THE PENTAGON

A Mathematics Magazine for Students

CONTENTS

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What's the Fractal Dimension of *KME?*

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Presented at the 1991 National Convention and
awarded FIRST PLACE by the Awards Committee.

Introduction.

Fractal geometry is emerging as an exciting and fascinating subject
in mathematics. It is a brand new branch of mathematics, still in its
infancy. The term *fractal* itself was coined just a mere sixteen years ago
by a man named Benoit B. Mandelbrot, who is considered to be the
father of fractal geometry. Articles about fractals abound in
mathematical and scientific journals, as well as in some of the less
technical magazines being published. Beautiful, brightly-colored pictures
of them appear in calendars, posters, tee-shirts, books ... the list goes on
and on. They have been described by some as art. Dr. Mandelbrot claims
fractal geometry to be the geometry of nature. As more and more people
investigate it, applications of this new branch of mathematics are being
found in all the sciences, medicine, and the arts. Fractals were even used
to simulate alien landscapes in one of the Star Trek movies. The field of
fractal geometry is startlingly wide open for research and is an
unbelievably rich subject. This paper will just barely scratch the surface
of the subject. In it, I hope to introduce the topic at its most elementary
level. The classic fractals with which I begin this paper have actually
been around for many years before fractals were called fractals. (In those
days they were considered mathematical monsters!) The really beautiful
fractals that mesmerize the beholder are much too complicated to
investigate in a paper of this scope.

The Game of Chaos.

I would like to begin with a game that you may have seen before. It is called the Chaos Game. To set up for the game, mark three dots on a piece of paper, one at each of the upper corners, and one at the lower left corner (see Figure 1). These dots represent the vertices of a right triangle. Next, label one vertex with the numbers 1 & 2, another with 3 & 4, and the last with 5 & 6. Now we are ready to begin the game. The first move is to close your eyes in an attempt to ensure randomness as you mark a point anywhere on the page; we will call this point P_0. Next, roll a standard six-sided die. The outcome of the roll will correspond to one of the vertices we labeled. The randomness provided by the roll of a die is what puts the *chaos* in the Chaos Game. Now mark a new point, P_1, halfway between the previous point, P_0, and the vertex determined by the roll. Next, roll the die again to randomly choose a vertex and plot another point, P_2, halfway between P_1 and the new randomly selected vertex. This process of rolling a die and plotting a new point halfway between the last point and the randomly chosen vertex is *iterated* (repeated) until the player tires of the game.
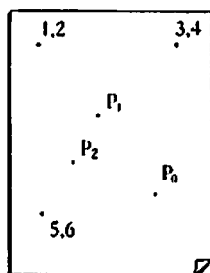
Figure 1. How to play the Chaos Game.
The first roll of the die was a 2 and the next roll was a 5.

Based on what you see happening, try to predict what image will emerge as the number of iterations performed approaches infinity. I suspect that if you have never seen this game played before, you would expect the final image to be a chaotic jumble of randomly placed points. You might be surprised to find that this is not exactly the case. Chaos is involved, but there is order to the chaos! After several thousand iterations the image that emerges is a classic fractal known as the *Sierpinski Gasket*. Figure 2 is a computer generated image of this fractal. It is not difficult to write computer or calculator programs to play this game. (A program for a TI-81 graphics calculator is provided in

Appendix 1 for interested readers.) This final image is called the *attractor* for this particular process because all the points plotted are attracted to this image by the rules of the Chaos Game.
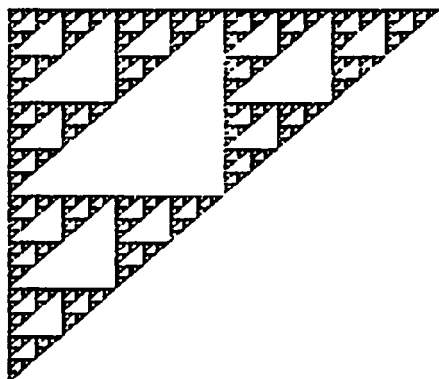
Figure 2. The Sierpinski Gasket.

What is a Fractal?

Now you may be asking yourself, "What is a fractal, anyway?" Benoit B. Mandelbrot provides the following definition: "A fractal will be defined as a set for which the Hausdorff-Besicovitch dimension strictly exceeds the topological dimension" (Mandelbrot, p. 15). Obviously, another more intuitive definition is preferable. Robert L. Devaney gives a description of fractals that will serve our purposes rather well, although it is not equivalent to Mandelbrot's definition. He describes a fractal as "... a geometric shape that has two special properties: (1) the object is *self-similar* and (2) the object has *fractional dimension*" (Devaney, p. 130).

Fractal Self-Similarity.

An explanation of these terms is in order here. An object is self-similar if a portion of the object is a miniature version of the whole object. For example, if you take a line segment, divide it into any number of congruent pieces, each piece will be a miniature replica of the original. Thus, a line segment is self-similar (see Figure 3). Furthermore, if you take a square and divide each side into any number of congruent segments, extending these divisions across the square will divide the square into smaller squares, each of which is similar to the original square, but on a smaller scale. We say that a square is self-similar. Extending this process to the cube in three dimensions, we find similar

results. Thus the line segment, the square and the cube are indeed all self-similar but they are not fractals according to Devaney. They clearly do not have fractional dimension, at least not by a Euclidean notion of dimension.
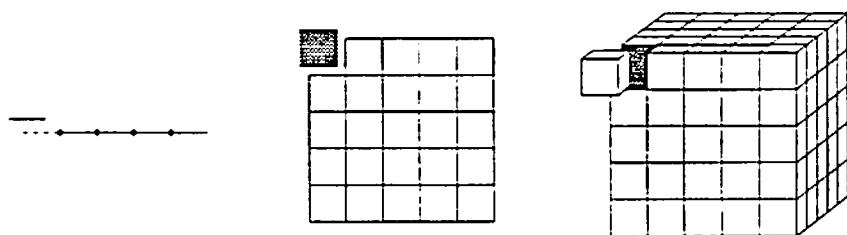
Figure 3. Self-similarity of line, square, and cube.

Moving into the realm of fractals, we will first turn our attention to another classic fractal called the *Koch Curve*. This figure is self-similar, but not on just any scale, as with the Euclidean objects we just examined. The best way to illustrate this idea is to show how the Koch Curve is constructed (see Figure 4(a)). We start with a line segment of unit length. Removing the middle 1/3, we replace it with two segments of the same length as the one we removed. Now we have 4 segments, each 1/3 the size of the original. In the next iteration, each of the new segments have their middle 1/3 section replaced by two more. We now have 16 segments of length 1/9. As the number of iterations of this process approaches infinity, we get the Koch Curve. Now, if we zoom in on a section of the curve and magnify it by a factor of 3, we get the Koch Curve back. That is why we say it is self-similar on a scale of 1/3 (see Figure 4(b)).

Stage 0   Stage 1

Stage 2   Koch Curve
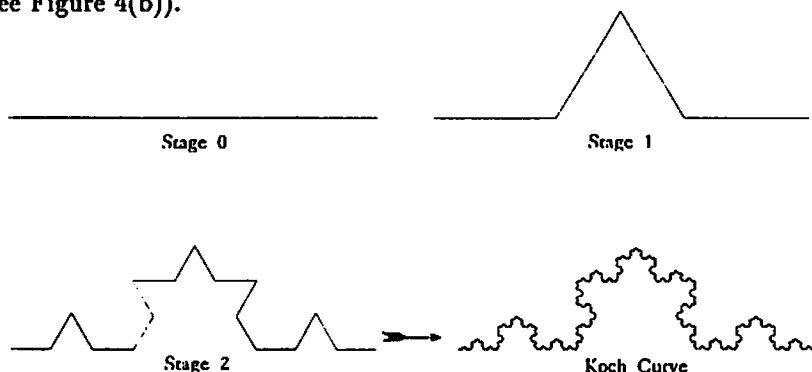
Figure 4(a). Construction of Koch Curve.

Figure 4(b). Koch Curve and magnification of a section.

Now we will turn our attention to our old friend the Sierpinski Gasket (Figure 2). Notice that each of the corners contains a small copy of the whole figure. In fact, the perimeter of each of the three copies is 1/2 the perimeter of the original figure, and each of the three small copies contain three smaller copies 1/4 the size of the whole, and so on. This fractal is said to be self-similar on a scale of 1/2.

What we find is that some self-similar fractals have a characteristic scale upon which they are self-similar.

Fractional Dimension.

Turning to Devaney's second fractal property, we will now explore the idea of *fractional dimension*. First, I must clarify that using the term fractional requires a loose interpretation of the meaning of the word. Here fractional dimension means having dimension not equal to an integer.

Recall that a point has Euclidean dimension (or as Mandelbrot calls it, topological dimension) of 0. A line segment has Euclidean dimension of 1 (length.) If you can picture some dust on a piece of thread, imagining each dust particle as a point, and the piece of thread as a line, then that collection of dust begins to take on another characteristic beyond the 0 dimension. The dust doesn't exactly cover the thread; there exists space between the particles. Dust on a piece of thread could be expected to have a fractional dimension somewhere between 0 and 1. Furthermore, if you again think of a length of thread as a line, and a piece of lace as a length of thread with lots of bends in it, then that line has something, some characteristic that goes beyond mere length. It begins to fill an area of the two-dimensional plane. Therefore, its fractional dimension is expected to be greater than 1, but it doesn't quite fill it, so its fractional dimension should somehow be less than 2. Similarly, a filled-in square is a surface that has the Euclidean dimension of 2 (length and width.) Likewise, a solid cube fills a region of space, giving it a Euclidean dimension of 3 (length, width, and depth.) Now, if you think of a sponge as a highly convoluted surface that begins to fill a

region of space, but doesn't completely fill that space, then that sponge would be expected to have a fractional dimension whose value is somewhere between 2 and 3.

Before examining the concept of fractional dimension in more detail, it must be emphasized that there are several accepted methods for finding fractal dimensions; we will start out using the *self-similarity dimension*, symbolized D_s. Recall the earlier discussion of the self-similarity of the line segment, square, and cube in Figure 3. If we divide the line segment into an arbitrary number of congruent pieces, say 5, and magnify a piece by a factor of 5, then we get the original segment back. The number of pieces is equal to the magnification factor raised to the first power. Next, if we divide a square's sides into 5 congruent segments and extend them across the square, we get 25 smaller squares. Magnifying one of the smaller squares by a factor of 5, we get the original square back. The number of small squares is equal to the magnification factor raised to the second power. Finally, if we take a cube and slice it up so that each edge is divided into five congruent segments, we get 125 smaller cubes, each of which can be magnified by five to return the original cube. The number of small cubes is equal to the magnification factor raised to the third power. Notice that the exponent in each of these examples is exactly the dimension of the object being examined. This is the idea behind the self-similarity dimension, D_s. In general,

$$\text{Number of pieces} = \text{Magnification}^{D_s}.$$

Using logarithms, we can solve for D_s as shown below:

$$D_s = \frac{\log(\text{Number of pieces})}{\log(\text{Magnification})}$$

(Devaney, pp. 144-45).

Recall that when we discussed the Koch Curve in Figure 4(b), we had four chunks that were small copies of the whole curve. Each chunk could be magnified by 3 to return a copy the same size as the original curve. Plugging these values into the above equation, we get

$$D_s = \frac{\log(4)}{\log(3)} = 1.262\ldots.$$

This is a value we would have expected. Because the curve is more intricate than a 1-dimensional line segment (it wanders around on the plane some), we would expect its fractal dimension to be greater than 1. But it doesn't come very close to filling an area of the 2-dimensional

plane, so we would expect the curve's fractal dimension to be much smaller than 2. The Koch Curve is indeed a fractal. It is self-similar and it has a fractional dimension of about 1.262.

Now the Sierpinski Gasket of Figure 2 comes a little closer to filling a 2-dimensional triangle, so we will expect it to have a fractal dimension closer to 2. Recall that we have 3 sub-triangles that can be magnified by 2 to get back a copy the same size as the original. Plugging those values into the self-similarity dimension equation, we get

$$D_s = \frac{\log(3)}{\log(2)} = 1.585.\ldots.$$

The Sierpinski Gasket is therefore a fractal -- it is self-similar and its fractional dimension is about 1.585.

We have now investigated two bonafide fractals. Both the Sierpinski Gasket and the Koch Curve satisfy Devaney's two criteria for being a fractal: self-similarity and fractional dimension.

Generating Fractals with Geometric Transformations.

I will now examine general geometric transformations which can be used to generate certain fractals on a computer. The computer program which motivates this discussion is due to Ray Barton, a mathematics teacher from Utah. The program plots a series of points that collectively make up a fractal. The point $P_{n+1} = (X_{n+1}, Y_{n+1})$ is obtained from the preceding point $P_n = (X_n, Y_n)$ using the following two recursive equations:

$$\begin{cases} X_{n+1} = X_n \cdot R \cdot \cos(A) - Y_n \cdot S \cdot \sin(A) + H \\ Y_{n+1} = X_n \cdot R \cdot \sin(A) + Y_n \cdot S \cdot \cos(A) + K \end{cases}$$

These equations ought to look familiar. They are modifications of the rotation equations that we studied in calculus, but with scaling factors multiplied in and translations added. Since they can do more than merely rotate a point, they are called transformation equations. The table below explains the variables in these equations.

Recall the Chaos Game that we played at the beginning. The roll of a die randomly selected one of three transformations for plotting each new point. The pair of equations above can be used in a computer program to define a transformation for each new point to be plotted.

Variable	Represents
X_{n+1}	X coordinate of the new point
Y_{n+1}	Y coordinate of the new point
X_n	X coordinate of the old point
Y_n	Y coordinate of the old point
R	Horizontal scaling factor
S	Vertical scaling factor
A	Angle of rotation
H	Horizontal translation
K	Vertical translation

Table of variables used in the transformation equations.

To make a computer play the Chaos Game, we need to first define the three transformations. This can be done by setting up three pairs of transformation equations and plugging in appropriate values for each variable in each equation. The random function of a computer language can be used to randomly choose the coordinates of a beginning point. That point can then be plotted, and its coordinates plugged into a randomly selected pair of transformation equations to produce the coordinates of a new point, which can be fed into another transformation. This process can be iterated.

In Appendix 2, I have listed a program written in GW BASIC for playing the Chaos Game. In it, the horizontal and vertical scaling factors, R and S, are set equal to 1/2 in all three of the transformations. (Recall that at each level of magnification, the sub-triangles of the Sierpinski Gasket are 1/2 the size of the triangles at the next higher level.) Also, the horizontal and vertical translations, H and K, are set to $\pm 1/2$, depending upon which transformation we look at. (Remember each new point was plotted halfway between the old point and the vertex chosen?) The angle of rotation, A, is set to 0. (Rotation does not come into play in this particular game.)

Transformation	Scaling Factors		Angle of	Translations	
	Horiz.	Vert.	Rotation	Horiz.	Vert.
	R	S	A	H	K
1	0.5	0.5	0	-0.5	0.5
2	0.5	0.5	0	0.5	0.5
3	0.5	0.5	0	-0.5	-0.5

Transformation parameters used in the Chaos Game (Barton, pp. 524-526).

A Fractal Called *KME*.

Now I would like to investigate a fractal of my own creation. It is shown in Figure 5. It should be obvious why I call it *KME*. Notice the self-similarity of this fractal. The whole thing spells out *KME*, but also each piece of each letter spells out *KME*, and each piece of each of those letters spell out *KME*, and so on. Theoretically, it contains infinite detail, but in reality, the detail is limited by the size of the pixels on my computer screen. This fractal was made using eleven transformations. Each transformation is responsible for a piece of a letter. The parameters I used are summarized in the following table.
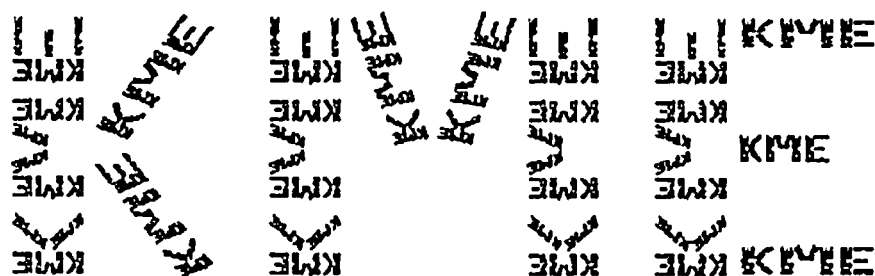
Figure 5. *KME* Fractal.

Transformation		Scaling Factors Horiz. Vert.		Angle of Rotation	Translations Horiz. Vert.	
		R	S	A	H	K
K	1	0.4	0.2	$\pi/2$	-0.855	0
	2	0.2	0.1	$\pi/3$	-0.625	0.2
	3	0.2	0.1	$2\pi/3$	-0.625	-0.2
M	4	0.4	0.2	$\pi/2$	-0.295	0
	5	0.2	0.1	$7\pi/12$	-0.11	0.2
	6	0.2	0.1	$5\pi/12$	0.08	0.2
	7	0.4	0.2	$\pi/2$	0.27	0
E	8	0.4	0.2	$\pi/2$	0.55	0
	9	0.15	0.1	0	0.8	0.335
	10	0.1	0.1	0	0.75	0
	11	0.15	0.1	0	0.8	-0.325

Table of parameters for the *KME* Fractal.

The first three transformations make up the *K*. The letter *K* is made up of three lines: a vertical line, and two angled lines. Transformation 1

sends points to the vertical line that makes up the spine of the K. Notice that its horizontal and vertical scaling factors are twice the value of the next two, which make up the arm and leg of the K. This is because the spine is twice as long and twice as wide as the other two components of the K. The angle of rotation in transformation 1 is $\pi/2$, making the spine vertical. The angle in transformation 2 is $\pi/3$. This is the arm of the K. And the angle in the 3rd transformation is $2\pi/3$. This is the angle of the leg of the K. The last two parameters, H and K, position each transformation horizontally and vertically on the screen. Notice that the horizontal translations are all negative values. This is because the K is positioned to the left of (0,0), the center. Transformation 1, the spine of the K, is centered vertically, so its vertical translation is 0. Transformation 2, the arm of the K, is centered above the x-axis, so it has a positive value for its vertical translation. Likewise, since transformation 3, the leg of the K, is centered below the x-axis, its vertical translation has a negative value. The other parts of the KME fractal were constructed similarly, with parameter values appropriate for each piece's size and position (see the program listing in Appendix 3).

Are we certain that KME is indeed a fractal? Recall the definition quoted from Devaney earlier. In order for an object to be a fractal by his definition, it must be self-similar and have fractional dimension. It is obvious that KME is self-similar and thus satisfies the first requirement, but in addition we must answer the question, "What is the fractal dimension of KME?" Although KME is self-similar, it is not self-similar on a uniform scale, as you can see by looking at the values in the scaling factor columns in the table of parameters. This fact made it impossible for me to use the formula for self-similarity dimension D_s which we defined earlier. Since this self-similarity dimension was not applicable, I had to examine dimension from a different perspective.

Fortunately, as was mentioned earlier, there are other ways to describe dimension. One interesting method that is sometimes used is called the *box-counting method* (Barnsley, pp. 190-93). This method involves placing a grid over the fractal and counting the number of boxes that contain any part of the fractal, and then putting successively finer grid sizes on the fractal and counting the number of smaller boxes that contain some of the fractal with each grid you use. After this is done, the data gathered is analyzed using a statistical process known as linear regression. Linear regression will provide us with a line that best fits the data points. The slope of the line of best fit is the *box-counting dimension* of the fractal being examined.

This method is actually an experimental way of estimating a fractal's

dimension. Because the counts often vary slightly with each repetition of the experiment, a more accurate estimate may be obtained by performing the box-count more than once. This is the method I first used to estimate KME's fractal dimension. I recruited the help of one of my professors, Ron Palcic, to help count boxes. We each counted boxes independently, and pooled our data in order to get a decent set of data points to analyze.

First, we placed a grid of squares each having sides measuring 5 units over my fractal and counted the number of boxes that contained some points, then we repeated the same process with grids of 4, 3, and 2 units respectively. Next, the logarithms of the reciprocals of the grid sizes and the logs of the box counts were computed. These logarithms make up the coordinates of the data points to be analyzed in the next step of the process. The results are summarized in the following table.

	Grid Size (c)	Box Count $N(c)$	log(1/c)	log[$N(c)$]
My box-count	5	119	-0.698970004	2.075546961
	4	179	-0.602059991	2.252853031
	3	279	-0.477121254	2.445604203
	2	511	-0.301029995	2.708420900
Ron's box-count	5	126	-0.698970004	2.100370545
	4	189	-0.602059991	2.276461804
	3	262	-0.477121254	2.418301291
	2	488	-0.301029995	2.688419822

KME Fractal box-count.

The values of the logarithms in the last two columns of the table can be treated as the x- and y-coordinates of eight data points. Now with these points, we can perform linear regression on them to find the equation for the line of best fit.

I entered the data from the last two columns of the table above into a calculator and had it run linear regression on the data. The resulting equation for the line of best fit is

$$y = 3.155522615 + 1.509777558x$$

(with correlation coefficient $r = 0.9973459727$ -- very close to 1!) The graph of the data points and the line of best fit is shown in Figure 6.
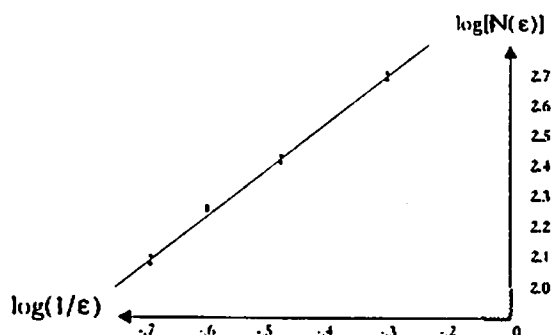
Figure 6. Linear regression on KME box-count data points.

The slope of this line, 1.509777558, is the box-counting estimate of the fractal dimension of the KME fractal. Is Devaney's second requirement satisfied? It appears so, but since this is but an approximation method it would be preferable to find an analytical approach to answer this question.

Now, since there are so many ways that fractal dimensions can be calculated, I was curious to see how this estimated dimension would compare with one calculated by another method. Michael Barnsley describes a measure of fractal dimension that utilizes the self-similarity properties of a fractal, but does not require the fractal to have self-similarity on a uniform scale, as does D_s as described previously. He describes a measure of fractal dimension that allows for scaling factors that vary from one transformation to another (Barnsley, pp. 185-186):

$$1 = s_1^d + s_2^d + s_3^d + \ldots + s_n^d$$

where d is the fractal dimension, n is the total number of transformations involved and s_i is the scaling factor for the ith transformation ($i = 1$, 2, 3, ..., n).

The problem I encountered with this method was that it requires *similitude*. In this case, that means that each transformation's horizontal scaling factor must equal its vertical scaling factor. In my KME fractal, the scaling factors not only vary from transformation to transformation, but within each transformation the horizontal and vertical scaling factors, R and S, are not always equal. Thus, KME does not have similitude. Since Barnsley's definition of dimension did not apply directly, I decided to use his definition to find upper and lower bounds of

the dimension of KME.

For the lower bound, I used min(R,S) for s_i in each transformation:

$$1 = .2^d + .1^d + .1^d + .2^d + .1^d + .1^d + .2^d + .2^d + .1^d + .1^d + .1^d.$$

To find the value of d, I set the expression on the left of the equation equal to y and let $d = x$. Next, I graphed it on a graphics calculator, and then graphed the line $y = 1$ over it. The x-coordinate of the point where these two graphs intersect is the value of d. Zooming in on this point, I found the lower bound of d to be approximately 1.21.

For the upper bound, I used max(R,S) for s_i in each transformation:

$$1 = .4^d + .2^d + .2^d + .4^d + .2^d + .2^d + .4^d + .4^d + .15^d + .1^d + .15^d.$$

I used the graphics calculator again to similarly approximate the value of the upper bound of d. This yielded a value for d around 1.86.

Since the actual dimension must fall between the bounds 1.21 and 1.86, KME indeed has fractional dimension. Since it is also self-similar, it is a fractal by Devaney's definition. But we still do not have an exact value for its dimension yet. We need a definition of fractal dimension that we can use with a fractal such as KME that does not have similitude. I propose a slight modification of Barnsley's definition: For self-similar fractals without similitude, use the average of the scaling factors R and S in each transformation in place of s_i (that is, $s_i = (R_i + S_i)/2$) in Barnsley's equation, above. Using this new definition with the KME fractal, we have:

$$1 = .3^d + .15^d + .15^d + .3^d + .15^d + .15^d$$
$$+ .3^d + .3^d + .125^d + .1^d + .125^d.$$

This approach yields a value for d of 1.5065... which is wonderfully close to 1.509777558 (the box-counting estimate).

In summary, Devaney describes a fractal as a self-similar object with fractional dimension. I found that KME meets both of these criteria and so it is indeed a fractal. In fact, in answer to the question posed in the title of this paper, I claim that the fractal dimension of KME is approximately 1.51.

for helping with my first fractal program and answering many practical questions, and my husband, Scott Wilson, for technical support with the graphics for this paper.

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Appendix 1. The Chaos Game played on the TI-81 Graphics Calculator.

```
ClrDraw                 If R=3              0->A
0->Xmin                 1->A                If R=1
1->Xmax                 If R=3              0->B
0->Ymin                 1->B                (X+A)/2->X
1->Ymax                 If R=2              (Y+B)/2->Y
0->X                    0->A                Pt-On(X,Y)
.25->Y                  If R=2              Goto 1
Lbl 1                   1->B                End
Int (3*Rand+1)->R       If R=1
```

Appendix 2. The Chaos Game played on an IBM compatible computer.

```
05 '**************************************************************
10 '*        The Chaos Game (Draws Sierpinski Gasket)
20 '*               Written in GW Basic
30 '* Modified by Mary Wilson from a program written by Ray Barton
40 '* and published in the October 1990 issue of Mathematics Teacher.
50 '*
60 '*               Transformation Parameters
70 '*
80 '*        X,Y           Coordinates of preimage
90 '*        X1,Y1         Coordinates of image
100 '*       R             Horizontal scaling factor
120 '*       S             Vertical scaling factor
130 '*       A             Angle of rotation
140 '*       H             Horizontal translation
150 '*       K             Vertical translation
160 '*
170 '**************************************************************
180 '*************** Give screen Cartesian Coordinates ************
190 ' -1 <= X <=1; -1 <= Y <=1
200 SCREEN 12: CLS
210 WINDOW (-1,-1)-(1,1)
220 '********* Randomly select an initial point and plot it ***********
230 RANDOMIZE: VIEW: CLS: KEY OFF
240 X = RND
250 Y = RND
260 PSET (X,Y)
270 '*************** Randomly select a transformation **************
280 CHOICE = INT(RND*3)+1
290 ON CHOICE GOSUB 370, 420, 470
300 '******************** Transform the point ******************
310 X1 = X*R*COS(A) - Y*S*SIN(A) + H
320 Y1 = X*R*SIN(A) + Y*S*COS(A) + K
330 X = X1: Y = Y1
340 PSET(X,Y)
350 IF INKEY$ = "" THEN 280
360 END
370 '******************** Transformation One ****************
380 R = 0.5: S = 0.5
390 A = 0
400 H = -0.5: K = 0.5
410 RETURN
```

420 '*********************** Transformation Two *****************
430 R = 0.5: S = 0.5
440 A = 0
450 H = 0.5: K = 0.5
460 RETURN
470 '*********************** Transformation Three *****************
480 R = 0.5: S = 0.5
490 A = 0
500 H = -0.5: K = -0.5
510 RETURN

Appendix 3. The Chaos Game modified to draw the KME fractal.

```
05 '***************************************************************
10 '*              The Chaos Game (KME Version)
20 '*                  Written in GW Basic
30 '* Modified by Mary Wilson from a program written by Ray Barton
40 '* and published in the October 1990 issue of Mathematics Teacher.
50 '*
60 '*              Transformation Parameters
70 '*
80 '*       X,Y          Coordinates of preimage
90 '*       X1,Y1        Coordinates of image
100 '*      R            Horizontal scaling factor
120 '*      S            Vertical scaling factor
130 '*      A            Angle of rotation
140 '*      H            Horizontal translation
150 '*      K            Vertical translation
160 '*
170 '***************************************************************
180 '************** Give screen Cartesian coordinates **************
190 ' -1 <= X <=1; -1 <= Y <=1
200 SCREEN 12: CLS
210 WINDOW (-1,-1)-(1,1)
220 '********* Randomly select an initial point and plot it **********
230 RANDOMIZE: VIEW: CLS: KEY OFF
240 X = RND
250 Y = RND
260 PSET (X,Y)
270 '************** Randomly select a transformation **************
280 CHOICE = INT(RND*11)+1
290 ON CHOICE GOSUB 370,420,470,520,570,620,670,720,770,820,870
```

```
300 '*********************** Transform the point ******************
310 X1 = X*R*COS(A) - Y*S*SIN(A) + H
320 Y1 = X*R*SIN(A) + Y*S*COS(A) + K
330 X = X1: Y = Y1
340 PSET(X,Y)
350 IF INKEY$ = "" THEN 280
360 END
365 '*********** Transformations 1-3 produce the letter K **********
370 '*********** Transformation One: The 'spine' of the K ***********
380 R = 0.4: S = 0.2
390 A = 1.5708: REM pi/2
400 H = -0.855: K = 0
410 RETURN
420 '**** Transformation Two: The angled line at the top of the K ****
430 R = 0.2: S = 0.1
440 A = 1.0472: REM pi/3
450 H = -0.625: K = 0.2
460 RETURN
470 '** Transformation Three: The angled line at the bottom of the K **
480 R = 0.2: S = 0.1
490 A = 2.0944: REM 2pi/3
500 H = -0.625: K = -0.2
510 RETURN
515 '******** Transformations 4-7 produce the letter M **************
520 '***** Transformation Four: The left-hand 'spine' of the M *******
530 R = 0.4: S = 0.2
540 A = 1.5708: REM pi/2
550 H = -0.295: K = 0
560 RETURN
570 '** Transformation Five: The angled line on the left inside the M **
580 R = 0.2: S = 0.1
590 A = 1.8326: REM 7pi/12
600 H = -0.11: K = 0.2
610 RETURN
620 '** Transformation Six: The angled line on the right inside the M **
630 R = 0.2: S = 0.1
640 A = 1.309: REM 5pi/12
650 H = 0.08: K = 0.2
660 RETURN
670 '***** Transformation Seven: The right-hand 'spine' of the M *****
680 R = 0.4: S = 0.2
690 A = 1.5708: REM pi/2
700 H = 0.27: K = 0
```

```
710 RETURN
715 '********** Transformations 8-11 produce the letter E ***********
720 '********** Transformation Eight: The 'spine' of the E ***********
730 R = 0.4: S = 0.2
740 A = 1.5708: REM pi/2
750 H = 0.55: K = 0
760 RETURN
770 '*********** Transformation Nine: The top of the E *************
780 R = 0.15: S = 0.1
790 A = 0
800 H = 0.8: K = 0.335
810 RETURN
820 '********** Transformation Ten: The middle of the E ************
830 R = 0.1: S = 0.1
840 A = 0
850 H = 0.75: K = 0
860 RETURN
870 '********* Transformation Eleven: The bottom of the E **********
880 R = 0.15: S = 0.1
890 A = 0
900 H = 0.8: K = -0.325
1000 RETURN
```

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Paper Winners from Previous Conventions

Harold L. Thomas, *National President*

Kansas Alpha

Pittsburg State University
Pittsburg, Kansas 66762

Based on remarks presented at the 1991 National Convention.

At the November 1989 meeting of the National Council, it was decided that we should recognize the 60th anniversary of the founding of Kappa Mu Epsilon at the 28th Biennial Convention to be held in April 1991 at the University of North Alabama in Florence, Alabama. One of the recognitions agreed on by the Council was to honor all first place paper presenters from previous national conventions and to invite them to attend the Alabama convention. Some assistance was provided from the national treasury to help with their travel expenses.

The first task faced in this endeavor was the location of these individuals. The files of the National Secretary revealed that the first award given for a convention paper was at the 1951 convention hosted by Missouri Alpha in Springfield, Missouri. Working with the corresponding secretaries of the chapters involved, addresses were obtained for eighteen of the twenty paper winners for the national conventions from 1951 through 1989. These individuals were then contacted and invited to attend the 1991 convention. If they were not able to attend, we asked for a brief summary of their activities since receiving their first place award. A total of thirteen responses were received with four of these able to attend the Alabama convention.

Through this article, we want to share highlights of the responses with our readers.

Hans J. Stetter (1951)

Professor of numerical mathematics at the Tech. U. of Vienna (Austria). Visiting professor at the U. of California, San Diego, Oxford

U. and the U. of Auckland (New Zealand). Received his PhD in mathematics at Tech. U. of Munich (Germany). Has authored two books and seventy research papers.

Raul Pettai (1953)

Joined Bell Telephone Labs in NJ after graduating from Colorado A&M. Later joined the Surface Communication Lab of RCA in NY and now is with Ratheon. Received the MSEE degree and presently works with satellite systems and ground terminals.

Patricia Nash McGreevy (1959)

Married for thirty years with six children and five grandchildren. Taught third grade for seven years and currently teaches freshman religion at Hayden Catholic High School in Topeka, KS.

Joan A. Carlow Johnson (1965)

Graduated from Marillac College in 1970. Has taught in San Francisco and on the Navajo Indian Reservation. Currently is the Special Ed Coordinator at the Tuba City, Arizona Boarding School. Received a masters in educational administration in 1989.

William J. Georgou (1971)

Currently resides in St. Paul, Minnesota.

Sandra K. Peer (1975)

Graduated from Washburn University in 1975. Has taught school in Topeka and Wichita, KS. Received the Distinguished Classroom Teaching Award from the Wichita Public Schools in 1986 and the 1990 Presidential Award for Excellence in Mathematics Teaching. Completed the masters degree in 1988.

Michele L. Hartman (1977)

Currently works as a technical staff specialist for Aerojet Electro Systems in Azusa, CA. *Attended the Alabama Convention.*

Michael Hewett (1979)

Served on the 1985 winning team at the ACM programming competition in New Orleans. Worked in research and development in artificial intelligence at Stanford U. Now works with IBM in Boca Raton, FL on Unix systems development. *Attended the Alabama Convention.*

David L. Fox (1981)

Commissioned officer in the USAF. Served as a C-141 pilot until 1989 and then joined Delta Air Lines as a pilot. Reactivated for military duty in support of Operations Desert Shield/Storm.

Thomas C. Bressoud (1983)

Graduated magna cum laude from Muskingum College in 1983. Received a masters degree in computer science in 1987 from Boston U. Worked at MIT Lincoln Lab on real-time systems. Currently working on the PhD in computer science at Cornell.

Susan Elaine Kelly (1985)

Graduated in 1985 from the University of Wisconsin - Eau Claire. Has almost completed the PhD in mathematics at Washington U. in St. Louis and would now like to find a job.

Lori Baskins (1987)

Attended Washington U. Law School in St. Louis and is an attorney in St. Louis. *Attended the Alabama Convention.*

Kevin Chartier (1989)

Currently in graduate school at Kansas State U. in Manhattan studying statistics. Is most proud of the fact that he is the father of 2 year old twins. *Attended the Alabama Convention.*

As can be seen from the above, past *KME* convention paper winners have led varied and interesting lives. We wish them continued success and satisfaction in all their endeavors.

UNA Welcomes KME

While Dr. John E. Atkinson (front left) of Missouri Lambda and National Secretary Robert L. Bailey look on, National Treasurer Jo Ann Fellin and Dr. George R. Mach of California Gamma pose for his wife at the 28th Biennial Convention held 11-13 April 1991 at the University of North Alabama. The sidewalk painting of the *KME* shield was the work of Vicky Locker, a mathematics and computer science major at UNA and a member of Alabama Beta.

Thank You Alabama Beta!

The Problem Corner

Edited by Kenneth M. Wilke

The Problem Corner invites questions of interest to undergraduate students. As a rule the solution should not demand any tools beyond calculus. Although new problems are preferred, old ones of particular interest or charm are welcome, provided the source is given. Solutions should accompany problems submitted for publication. Solutions of the following problems should be submitted on separate sheets before 1 August 1992. Solutions received after the publication deadline will be considered also until the time when copy is prepared for publication. The solutions will be published in the Fall 1992 issue of *The Pentagon*, with credit being given to student solutions. Affirmation of student status and school should be included with solutions. Address all communications to Kenneth M. Wilke, Department of Mathematics, 275 Morgan Hall, Washburn University, Topeka, Kansas 66621.

PROBLEMS 450-454.

Problem 450. Proposed by Bob Prielipp, University of Wisconsin-Oshkosh, Oshkosh, Wisconsin. Determine the smallest odd number $k > 1$ of squares of consecutive positive integers whose sum is a perfect square.

Problem 451. Proposed by Bob Prielipp, University of Wisconsin-Oshkosh, Oshkosh, Wisconsin. Find the value of the following limit.

$$\lim_{n \to \infty} e^{-n}\left(1 + \frac{1}{n}\right)^{n^2}$$

Problem 452. Proposed by Russel Euler, Northwest Missouri State University, Marysville, Missouri. Evaluate

$$\int \frac{\cos(x)}{\sin(x) + \cos(x)} \, dx$$

using as few steps as possible.

Problem 453. Proposed by Bob Prielipp, University of Wisconsin-Oshkosh, Oshkosh, Wisconsin. Prove that if a function f satisfies the equation $f(x + y) = f(x) \cdot f(y)$ for all real numbers x and y and if $f(x) = 1 + g(x)$ for all real numbers x where $\lim g(x) = 1$ as $x \to 0$, then $f'(x)$ exists for each real number x and $f'(x) = f(x)$.

Problem 454. Proposed by Charles Ashbacher, Hiawatha, Iowa. On page 29 of the book *Unsolved Problems in Number Theory* by Richard K. Guy there is the following problem: "Graham asks if $s(n) = [n/2]$ implies that n is 2 or a power of 3." (a) Prove the converse of this statement. (b) Prove that if $n = 2^j 3^k$ with j, $k > 1$ then n cannot satisfy the conditions of Guy's problem. Here $s(n)$ is the sum of the aliquot divisors of n (excluding n) and $[x]$ is the greatest integer function.

Please help your editor by submitting problem proposals.

SOLUTIONS 440-444 and OBG1-OBG5.

Problem 440. Proposed by Bob Prielipp, University of Wisconsin-Oshkosh, Oshkosh, Wisconsin. Let

$$I_1 = \int_0^1 \frac{1}{\sqrt{1 - x^2}} \, dx \quad \text{and} \quad I_2 = \int_0^1 \sqrt{1 - x^2} \, dx.$$

Without determining the value of either I_1 or I_2, prove that $I_1 = 2I_2$.

Solution by Mohammad K. Azarian, University of Evansville, Evansville, Indiana.

If $y = \sqrt{1 - x^2}$, where $0 \leq x \leq 1$, then the arc length formula gives us I_1, which is one-fourth of the circumference of the circle $x^2 + y^2 = 1$, which is $\pi/2$. On the other hand, $2I_2$ is twice the area of the region bounded by $y = \sqrt{1 - x^2}$, where $0 \leq x \leq 1$, and the x-axis. Thus $2I_2$ is the same as the area of the semicircle $y = \sqrt{1 - x^2}$, where $-1 \leq x \leq 1$, and the x-axis, which again is $\pi/2$. Therefore $I_1 = 2I_2$.

Also solved by the Alma College Problem Solving Group, Alma College, Alma, Michigan; Mohammad Parvez Shaikh, Kalamazoo, Michigan; the New York Lambda Problem Solvers, C.W. Post Campus, Long Island University, Brookville, New York; Richard A. Gibbs, Fort Lewis College, Durango, Colorado; and the proposer.

Problem 441. Proposed by Albert White, Saint Bonaventure University, Saint Bonaventure, New York. Al has a batting average of 0.333 while Bob, who follows Al in the batting order, has a batting average of 0.222. What is the probability that Al gets his next hit before Bob does? Assume that they alternate taking turns at bat and that the performance of one player does not affect the performance of the other player.

Solution by Mike Petree, Washburn University, Topeka, Kansas.

Suppose there is a game between A and B. A and B take turns with A going first. Let the probability of A winning any particular turn be a. Let the probability of B winning any particular turn be b. Then we have

$$P(A \text{ wins}) = a \sum_{k=0}^{\infty} \left((1-a)(1-b) \right)^k$$

$$= \frac{a}{1 - (1-a)(1-b)} = \frac{a}{a + b - ab} .$$

Similarly,

$$P(B \text{ wins}) = (1-a)b \sum_{k=0}^{\infty} \left((1-a)(1-b) \right)^k$$

$$= \frac{(1-a)b}{1 - (1-a)(1-b)} = \frac{b - ab}{a + b - ab} .$$

Substituting $a = 0.333$ and $b = 0.222$, we have P(Al getting the first hit) $= 0.6922$ and P(Bob getting the first hit) $= 0.3078$.

Also solved by the Alma College Problem Solving Group, Alma College, Alma, Michigan; the Eastern Kentucky University Problem Solving Group, Eastern Kentucky University, Richmond, Kentucky; Charles Ashbacher, Hiawatha, Iowa; the New York Lambda Problem Solvers, C.W. Post Campus, Long Island University, Brookville, New York; Richard A. Gibbs, Fort Lewis College, Durango, Colorado; and the proposer.

Editor's Comment. As pointed out by our featured solver and by the New York Lambda Problem Solvers, if $a = 1/3$ and $b = 2/9$, then the answer would have been 9/13.

Problem 442. Proposed by the editors. Find all primes p such that each nonzero element of $\mathbb{Z}_p$ is its own multiplicative inverse.

Solution by Bob Prielipp, University of Wisconsin-Oshkosh, Oshkosh, Wisconsin.

We shall show that 2 and 3 are the only prime numbers that satisfy the given condition. The specified condition is equivalent to

$$(*) \qquad\qquad x^2 \equiv 1 \text{ (mod p)}$$

for each nonzero element x of $\mathbb{Z}_p$ where p is a prime number. It is easily checked that (*) holds when $p = 2$ and when $p = 3$. Suppose that $p > 3$. Then $2 \in \mathbb{Z}_p$. If 2^2 were congruent to 1 modulo p, then p would divide $2^2 - 1 = 3$. This implies that $p < 3$ contradicting the fact that $p > 3$. This same proof would show that the only integers $n > 1$ which are such that each nonzero element of $\mathbb{Z}_n$ is its own multiplicative inverse are 2 and 3.

Also solved by the Eastern Kentucky University Problem Solving Group, Eastern Kentucky University, Richmond, Kentucky; Charles Ashbacher, Hiawatha, Iowa; the New York Lambda Problem Solvers, C.W. Post Campus, Long Island University, Brookville, New York; and Richard A. Gibbs, Fort Lewis College, Durango, Colorado.

Problem 443. Proposed by the editor. The integer 253 has the property that $253^4 = 4097152081$ and $253 = 81 + 20 + 15 + 97 + 40$. Find all three and four digit integers N which have this property where N is a perfect square or higher power. Note that digits are paired starting from the right.

Solution by Charles Ashbacher, Hiawatha, Iowa.

Let n be any integer having the property described in the statement of the problem. The following solution uses a computer program written in UBASIC to calculate solutions for integers n where the exponent ranges from 2 to 20. UBASIC is a public domain extended precision BASIC for use on IBM compatible computers. For the exponent 4, our

featured solver gives the following values for n:

$$133^4 = 312900721 \quad \text{and} \quad 3 + 12 + 90 + 7 + 21 = 133$$
$$166^4 = 759333136 \quad \text{and} \quad 7 + 59 + 33 + 31 + 36 = 166$$
$$187^4 = 1222830961 \quad \text{and} \quad 12 + 22 + 83 + 9 + 61 = 187$$
$$198^4 = 1536953616 \quad \text{and} \quad 15 + 36 + 95 + 36 + 16 = 198$$
$$199^4 = 1568239201 \quad \text{and} \quad 15 + 68 + 23 + 92 + 1 = 199$$
$$232^4 = 2897022976 \quad \text{and} \quad 28 + 97 + 2 + 29 + 76 = 232$$
$$243^4 = 3486784401 \quad \text{and} \quad 34 + 86 + 78 + 44 + 1 = 243$$
$$253^4 = 4097152081 \quad \text{and} \quad 40 + 97 + 15 + 20 + 81 = 253$$
$$286^4 = 6690585616 \quad \text{and} \quad 66 + 90 + 58 + 56 + 16 = 286$$
$$342^4 = 13680577296 \quad \text{and} \quad 1 + 36 + 80 + 57 + 72 + 96 = 342.$$

Of these, only n = 243 satisfies all the conditions of the problem.

For cubes, Ashbacher found that n = 109, 143, 153, 154, 188, 197, 198, 199 and 208 are the only values of n and that no solutions of the problem exist. For fifth powers, Ashbacher found that n = 144, 154, 197, 287, 296, 298, 307, 342, 351, 352, 386 and 441 are the only values of n and that the only solutions to the problem are n = 144 and 441. For sixth powers, there are 16 values of n ranging from n = 126 to n = 496. For seventh powers, there are 24 values of n ranging from n = 230 to n = 792. For eighth powers, there are 5 values of n ranging from n = 451 to n = 639. For ninth powers, there are 16 values of n ranging from n = 440 to n = 892. For tenth powers, there are 11 values of n ranging from n = 529 to n = 892. Ashbacher was unable to find a number theoretic property which would eliminate all powers of an integer n above certain value.

Editor's Comment. The only solution to the problem as stated is $243^4 = 3486784401$ and $34 + 86 + 78 + 44 + 1 = 243$. The following argument justifies this statement and supplies the "missing" number theoretic property referred to by our featured solver. Let n be an integer having at most k digits which satisfies the conditions of the problem. Then n^4 has at most 4k digits. We can write n^4 in base 100 as

$$(1) \qquad n^4 = a_{2k-1}100^{2k-1} + a_{2k-2}100^{2k-2} + \cdots + a_1 100 + a_0$$

so that n is the string of digits "$a_{2k-1}a_{2k-2}\cdots a_1 a_0$" where $0 < a_i < 100$ for $0 \leq i \leq 2k-1$. Then

$$(2) \qquad n^4 - n = \sum_{i=0}^{2k-1} a_i(100^i - 1) \equiv 0 \pmod{99}.$$

By the Chinese Remainder Theorem, one can easily show that all solutions of the congruence $n^4 \equiv n \pmod{99}$ are given by

(3) $n = 0, 1, 22, 34, 45, 55, 67$ and $88 \pmod{99}$.

Since n^4 has at most 16 decimal digits, then by (1) $a_{2k-1} = a_7$ and the largest possible $n = 792$ corresponding to $a_i = 99$ for $i = 0$ to 7. Then $792^4 = 393460125696$. This shows immediately that there are no four digit values of n which satisfy the conditions of the problem and also that $n \leq 792$. The largest possible fourth power $< 792^4$ having the maximal "digit sum" base 100 is 389999999999 which yields $n = 38 + 5 \cdot 99 = 533$. Hence $n \leq 533$. But $533^4 = 80706559921$. The largest possible fourth power $< 533^4$ having the maximal "digit sum" base 100 is 79999999999 which yields $n = 7 + 5 \cdot 99 = 502$. Hence $n \leq 502$. Repeating this process further does not appreciably reduce the upper bound on n.

Taking 502 as an upper bound on possible values of n and using the possible residues $\pmod{99}$ listed in (3), there are 42 values of n which need testing. Of these, there are ten solutions as found in our featured solution. Examining the list of 42 possible values, the only perfect powers are 100, 121, 144, 243, 441 and 484. Of these, all are squares except for $n = 243$ which is a perfect cube. Finally, since none of these squares satisfy the required "power" property and since $243^4 = 3486784401$ and $1 + 44 + 78 + 86 + 34 = 243$, this is the solution to the problem as originally intended.

Problem 444. Proposed by the editor. (This problem is dedicated to the 50th anniversary of *The Pentagon*.) Let r_n be defined by $r_n = 1941r_{n-1} + 1940$ where r_0 is an integer. Find an integer r_0 such that r_{50} is divisible by 1991 or prove that none exist.

Solution by the Eastern Kentucky University Problem Solving Group, Eastern Kentucky University, Richmond, Kentucky.

We have $r_n = 1941r_{n-1} + 1940 = 1941(1941r_{n-2} + 1940) + 1940 = 1941^2 r_{n-2} + 1940(1941 + 1)$. Continuing in this fashion, we obtain the explicit formula

(1) $$r_n = 1941^n r_0 + 1940 \sum_{k=0}^{n-1} 1941^k.$$

In particular,

(2) $r_{50} = 1941^{50}(r_0 + 1) - 1.$

Hence we must solve the congruence

(3) $1941^{50}x \equiv 1 \pmod{1991}.$

Now it is easily shown that $1941^{50} \equiv 1013 \pmod{1991}$. Hence (3) becomes $1013x \equiv 1 \pmod{1991}$ which has the solution $x \equiv 1024 \pmod{1991}$. Hence we can take r_0 to be any integer $r \equiv 1023 \pmod{1991}$, the smallest positive integer r being 1023. By taking $r_0 = 1023$ we have

$$r_{50} = 1941^{50}(1023 + 1) - 1 \equiv 1013 \cdot 1024 - 1 \equiv 0 \pmod{1991}.$$

Also solved by Charles Ashbacher, Hiawatha, Iowa; the New York Lambda Problem Solvers, C.W. Post Campus, Long Island University, Brookville, New York; and Richard A. Gibbs, Fort Lewis College, Durango, Colorado. One incorrect solution was received.

OBG 1. Among grandfather's papers a bill was found:

                          72 turkeys $ -67.9- .

The first and last digits of the number that obviously represented the total price of these fowls are replaced here by blanks, for they have faded and are now illegible. What are the two faded digits and what was the price of one turkey?

Solution by the Alma College Problem Solving Group, Alma College, Alma, Michigan.

    Let A and B be the two missing digits in the bill respectively. In order for each turkey to cost a whole number of cents, 72 must divide A679B. Since 8 divides 72, 8 also divides A679B. Since 8 divides 800, then B must be 2. Similarly 9 must divide A6792. So 9 divides (A+6+7+9+2) = A+24. Therefore A must be 3. The total bill is $367.92 with each turkey costing $5.11.

Also solved by Kendall Bailey, Drake University, Des Moines, Iowa; Charles Ashbacher, Hiawatha, Iowa; the New York Lambda Problem Solvers, C.W. Post Campus, Long Island University, Brookville, New York; Fred A. Miller, Elkins, West Virginia; and Bob Prielipp, University of Wisconsin-Oshkosh, Oshkosh, Wisconsin.

Editor's Comment.   All solutions received were similar to the featured solution.

OBG 2. A city with a circular wall has two gates, one at each end of the north and south diameter. From the north gate a road leads directly north and from the south gate a road leads directly east. What is the diameter of the city if from a point 3 miles north of the north gate it is just possible to see past the wall to a point nine miles east of the south gate?

Solution by Diane Cramer, Eastern Illinois University, Edwards, Illinois.

In the figure below, let D be the center of the city, B be the location of the south gate, A be a point 3 miles north of the north gate and C be the point 9 miles east of the south gate. Then E is the point of tangency of a line of sight connecting points A and C. Let r = DE = DB be the radius of the city.

By applying the Pythagorean Theorem to triangles BCD and CDE respectively, we have $CD^2 = r^2 + 81$ and thus $CE = 9$. Similarly in triangle ADE, $AE = \sqrt{6r + 9}$. Finally applying the Pythagorean Theorem to triangle ABC, we have

$$(3 + 2r)^2 + 9^2 = (9 + \sqrt{9 + 6r})^2$$

or

$$4r^4 + 12r^3 + 9r^2 - 496r - 729 = (2r + 3)(2r - 9)(r^2 + 6r + 27) = 0.$$

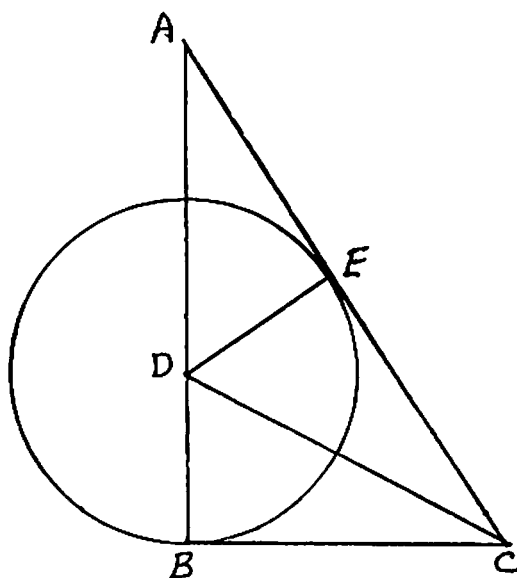Hence the diameter of the city is $2r = 9$ miles.

Also solved by Kendall Bailey, Drake University, Des Moines, Iowa; Charles Ashbacher, Hiawatha, Iowa; the New York Lambda Problem Solvers, C.W. Post Campus, Long Island University, Brookville, New York; Fred A. Miller, Elkins West Virginia; the Alma College Problem Solving Group, Alma College, Alma, Michigan; the Eastern Kentucky University Problem Solving Group, Eastern Kentucky University, Richmond, Kentucky; Mohammad Parvez Shaikh, Kalamazoo, Michigan; Dan Rutterman, Purdue University, West Lafayette, Indiana; and Bob Prielipp, University of Wisconsin-Oshkosh, Oshkosh, Wisconsin.

Editor's Comment. All solutions received were similar to the featured solution and used similar triangles or trigonometry to reach the same result.

OBG 3. The graph of a traffic count past a certain point is found to resemble a sine curve with a minimum of 30 at midnight and a maximum of 900 at noon. Write an equation which will give the traffic count at any time of the day. Also determine how many cars passed the point between 11:00 a.m. and noon.

Solution by the New York Lambda Problem Solvers, C.W. Post Campus, Long Island University, Brookville, New York.

Because the traffic curve ranges between 30 and 900, before the sine curve was shifted upward it must have ranged between $\pm(1/2)(900 - 30)$ $= \pm 435$. Thus the sine curve was shifted upward by $435 + 30 = 465$. Furthermore, since 12 hours corresponds to a period of π radians, the equation for the traffic count $C(t)$ at time t must be

$$C(t) = 435 \sin\left(\frac{\pi t}{12}\right) + 465$$

where t is the time counting from 6 a.m. From 11 a.m. to noon corresponds to t changing from 5 to 6, so the number of cars between these times is

$$\int_5^6 C(t)\, dt = \left(-435 \cos\left(\frac{\pi t}{12}\right)\frac{12}{\pi} + 465t\right)\Bigg|_5^6$$

$$= 465 + \frac{2610 \sqrt{2 - \sqrt{3}}}{\pi},$$

which is approximately 895 cars.

Also solved by Charles Ashbacher, Hiawatha, Iowa; the Alma College Problem Solving Group, Alma College, Alma, Michigan; and Mohammad Parvez Shaikh, Kalamazoo, Michigan.

OBG 4. To number the pages of a bulky volume, the printer used 1890 digits. How many pages does the volume have?

Solution by Steven Goldman, Granada Hills, California.

In order to solve this problem, the total number of digits must be broken up into the number of pages having the same number of digits. There are 9 digits used in pages 1-9. There are $90 \cdot 2 = 180$ digits used in pages 10-99. There are $1071 = 1890 - 189$ digits remaining. To find the number of pages requiring three digits, divide the number of remaining digits by 3 to get 567 which represents the total number of pages requiring three digits. (If the number of remaining digits had not been divisible by 3, the problem would not have had a solution.) Since the first page requiring three digits is page 100, the total number of pages is 666.

Also solved by Kendall Bailey, Drake University, Des Moines, Iowa; Charles Ashbacher, Hiawatha, Iowa; the New York Lambda Problem Solvers, C.W. Post Campus, Long Island University, Brookville, New York; Fred A. Miller, Elkins, West Virginia; the Alma College Problem Solving Group, Alma College, Alma, Michigan; and Bob Prielipp, University of Wisconsin-Oshkosh, Oshkosh, Wisconsin.

Editor's Comment. All solutions received were similar to the featured solution.

OBG 5. Three numbers are in arithmetic progression. Three other numbers are in geometric progression. Adding the corresponding terms of these two progressions successively, we obtain 85, 76 and 84, respectively; adding all three terms of the arithmetic progression, we obtain 126. Find the terms of both progressions.

Composite solution from solutions submitted by Mohammad Parvez Shaikh, Kalamazoo, Michigan and Sean Forbes, Drake University, Des Moines, Iowa.

Let the arithmetic progression be $(x - d, x, x + d)$ and the geometric progression be (a, ar, ar^2). Then since the sum of the terms of the arithmetic progression is 126, we have $x = 42$. Adding corresponding terms of the progressions and substituting 42 for x yields the following equations:

(1) $a + 42 - d = 85$ or $a - d = 43$,

(2) $ar + 42 = 76$ or $ar = 34$, and

(3) $ar^2 + 42 + d = 84$ or $ar^2 + d = 42$.

Adding equations (1), (2) and (3) yields

(4) $a + ar + ar^2 = 117$.

By substituting $a = 34/r$ into equation (4) and simplifying, we obtain $34r^2 - 85r + 34 = (17r - 34)(2r - 1) = 0$. Hence $r = 1/2$ or $r = 2$. For $r = 1/2$, the respective progressions are 17, 42, 67 and 68, 34, 17. For $r = 2$, the respective progressions are 68, 42, 16 and 17, 34, 68.

Also solved by the Alma College Problem Solving Group, Alma College, Alma, Michigan; Charles Ashbacher, Hiawatha, Iowa; New York Lambda Problem Solvers, C.W. Post Campus, Long Island University, Brookville, New York; Fred A. Miller, Elkins, West Virginia; Bob Prielipp, University of Wisconsin-Oshkosh, Oshkosh, Wisconsin; and Richard A. Gibbs, Fort Lewis College, Durango, Colorado.

Convention Winners

National President Harold L. Thomas (far right) and National
President-Elect Arnold D. Hammel (far left) congratulate the authors of
the four best papers presented at the 28th Biennial Convention held 11-
13 April 1991 at the University of North Alabama. In addition to their
certificates and prize checks, first place winner Mary J. Wilson (right) of
Kansas Delta received an HP-28S calculator and second place winner J.
Ben Shafer (left) of Iowa Alpha received an HP-42S calculator. Robert G.
Donnelly, Jr. (rear) of Virginia Gamma placed third and Christin
Vandiver (center) of Alabama Beta placed fourth.

Hewlett-Packard donated the prize calculators as well as a second
HP-28S, which was won as a door prize at the Friday evening banquet by
Chad Stoltz (not shown) of Nebraska Alpha.

Thank You Hewlett-Packard!

Kappa Mu Epsilon News

Edited by Mary S. Elick, Historian

News of chapter activities and other noteworthy *KME* events should be sent to Mary S. Elick, Historian, Kappa Mu Epsilon, Mathematics Department, Missouri Southern State College, Joplin, Missouri 64801.

INSTALLATION OF NEW CHAPTERS

Missouri Lambda Chapter
Missouri Western State College, St. Joseph, Missouri

The installation of the Missouri Lambda Chapter of Kappa Mu Epsilon was held on February 10, 1991, in Room 110 of the Student Center on the campus of Missouri Western State College. Dr. Jo Ann Fellin, OSB, National Treasurer of Kappa Mu Epsilon, conducted the installation ceremony. Associate professors John Atkinson and Jerry Wilkerson, Kappa Mu Epsilon members initiated by the KS Beta and MO Beta Chapters respectively and currently on the faculty at Missouri Western, also participated in the ceremony. Dr. Atkinson served as Conductor. Thirteen students and seven faculty in addition to Atkinson and Wilkerson constituted the founding group of the new chapter at Missouri Western. Those initiated were:

Students: Anita K. Chancey, Audrey G. Davis, Robin Fowler, Douglas A. Gibson, Wanda S. Gibson, Julie Hansbrough, Kevin R. Heyde, Susan K. Nichols, Gena J. Puckett, Roy E. Rhinehart, Eric Toot, Tammy Steinkamp, and David Vlieger.

Faculty: Jennifer S. Austin, Christopher P. Godfrey, Bill L. Huston, David John, Kenneth W. Lee, Don Mahaffy, and Leo H. Schmitz.

Dr. Fellin, OSB, began the afternoon ceremony with a short history of Kappa Mu Epsilon. Following the installation of officers, William J. Nunez, III, the Dean of Liberal Arts and Sciences at Missouri Western State College, congratulated the group and spoke on the importance of honor societies in higher education. Several relatives and friends of the initiates were present at the 3 p.m. installation which was followed by a reception.

Officers installed during the ceremony were: Susan K. Nichols, president; Julie Hansbrough, vice-president; Gena J. Puckett, recording secretary; and Douglas A. Gibson, treasurer. Faculty members John Atkinson and Jerry Wilkerson accepted the responsibilities of the corresponding secretary and faculty sponsor, respectively.

Texas Kappa Chapter
University of Mary Hardin-Baylor, Belton, Texas

The installation of the Texas Kappa Chapter of Kappa Mu Epsilon was held on February 21, 1991, in Hardy Hall on the campus of the University of Mary Hardin-Baylor. Dr. Harold L. Thomas, National President of Kappa Mu Epsilon, conducted the installation ceremony. Sherry O'Neal, president of Delta Psi Theta, the petitioning club, served as Conductor during the ceremony. Twenty-four students and three faculty constituted the founding group of the new chapter at the University of Mary Hardin-Baylor. Those initiated were:

Students: Florence Akinyi, Abeer Al-Naji, Garry Bartek, Curtis Breaux, Claudia Drayton, Charles Fewless, Helene Gaede, Kerry Geiger, Don Henslee, Roger Hoelscher, Melinda Hollan, Neil Ling, Susannah Marshall, Regina Noles, Sherry O'Neal, Taeko Osterman, Jacqueline Pilkey, Bernice Reeves, Melissa Santana, Karen Scott, Shane Scott, Darren Seifer, Edward Tunstall, and Stephanie Williams.

Faculty: Prof. Peter Chen, Dr. William Harding, and Prof. Maxwell Hart.

Following the installation ceremony, Dr. Thomas gave a brief history of honor societies in colleges and universities and, in particular, the founding of Kappa Mu Epsilon. Several University of Mary Hardin-Baylor administrators attended the 4:30 p.m. installation as well as

many relatives and friends of the initiates. A large group enjoyed dinner with Dr. Thomas at Frank's Lakeview Inn after the formal installation.

Officers installed during the ceremony were: Karen Scott, president; Don Henslee, vice-president; Jacqueline Pilkey, recording secretary; and Abeer Al-Naji, treasurer. Faculty members Peter Chen and Maxwell Hart accepted the responsibilities of the corresponding secretary and faculty sponsor, respectively.

South Carolina Delta Chapter
Erskine College, Due West, South Carolina

The South Carolina Delta Chapter of Kappa Mu Epsilon was installed on April 28, 1991 following a banquette in the Founder's Room in Moffatt Dining Hall at Erskine College. Donald Aplin, corresponding secretary of the South Carolina Gamma Chapter at Winthrop College conducted the installation ceremony. Larry Holloman, President of the South Carolina Gamma Chapter, assisted in the ceremony. Nine students and three faculty constituted the founding members of the new chapter at Erskine College. Those initiated were:

Students: Mark Armstrong, Kim Cotter, Jodi Dixon, Emily Eich, John Hoy, Susan Linderman, Travis Mauldin, Jennifer Ray, and Dawn Alison Smith.

Faculty: Dr. Ann Bowe, Dr. James Bowe, and Prof. William Linderman.

Dr. James W. Gettys, Jr., Vice President and Dean of the College at Erskine College, and his wife were invited guests.

After the ceremony an informal discussion was held. Larry Holloman and Donald Aplin answered questions about activities and procedures that have been successful at the South Carolina Gamma Chapter and told about national and regional conventions. Upon being informed of severe weather approaching, the president of the newly installed chapter adjourned the meeting.

Officers installed during the ceremony were: Mark Armstrong, president; Dawn Alison Smith, vice-president; and Kim Cotter, secretary/treasurer. Faculty member Ann Bowe accepted the responsibilities of faculty sponsor/corresponding secretary.

CHAPTER NEWS

Alabama Gamma   University of Montevallo, Montevallo
Chapter President - Cindy Pruitt
7 initiates

Other 1991-92 Officers: Beverly Smith and Marsha Oden, vice presidents; Kim Wilson, secretary; Brenda Valentine, treasurer; Charles F. Coats, corresponding secretary/faculty sponsor.

Alabama Zeta   Birmingham-Southern College, Birmingham
Chapter President - Heath Gatlin
45 actives

John Whitaker was presented with the chapter *KME* Service Award on Honors Day. Heath Gatlin, Erica Taylor, John Whitaker, Dr. Sherry Gale, Dr. Shirley Branan, and Dr. N. Bosmia attended the national *KME* meeting at the University of North Alabama. Other 1991-92 officers: Erica Taylor, vice president; Julia Spazzarini, secretary/treasurer; Lola F. Kiser, corresponding secretary; Shirley Branan, faculty sponsor.

California Gamma   California Polytechnic State University, San Luis Obispo
Chapter President - Susan Rehn
30 actives, 18 initiates

California Gamma was active in the winter and spring quarters. The chapter helped the School of Science and Mathematics with its SMART (Science and Mathematics Are Really Terrific) program. The Club participated in Club Days in April. President Andrew Skrylov, Vice President Andrew Schaffner and Pledgemaster Cindy Walter attended the *KME* Biennial Convention. The rest of the club members helped the mathematics department conduct its 39th Annual Mathematics Contest and helped with other activities involved in SOSAM's Science and Mathematics Awareness Days (April 12, 13). Despite the reduced number of participants due to the cancellation of Poly Royal, the contest was quite successful. The Club held a tee-shirt fundraiser during the Math Contest and a combined book sale/tee-shirt sale on April 24, 25 and 26th. Eighteen pledges were initiated at the Annual Banquet on June 8 at Embassy Suites Hotel in San Luis Obispo. Other 1991-92 officers: Philip Banks, vice president; Leo Flores, secretary/publicity chairman;

Shelley Hot, treasurer; Jennifer Huskey, pledgemaster; Michael Jeffris, SOSAM representative; Andrew Schaffner, Curriculum Committee representative; Jennifer Courter, social chairperson; Lynne Gobby, alumni representative; Raymond D. Terry, corresponding secretary/faculty sponsor.

Colorado Gamma   Fort Lewis College, Durango
    Chapter President - Rachel Zeller
    30 actives, 9 initiates

In addition to the initiation meeting, two regular meetings were held during the spring semester. At the first of these, Chapter President David Beazley previewed his talk for the upcoming MAA Rocky Mountain section meeting. He spoke on "The Fast Drawing of Ellipses." Richard Gibbs and students Rachel Zeller and John Renfro attended the Biennial Convention and had a great time. A video tape of the convention was shown at the second meeting. Other 1991-92 officers: Duane Brown, vice president; Gretchen Rothschopf, secretary; John Renfro, treasurer; Richard A. Gibbs, corresponding secretary; Deborah Berrier, faculty sponsor.

Colorado Delta   Mesa State College, Grand Junction
    Chapter President - Karen Hughes

Spring semester activities included a talk on February 7 by Dr. Carl Kerns entitled "Maximizing and Minimizing Without Calculus," a video on "Similarity" viewed on March 26, and a second video "The Story of Pi," seen on April 18. Other 1991-92 officers: Daniel Carroll, vice president; Duncan Thompson, secretary; Karl Castleton, treasurer; Harold Davenport, corresponding secretary; Cliff Britton, faculty sponsor.

Georgia Alpha   West Georgia College, Carrollton
    Chapter President - Fredricka Ann Leonard
    20 actives, 6 initiates

The Georgia Alpha Chapter of *KME* held its annual initiation meeting May 30, adding 6 new pledges to its roll. At the reception following the initiation, it was announced that three chapter members had been awarded scholarships for 1991-92: Fredricka A. Leonard (Crider Award), Matthew J. Sartori (Cooley Award) and Robert B. Jennings

(Whatley and Boykin Awards). Other 1991-92 officers: Kelly Graham, vice president; Michelle Williams, secretary; Paul McKinzey, treasurer; Joe Sharp, corresponding secretary/faculty sponsor.

Illinois Delta   College of St. Francis, Joliet
       Chapter President - Mark Mitchell
       22 actives, 18 initiates

       During the spring semester two actuaries from CNA, Chicago, spoke to interested students and faculty. Three students accompanied by their faculty sponsor attended the Biennial Convention at University of North Alabama. Other 1991-92 officers: Jennifer Rogers, vice president; Michelle Peltonen, secretary; Jennifer Wojciechowski, treasurer; Sister Virginia McGee, corresponding secretary/faculty sponsor.

Indiana Alpha   Manchester College, North Manchester
       Chapter President - Curt Beery
       15 actives, 6 initiates

       Other 1991-92 officers: Suzy Oaks, vice president; Kathy Byrum, secretary; Kathy Keener, treasurer; Stan Beery, corresponding secretary; Deb Hustin, faculty sponsor.

Indiana Gamma   Anderson University, Anderson
       Chapter President - Jonathan Hendrickson
       8 actives, 7 initiates

       Other 1991-92 officers: Gina Shellenbarger, vice president; Melissa Davis,   secretary/treasurer;   Stanley   Stephens,   corresponding secretary/faculty sponsor.

Indiana Delta   University of Evansville, Evansville
       Chapter President - Sara Wenrick
       35 initiates

       During the spring semester Indiana Delta offered free tutoring and sponsored a math competition. Other 1991-92 officers: Amy Simpson, vice president; Amy Draper, secretary/treasurer; Melba Patberg, corresponding secretary; Mohammad Azarian, faculty sponsor.

Iowa Alpha   University of Northern Iowa, Cedar Falls
Chapter President - J. Ben Schafer
38 actives, 2 initiates

The high point of this semester was the National Convention in Florence, Alabama. Students Mark Bohan, Mary Bond, Rachel Britson, Bill Pothoff, Ben Schafer, Lori Scott and Tascha Yoder were accompanied by faculty John S. Cross, John E. Bruha and John C. Longnecker. The 1,800 plus mile trip in two minivans included a very interesting visit to the U.S. Space and Rocket Center in Huntsville, AL. Tascha Yoder presented her paper on "K Dimension Continued Fractions and the Golden Ratio" and Ben Schafer's presentation on "Fractal Geometry: A General Overview" was awarded second place in the national competition. Students presenting papers at Iowa Alpha chapter meetings included: Tascha Yoder on "Continued Fractions" and Mary Bond on "A Binary Tree Program." Michael Collins addressed the Spring initiation banquet on "The Logistic Map: One Pathway to Chaos." Other 1991-92 officers: Steve Walk, vice president; Julie Beck, secretary; Mary Bond, treasurer; John S. Cross, corresponding secretary/faculty sponsor.

Iowa Gamma   Morningside College, Sioux City
Chapter President - Daniel V. Wenham
11 actives, 2 initiates

Monthly meetings featuring a collection of brain teaser problems were held. Plans were made to meet jointly in the fall with the student physics organization to view a film on fractals. The chapter also discussed possible fundraisers and began making plans to next year honor an individual who demonstrates outstanding commitment to *KME* and the mathematics department. Other 1991-92 officers: Denise Bohner, vice president; M. N. Hassan Shahin, secretary; Jonathen Flentgen, treasurer; Stephen Nimmo, corresponding secretary; Doug Swan, faculty sponsor.

Iowa Delta   Wartburg College, Waverly
Chapter President - Stephanie Hurley
37 actives, 29 initiates

The spring term began for the Iowa Delta Chapter with a pizza and bowling party in January. Dr. William Slough, a new member of the Wartburg Mathematics and Computer Science Department, presented "Variations on the Hypercube" as the February meeting program. On March 16, the chapter co-sponsored with the Department, the fourteenth

annual Wartburg Math Field Day with participants from twelve different schools. Twenty-nine new members were initiated into the chapter on March 23. This largest ever group of initiates heard Joette Schleisman, Assistant Vice President-Product Development Leader at Century Life of America, who is also a Fellow in the Society of Actuaries, speak on "Mathematics: A Foundation for the Future." The year ended with the traditional May term picnic. Other 1991-92 officers: Richard Brooks, vice president; Julie Rhoades, secretary; Nancy Wirth, treasurer; August Waltmann, corresponding secretary; Lynn Olson, faculty sponsor.

Kansas Alpha   Pittsburg State University, Pittsburg
    Chapter President - Pam Vandervoort
    40 actives, 18 initiates

The Spring semester activities started with a pizza party and initiation in February for eighteen new members. Following the initiation ceremony, Professors Elwyn Davis, Don Hight, Gary McGrath and Harold Thomas of the Mathematics Department gave an enlightening theatrical presentation on "Proofs and Refutations." The program for the March meeting was given by Mark Stewart. He made a trial run on his paper, "Highway Transition Curves," which was accepted for presentation at the national convention in Florence, AL. Seven students and two faculty from KS Alpha attended the Alabama convention. An enjoyable time was had by all. The chapter assisted the Mathematics Department faculty in administering and grading tests given at the annual Math Relays on April 23, 1991. Several members also worked on the Alumni Association's Annual Phon-o-thon. The final meeting of the semester was a social event held at Professor McGrath's home. Homemade ice cream and cake were served to those present. Reports were given by those who had attended the national convention in April. Officers for the 1991-92 school year were elected. The annual Robert M. Mendenhall awards for scholastic achievement were presented to Lori Bruns, Larry Reynolds and Mark Stewart. Other 1991-92 officers: Kris Mengarelli, vice president; Rebecca Newcomb, secretary; Regina Hulvey, treasurer; Harold L. Thomas, corresponding secretary; Joe Siler, faculty sponsor.

Kansas Beta   Emporia State University, Emporia
    Chapter President - Susan Hurt
    25 actives, 4 initiates

Other 1991-92 officers: Sarah Gleason, vice president; Michelle Land,

secretary; David Herrs, treasurer; Connie Schrock, corresponding secretary; Larry Scott, faculty sponsor.

Kansas Gamma   Benedictine College, Atchison
    8 actives, 16 associates and participants

Campus editions of *The Exponent* came out in February and March this semester. On February 17, chapter members were instructed by the reference librarian on the use of "Dialog" for mathematical research. For the March meeting, alum John Hutchinson came from Wichita State to speak on "Data Base Problems Encountered on the Job." Also in March, Chapter President Matt McIntosh organized a group to participate in the College Phonathon. Students Karen Dreiling, Nancy Sheble, Ty Anderson and faculty member Jo Ann Fellin, OSB, traveled to Florence, AL, for the national convention in April. Ty Anderson presented his paper on "Magical Minimal Surfaces" and the foundress of Kansas Gamma, Sister Helen Sullivan, OSB, received the distinguished member service award. On April 27, members and associates took charge of the 21st Mathematics Tournament at Benedictine for area high school students. Special features this year included the sale of t-shirts designed for the occasion. Chapter activity culminated in a well-attended spring picnic at Sugar Lake. Chapter secretary Ty G. Anderson gave the valedictory address at graduation. This honor was shared with his twin brother. Officers for 1991-92: Jill Weigand, student government representative; Jo Ann Fellin, OSB, corresponding secretary/faculty sponsor. Other officers will be elected in the fall.

Kansas Delta   Washburn University, Topeka
    Chapter President - Scott McFarland
    30 actives, 18 initiates

Kansas Delta held a February initiation ceremony and dinner hosted by the Mathematics Department members. An end-of-semester pre-finals picnic was held in May. Other 1991-92 officers: Jessica Dyck, vice president; Jennifer Hudson, secretary; Michelle Reed, treasurer; Allan Riveland, corresponding secretary; Ron Wasserstein, faculty sponsor.

Kansas Epsilon   Fort Hays State University, Hays
        31 actives, 6 initiates

Chapter activities included a spring initiation banquet held April 17 and the production of a display for Mathematics Awareness Week. Student officers for 1991-92 have not yet been elected. Serving as corresponding secretary and faculty sponsor are Charles Votaw and Mary Kay Schippers, respectively.

Kentucky Alpha   Eastern Kentucky University, Richmond
        Chapter President - Kevin Huibregtse
        41 actives, 27 initiates

This year's initiation ceremony included an interesting talk by Dr. Charles Franke on "Stability in Recurrence Relations." The traditional party following was held in the student center. The major event of the semester was the national *KME* convention. Eight students and Dr. Costello attended the convention. Three students presented talks. In addition to convention activities, the group also toured Wilson Lock and Dam and enjoyed seeing a barge locked through. Before leaving Florence, they lunched at a 60's style restaurant with members of the "Alabeta Bama" chapter. Upon returning home, several students designed a t-shirt with a *KME* fractal on the front and the question, "Does Bo know Calculus?" on the back. Other semester activities included a visit to Cumberland Falls in hopes of viewing the moonbow, and presentations by Jose Grinage and Greg Garrett on mathematics in the production of steel and mathematics in software development. Other 1991-92 officers: James Hannis, vice president; Monica Klein, secretary; Gary Cline, treasurer; Patrick Costello, corresponding secretary/faculty sponsor.

Maryland Alpha   College of Notre Dame of Maryland, Baltimore
        Chapter President - Marta A. Blotny
        11 actives, 6 initiates

Six members were inducted and four associate members received during the annual initiation ceremonies. After dinner the faculty, students and friends were honored to hear Father Frank Haig, S.J., of Loyola College, Baltimore, speak on the topic "Mathematics and Physics: Will the Twain Ever Meet?" Other 1991-92 officers: Sandy Burgess, vice president; Lisa Myers, secretary; Judy Urban, treasurer; Sister Marie Dowling, corresponding secretary; Dr. Joseph DiRienzi, faculty sponsor.

Maryland Delta   Frostburg State University, Frostburg
   Chapter President - Beth Stallings
   38 actives, 15 initiates

In February, the chapter enjoyed a demonstration of graphics calculators presented by Dr. Donald Shriner. On March 10, Maryland Delta Chapter inducted the following new members: Diana Beisel, Christine Bittinger, Angela Blythe, James Boden, Gloria Broadwater, Professor Kathleen Elder, Candice Hartman, Kenneth Jackson, Tina Judy, Jacquelyn Noe, Jennifer Peterson, Paul W. Riley, Jean Ryan, Shannon Shook and Steven Smith. Dr. Greg Latta presented a presentation on "Mathematics and Music" to the initiates and others in attendance. Other 1991-92 officers: Steven Smith, vice president; Diana Beisel, treasurer; Edward White, corresponding secretary; John Jones, faculty sponsor. The secretary has not yet been selected.

Michigan Beta   Central Michigan University, Mt. Pleasant
   Chapter President - Laurie Raven
   30 actives, 25 initiates

Members held weekly help sessions for students in freshman-sophomore mathematics classes. The February initiations of new members was preceded by a banquet in the University Center and followed by a talk on graphing calculators by CMU Professor Chuck Vonder Embse. On April 10, seven members and their advisor packed themselves into a suburban and traveled to Florence, Alabama for the National Convention. Everyone had a great time both traveling and at the convention. The hospitality and hard work of the students, faculty and staff of University of North Alabama are appreciated. Other semester activities included guest speakers Theresa Budzynski Gee, past president of Michigan Beta, who discussed job opportunities as an actuary, and Professor Robert Lopez of Rose-Hulman Institute, who spoke on symbolic algebra computer packages. The annual spring picnic closed out a successful semester. Other 1991-92 officers: Tom DeClark, vice president; Betsy Bacon, secretary; Pete Shavinski, treasurer; Arnold Hammel, corresponding secretary/faculty sponsor.

Mississippi Alpha   Mississippi University for Women, Columbus
   Chapter President - Mary Beth Falcon
   9 actives

Mississippi Alpha operated a free tutoring service for students in

lower level math courses. Two students and one faculty member attended the national meeting in Florence. Other 1991-92 officers: Rebecca Cagle, vice president; Teresa Loper, secretary; Mary Jane Chambers, treasurer; Shao Chen Yang, corresponding secretary/faculty sponsor.

Missouri Beta   Central Missouri State University, Warrensburg
　　　Chapter President - Michael Prock
　　　20 actives, 18 initiates

The spring semester was busy for Missouri Beta. Programs at monthly meetings included talks on "Algebra Tiles" and "Graduate Programs in Mathematics." Eighteen members and 14 associate members were initiated in March. Five students and two faculty attended the national convention in Florence, AL, in April. Dr. Gerald Schrag, one of the chapter sponsors, passed away in March. He is sadly missed by both students and faculty. Other 1991-92 officers: Mica Johnson, vice president; Kirk Monsees, secretary; Sarah Moss, treasurer; Rhonda McKee, corresponding secretary; Debbie Detrick, Larry Dilley and Homer Hampton, faculty sponsors.

Missouri Gamma   William Jewell College, Liberty
　　　Chapter President - James Mathis
　　　27 actives, 10 initiates

Guest speaker for the spring, 1991 banquet was Dr. Charles Robinson of Hardin-Simmons University, Abilene, Texas. Other 1991-92 officers: Tim Anderson, vice president; Steve Swenson, secretary; Joseph T. Mathis, treasurer/corresponding secretary/faculty sponsor.

Missouri Epsilon   Central Methodist College, Fayette
　　　Chapter President - Richard Courter
　　　8 actives, 2 initiates

Other 1991-92 student officers have not yet been elected. Faculty officers: William D. McIntosh, corresponding secretary/faculty sponsor; Linda O. Lambke, faculty sponsor.

Missouri Eta   Northeast Missouri State University, Kirksville
   Chapter President - Scott Niemeyer
   30 actives, 14 initiates

   In February Missouri Eta was busy with the annual Math EXPO - a
math contest held for high school students. In April the chapter
sponsored a Win, Lose, or Draw tournament as part of the festivities
associated with Common Ground Week, a version of "Greek Week" for
non-social organizations. Also in April, five students and one faculty
member attended the national convention. A picnic with the math
faculty, the Actuarial Science Club, and the student chapter of MAA
brought semester activities to a close. Other 1991-92 officers: Becky
Evans, vice president; Debi Brown, secretary; Angela Hahn, treasurer;
Mary Sue Beersman, corresponding secretary; Mark Faucette, faculty
sponsor.

Missouri Theta   Evangel College, Springfield
   Chapter President - Jonathan Raines
   4 actives, 6 initiates

   Other 1991-92 officers: Greg Hayden, vice president; Don Tosh,
corresponding secretary.

Missouri Iota   Missouri Southern State College, Joplin
   Chapter President - Melissa Sherrel
   26 actives

   The first business meeting of the semester featured a program by Dr.
Gwen Murdock of the MSSC faculty who spoke on "Mathematics of
Psychology." Initiation of 15 new members was held on March 7 at
Kitchen Pass. Several parents and friends attended the initiation and the
banquet which followed. Within days of the initiation, all were saddened
by the sudden death of Chapter President Wayne Cripps. In April,
members viewed the film "Turning a Sphere Inside Out." Also in April
two faculty and seven students traveled to North Alabama University in
Florence for the 28th Biennial Convention. Final semester activity was a
pre-finals cook-out at Mrs. Elick's house. Other 1991-92 student officers
have not yet been selected. Faculty officers: Mary Elick, corresponding
secretary; Linda Hand, faculty sponsor.

Missouri Lambda   Missouri Western State College, St. Joseph
    Chapter President - Robin Fowler
    22 actives, 20 initiates

    Other 1991-92 officers: Audrey Davis, vice president; Susan Nichols, secretary; Roy Rhinehart, treasurer; John Atkinson, corresponding secretary; Jerry Wilkinson, faculty sponsor.

Nebraska Alpha   Wayne State College, Wayne
    Chapter President - Amy Anderson

    Throughout the spring semester, chapter members served as evening monitors of the Math-Science building to earn money for the organization. Patrick Spieler, Sioux City, Iowa, was named this year's outstanding freshman in mathematics. The designation carries with it payment of national *KME* dues, a one-year honorary membership in the local chapter and the addition of the recipient's name to a permanent plaque. Amy Anderson and Rick Nordhues were awarded the $25.00 book scholarships given by the chapter to two of its members each year. Also honored this spring was sponsor Dr. Jim Paige, who was chosen as the outstanding professor in the Mathematics and Science Division. This selection is determined by votes of all students taking courses in the Division. Students Amy Anderson, Susan Sorenson, Jaime Tiller, Jared Sass, Chad Stoltz and faculty John Fuelberth and Fred Webber attended the 28th Biennial Convention in Florence, AL. In other activities, the chapter participated in the annual Wayne State College-Quiz Bowl and assisted the mathematics faculty with the Seventeenth Annual W.S.C. Mathematics Contest in May. Other 1991-92 officers: Jaime Tiller, vice president; Jill Brehm, secretary/treasurer; Susan Sorensen, historian, Fred Webber, corresponding secretary; Jim Paige and Hilbert Johs, faculty sponsors.

Nebraska Delta   Nebraska Wesleyan University, Lincoln
    Chapter President - Matthew Meyer
    20 actives, 9 initiates

    Monthly meetings were held jointly with the Mathematics/ Computer Science Club; programs centering on career opportunities. The fundraiser for the semester was a computer match-up for Valentine's Day. New members were initiated at the Annual Spring Picnic. Other 1991-92 officers: Joseph C. Roth, vice president; Kenneth L. Guiberson,

secretary; John R. Heckman, treasurer; Muriel Skoug, corresponding secretary/faculty sponsor.

New Mexico Alpha   University of New Mexico, Albuquerque
Chapter President - William C. Grover
30 actives, 24 initiates

Other 1991-92 officers: David Morrow, vice president; David Black, secretary; Marjorie Bond, treasurer; Richard Metzler, corresponding secretary/faculty sponsor.

New York Eta   Niagara University, Niagara University
Chapter President - Jamie Robertson
11 actives, 3 initiates

The annual banquet and initiation was held March 23 with Dr. Lawrence Boxer from the Department of Computer and Information Sciences of Niagara University the featured speaker. His topic was "Violence in Computational Geometry." A delegation attended the national convention at the University of North Alabama in Florence. Senior Joseph Scherer presented his paper, "Dimensional Discoveries," at the convention. Other 1991-92 officers: Paul Schreiner, vice president; Tracy Melton, secretary/treasurer; Robert Bailey, corresponding secretary; Kenneth Bernard, faculty sponsor.

New York Lambda   C.W. Post Campus/Long Island University, Brookville
Chapter President - Colleen O'Boyle
20 actives, 9 initiates

The highlight of the spring semester was the annual installation and banquet. The speaker of the evening was a former student and Kappa Mu Epsilon member, Susan Blaurock, who spoke on her experiences in the actuarial field. The chapter problem solving group continues to be active. Colleen O'Boyle and Kevin O'Reilly attended the biennial convention in Florence, AL. Kevin served as a member of the judging committee and found it very enlightening. Student officers for 1991-92 will be elected in the Fall. Faculty officers: Sharon Kunoff, corresponding secretary; Andrew Rockett, faculty sponsor.

North Carolina Gamma   Elon College, Elon College
    Chapter President - David Power
    22 actives, 17 initiates

North Carolina Gamma supported a team consisting of David Power,
Kris McMillan and Rick Mociolek in the National Mathematical
Modeling Contest (MCM) March 1-3. On April 25, during Math
Awareness Week, the chapter sponsored the Elon College weekly coffee.
Several presentations emphasizing the importance of mathematics for
industry, technology and science were displayed. The *KME* initiation of
new members took place on Wednesday, April 24, in the Fine Arts
Recital Hall. The guest speaker for the ceremony was Dr. Gerald Francis,
Vice President for Academic Affairs at Elon College, who talked about
the importance of mathematics for the '90's. Other 1991-92 officers: John
Prescott, vice president; Lori Blanchard, secretary; Jennifer Lee,
treasurer; Rosalind Reichard, corresponding secretary; Jeff Clark, faculty
sponsor.

Ohio Alpha   Bowling Green State University, Bowling Green
    Chapter President - Malcolm Shrimplin
    52 actives, 23 initiates

The Ohio Alpha chapter of *KME* started a busy spring semester by
ordering chapter tee-shirts and helping with the postage cost of sending
cookies to our troops in Operation Desert Storm. On February 8, the
chapter hosted Professor Carl Cowen from Purdue University. Professor
Cowen gave a talk entitled "Sophomoric Matrix Multiplication" and
discussed opportunities for graduate studies in mathematics. The chapter
held its annual induction banquet on March 11. Highlights included the
induction of 23 members, entertainment by the Logarythms, a faculty
barbershop quartet, and the presentation of the *"KME* Excellence in
Teaching Mathematics Award" to Dr. Frederick Rickey. In April, the
chapter hosted the students who were attending the 75th Annual Meeting
of the Ohio Section of the Mathematical Association of America. Also in
April, the chapter held officer elections and sponsored a walleyball game
at the student recreation center. Other 1991-92 officers: Kimberly Kukla,
vice president-programming; Debbie Lutz, vice president-inductions;
Angela Baumgard, secretary/treasurer; Waldemar Weber, corresponding
secretary; Neal Carothers, faculty sponsor.

Ohio Zeta   Muskingum College, New Concord
    Chapter President - Kristi Pritchett
    26 actives, 7 initiates

Student talks were presented in January and March by Jon Ransom and Craig Wilson, respectively. Induction of new members was held in February. Ten students attended the national convention April 11-14 in Florence, AL: Jen Suschil, Craig Wilsin, Kristi Pritchett, Ben Kwok, Ronnie Asher, Kelly Rossiter, Shelly Peters, Laura Dosch, Steve Miller, and Mac Aljancic. Jen Suschil and Craig Wilsin had papers on the program. Other 1991-92 officers: Andrew Aljancic, vice president; Molly King, secretary; Shelly Peters, treasurer; James L. Smith, corresponding secretary; Russ Smucker, faculty sponsor.

Oklahoma Alpha   Northeastern State University, Tahlequah
    Chapter President - Michael Seals
    33 actives, 11 initiates

The spring initiation ceremonies for 11 students were held in the banquet room of the Western Sizzlin' Restaurant in Tahlequah. During Math Awareness Week, Darryl Linde, NSU Mathematics Department, presented the talk, "There is More Than One Size of Infinity." Following the presentation, the annual ice cream social was held on the lawn outside the science and math building. Other 1991-92 officers: Luke Foster, vice president; Leslie Tramell, secretary; Susan Dismore, treasurer; Joan E. Bell, corresponding secretary/faculty sponsor.

Oklahoma Gamma   Southwestern Oklahoma State University, Weatherford
    Chapter President - Melissa Kirkland
    25 actives, 17 initiates

Four students and two faculty attended the national convention. Other 1991-92 officers: Dixie Harris, vice president; Jeremy Osmus, secretary; Jodi Lubinus, treasurer; Wayne Hayes, corresponding secretary; Robert Morris, faculty sponsor.

Oklahoma Delta   Oral Roberts University, Tulsa
    Chapter President - Jason Graves
    14 actives, 9 initiates

Oklahoma Delta helped plan and sponsor a hooding ceremony and reception for graduating seniors and their parents. The chapter spent

some time considering various money-making projects for next year. Other 1991-92 officers: Richard Kirby, vice president; Elizabeth Jacobsen, secretary; Mark Gollahon, treasurer; Debra Oltman, corresponding secretary; Roy Rakestraw, faculty sponsor.

Pennsylvania Beta   La Salle University, Philadelphia
  Chapter President - Jason DiVirgilio
  15 actives

Through the efforts of the former president, Christina Foley, and Dr. Van Rossum, we had an active spring. Len Wisniewski spoke about graduate life in computer science. Four local faculty gave lectures: Van Rossum on "Doing Research in Number Theory," DiDio on "Chaos and Fractals," Michalek on "Lie Theory," and Kirsch on "Visual Programming." Other 1991-92 officers: Kathleen Robinson, vice president; Geralyn Bowers, secretary; Charles Nyce, treasurer; Hugh N. Albright, corresponding secretary; Carl McCarty, faculty sponsor.

Pennsylvania Delta   Marywood College, Scranton
  Chapter President - Teresa Larkin
  10 actives, 3 initiates

Semester activities included the annual high school math contest, attendance at the student math seminar at Moravian College, and induction of new members on May 2. Other 1991-92 officers: Janel Caporali, vice president; Rhoda Dellecave, secretary/treasurer; Sister Robert Ann von Ahnew, corresponding secretary/faculty sponsor.

Pennsylvania Epsilon   Kutztown University, Kutztown
  Chapter President - Doris Sagl
  12 actives, 10 initiates

An initiation banquet was held April 5 for ten new members. The speaker for the occasion was Dr. Thomas Fernsler of Wilson College, Chambersburg, PA, who spoke on "Triskaidekaphobia: The History of Superstitions surrounding the Number 13." Other 1991-92 officers: Ursula Johrend, vice president; Andrea Schaeffer, secretary; Christine Hartman, treasurer; Cherry C. Mauk, corresponding secretary; Randy Schaeffer, faculty sponsor.

Pennsylvania Eta   Grove City College, Grove City
    Chapter President - Kimberly Ayers
    36 actives, 3 initiates

    The spring initiation of new members and election of officers was
held March 25. The annual *KME* spring picnic was held May 5 at the
Grove City Community Park. Students and faculty enjoyed volleyball
before and after the meal. The Outstanding Freshman Mathematics
Student was announced at the Parents Day Awards Ceremony on May 4.
Other 1991-92 officers: Julie Campbell, vice president; Jeannette Jordan,
secretary; Krista La Comb, treasurer; Marvin Henry, corresponding
secretary; Dan Dean, faculty sponsor.

Pennsylvania Theta   Susquehanna University, Selinsgrove
    Chapter President - Suzanne Strusz
    16 actives, 4 initiates

    Semester activities included initiation of four new members on April
24 and a talk by Dr. Tyler on Frieze Groups. Other 1991-92 officers:
Karen Bartashunas, vice president; Richard Keller, secretary; Soren
Huba, treasurer; Carol Harrison, corresponding secretary/faculty sponsor.

Pennsylvania Iota   Shippensburg University of Pennsylvania, Shippensburg
    Chapter President - Marianne Paul
    24 actives, 13 initiates

    Other 1991-92 officers: Jeffrey Rady, vice president; Debra Callender,
secretary; Frederick Nordai, treasurer; Michael Seyfried, corresponding
secretary; Rick Ruth, faculty sponsor.

Pennsylvania Kappa   Holy Family College, Philadelphia
    Chapter President - Melissa A. Kershes
    15 actives, 7 initiates

    Tutoring continued to be provided by chapter members for students
in need of help. The major event of the semester was the initiation of
new members. Former Holy Family College Math Majors and *KME*
members, Violet Cali, '71, Constance Hefner, '89, Vincent Frascatore,
'90, Karen S. McDowell, '90, and Kathleen Revak, '90, spoke to those
assembled. Linda Czajka, '83, Sister Louise Wallowicz, '77, and Sister
Theresa Lubaszemski, '87, all *KME* members, also participated in the
initiation ceremonies. All present, fathers, mothers and friends, enjoyed

the event. Other 1991-92 officers: David McCabe, vice president, Michael Malone, secretary/treasurer; Sister Mary Grace Kuzawa, faculty sponsor.

Pennsylvania Mu   St. Francis College, Loretto
   Chapter President - James Kelly
   27 actives, 8 initiates

Induction of eight new members was held Tuesday, April 23, bringing the total membership to 103. The event was accompanied by dinner and a mass said by *KME* member Father Oliver Hebert, T.O.R. Senior officers Antonine Gatto and Kristine Miller were also presented books in appreciation of their efforts to the society and the college. Other 1991-92 officers: John Miko, vice president; Amy Miko, secretary; Paula Knaze, treasurer; Peter Skoner, corresponding secretary; Adrian Baylock, faculty sponsor.

Pennsylvania Nu   Ursinus College, Collegeville
   Chapter President - Charles Kullmann
   21 actives, 5 initiates

During the spring semester, Pennsylvania Nu enjoyed a lecture entitled "Some Topics in Number Theory" by Professor Robert Styer of Villanova University and a presentation, "Applications of Bayes Theorem" by Professor Allan Rossman of Dickinson College. The initiation and reception for new members was held on April 19. Other 1991-92 officers: Jill Ramsland, vice president; Kevin Acken, secretary; Deborah Collinge, treasurer; Jeff Neslen, corresponding secretary, Richard Bremiller, faculty sponsor.

Pennsylvania Xi   Cedar Crest College, Allentown
   Chapter President - Susan Kleckher
   13 actives

The BIG project of the Spring semester was MathConn 91. Two hundred fifty-one students and 65 teachers from 50 schools in Eastern Pennsylvania and New York State registered for the 5 1/2 hour long event whose two-fold objectives are: To stimulate interest in math-related careers for seventh and eighth grade girls and to help teachers in those grades enhance their teaching skills and deal with the current technological explosion in the field. In other activities, three Pennsylvania Xi students presented student research projects at

EUREKA, fifth National Conference on Undergraduate Research at California Institute of Technology in Pasadena, CA. Topics were: Knots, Graphs and Matrices, and Computers in the Classroom. Other 1991-92 officers: Sandra Fry, vice president; Karen Haase, secretary; Carol Kabayashi, treasurer; Regina Brunner, corresponding secretary, Charles Chapman, faculty sponsor.

Tennessee Alpha   Tennessee Technological University, Cookeville
    Chapter President - Robert Talbert
    30 actives, 19 initiates

    Other 1991-92 officers: Lynn McHenry, vice president; Martye Link, secretary; Daniel Bardayan, treasurer; Frances Crawford, corresponding secretary; Barbara Briggs, faculty sponsor.

Tennessee Gamma   Union University, Jackson
    Chapter President - Paula Putman
    13 actives, 12 initiates

    Other 1991-92 officers: Blake Watkins, vice president; Lisa Meacham, secretary/treasurer; Don Richard, corresponding secretary; Dwayne Jennings, faculty sponsor.

Texas Alpha   Texas Tech University, Lubbock
    Chapter President - Paul Pierce
    25 actives, 17 initiates

    Semester activities included the induction of 17 new members and the annual recognition banquet held April 18. Other 1991-92 officers: Mark Damron, vice president; Amy Norton, secretary; Krista Reed, treasurer; Robert Moreland, corresponding secretary/faculty sponsor.

Texas Beta   Southern Methodist University, Dallas
    Chapter President - Andrew Turner
    59 initiates

    Other 1991-92 officers: Zen Chu, vice president; Brian Fielden, secretary/treasurer; Robert Davis, corresponding secretary/faculty sponsor.

Texas Eta   Hardin Simmons University, Abilene
    Chapter President - Charles Reed
    17 actives, 7 initiates

Texas Eta held its seventeenth annual induction banquet March 8. Seven new members were inducted: Paul Ahner, Jr., Tulsa, OK; Tracy Sheehy, Brownwood, TX; Jim Sims, Overton, TX;and Rachel Bein, Thomas Coskey, Laura Newman and Louis Revor, Abilene, TX. Local membership now totals 132. Dr. Kenneth Retzer, Professor of Mathematics at Abilene Christian University, addressed the chapter on the subject "Mathematics Education: Entering the Twenty-first Century." Leading the induction ceremonies were Charles Reed, president; Tondi Jeter, vice president; and Kristen Knebel, secretary/treasurer. Other officers for 1991-92: Louis Revor, vice president; Jill Sims, secretary/treasurer; Mary Wagner-Krankel, corresponding secretary; Charles Robinson and Ed Hewett, faculty sponsors.

Texas Iota   McMurry University, Abilene
    Chapter President - Rusty Teeter
    34 actives

The speaker for the spring initiation banquet was Dr. Bo Green of Abileen Christian University. His topic was "On the Shoulders of Giants." Another semester activity was a Mexican "Pile-on" dinner and the viewing of a number sense video. Other 1991-92 officers: Charles Converse, vice president; Randy McCarble, secretary; Jacqueline Bryan, treasurer; Diahne Dulin, corresponding secretary; Bill J. Dulin, faculty sponsor.

Texas Kappa   University of Mary Hardin-Baylor, Belton
    Chapter President - Karen Scott
    10 actives, 27 initiates

Texas Kappa sponsored a live educational satellite video-teleconference for fifty 6-14 graders on November 29. The theme was "Mars ... Live the Adventure." Cathy Seely, director of Mathematics at Texas Education Agency, and Sam Zigrossi, manager of Education IBM, Austin, were featured speakers at a chapter-sponsored banquet on April 30. The focus of the event was "Leading Mathematics Education into the 21st Century". Eighty people were in attendance. Other 1991-92 officers: Don Henslee, vice president; Jacqueline Pilkey, secretary; Abeer Al-Naji,

treasurer; Peter Chen, corresponding secretary; Maxwell Hart, faculty sponsor.

Wisconsin Alpha   Mount Mary College, Milwaukee
    4 actives, 3 initiates

   The major activity of the spring semester was the biennial convention in Florence, AL. Students Sandra Erickson, Cyndi Heim, Jill Rogahn and Lauri Malisch, accompanied by Sister Adriene Eickman, attended the convention. On May 7 the chapter sponsored a pizza party, inviting prospective members and interested students. Student officers will be elected in the Fall. Sister Adriene Eickman is corresponding secretary and faculty sponsor.

Wisconsin Gamma   University of Wisconsin - Eau Claire, Eau Claire
    Chapter President - Jackie Hoffman
    30 actives, 10 initiates

   Wisconsin Gamma held monthly meetings with programs provided by student speakers. During honors week 10 new members were initiated. The highlight of the spring activities was the *KME* national convention. Three chapter officers attended the meeting, with the treasurer serving on the awards committee. All reported back that it was a rewarding experience. The club held two fundraisers: a popcorn sale and a very successful booksale. On the social scene, the organization joined with the Chemistry Club for a spring picnic. Other 1991-92 officers: Jeff Ion, vice president; Michelle Larson, secretary; Tammy Christel, treasurer; Tom Wineinger, corresponding secretary/faculty sponsor.

Report on the 28th Biennial Convention

The Twenty-Eighth Biennial Convention of *Kappa Mu Epsilon* was held April 11-13, 1991 on the campus of the University of North Alabama, Florence, Alabama, with Alabama Beta the host chapter.

On Thursday evening, April 11, registration was held at the Robert Miller Guillot University Center, followed by a mixer. Entertainment was provided by the Foster Family String Band, named the country's top bluegrass band in each of the last five years. The National Council and the Regional Directors met in Room 206, University Center.

On Friday morning, April 12, registration continued at University Center and a continental breakfast was provided. The first general session was held in the Performance Center at University Center commencing at 8:30 a.m. with Harold L. Thomas of Kansas Alpha, National President, presiding. Dr. Robert L. Potts, President of the University of North Alabama, gave an address of welcome and Arnold D. Hammel of Michigan Beta, National President-Elect, responded for the Society. Stacy Barringer, President of Alabama Beta, presented a greeting to the delegates.

A roll call of the chapters was made by Robert L. Bailey of New York Eta, National Secretary. Thirty-five chapters and about 200 members were in attendance. Travel vouchers were filed and delegate voting cards were issued. The following new chapters installed during the 1989-91 biennium were recognized: Oklahoma Delta at Oral Roberts University, installed on April 10, 1990; Colorado Delta at Mesa State College, installed on April 27, 1990; North Carolina Gamma at Elon College, installed May 3, 1990; Pennsylvania Xi at Cedar Crest College, installed October 30, 1990; Texas Kappa at the University of Mary Hardin-Baylor, installed February 21, 1991; and Missouri Lambda at Missouri Western State College, installed February 10, 1991. Missouri Lambda was represented by a delegation at this convention.

A petition for a new chapter at Erskine College in Due West, South Carolina, was presented by Harold L. Thomas, National President. It was moved and seconded that this petition be accepted and the delegates voted unanimously in favor of establishing the new chapter. President Thomas indicated that arrangements would be made to install this

chapter by the end of the present school year, if possible.

An announcement concerning the composition of the Awards Committee was made to the delegates. This was in response to a resolution which was adopted at the 1989 National Convention. The resolution reads as follows:

> "Resolved that the National Council investigate a revision in the paper awards selection procedure at biennial conventions. This procedure would allow students to have input into the selection of the best papers, via one vote per chapter on the top four papers. This vote would then be used by the Awards Committee as part of their selection procedure."

At the November 1989 Council Meeting, the National Council determined that the Awards Committee should be composed of 4 students and 4 faculty members representing as many chapters as possible and in such a way that committee members would not be selected from chapters which had students presenting papers. The delegates present were informed that the new composition of the Awards Committee will be in effect at this convention.

It was also announced that the *KME Initiation and Installation Ceremonies* booklet is still under revision. The updated version should be ready in the near future.

The Nominating Committee report was presented by Harold L. Thomas in place of James Smith of Ohio Zeta, chair of the Nominating Committee who could not be present due to illness. The committee nominated Sr. Jo Ann Fellin of Kansas Gamma for the office of National Treasurer and Robert L. Bailey of New York Eta for the office of National Secretary. The nominees were introduced to the delegates and additional nominations were requested from the floor. There being none, nominations were closed.

During the coffee break, the Awards Committee meet in Room 206, University Center.

Arnold D. Hammel of Michigan Beta, National President-Elect, presided during the presentation of the following student papers:

1) *The Lattice of Invariant Subspaces of an Algebra*
   JENNIFER A. SUSCHIL, Ohio Zeta
   Muskingum College

2) *K Dimension Continued Fractions and the Golden Ratio*
   TASCHA GWYN YODER, Iowa Alpha
   University of Northern Iowa

3) *I've Got a Secret*
   CHRISTIN VANDIVER, Alabama Beta
   University of North Alabama

4) *Highway Transition Curves*
   MARK STEWART, Kansas Alpha
   Pittsburg State University

5) *Dimensional Discoveries*
   JOSEPH SCHERER, New York Eta
   Niagara University

At 11:50 a.m., a group picture was taken on the steps of Rogers Hall. Convention committees met during lunch.

The convention reconvened at 1:30 p.m. in Performance Center. Arnold D. Hammel of Michigan Beta, National President-Elect, presided during the presentation of the following student papers:

6) *Planes from Angles*
   ROBERT W. HAYDEN, Missouri Kappa
   Drury College

7) *What's the Fractal Dimension of KME?*
   MARY J. WILSON, Kansas Delta
   Washburn University

At 2:25 p.m., a student section met in the Performance Center with Stacy Barringer, President of Alabama Beta, presiding. A faculty section met in Room 207, University Center with Harold L. Thomas of Kansas Alpha, National President, presiding.

At 3:35 p.m., the convention reconvened for the presentation of papers with Arnold D. Hammel, National President-Elect, presiding. The following papers were presented:

8) *New Tools for Mathematics Students*
   LISA WHITIS, Kentucky Alpha
   Eastern Kentucky University

9) *Differentiating a^x: An Alternative Proof*
   ROBERT G. DONNELLY, JR., Virginia Gamma
   Liberty University

10) *M. C. Escher: Artist of the Imagination*
    T. CRAIG WILSON, Ohio Zeta
    Muskingum College

At 7:00 p.m., the convention banquet was held in the Banquet Hall of University Center with Stacy Barringer of Alabama Beta as mistress of ceremonies. The invocation was given by Dan Graham of Alabama Beta and following dinner, musical selections were provided by Debra Keith of the group Blue Ivory. The keynote address was given by James B. Odom, President and Chief Executive Officer of Applied Research, Inc. located in Huntsville, Alabama. Harold L. Thomas, National President, then presented a synopsis of the history of *Kappa Mu Epsilon* over the last sixty years to commemorate the Sixtieth Anniversary of the founding of *KME*.

At 7:30 a.m. on Saturday, April 13, a special Southern Breakfast was enjoyed by the delegates in the Banquet Hall, University Center. During this time the Regional Directors also met over breakfast in the Banquet Hall.

The convention reconvened at 8:30 a.m. in the Performance Center. Arnold D. Hammel of Michigan Beta, National President-Elect, presided during the presentation of the following papers:

11) *Some Legal Application of Probability*
    KATHY MARIE PONDER, Kentucky Alpha
    Eastern Kentucky University

12) *Fractal Geometry: A General Overview*
    J. BEN SCHAFER, Iowa Alpha
    University of Northern Iowa

13) *Magical Minimal Mania*
    TY G. ANDERSON, Kansas Gamma
    Benedictine College

14) *The Jacobi Symbol*
    ONECIA GIBSON (graduate student), Kentucky Alpha
    Eastern Kentucky University

The Awards Committee met in Room 206, University Center at 10:00 a.m.

The second business meeting was held at 10:15 a.m. in the Performance Center with Harold L. Thomas, National President, presiding.

The following national officers presented reports (copies attached):

Business Manager, *The Pentagon* — Sharon Kunoff, New York Lambda
Editor, *The Pentagon* — Andrew M. Rockett, New York Lambda
National Historian — Mary Elick, Missouri Iota
National Treasurer — Sr. Jo Ann Fellin, Kansas Gamma
National Secretary — Robert L. Bailey, New York Eta
National President-Elect — Arnold Hammel, Michigan Beta
National President — Harold L. Thomas, Kansas Alpha

Stacy Barringer of Alabama Beta reported for the student section meeting, while Mary Sue Beersman reported for the faculty section meeting.

John Cross of Iowa Alpha, chair of the Auditing Committee reported that the National Treasurer's records were found to be accurate and in good order.

Mary Sue Beersman, Chair of the Resolutions Committee, reported for the Committee. The following resolutions were adopted:

> Whereas *Kappa Mu Epsilon* has been holding its 28th Biennial Convention celebrating the 60th anniversary of *Kappa Mu Epsilon* on the picturesque campus of the University of North Alabama and whereas the convention has been both an enjoyable and rewarding experience for all of us, be it resolved that we express appreciation

> 1. To the host chapter, Alabama Beta, its president, Stacy Barringer, its corresponding secretary, Eddy Joe Brackin, its faculty sponsor, Patricia Roden, to the members of the Mathematics Department, and to the administration of the University of North Alabama, for their southern hospitality and efficient organization which have been so important to the success of this convention.

> 2. To each of the national officers of *Kappa Mu Epsilon* for

the many hours of service they have contributed in preparation for and during the convention.

3. To the Foster Family String Band with their entertaining Blue Grass music, to Debra Keith of Blue Ivory for singing the blues, and to James Odom for his informative banquet address.

4. To the various committees who worked so diligently both before and during this convention to insure its success.

5. Last, but not least, to the fourteen students who presented papers at this convention and to the one student who prepared a paper and was not able to attend.

President Harold Thomas presided during the election of officers for 1991-95. Since no other nominations were presented from the floor, a unanimous ballot was cast for a second term for both the incumbent National Treasurer and National Secretary. President Thomas announced that Mary Sue Beersman, MO Eta, has accepted appointment as Director of Region 4 for 1991-95.

An invitation to host the Twenty-Ninth Biennial Convention was extended by New York Eta, Niagara University.

George R. Mach of California Gamma, former National Secretary, addressed the delegates with a few remarks concerning the involvement of *KME* members following graduation in such activities as helping to establish a new chapter or volunteering to be a speaker at a chapter meeting. Arnold D. Hammel of Michigan Beta, National President-Elect, explained the criteria for the selection of the recipient of the George R. Mach Distinguished Service Award which is given each biennium to the person who has made major contributions to *Kappa Mu Epsilon*. This biennium's recipient is Sr. Helen Sullivan, the citation for whom reads as follows:

CITATION FOR SISTER HELEN SULLIVAN, OSB
THE GEORGE R. MACH DISTINGUISHED SERVICE AWARD
APRIL 12, 1991

Sister Helen Sullivan's service to *Kappa Mu Epsilon* began in 1940 when she became the foundress of the Kansas

Gamma Chapter at Mount St. Scholastica College in Atchison, Kansas shortly after completing her doctorate. From that time until she left college teaching in 1970, she supported the national organization by attending and sponsoring students at numerous regional and national conventions. She served as National Historian from 1943-47, gave generously to committee work for the organization, and hosted the national convention in 1967.

Over the years that Sister Helen taught at Mount St. Scholastica College, now Benedictine College, she encouraged women in scholarly work and leadership activities through Kansas Gamma. Many of these women participated actively at conventions, presented award-winning papers, and published in *The Pentagon*.

Sister Helen maintains an interest in *Kappa Mu Epsilon* and specifically in Kansas Gamma Chapter members. Even after leaving the College, she was always present at Kansas Gamma's five-year celebrations, most recently at the 50th anniversary celebrated last May.

We take pleasure in recognizing Sister Helen Sullivan's 30 years of active service to *Kappa Mu Epsilon* and her 50 years of concern for Kansas Gamma by presenting her with the George R. Mach Distinguished Service Award.

An award of $100 will be given to Kansas Gamma, the chapter with which Sr. Helen Sullivan was associated for so many years.

Richard Gibbs of Colorado Gamma, Chair of the Awards Committee, reported for the committee. Certificates of participation were presented to all 14 student speakers. In addition, each speaker received an award of $60 in commemoration of the 60th Anniversary of the founding of *KME*, and a T-shirt from Alabama Beta. The following awards for student papers were announced and presented:

First Place ($60) - Mary J. Wilson, Kansas Delta
Second Place ($40) - J. Ben Schafer, Iowa Alpha
Third Place ($30) - Robert G. Donnelly, Jr., Virginia Gamma
Fourth Place ($20) - Christin Vandiver, Alabama Beta

In addition, the first place winner also received an HP-28S calculator and the second place winner an HP-42S calculator, courtesy of the Hewlett-

Packard Company.

The following officers were installed by Harold L. Thomas, National President, for the term 1991-95:

National Treasurer - Sr. Jo Ann Fellin, Kansas Gamma
National Secretary - Robert L. Bailey, New York Eta

Convention evaluation forms were distributed to the delegates and collected by the host chapter. Copies of the reports of the national officers were made available to the delegates.

Travel allowances were paid to the delegates by Sr. Jo Ann Fellin of Kansas Gamma, National Treasurer. The convention was adjourned at 11:52 a.m.

Robert L. Bailey

Report of the President

Since my installation as National President at the 27th Biennial Convention, we have installed six new chapters, which brings the total number of active chapters to 109. I am pleased to report that none of the chapters were put on inactive status during the past biennium. New chapters added are Oklahoma Delta at Oral Roberts University (installed by Harold Thomas and Mary Elick, April 10, 1990); Colorado Delta at Mesa State College (installed by Richard Gibbs, April 27, 1990); North Carolina Gamma at Elon College (installed by James Lightner, May 3, 1990); Pennsylvania Xi at Cedar Crest College (installed by James Pomfret, October 30, 1990); Missouri Lambda at Missouri Western State College (installed by Sister Jo Ann Fellin, February 10, 1991); and Texas Kappa at the University of Mary Hardin-Baylor (installed by Harold Thomas, February 21, 1991). At this convention, we are acting on the petition from Erskine College at Due West, South Carolina. In addition, two other institutions have received petition forms. I have also corresponded with fourteen colleges and universities that have indicated an interest in *Kappa Mu Epsilon*. If you have friends and colleagues at schools that do not have a *KME* chapter, but are interested, have them contact me.

The National Council continues to support the regional structure of *KME*. Please refer to the report by President-Elect Arnold Hammel for the report of regional conventions. With much gratitude, we recognize

the work and efforts of our Regional Directors. These people have served our Society well and deserve the thanks of each of us. I would especially cite Homer Hampton, Region 4 Director, whose term expires with this convention. Since 1983, Homer has been diligently looking after *KME* interests in Region 4. Thanks, Homer, for a job well done.

A special thanks is extended to each of the faculty who serve as corresponding secretaries and faculty sponsors with our active chapters. I know many of you played an important role in assisting your students in the preparation of the excellent papers we have on the convention program this year. Furthermore, we all express our gratitude to each of the students who did the work, endured the stress, and prevailed in submitting and presenting a paper at this convention. Without the student papers, the major focal point of the convention does not exist. We are further indebted to all of the individuals who did all of the work necessary to bring this convention to fruition and to those who have served on the convention committees. Almost without exception, everyone who was asked to serve on a convention committee willingly agreed to do so. This kind of response, both at convention time, and throughout my tenure thus far, has made the privilege of being your President much easier. To all of you at Alabama Beta (under the capable direction of Eddy Joe Brackin and Pat Roden), and to each committee member, please accept our most sincere thanks for jobs well done.

During the past biennium, I have represented *Kappa Mu Epsilon* at the annual meetings of the Association of College Honor Societies (ACHS). It has been very helpful to meet with officers of the other 57 honor societies that are members of ACHS for the purpose of exchanging ideas and acquiring suggestions as to how we can possibly improve on the programs we currently have in place. The National Council will, in later meetings, focus on implementing some of these ideas to help *Kappa Mu Epsilon* move forward towards an even better and stronger national honor society.

I next want to recognize the fantastic job which is being done by those who work with, manage, write for, and produce our journal, *The Pentagon.* We are most appreciative of the editorial leadership of Andy Rockett (NY Lambda) and the sound business management given to us by Sharon Kunoff (NY Lambda). We thank these two, and all the people staffing the low profile jobs who truly give us a journal which is respected nationwide by our professional mathematics community.

Finally, I want to recognize and applaud the outstanding efforts put forth by other members of the National Council in their respective areas of responsibility. We have special indebtedness to these very capable and

conscientious individuals who so unselfishly give of their time and efforts in making our honor society the very best it can possibly be.

In summary, I can honestly say that I have thoroughly enjoyed the privilege of serving *Kappa Mu Epsilon* at the national level the past several years. I look forward to the completion of my term as your National President. Best wishes to each of you as we continue to work for the improvement of this very special Honor Society -- *Kappa Mu Epsilon*.

Harold L. Thomas

Report of the President-Elect

One of the responsibilities of the President-Elect is to serve as coordinator of regional activities of the Society through the regional directors. During the Spring of 1990, there were four regional conventions held in:

Region I at Pennsylvania Theta, Susquehanna University;
        April 27-28, four chapters, 41 participants;
        James Pomfret, Regional Director.

Region II at Wisconsin Alpha, Mount Mary College;
        March 16-17, three chapters, 35 participants;
        Sister Adrienne Eickman, Regional Director.

Region III at South Carolina Gamma, Winthrop College;
        March 30-31, four chapters, 30 participants;
        Patrick Costello, Regional Director.

Region IV at Kansas Gamma, Benedictine College;
        March 17, thirteen chapters, 82 participants;
        Homer Hampton, Regional Director.

Programs at the regional conventions included student papers, guest talks, local tradition banquets and lunches, faculty discussions, student discussions and good social times. We extend our sincere thanks to the host chapters, regional directors, and all who participated in this regional activity. We also appreciate the efforts of the other Regional Directors, Richard Gibbs, Region V, and Raymond Terry, Region VI, in attempting to have regional conventions in their regions.

It is another of the President-Elect's responsibilities to make arrangements for the presentation of student papers at the National Convention. I am please to report that fifteen students, representing ten chapters and eight states, submitted papers for this convention. Fourteen of the papers were written by undergraduate students. All fifteen papers are being presented at this convention. On behalf of our entire Society, I want to extend special thanks to the members of the Paper Selection Committee who read and ranked the papers: Professor John Fuelberth (Nebraska Alpha), Professor Javad Habibi (Ohio Zeta), and Professor George Mitchell (Pennsylvania Zeta). Special thanks also goes to the Awards Committee. Their much appreciated effort this weekend leads to the choosing of the four papers that receive awards. The members of this committee are: Richard Gibbs (Colorado Gamma), Chair, Donald Alpin (South Carolina Gamma), Shirley Branan (Alabama Zeta), Sr. Adrienne Eickman (Wisconsin Alpha), Theodore Herzog (Wisconsin Gamma), David McWilliams (Missouri Alpha), Kevin O'Reilly (New York Lambda), and Melissa Sherrel (Missouri Iota). In addition, I want to express our sincere thanks to the fifteen students who prepared, submitted and presented papers. It is these papers and the work of the Selection Committee and Awards Committee which are the most important components in having a successful convention.

In response to a resolution from the April 1989 National Convention, the National Council at its November 1989 meeting determined that the Awards Committee will be composed of four students and four faculty members representing as many chapters as possible. Efforts will be made to select committee members from chapters which have no students presenting papers. The criteria used by the Paper Selection and Awards committees are as follows and also appear in the Spring 1990 *Pentagon* Announcement of the National Convention as well as in a Fall 1990 letter to local chapters: (A) The paper will be judged on (1) topic originality, (2) appropriateness to the meeting and audience, (3) organization, (4) depth and significance of the content and (5) understanding of the material. (B) The presentation will be evaluated on (1) style of presentation, (2) maintenance of interest, (3) use of audio-visual materials (if applicable), (4) enthusiasm for the topic, (5) overall effect and (6) adherence to the time limit.

Another responsibility of the President-Elect is the coordination of the selection of the George R. Mach Distinguished Service Award. I want to thank those corresponding secretaries and faculty sponsors who made nominations for the Mach Award. The recipient of the 1991 award will be announced at the Saturday morning session.

<div align="right">Arnold D. Hammel</div>

Report of the National Secretary

During the last biennium, six new chapters of *Kappa Mu Epsilon* were installed as listed below:

Chapter	Institution	Installation Date
Oklahoma Delta	Oral Roberts University	4/10/90
Colorado Delta	Mesa State College	4/27/90
North Carolina Gamma	Elon College	5/03/90
Pennsylvania Xi	Cedar Crest College	10/30/90
Missouri Lambda	Missouri Western State College	2/10/91
Texas Kappa	University of Mary Hardin-Baylor	2/21/91

The Society now has 109 active chapters in 31 states.

During the last biennium 2,315 members were initiated. The 109 active chapters have a combined membership of 47,874 and the 29 inactive chapters have a combined membership of 6,390, making the total membership of *Kappa Mu Epsilon* 54,264 at the end of the biennium.

As National Secretary, I maintain permanent files on all active and inactive chapters, including reports of all initiations. I order membership certificates for all new members and I stock all supplies, including forms, invitations and jewelry. I assist corresponding secretaries in any ways that I can and I take minutes of National Council meetings and Biennial Conventions.

Robert L. Bailey

Financial Report of the National Treasurer
1989-91 Biennium (March 14, 1989 through March 11, 1991)

Assets at beginning of biennium $53008.08

RECEIPTS

Receipts from Chapters
    Initiates (2315) $34725.00
    Jewelry   1436.75
    Supplies   229.00
Interest   8140.67

Miscellaneous		1737.09	
Certificate replacements	7.50		
Overpays	30.00		
Insuff funds reimbursement	61.50		
New Chapter Fees	829.44		
Pentagon (advance returned)	700.00		
Herff Jones refund	108.65		
Total Receipts during biennium		46268.51	
Receipts plus Assets			99276.59

EXPENDITURES

Jewelry		1767.58	
Printing		6148.32	
Pentagon ($700 advance returned — see above)		14468.13	
Travel		3067.99	
Conventions		8956.53	
1989 Biennial Convention	8343.56		
1990 Regional meetings	612.97		
ACHS dues		120.00	
Miscellaneous		3086.25	
National Council Meeting	412.95		
ACHS Meetings	190.00		
Supplies	282.24		
Telephone	473.83		
Postage	998.05		
Chapter installations	432.68		
Insufficient funds	31.50		
Overpay refunds	30.00		
Installation deposit refunds	40.00		
Bonding of Treasurer	195.00		
Total Expenditures		37614.80	

Assets at end of biennium		61661.79
Exchange National Bank #346896	7410.56	
Treasury Bond	9978.70	
Bank IV #0617008418	27037.72	
Bank IV #0640003303	13158.24	
Bank IV #116106	4076.57	

Jo Ann Fellin, OSB

Report of the National Historian

The files of the National Historian are being maintained and continually updated with the reports received from chapters about their events and activities, with information received from Regional Directors about regional conventions and items of interest related to the region, and with material received from the National Officers which has historical significance.

News items have been solicited from corresponding secretaries semi-annually, in January and May. These responses, as well as installation reports of new chapters furnished by the installing officers, are then edited for publication in the *Kappa Mu Epsilon News* section of *The Pentagon.*

During the past biennium, 77 of the active chapters responded at least once to the chapter news request. Special mention goes to the following 26 chapters for their cooperation in responding to all four inquiries: CA Gamma, CO Gamma, IA Alpha, IA Delta, KS Alpha, MD Delta, MI Beta, MS Gamma, MO Alpha, MO Gamma, MO Epsilon, MO Eta, MO Iota, NE Alpha, NE Gamma, NE Delta, NY Alpha, NY Eta, NY Lambda, OH Zeta, OK Alpha, OK Gamma, PA Alpha, PA Kappa, TX Eta and WI Gamma. I urge chapters to reply to the requests for chapter news even if it is only to identify chapter officers. This will provide chapters with a permanent record of their local officers in the event they do not retain that information within their own chapter.

As a national officer, it was my pleasure to assist, in April 1990, with the installation of OK Delta Chapter at Oral Roberts University in Tulsa, OK.

Other activities of the Historian's Office during the past biennium revolved around compiling and editing a history of *The Pentagon* for publication in the Fall 1990 Golden Anniversary issue of the journal and updating the *KME History and Information* booklet which was distributed to you at this convention. The latter was accomplished with considerable assistance from the National President.

I wish to thank all of those with whom I have corresponded relative to this office -- the National Officers, the Regional Directors, Corresponding Secretaries, and individual *KME* members. Especially, I wish to thank Dr. Andy Rockett, editor of *The Pentagon*, for his help and suggestions relative to the *Kappa Mu Epsilon News* section. I have enjoyed serving these past two years as your National Historian.

Mary S. Elick

Report of the Editor of *The Pentagon*

With my appointment at the last national convention as editor of *The Pentagon*, our official journal of *Kappa Mu Epsilon*, Mathematics Honor Society, I joined the ranks of all editors who take pride not only in the continuation of an established publication but also in the opportunity to foster changes to enhance that publication.

During the past two years, *The Pentagon* has become a copyrighted magazine in which twelve student papers have appeared as well as the abstracts of seven student presentations made at the Spring 1990 Region I convention. The Fall 1990 issue featured the fiftieth anniversary of *The Pentagon* with articles contributed by Harold L. Thomas, National President of our Society, and by Mary S. Elick, National Historian. The photograph of Dr. Carroll V. Newsom, founding editor of *The Pentagon*, appeared through the courtesy of the New York University Archives. A complete roster of editors, associate editors and business managers was given chronologically, beginning with the founding of the journal in 1941. With the help of the business manager and the national officers, I have assembled a set of back issues that are now part of the editor's official files; my thanks also go to Fred A. Webber, corresponding secretary of Nebraska Alpha, for donating a copy of the Spring 1966 issue that made my collection complete.

Our magazine has had format changes over the years and I hope the new cover design and uniform type fonts for the text do justice to the high quality of the student papers I have had the opportunity to publish. A group of volunteer faculty referees from various institutions has been established to review submissions and their help will be acknowledged in the Spring 1992 issue. The continued efforts and prompt attention to details by associate editors Kenneth M. Wilke and Mary S. Elick have greatly simplified my tasks, as have the use of the facilities of the Instructional Media Center of Long Island University.

Andrew M. Rockett

Report of the Business Manager of *The Pentagon*

In this, my first biennial report since taking over as business manager of *The Pentagon*, I want to thank Gerald White for his help in transferring the files. E-mail and the expertise of Steve Voege of the C. W. Post Computer Center made the transition to the C. W. Post VAX

relatively painless, and he has earned my deepest gratitude. Zip code order mailing labels appear on command.

We hope you are as satisfied with the appearance of *The Pentagon* as we are. Since costs per issue decrease as the number of subscribers increase, we would like to increase our subscription list which has remained at about 2800 for several years. To this end I have been mailing renewal statements to people as their subscriptions expire and I have been getting between 70 and 100 people renewing who would not do so without this reminder. I would like to encourage those of you who are no longer *Pentagon* subscribers to see me about reinstating your subscription. We have so far kept the domestic cost at $5.00 for two years which is the same as other similar magazines. However, increased postal costs might warrant an increase before the next meeting. Last year we did find it necessary to increase the cost of foreign subscriptions to $5.00 per year including postage.

In a further bid to enlarge our subscription list, Dr. Rockett made up a "sampler issue" which I had displayed at the joint mathematics meetings in San Francisco. The response from this has been small but it did increase our exposure. Our biggest problem to date has been bad addresses. Corresponding secretaries must be sure that *The Pentagon* copy of the new member card contains a correct permanent address that will be current for two years. (Dorm addresses usually change yearly.) Chapter members should be reminded each year to contact me if their address has changed. It would help if, when giving a new address, the old address is mentioned in the communication. Since we do not pay to have undeliverable copies returned we do not know if a copy if not delivered. However, I have been sending the renewals by first class mail and have received almost 100 "return to sender" in a mailing of 700. This is an indication that many of the magazines are ending up in the dead letter office. Please don't let yours or your student's issues be among them! We have even found that some of our institutional issues have been going to outdated addresses and we are in the process or correcting this!

We expect to be mailing our spring issue in a few weeks. If you do not receive yours, please contact me and I will check to see if you are entered correctly. Happy reading!

<div align="right">Sharon Kunoff</div>
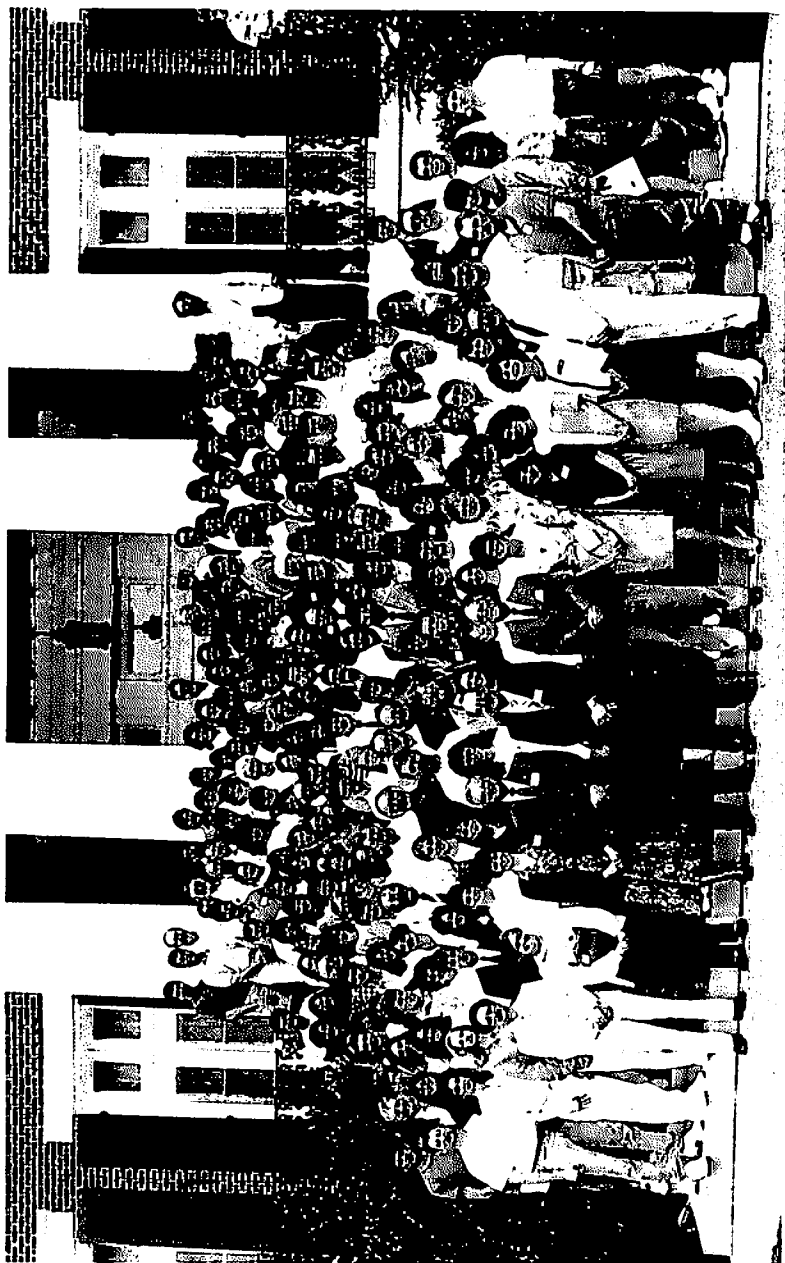
Twenty-Eighth Biennial Convention of Kappa Mu Epsilon, 11-13 April 1991, at the University of North Alabama, Florence, Alabama.

Front row (*left to right*): A.M. Rockett, S. Kunoff, J.A. Fellin, H.L. Thomas, A.D. Hammel,

Kappa Mu Epsilon National Officers

Harold L. Thomas   *President*
        Department of Mathematics
   Pittsburg State University, Pittsburg, Kansas 66762

Arnold D. Hammel   *President-Elect*
        Department of Mathematics
   Central Michigan University, Mt. Pleasant, Michigan 48859

Robert L. Bailey   *Secretary*
        Department of Mathematics
   Niagara University, Niagara University, New York 14109

Jo Ann Fellin   *Treasurer*
        Mathematics and Computer Science Department
         Benedictine College, Atchison, Kansas 66002

Mary S. Elick   *Historian*
        Department of Mathematics
   Missouri Southern State College, Joplin, Missouri 64801

Kappa Mu Epsilon, Mathematics Honor Society, was founded in 1931. The object of the Society is fivefold: to further the interests of mathematics in those schools which place their primary emphasis on the undergraduate program; to help the undergraduate realize the important role that mathematics has played in the development of western civilization; to develop an appreciation of the power and beauty possessed by mathematics due to its demands for logical and rigorous modes of thought; to provide a Society for the recognition of outstanding achievement in the study of mathematics at the undergraduate level; and to disseminate the knowledge of mathematics and familiarize the members with the advances being made in mathematics. The official journal of the Society, *The Pentagon*, is designed to assist in achieving these objectives as well as to aid in establishing fraternal ties between the Chapters.

Active Chapters of Kappa Mu Epsilon

Listed by date of installation.

Chapter	Location	Installation Date
OK Alpha	Northeastern Oklahoma State University, Tahlequah	18 April 1931
IA Alpha	University of Northern Iowa, Cedar Falls	27 May 1931
KS Alpha	Pittsburg State University, Pittsburg	30 Jan 1932
MO Alpha	Southwest Missouri State University, Springfield	20 May 1932
MS Alpha	Mississippi University for Women, Columbus	30 May 1932
MS Beta	Mississippi State University, Mississippi State College	14 Dec 1932
NE Alpha	Wayne State College, Wayne	17 Jan 1933
KS Beta	Emporia State University, Emporia	12 May 1934
NM Alpha	University of New Mexico, Albuquerque	28 March 1935
IL Beta	Eastern Illinois University, Charleston	11 April 1935
AL Beta	University of North Alabama, Florence	20 May 1935
AL Gamma	University of Montevallo, Montevallo	24 April 1937
OH Alpha	Bowling Green State University, Bowling Green	24 April 1937
MI Alpha	Albion College, Albion	29 May 1937
MO Beta	Central Missouri State University, Warrensburg	10 June 1938
TX Alpha	Texas Tech University, Lubbock	10 May 1940
TX Beta	Southern Methodist University, Dallas	15 May 1940
KS Gamma	Benedictine College, Atchison	26 May 1940
IA Beta	Drake University, Des Moines	27 May 1940
TN Alpha	Tennessee Technological University, Cookeville	5 June 1941
NY Alpha	Hofstra University, Hempstead	4 April 1942
MI Beta	Central Michigan University, Mount Pleasant	25 April 1942
NJ Beta	Montclair State College, Upper Montclair	21 April 1944
IL Delta	College of St. Francis, Joliet	21 May 1945
KS Delta	Washburn University, Topeka	29 March 1947
MO Gamma	William Jewell College, Liberty	7 May 1947
TX Gamma	Texas Woman's University, Denton	7 May 1947
WI Alpha	Mount Mary College, Milwaukee	11 May 1947
OH Gamma	Baldwin-Wallace College, Berea	6 June 1947
CO Alpha	Colorado State University, Fort Collins	16 May 1948
MO Epsilon	Central Methodist College, Fayette	18 May 1949
MS Gamma	University of Southern Mississippi, Hattiesburg	21 May 1949

IN Alpha	Manchester College, North Manchester	16 May 1950
PA Alpha	Westminster College, New Wilmington	17 May 1950
IN Beta	Butler University, Indianapolis	16 May 1952
KS Epsilon	Fort Hays State University, Hays	6 Dec 1952
PA Beta	LaSalle University, Philadelphia	19 May 1953
VA Alpha	Virginia State University, Petersburg	29 Jan 1955
IN Gamma	Anderson University, Anderson	5 April 1957
CA Gamma	California Polytechnic State University, San Luis Obispo	23 May 1958
TN Beta	East Tennessee State University, Johnson City	22 May 1959
PA Gamma	Waynesburg College, Waynesburg	23 May 1959
VA Beta	Radford University, Radford	12 Nov 1959
NE Beta	Kearney State College, Kearney	11 Dec 1959
IN Delta	University of Evansville, Evansville	27 May 1960
OH Epsilon	Marietta College, Marietta	29 Oct 1960
MO Zeta	University of Missouri - Rolla, Rolla	19 May 1961
NE Gamma	Chadron State College, Chadron	19 May 1962
MD Alpha	College of Notre Dame of Maryland, Baltimore	22 May 1963
IL Epsilon	North Park College, Chicago	22 May 1963
OK Beta	University of Tulsa, Tulsa	3 May 1964
CA Delta	California State Polytechnic University, Pomona	5 Nov 1964
PA Delta	Marywood College, Scranton	8 Nov 1964
PA Epsilon	Kutztown University of Pennsylvania, Kutztown	3 April 1965
AL Epsilon	Huntingdon College, Montgomery	15 April 1965
PA Zeta	Indiana University of Pennsylvania, Indiana	6 May 1965
AR Alpha	Arkansas State University, State University	21 May 1965
TN Gamma	Union University, Jackson	24 May 1965
WI Beta	University of Wisconsin - River Falls, River Falls	25 May 1965
IA Gamma	Morningside College, Sioux City	25 May 1965
MD Beta	Western Maryland College, Westminster	30 May 1965
IL Zeta	Rosary College, River Forest	26 Feb 1967
SC Beta	South Carolina State College, Orangeburg	6 May 1967
PA Eta	Grove City College, Grove City	13 May 1967
NY Eta	Niagara University, Niagara University	18 May 1968
MA Alpha	Assumption College, Worcester	19 Nov 1968
MO Eta	Northeast Missouri State University, Kirksville	7 Dec 1968
IL Eta	Western Illinois University, Macomb	9 May 1969
OH Zeta	Muskingum College, New Concord	17 May 1969
PA Theta	Susquehanna University, Selinsgrove	26 May 1969
PA Iota	Shippensburg University of Pennsylvania, Shippensburg	1 Nov 1969
MS Delta	William Carey College, Hattiesburg	17 Dec 1970
MO Theta	Evangel College, Springfield	12 Jan 1971

PA Kappa	Holy Family College, Philadelphia	23 Jan 1971
CO Beta	Colorado School of Mines, Golden	4 March 1971
KY Alpha	Eastern Kentucky University, Richmond	27 March 1971
TN Delta	Carson-Newman College, Jefferson City	15 May 1971
NY Iota	Wagner College, Staten Island	19 May 1971
SC Gamma	Winthrop College, Rock Hill	3 Nov 1972
IA Delta	Wartburg College, Waverly	6 April 1973
PA Lambda	Bloomsburg University of Pennsylvania, Bloomsburg	17 Oct 1973
OK Gamma	Southwestern Oklahoma State University, Weatherford	1 May 1973
NY Kappa	Pace University, New York	24 April 1974
TX Eta	Hardin-Simmons University, Abilene	3 May 1975
MO Iota	Missouri Southern State College, Joplin	8 May 1975
GA Alpha	West Georgia College, Carrollton	21 May 1975
WV Alpha	Bethany College, Bethany	21 May 1975
FL Beta	Florida Southern College, Lakeland	31 Oct 1976
WI Gamma	University of Wisconsin - Eau Claire, Eau Claire	4 Feb 1978
MD Delta	Frostburg State University, Frostburg	17 Sept 1978
IL Theta	Illinois Benedictine College, Lisle	18 May 1979
PA Mu	St. Francis College, Loretto	14 Sept 1979
AL Zeta	Birmingham-Southern College, Birmingham	18 Feb 1981
CT Beta	Eastern Connecticut State University, Willimantic	2 May 1981
NY Lambda	C. W. Post Center of Long Island University, Brookville	2 May 1983
MO Kappa	Drury College, Springfield	30 Nov 1984
CO Gamma	Fort Lewis College, Durango	29 March 1985
NE Delta	Nebraska Wesleyan University, Lincoln	18 April 1986
TX Iota	McMurry College, Abilene	25 April 1987
PA Nu	Ursinus College, Collegeville	28 April 1987
VA Gamma	Liberty University, Lynchburg	30 April 1987
NY Mu	St. Thomas Aquinas College, Sparkill	14 May 1987
OH Eta	Ohio Northern University, Ada	15 Dec 1987
OK Delta	Oral Roberts University, Tulsa	10 April 1990
CO Delta	Mesa State College, Grand Junction	27 April 1990
NC Gamma	Elon College, Elon College	3 May 1990
PA Xi	Cedar Crest College, Allentown	30 Oct 1990
MO Lambda	Missouri Western State College, St. Joseph	10 Feb 1991
TX Kappa	University of Mary Hardin-Baylor, Belton	21 Feb 1991
SC Delta	Erskine College, Due West	28 April 1991