Everyman's Visit to the Land of the Mathematicians

An Imaginary Journey to the Abode of Some of the Great Mathematicians

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Baltimore, Maryland

Introduction

This sketch of the history of mathematics is intended for a junior high school audience, although it would not be too simple for a senior high school audience.

The scene is laid in an imaginary land where the great mathematicians of the past have congregated after their lines on earth were ended. Therefore we find men widely separated in time speaking to each other. The organization of the episodes into subjects and the conversations was chosen in order to bring out the abstract character of pure mathematics, and by reference to applications of mathematics to show that purely theoretical work usually, though not always, preceded the practical applications. The closing paragraph of the epilogue states the purpose of the play.

The following authors and publishers have kindly granted permission for the reproduction of pictures and quotations:

Mr. Claude Bragdon and his publishers, Alfred A. Knopf, Inc.; for the two illustrations: "Sinbad, lost in the desert, discovers the five Platonic solids," from *The Frozen Fountain;* and "The hexagram and equilateral triangle in nature" from *The Beautiful Necessity.*

Ginn and Company for the quotation of the quatrain found on page 389 of the second volume of David Eugene Smith's History of Mathematics.

Professor H. W. Turnbull and his publishers, Methuen and Company, Ltd. for the quotation of the last paragraph of *The Great Mathematicians.*

Production Notes

Scenery: The backdrop was an adaptation of Claude Bragdon's drawing as indicated in the tracing. Blue cardboard (the color is not important) was cut into strips about five inches wide and glued into the figures, then pinned to the curtain at the back of the stage.

In Episode III kindergarten tables covered with artificial grass mats were used. The same scene was used in Episode IV. No scenery other than the backdrop was used in Episodes I, II, and the interlude.

In Episode V two period chairs, a period table, and a large globe were grouped in the center of the stage.

Posters: "The hand of God" from the Riccioli frontispiece was hung on the proscenium. The hexagram poster and the equilateral triangle poster were placed on easels at the side of the stage where they remained throughout the performance. Vitruvius carried two posters, one of the restoration of the Parthenon and one of the Sphinx and Pyramids. All of the posters were drawn boldly on tagboard with india ink.

Properties: A rope knotted so as to form the 3-4-5 triangle was carried by the Egyptians, and a bamboo pole borrowed from the gymnasium was used to raise it aloft.

One small scroll is needed for the Greeks.

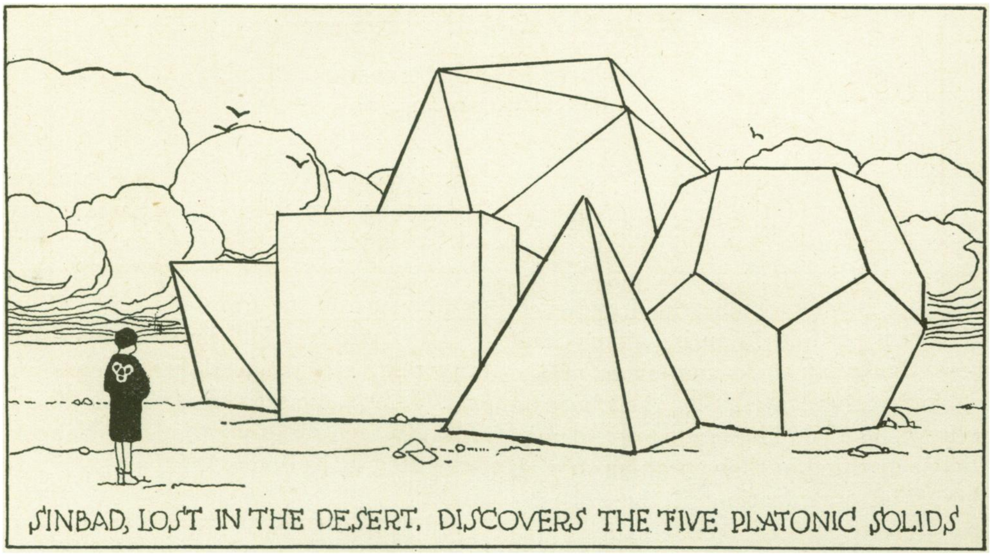
Grosseteste carried a large folded piece of paper, sealing wax prominently displayed.

A reproduction of the Roman abacus was carried by the Roman.

Two old books with leather bindings were used by those who had to have books.

Costumes: Everyman wore black trousers, a dark blue jacket, and a red beret.

The Egyptians had headdresses made



From Bragdon, Claude, *The Frozen Fountain*, N.Y. Alfred A. Knopf, 1932
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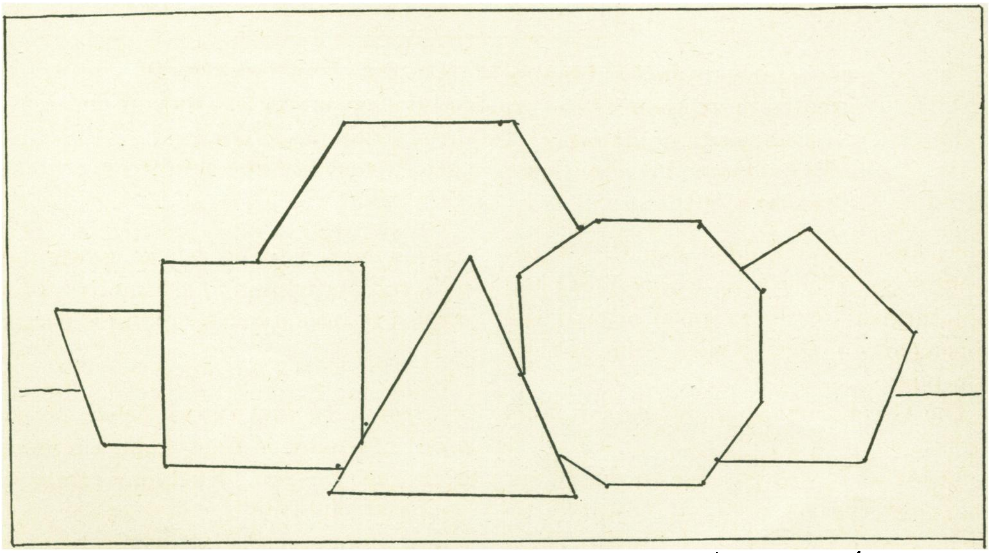
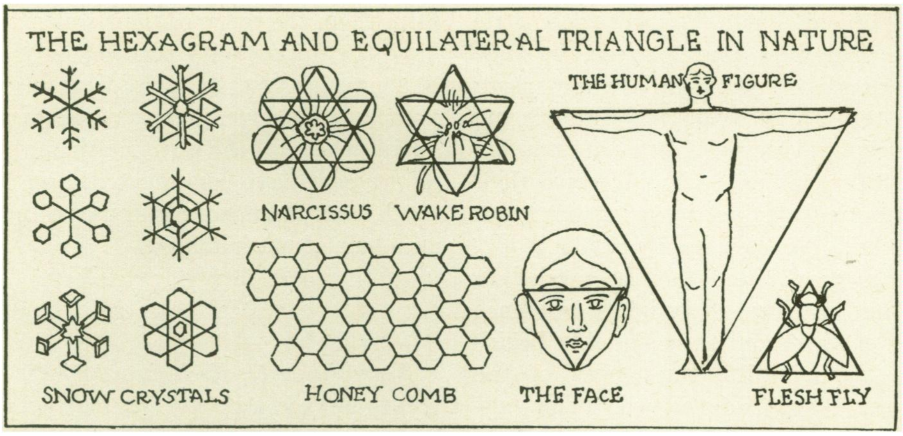
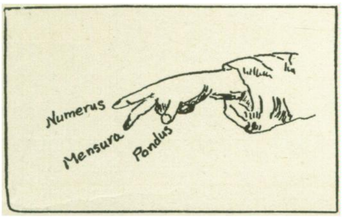


The adaptation of Mr. Bragdon's picture above made of strips of cardboard about five inches wide and pinned to the curtains at the back of the stage.



From Bragdon, Claude, *The Beautiful Necessity*, N.Y., Alfred A. Knopf, 1922. Reproduced by permission of Mr. Bragdon and Alfred A. Knopf, Inc.
(*This was divided into two posters, the hexagrams on one, and the equilateral triangles on the other.*)



From the reduced facsimile of the frontispiece in Riccioli: *Almagestum Novum*, Bologna, 1651 as reproduced in Stimson, Dorothy, *The Gradual Acceptance of the Copernican Theory of the Universe*, New York, 1917

of turkish towels folded like Red Cross headdresses. They wore white shorts and had turkish towels wrapped around the upper parts of their bodies as far as their arm-pits.

The Greeks and Romans wore Roman togas.

As far as it was possible to do so, the following characters wore costumes in keeping with their periods: Stevin, Vieta, Cardan, Recorde, Napier, Descartes, Newton, and Leibniz.

The Arab wore an Arabian costume.

Grosseteste wore a college gown with a hood, and a cap of velvet such as is worn by some church choirs.

Fibonacci wore a college gown faced with red material, and a headdress of red draped to resemble his cap in his portrait.

Prologue

(*Spoken by* Everyman *before the curtain.*) My name is Everyman. I represent each one of you. Everyone, from the youngest child in the first grade to the oldest among you is taught mathematics. Few of us, however, realize the vastness of the subject because it is difficult for those who have not gone far beyond arithmetic to appreciate its magnitude.

This is a mathematical world we live in. Nature itself seems to be governed by mathematical laws. We see geometric shapes in flowers, plants, trees, crystals, —indeed Plato is said to have remarked: "God eternally geometrizes." Animals and insects show evidence of an innate number sense. Bees, for example, illustrate their mathematical instinct by using the hexagon in building their honey combs.

Savage man found that he needed to count and measure early in his existence on the earth. From these humble beginnings, Mathematics, the Queen of the Sciences, slowly developed. The all-pervasiveness of mathematics was realized early. This picture was taken from a book published in 1651 and it represents pictorially words from a Hebrew book written in the first century B.C. It shows the hand of God, one finger marked "number" the second "measure," and the third "weight." It refers to these words: "But thou hast ordered all things in measure, number, and weight."

Much of the mathematics we study today, however, was not inspired by the deliberate attempt to create something useful. The theories and processes were created by mathematicians following a planned and definite line of reasoning, much as a game is played according to certain rules. Jacobi, a famous mathematician, said that the true end of mathematics was the greater glory of the human mind.

Keep that statement in mind—try to forget for a while that man frequently expects some material return for his labor. The great men of the world are content to work for the work's sake with no thought of material reward. Realize that mathematics shows as perhaps no other study does the power of man's mind. Learn how wonderful were the achievements of the men who made mathematics and laid the foundations for our marvellous mechanical civilization—how much more wonderful than the machines themselves were the minds that made them possible.

I am, as your representative, going to meet some of these great men and hear from them the story of their work. I shall have the opportunity to meet only a few of them, because there are so many. Use your imaginations, pretend that we are in a land where all the great mathematicians of the past have congregated, and try to catch from them some glimpse of the true grandeur of mathematics.

Geometry

Episode I

(*Curtain parts, disclosing stage dimly lit.* Everyman *is seen at left, looking at the background. He turns and speaks.*)

Everyman: This must be the place where the mathematicians have gathered.

(Plato *enters from the right.* Everyman *meets him at center.*)

Everyman: Sir, am I in the land of the mathematicians?

Plato: You are. Who are you, and why have you come here?

Everyman: I am Everyman. I have been taught arithmetic for six years and I have heard that there is much more to mathematics than mere arithmetic. I wanted to find out, that is why I am here. Can you tell me? Are you one of the great mathematicians?

Plato: "Wanted to find out"—that is what impels men to make discoveries in any field. I am Plato and I lived in Greece about two thousand, four hundred years ago, about 430 B.C. I am not one of the great mathematicians, but I am here because I knew how important mathematics was and insisted that young people should be taught mathematics. I had a school, very much like your colleges, and I had these words put over the door: "Let no one ignorant of geometry enter here."

Everyman: Geometry—who discovered it?

Plato: The word *geometry* comes from the Greek words *geo* meaning earth and *metron* to measure. Geometry means *earth-measure.* We Greeks got our first ideas of geometry from the Egyptians who used it in measuring land.

(Two Egyptians *bearing knotted rope*

enter left and proceed to stake out triangle. They stop work only to make speeches, then resume it again. They move towards the right.)

PLATO: Here are two of them, we shall see how they worked.

(PLATO *and* EVERYMAN *advance towards* EGYPTIANS.)

Tell this youth who you are and what you are doing.

FIRST EGYPTIAN: We are surveyors, attached to Pharaoh's tax department. Every year when the Nile floods the valley all boundaries are washed away and we must put them back so that each man may know his now land again.

SECOND EGYPTIAN: We are using this rope with these knots—we fasten it here—and here—and here.

(*Addressing* PLATO): Hold this, sir, so that we may raise it.

(PLATO *slips loop over his staff and raises it, so that rope is taut; the* EGYPTIANS *hold knots on floor.*)

Now we can use this to relocate the boundaries.

EVERYMAN: A right triangle! How did they do that? If I tied two knots in a rope and stretched it so, would it always make a right triangle?

(PLATO *lowers staff. The* EGYPTIANS *proceed staking towards right and exit when they reach door.*)

PLATO: Not unless you tied the knots in particular places. These men are called harpodonaptae—rope stretchers. Pythagoras, one of the Greek mathematicians, is said to have proved the principle that underlies the Egyptian rope-stretching.

EVERYMAN: These Egyptians must have known a great deal of geometry.

PLATO: Yes, they knew many practical applications, they used them in building their Pyramids and their huge temples; but they did not know why these practical applications always worked. The Greeks studied that—and there is the man who began that study.

(*Enter* THALES *from right, gazing at the stars as he walks slowly. He bumps into* PLATO, *as* PLATO *and* EVERYMAN *approach him.*)

PLATO: Look out, Thales, old fellow, bring your eyes down to earth or you'll be in a ditch again.

THALES (*with difficulty, brings himself to earth again*): Oh! it's you, Plato. Who's that with you?

PLATO: This is Everyman. He is visiting us to find out about mathematics. Tell him something about yourself.

THALES: Now isn't that a nice thing to ask a man to do—talk about himself! What do you want me to tell him—how I predicted the eclipse of the sun in 585 B.C. or how I developed abstract proofs about lines, or how I cornered the olive market —or what?

PLATO: That's enough. Without going into detail, he knows that you are an astronomer, a geometrician, and a shrewd business man. And, Everyman, he did excellent work in all of those fields.

(THALES *has turned and resumed his star-gazing. He moves slowly to the right during the next speech and goes out when he reaches the door. Meanwhile* PYTHAGORAS *enters from left in grand manner as* PLATO *finishes speaking above.* PLATO *sees him.*)

PLATO (*aside to* EVERYMAN): Ah! Pythagoras—he's the head of a famous secret society, be sure you treat him with *great* respect.

(*To* PYTHAGORAS): Hail, master, here is one who would speak with you.

PYTHAGORAS: Let him approach.

EVERYMAN (*with great deference*): Pythagoras—master—Plato told me you could teach me many things.

PYTHAGORAS (*impressively*): I can. Number is the basis of *all* things. I have found number in sounds. I have heard the music of the spheres, I—but I impart my knowledge only to those who have the right to wear this sign.

(*Points to pentagram on his costume.*)

EVERYMAN: I see—but can you tell me who it was among your followers who found that there were numbers, incommensurables I think you call them, numbers that cannot be expressed exactly as whole numbers or fractions.

PYTHAGORAS (*startled*): How do *you* know that such numbers exist? That is one of our secret mysteries.

(EUCLID *enters from left.*)

PLATO: Euclid, here, wrote it in a book, along with all the other geometrical facts that had been discovered, and with some new facts he discovered himself.

(PYTHAGORAS *eagerly takes scroll from* EUCLID *and reads it attentively until curtain.* PLATO *continues, addressing* EVERYMAN.)

You'll study Euclid's book in its modern form some day. It's very slightly changed.

EVERYMAN: What good will studying your book do me, Euclid?

EUCLID: Once, long ago, a student of mine asked me that same question. I told the slave to give him a sixpence since he must have some thing from what he learned. It is true that only a few people will actually use what they study in my book, but everyone who studies it properly will gain some insight into the methods of rigorous logical thinking. In my opinion that is reason enough for studying it.

PLATO: Reason enough. And Euclid, Everyman, arranged the particular kind of geometry that he studied so well that few changes have been made in it.

Curtain

APPLICATIONS OF MATHEMATICS IN ANCIENT TIMES

Episode II

(PLATO *enters left with* EVERYMAN. ARCHIMEDES *is kneeling, tracing a figure on the floor and is obviously engaged in considering a problem.*)

PLATO: There is Archimedes, the greatest mind in science of the ancient world. He is working on a problem in geometry—he has drawn his figure in the sand. He is said to have been doing that when the Romans captured Syracuse in 212 B.C. One story has it that a Roman soldier came upon him while he was thus engaged and tried to take him to the Roman commander, Marcellus; but Archimedes refused to go until he had completed his solution of the problem. Thereupon, the soldier, not understanding, killed him; much to the regret of Marcellus, who greatly revered Archimedes' learning. Marcellus punished the soldier and showed great favor to the family of the scholar.

(ARCHIMEDES *sits back on his heels and contemplates his figure with an air of satisfaction.*)

He has finished his problem now, perhaps he will speak to us.

(*They go towards* ARCHIMEDES *who rises as they approach.*)

Greetings, Archimedes, will you tell my young friend, Everyman, something of your work?

ARCHIMEDES: With pleasure, though I can give him only a brief summary in the time I have—I did so many things. I am interested in many aspects of science connected with mathematics. I am a geometer and an analyst, a mathematician and an engineer. Most of my mathematical work is too difficult for those who are not especially trained, but you will be interested in hearing of some of my inventions, though they are not the most important part of my work. I wrote a treatise on levers and machines in general—you know the lever has tremendous possibilities. Give me a place where I can stand and I will move the world. You know, also, no doubt, the story of how I leaped from my bath crying "Eureka"—that means "I have found it" in your language-when I discovered a method for discovering the amount of gold in King Hiero's crown. He had information that the goldsmith who made the crown had kept some of the gold that was given him for the crown and put another metal in its place. I found that by measuring the amount of water displaced by an object I could tell what material the object was made of; since a given weight of any material would displace a definite amount of water. I invented machines which the Syracusans used in fighting the Romans, though in truth, I did not invent them for that purpose, but merely as exercises in geometry. I worked with the screw and the spiral, and by means of a system of pulleys and cogwheels I was able to move a great ship loaded with freight and passengers over land. Everyone thought my work was wizardry of some sort, but it is very simple, I explained it all by mathematics.

(*During the recital* EVERYMAN *surveys* ARCHIMEDES *with wonder and awe. He is speechless.*)

PLATO: Truly a *very* brief summary, and not complete at that, Archimedes.

(ARCHIMEDES *smiles and shrugs, as he well knows he could never explain in a few minutes even a part of his work. He turns and kneels and begins working on a problem at the back.*)

Everyman, his work is staggering! There is only one other man who has ever done as much in mathematics, you will meet him later. Archimedes enriched even the highly developed Euclidean geometry, made important progress in algebra, laid the foundation of the scientific study of mechanics, and even anticipated the calculus. He reached a level which was not surpassed for two thousand years.

(VITRUVIUS *enters in a brisk businesslike manner. He carries the posters under his arm.*)

PLATO: Hail, Vitruvius, where are you off to in such a hurry? Stop and show Everyman what you are carrying, won't you?

VITRUVIUS: I'm off to see to the work my men are doing on an aqueduct, Plato, but I'll be glad to stop and speak to Everyman for a minute.

(*To* EVERYMAN): I am Vitruvius, a Roman engineer and architect under the Emperor Augustus. You know we Romans don't care much about this abstract and theoretical work of the Greeks.

(VITRUVIUS *glances at* PLATO, *who shakes his head at such a deplorable statement.*)

We *did* things.

(PLATO *looks a bit disgusted, he believes in the ideal and not the material.* VITRUVIUS *is a trifle self-satisfied and scornful of the man of ideals.*)

These pictures show two of the architectural works of Egypt and Greece. Take the Pyramids for example:

(VITRUVIUS *holds up poster. He rolls out the figures in the following speech with evident enjoyment and great impressiveness.*)

Those Egyptians were technical experts, I tell you. Some of those stones weigh fifty-four tons. They cut them in the quarries on the other side of the Nile to exact size and shape, floated them down the river on barges, and then levered them into position by sheer man-power. The Great Pyramid is about 760 feet on a side (it would take about fifteen minutes to walk around it), it's about 484 feet high. The slope of the sides is 51 degrees and a bit more—and they did not have protractors! The measurements of all parts of the Pyramids show a scheme of careful proportional planning. There's much more I could tell you about the Pyramids, but I haven't time now. Here's the Greek temple—let Plato tell you about that, he used to live in Athens.

(*Holds other poster up—gives Egyptian one to* EVERYMAN *who rolls it up as he listens.*)

PLATO: The Parthenon! I'll not go into as much detail as Vitruvius did about the Pyramids. There is one thing, though, that I want you to see. The Greeks were great believers in harmony and all of their public buildings are in perfect proportion. Notice the sturdiness and the calm and repose of the building—the beauty of it! There is not a straight line in the temple. The engineers and architects did that in order to overcome certain optical illusions. You see a long straight line appears to sag, so they made a slightly curved line here (*Points to steps.*) to overcome that. But in addition to this, the Greeks realized that a curved line was beautiful of itself. Great engineering skill and great mathematical skill were needed to plan and build such temples with such perfect proportions.

(VITRUVIUS *takes poster from* EVERYMAN.

VITRUVIUS: I must go now—the aqueduct, you know. Good-bye, Plato—Everyman—I'm off.

(*He walks quickly off.*)

EVERYMAN: But wait, Vitruvius, you haven't told me anything about Roman engineering. Oh, Plato—

(*He turns disappointedly to* PLATO.)

PLATO: I can tell you a bit about their work. The Romans were not interested in science and not successful in truly scientific work. They were practical people. Rome did not produce a single creative man of science, not a single mathematician of eminence. They were highly efficient surveyors, map-makers, architects, builders, and engineers. Roman roads, bridges, aqueducts, and buildings have never been surpassed.

Curtain

ARITHMETIC

Episode III

(AHMES, PYTHAGORAS, A ROMAN, FIBONACCI, STEVIN, *are seated in a semicircle talking.* EVERYMAN *enters and comes up to them. They stop talking as he approaches.*)

EVERYMAN: I hope I'm not interrupting anything important. I am Everyman and I've just met some of the great geometers —oh, Pythagoras, I'm glad to see you.

PYTHAGORAS: Greetings, Everyman. These are a few of the men who worked with numbers—arithmetic, you would call it, but it is not like the arithmetic you are taught. You remember that I believe that numbers are the basis of all things. I investigated the theory of numbers and discovered many marvellous things. Here is Ahmes, an Egyptian scribe, who wrote the oldest treatise on mathematics that the world possesses.

(AHMES *hands* EVERYMAN *a scroll, he glances at it as* AHMES *speaks.*)

AHMES: Here is my manuscript, Everyman. You will find in it many problems and their solutions. I have dealt with fractions in arithmetic, many problems in what you now call algebra, and practical geometry. My papyrus is prized not only because it is the oldest mathematical work in the world (I wrote it about 3500 years ago), but because it shows how the Egyptians wrote numbers.

PYTHAGORAS: Your method of writing numbers made it most difficult to do calculations. But then our Greek way was not much better. We used our alphabet and each letter represented a number.

(EVERYMAN *returns scroll to* AHMES *with a nod of thanks.*)

ROMAN: Yes, your system was most cumbersome, but I marvel at the things you discovered with it. Our Roman numbers were better, though I must admit that sometimes calculations were most difficult. We used to use an abacus to help us do our figuring.

(*Hands abacus to* EVERYMAN.)

FIBONACCI: Those Roman numbers of yours weren't so easy to handle.

ROMAN: How now, Leonardo Fibonacci of Pisa, do you know any better ones?

(ROMAN *looks doubtful.*)

FIBONACCI: Yes, I do.

(ROMAN *shows surprise.*)

We call them Arabic numbers, though I believe they got them from the Hindus. I learned about these numbers from the Moors when I was in Africa where my father had charge of the custom house. I first introduced them into Europe in a book I wrote in 1202 called the *Liber Abaci.* It was a long time though before everyone adopted them—a very long time. Simon Stevin, I have heard you discovered something that made calculation even easier.

STEVIN: In my work as inspector of dikes, quarter-master general of the army, and minister of finance for Holland I found that by the use of decimals all computations could be performed by integers alone, even when they involved fractions. I wrote a book about it, and many people began to use them. Later, other men perfected the symbolism and now I understand that decimals are in common use.

PYTHAGORAS: They tell me that even young children are now able to make calculations with ease that formerly even great mathematicians had difficulty in performing.

Curtain

ALGEBRA

Episode IV

(DIOPHANTUS, AN ARAB, CARDAN, VIETA, RECORDE, *seated talking.* EVERYMAN *enters.*)

DIOPHANTUS: You are Everyman—Archimedes told me of you and the purpose of your visit. I am Diophantus. My book was the first work devoted chiefly to algebra. It contains the solution of equations and uses abbreviations for some of the words and operations, thus giving a kind of symbolism.

AL KHOWARIZMI: My algebra was based on the work of the Hindus, Diophantus. They did more in algebra than you Greeks.

DIOPHANTUS: We were at our best in geometrical work, but our algebra was of some importance, Al Khowarizmi. Your book was well known in Europe, in fact, the name algebra was derived from the title of your book.

AL KHOWARIZMI: Yes, they called the science of solving equations after my "al-jebr w'al muqabalah." My rule was put into verse which may be crudely translated:

Cancel minus terms and then
Restore to make your algebra;
Combine your homogeneous terms
And this is called muqabalah.

VIETA: In general then, you would say that al-jebr has as the fundamental idea the transposition of a negative quantity, and muqabalah the transposition of a positive quantity and the simplification of each member?

AL KHOWARIZMI: Yes, Monsieur Vieta, just that. The early Latin translators used my title in various forms, and in the 16th century it was finally applied to the whole science and not only to the solution of equations.

(*To* CARDAN *who is eager to speak.*)

Yes, Master Cardan?

CARDAN: I called my algebra the *Ars Magna*, the great art. It was devoted primarily to the solution of several types of algebraic equations. I have been told that it was the first step toward modern algebra.

VIETA: I knew your book. The trouble with algebra when I began to work on it in France around 1580 was that there was no definite method of writing it. Many before me, you among them (*To* CARDAN, AL KHOWARIZMI, *and* DIOPHANTUS) discovered many important things. I tried to improve the symbolism.

RECORDE: So you did—and many of the mathematicians who followed you did so, too. (*To* EVERYMAN) I am Robert Recorde and I wrote two text books: *The Grounde of Artes*, an arithmetic; and *The Whettestone of Witte*, an algebra, which were used in the English schools. You owe the equal sign to me, I first used it in the *Whettestone of Witte*. I called them twin lines and used them to denote equality because nothing could be more equal than twin lines.

VIETA: Most of the great mathematicians after us contributed many things to algebra. Compared with some other branches of mathematics it is a young science, but I'm afraid you won't have time to learn all of that now.

Curtain

MATHEMATICS IN THE MIDDLE AGES

Interlude

(GROSSETESTE *paces up and down reading a letter.* EVERYMAN *enters and speaks to him.*)

Greetings, sir, I am Everyman. Which of the mathematicians are you?

GROSSETESTE: Greetings to you, Everyman. I am not a mathematician. I am the Bishop of Lincoln, Robert Grosseteste. I was the first chancellor at the University of Oxford about 1215. I was interested in science and I did everything in my power to teach it. I had a most promising pupil, Roger Bacon, you have heard of him?

(EVERYMAN *nods.*)

I insisted that mathematics was most important and the only true preparation for studying science. I wrote a book on the Calendar which had great influence I am told in bringing about the Gregorian reform.

EVERYMAN: You lived in the Dark Ages, didn't you?

GROSSETESTE: No age is ever dark—men have discovered that the more they study the so-called Dark Ages the more alive and bright they seem to be. It was the scholars of the Middle Ages who got manuscripts from Constantinople and from the Arabs and who translated them into Latin; thus preserving the learning of the Greeks. It is quite true that little original work was done in science—most people thought that whatever Aristotle said was final. I, myself, however advocated experiment and so did my pupil, Roger Bacon.

Curtain

THE FOUNDATIONS OF MODERN MATHEMATICS

Episode V

(DESCARTES *seated in chair.* EVERYMAN *enters.*)

EVERYMAN: Monsieur Descartes, I knew you from your picture. This mathematics is getting so involved and difficult that I can scarcely keep up with it.

DESCARTES: I understand. Mathematics in my time and in yours has gone far beyond the comprehension of the layman. Still, I can help you to some extent. You will meet three other mathematicians presently whose work laid the foundations of modern mathematics and modern science.

(NAPIER *enters.* DESCARTES *rises to greet him. Aside to* EVERYMAN.)

Here is John Napier, Laird of Merchistone, a Scot.

(*To* NAPIER.)

This, my lord, is Everyman, who desires to know something of your mathematical work.

NAPIER: (*acknowledging* EVERYMAN'S *bow.*) I devised a method of calculation that simplified computation and made it possible for astronomers and engineers to perform long and tedious operations with great ease. I called this short method the use of logarithms. Henry Briggs of England helped calculate the tables and made some improvements on my work. Has Descartes told you about his work?

DESCARTES: No, you came in just as I was about to.

(NAPIER *seats himself in chair.*)

I wrote a book on Analytical Geometry which combines algebra and geometry and makes it possible to translate facts about geometry into algebra and conversely. This makes the intricate and powerful machinery of algebra available for solving geometrical problems; and on the other hand, the geometrical illustration makes the algebra visible and concrete—But enough of that. Newton and Leibniz will be here shortly, you should know something about them. They had a tremendous quarrel once, but they have made peace now. Sir Isaac Newton is one of the greatest geniuses the world has ever known. His work is properly understood only by well-trained mathematicians and scientists, for it is the basis on which much of modern science rests, but it will be well for those not so well versed in mathematics to know something of Newton's work. Any one of his discoveries would have entitled him to undying fame—but *all* he did—he is superhuman.

(NEWTON *enters.* NAPIER *rises to greet him.* DESCARTES *shows him to a chair.*)

Tell Everyman of your work, Sir Isaac, if you please.

NEWTON: I won't do much more than give you the names—it would take far too much time to explain it all. I studied optics—invented the reflecting telescope, studied the spectrum, and discovered many things about light. I investigated the question of gravitation by mathematics and was able to formulate the laws by which it works. I invented the fluxional calculus—a branch of mathematics which I needed in some of my investigations. I did some work in chemistry and made a table of the boiling points of many metals.

DESCARTES: Marvellous—truly marvellous!

NEWTON: If I have seen farther than you, it is by standing on the shoulders of giants. To myself I seem to have been only like a boy playing on the seashore, and diverting myself in now and then finding a smoother pebble or prettier shell than ordinary, whilst the great ocean of truth lay all undiscovered before me.

DESCARTES: Not all undiscovered, Sir Isaac. You discovered so much that you made it easier for those who followed you to push back the boundaries of the unknown.

(LEIBNIZ *enters. He greets all.*)

This is Everyman, Freiherr von Leibniz, he wants to know something of your work.

LEIBNIZ: I worked on calculus, too, and since my symbols were easier to handle, those are the ones that are used today. I made some improvements in the notation of algebra; then, too, I invented the first calculating machine.

EVERYMAN (*aside to* DESCARTES—NEWTON *and* LEIBNIZ *talk quietly to each other.*) Who invented the calculus?

DESCARTES: Let's not discuss that—that is what Newton and Leibniz quarrelled about. Probably they both discovered it independently of each other.

LEIBNIZ: I heard your question—we won't start that dissension again, but I'll say to you what I said to the Queen of Prussia once when she asked my opinion of Newton. When I consulted leading mathematicians on the Continent on certain very difficult points, I got no sort of help from them; but as soon as I wrote to Sir Isaac I received complete answers the next day. Sir Isaac was responsible for much the better half of all the mathematics that had been done from the beginning of the world down to his time.

Curtain

EPILOGUE

(*Spoken by* EVERYMAN *before the curtain.*)

I have come back to you at this point, not because there were no other great mathematicians, but because there were too many and because their work is so involved and complicated that it does not lend itself easily to discussion. Mathematics is the backbone of our present civilization, economic and scientific. With all these applications pure mathematics does not lag behind the practical; for there are mathematical associations and mathematical journals in most countries. Perhaps the best way to express my purpose in seeing these great men will be to quote what Professor Turnbull, the Regius Professor of Mathematics in St. Andrews (the oldest university in Scotland) said at the end of his book. You can substitute the word "play" for "book." Here are his words:

"And if this little book perhaps, may bring to some whose acquaintance with mathematics is full of toil and drudgery, a knowledge of those great spirits who have found in it an inspiration and delight, then the story has not been told in vain. There is a largeness about mathematics that transcends race and time: mathematics may humbly help in the market place, but it also reaches to the stars. To one, mathematics is a game (but what a game!) and to another it is the handmaiden of theology. The greatest mathematics has the simplicity and inevitableness of supreme poetry and music, standing on the borderland of all that is wonderful in Science, and all that is beautiful in Art. Mathematics transfigures the fortuitous concourse of the atoms into the tracery of the finger of God."

End

BIBLIOGRAPHY

BELL, E. T., *The Queen of the Sciences*, Baltimore, Williams & Wilkins, 1931

BRAGDON, CLAUDE, *The Beautiful Necessity*, N. Y., Alfred A. Knopf, 1922

BRAGDON, CLAUDE, *The Frozen Fountain*, N. Y., Alfred A. Knopf, 1932

DANTZIG, TOBIAS, *Number, the Language of Science*, N. Y., The Macmillan Co., 1930

SANFORD, VERA, *Short History of Mathematics*, N. Y., Houghton Mifflin Co., 1930

SMITH, DAVID EUGENE, *History of Mathematics*, N. Y., Ginn & Co., 1923

STIMSON, DOROTHY, *The Gradual Acceptance of the Copernican Theory of the Universe*, N. Y., 1917

TURNBULL, H. W., *The Great Mathematicians*, London, Methuen & Co., 1929