve it was an 85 which helped a bit. Anyway, on the second test, I grabbed some files and studied them profusely, and scored a 100. I pissed off a few people, but I was happy with what I got. I guess I'm getting used to this college life after all. In all of my other classes I'm making As and Bs, and I'm completely content with what I got. I must say, the MPI really helped out with my study skills and my dealings with long, drawn-out, comprehensive tests that you don't see too much of in High School. Well, better go, got a football game to go to. Keep a smile, and don't forget to write back. Hear from you soon, and later on I'll tell you about a girl I met here... Rolla of all places."

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**KRISTI BASS (92-93)**  
(Physical Therapy, Psychology Major)

9-20-93 e-mail:

"Hey there, how's it going? How are things at the MPI? I'm sure they're going great.

Guess what! I found out my grade for my Chem test that I took last night. I got an A! I was so happy. Of course, it was a pretty easy test because all the information was a review, but still, I got a 99.

That was after he added the bonus points for some quizzes we had to hand in with the test.

Last Wednesday I had a Psych test and it was super hard. I studied a lot. Well, I got it back today and it wasn't so good. I managed to pull a C, but I need to do better than that if I want to keep my scholarship. I found a girl to study with in my class, so that should help some. I just need to start studying like you're supposed to--not the night before the test.

Today I had a Bio test, which I studied for for about six hours yesterday. It wasn't that difficult, but I haven't seen my grade yet either. Hopefully it will be good news. If not then I know next time what I need to do differently.

You are probably sitting there laughing at me because I still haven't learned how to study. I know how to study, I just haven't wanted to do it yet. I learned all this stuff last year at the MPI, it's just that I'm kind of lazy right now and don't want to spend two hours a night studying for a class when I don't have a test the next day. And obviously if I studied for two hours a night, then I wouldn't have to cram for a test. But that's me.

Well, I better get going. I have a Psych paper due Wednesday and I need to get started on it. It's not a major paper, so don't think I'm procrastinating. If I was procrastinating, I would wait until tomorrow to do it."

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### MPI ALUMNI E-MAIL ADDRESSES

Here are all the MPI Alumni e-mail addresses currently known to us, listed alphabetically by year:

- (84-85) **Jody Breshears**  
75540.3172@compuserve.com  
or breshear@umaxc.weeg.uiowa.edu  
Univ. of Iowa
- (84-85) **Pam Deters**  
70724.2143@compuserve.com  
Japan
- (84-85) **Doug Bullock**  
bullock@math.ucsb.edu  
Univ. of CA - Santa Barbara

- (84-85) **Sheryl Nance**  
snance@emx.cc.utexas.edu  
Univ. of Texas

- 
- (86-87) **Eugene Bae**  
baee@acq.osd.mil  
The Pentagon
- (86-87) **Suzanne Breshears**  
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Texas Women's Univ.
- (86-87) **Ken Hill**  
khill@vax1.umkc.edu  
UMKC
- (86-87) **Pat Liang**  
pwliang@indyvax.bitnet  
Univ. of Indiana - Med School
- (86-87) **John Winkler**  
jwink@uxh.cso.uiuc.edu  
Univ. of Illinois

- 
- (90-91) **Jason Anderson**  
jayscott@wpi.wpi.edu  
Worcester Polytech
- (90-91) **Matt Roberds**  
mroberds@vax1.umkc.edu  
UMKC
- 
- (91-92) **Laura Dilley**  
elsiedee@athena.mit.edu  
MIT
- (91-92) **Chris Gross**  
c594041@mizzoul.missouri.edu  
UM - Columbia
- (91-92) **Kristi Lynn**  
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UM - Rolla

- (91-92) **Tony Prettejohn**  
c593863@mizzoul.missouri.edu  
UM - Columbia
- (91-92) **Jeff Schreiner**  
cdt1599@falconnet.usafa.af.mil  
US Air Force Academy
- (91-92) **Sonya Smith**  
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Macalester College

- 
- (92-93) **Kristi Bass**  
stu93826@rcckhrst1.bitnet  
Rockhurst College

(92-93) **Todd Johann**  
Todd.E.Johann@Dartmouth.edu  
Dartmouth College

(92-93) **Eric Swearingen**  
s117312@umrvma.umar.edu  
UM - Rolla

**MPI E-MAIL ADDRESS:**

rdelaware@vax1.umkc.edu

"I'm so glad that I did not let my fear of the MPI get the best of me at enrollment time. The entire atmosphere at MPI is great--the instructors are all friendly and ready to help; the courses are challenging, but not overwhelming; and the day to day variety along with enrichment programs keep things from becoming monotonous. Of course, then there is my favorite part of the MPI--getting to know lots of great seniors from other schools. The MPI is a great opportunity, one which I will encourage many students to take advantage of in the future."

**Rachel Hayes**  
Fort Osage High School  
Fort Osage School District

**MORE 93-94 STUDENT IMPRESSIONS**

"I think that MPI has taught me to study at least ten minutes every day. MPI is tough but if you pass the classes it would be the most rewarding."

**Phanna Ly**  
East High School  
Kansas City School District

"MPI has forced me to push my knowledge and patience to their limits."

**Jill Dawson**  
Truman High School  
Independence School District

"My impression of MPI changes every day. On lecture days I look confused, on problem solving days I either smile or frown a lot depending on the assignment, and on test days my face (and my mind) are totally blank."

**Joanna Tucker**  
Wm. Chrisman High School  
Independence School District

"You must enter MPI with a determination to learn. It can be easy (or not so hard) if you put your best foot forward. Do not lose track of the lectures, review your notes, and do your homework every night. If you do not understand something, **ASK!** With these in mind, you will do good at MPI."

**Trang Tran**  
Northeast High School  
Kansas City School District

**A SOLUTION TO  
MATHEMATICS CHALLENGE #30**

Recall the problem statement:

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If you toss darts at a target and each dart can only yield either 4 points or 9 points, what is the largest score that you canNOT ever make? (Be sure to justify your answer.)

[From: Vena Long]

**SOLUTION:**

I

The easiest solution runs as follows:

First, observe that if any four CONSECUTIVE positive integers can be obtained as scores, then ALL succeeding ones can be obtained. [For instance, if  $n$ ,  $n+1$ ,  $n+2$ ,  $n+3$  are known to be possible scores, then the next number  $n+4$  is clearly also a possible score, and so on.]

Second, find by trial and error four such consecutive integers. This may take some time. In fact the first such four are:  $24 = 4 \cdot 6$ ,  $25 = 9 + 4 \cdot 4$ ,  $26 = 9 \cdot 2 + 4 \cdot 2$ , and  $27 = 9 \cdot 3$ . So, the largest positive integer (score) that is NOT a sum of (possibly zero) 4's and 9's is: 23.

II

An alternative, but less elegant solution is the following:



Any positive integer can be written as  $9m + 4n + k$ , where  $m, n = 0, 1, 2, 3, \dots$ , and  $k = 0, 1, 2$ , or  $3$ . [Just divide a given positive integer by 9 to get  $m$ , divide its remainder by 4 to get  $n$ , and what's left is  $k$ .]

If  $k = 0$ , we're done, because then the positive integer in question is just  $9m + 4n$ , clearly a possible score.

If  $k = 1$ , and  $n \geq 2$ , take 8 from  $4n$ , add it to  $k = 1$ , getting 9, add this to  $9m$ , and we're done. If  $k = 1$ , but  $n < 2$ , and  $m \geq 3$ , take 27 from  $9m$ , add it to  $k = 1$ , getting 28, add this to  $4n$ , and again we're done. The maximum remaining  $k = 1$  case is:  $9 \cdot 2 + 4 \cdot 1 + 1 = 23$ .

If  $k = 2$ , and  $m \geq 2$ , take 18 from  $9m$ , add it to  $k = 2$ , getting 20, add this to  $4n$ , and we're done. If  $k = 2$ , but  $m < 2$ , and  $n \geq 4$ , take 16 from  $4n$ , add it to  $k = 2$ , getting 18, add this to  $9m$ , and we're done again. The maximum remaining  $k = 2$  case is:  $9 \cdot 1 + 4 \cdot 3 + 2 = 23$ .

If  $k = 3$ , and  $n \geq 6$ , take 24 from  $4n$ , add it to  $k = 3$ , getting 27, add this to  $9m$ , and we're done. Finally, if  $k = 3$ , but  $n < 6$ , and  $m \geq 1$ , take 9 from  $9m$ , add it to  $k = 3$ , getting 12, add this to  $4n$ , and again we're done. The maximum remaining  $k = 3$  case is:  $9 \cdot 0 + 4 \cdot 5 + 3 = 23$ .

So in all cases, 23 is the largest positive integer (score) that is NOT a sum of (possibly zero) 4's and 9's.

### A SOLUTION TO PHYSICS CHALLENGE #21

Recall the problem statement:

#### RUNNING A YELLOW LIGHT

Every driver will occasionally have to make a quick decision whether or not to stop at a yellow light. His intuition about this has been built up by many tests and some mistakes, but a calculation might reveal some situations where intuition will not help.

For some given light duration and intersection size, what combinations of initial speed and

distance require you to stop (or run a red light)? What range of speed and distance would allow you to make it through in time? Notice that for a certain range of these parameters you can choose either to stop or not. But there is also a range in which you can do neither in time, in which case you may be in a lot of trouble.

[From: The Flying Circus of Physics by Jearl Walker]

#### SOLUTION:

Upon approaching an intersection whose light has just turned yellow, you can stop using a maximum NEGATIVE acceleration, race through the intersection at some maximum POSITIVE acceleration, or maintain your SAME speed. Let's consider an example:

Suppose your car is moving at initial velocity  $v_0 = 20$  mph (30 ft/sec) when the light turns yellow, the intersection is 30 ft wide, the duration of the yellow light is 2 sec, and your maximum possible acceleration is either  $a = +10$  ft/sec<sup>2</sup> (for increasing your speed) or  $a = -10$  ft/sec<sup>2</sup> (for decreasing your speed and stopping). Assuming ideal conditions (for instance, that your engine instantly responds to a push on the acceleration pedal), we can calculate the distances to the intersection needed for your three options:

Letting "t" = time, "s" = distance [with the initial distance when the light turns yellow set as  $s_0 = 0$ ], and "v" = velocity [with initial velocity  $v_0 = 30$  from above], we have the standard equations of 1-dimensional motion:

$$\begin{aligned} \text{Acceleration: } a(t) &= \pm 10 \text{ ft/sec}^2, \\ \text{Velocity: } v(t) &= \pm 10t + v_0 \\ &= \pm 10t + 30 \text{ ft/sec} \\ \text{and Distance: } s(t) &= \pm 5t^2 + 30t \text{ ft.} \end{aligned}$$

During the 2 sec. that the yellow light is on, at full POSITIVE acceleration [ $a = +10$  ft/sec<sup>2</sup>] you would travel a distance of  $s(2) = 5(2^2) + 30(2) = 80$  ft. Since the intersection itself is 30 ft. wide, you would therefore have to be no more than  $80 - 30 = 50$  ft. away to race through.

In the case of full NEGATIVE acceleration [ $a = -10 \text{ ft/sec}^2$ ], since stopping means a velocity of  $0 = -10t + 30$ , we have that  $t = 3 \text{ sec.}$  are required to come to a full stop, during which time you would travel a distance of  $s(3) = -5(3^2) + 30(3) = 45 \text{ ft.}$  Since you must stop before reaching the intersection, you would have to be at least 45 ft. away to stop in time.

Finally, if you are between 45 and 50 ft. away from the intersection, you have either option.

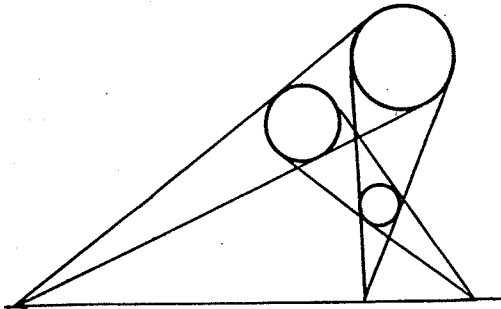
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### MATHEMATICS CHALLENGE #31

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Draw any 3 circles, no 2 of which are equal. There are then 3 PAIRS of circles. For each pair of circles, draw the 2 common outside tangent lines [see the sketch below] which of course, since the circles in the pair are not equal, must intersect somewhere in a point.

Show that the 3 intersection points so formed ALWAYS lie in a straight line.



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This problem is attributed to Professor John Edson Sweet, a famous engineer at Cornell University until his death in 1916.

[From: Ingenious Mathematical Problems and Methods, by L.A. Graham]

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### PHYSICS CHALLENGE #22

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#### PHYSICS AT THE BAT

If a batter hits a baseball too close to the end of the bat or too close to the neck of the bat, the impact will sting the batter's hands. At what point along the bat should

the ball be hit in order to minimize the sting?

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[From: Pasco Scientific Lab Notes]

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The MPI Newsletter is typed in WordPerfect 5.1 with MoreFonts and published five times a year on the first of the month during the months of August, October, December, February, and April at The Mathematics and Physics Institute, 600 W. Mechanic, Independence, MO 64050, phone (816) 235-1272, e-mail: rdelaware@vax1.umkc.edu. Please address all correspondence concerning this newsletter to 'MPI Newsletter'.

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