Mathematics an Essential of Culture*

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About 500 B.C. Phidias carved some statues, and ever since that time men of culture have been expected to know something about him. Four hundred fifty years ago Raphael painted some pictures, and it is now an accepted mark of culture to know a little about him. About the time the United States had its painful national birth, Mozart composed music, and to admit complete ignorance of Mozart today would be culturally humiliating.

Man is the only creature on earth that has ideals of beauty, power, and goodness and tries to give these material form as a means of conveying them to other men. We admire, honor, and envy those who have the ability to give objective expression to these ideals through the media of the various arts. But these ideals are man-conceived and are restricted by the limitations of those who try to express them. Man knows that his music, his paintings, his poetry, his sculpture, his architecture are of his creation even though the spiritual ideal that inspires them may be outside and beyond himself. Being man-made, his art has all the limitations of its creator. Man is eternally trying to find reality and truth that transcends the power of his art to express, something more enduring than a sunset or the canvas and the paint by which he tries to preserve it, something more fundamental than the harmony of sounds or the vibrations of strings or reeds, something more universal than the comedy or tragedy of the lives of men and the dramas by which they are portrayed on the stage. He tries to understand how the universe is put together, how it behaves, what sets and keeps it in motion, what it has been and what it is to become. And so a great compulsion drives him to an attempt to understand natural law, and ultimately he is forced to invent a language in which he can express nature’s laws. He is driven to mathematics. It is often the great artist who most clearly realizes the limitations of his art and turns to mathematics as a means of deeper penetration and more powerful revelation of the ultimate abstract ideal which is natural law.

It should be an essential part of general culture to know something of the steps by which mankind has come to some small understanding of the laws of the universe in which he lives and the language in which those laws are discovered, demonstrated, and expressed. In other words, some acquaintance with mathematics should be considered as essential to general culture just as is an acquaintance with literature, music, or painting.

This paper has a two-fold purpose: to give some examples of well-known persons (at least well-known in their own day) who turned to mathematics in order to achieve a deeper penetration of truth and beauty than could be gained by single-minded devotion to the art for which they were most widely known, and to make a small contribution to the dissemination of general culture as it relates to mathematics. This will be done by recounting certain facts from the biographies of selected persons.

**Christopher Wren**

On a tablet in the crypt of St. Paul’s Cathedral in London, the visitor reads this inscription: “If you seek his monument, look around you.” In the tomb beneath lies Christopher Wren, the man whose dream has been fashioned into the stone of the building. Look around you, look above, look below. Go outside and look at the double rows of columns, the majesty

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of the great dome, the perfect proportions, the symmetry. Visit other great churches and public buildings in London and other English cities and behold other monuments to this renowned artist, enduring monuments of his own designing.

In 1666 one of the greatest fires in history destroyed the city of London. Thousands of homes and shops, scores of public buildings, and dozens of churches were reduced to ashes. When the fury had passed and the smoke had lifted, plans for rebuilding were evolved. An over-all city plan was needed, and designs and specifications for public buildings and churches were called for. City officials, bishops, and the King of England sought the most capable architectural service the realm possessed. In this circumstance, all eyes turned to one man, Christopher Wren. So well did he dream and plan and execute that three centuries of time have become three hundred years of testimony to his architectural greatness.

The architectural achievements of Christopher Wren are space-filling and sense-appealing. Small wonder, then, that few laymen know him as the great mathematician that he was. Among other contributions he discovered the method for finding the length of any arc of a cycloid, and determined its center of gravity. The cycloid has been called "The Helen of Geometry" because of the beauty of the curve and because of the mathematical wars which it has inspired. To have made two outstanding contributions to the glories of Helen are more than one man's share of mathematical honors. A friend of Isaac Newton, he was in necessary league with other friends of that great mathematician to prod him gently but constantly to make known his discoveries. Wren was a great architect by compulsion of circumstance, but there can be little doubt that at heart he was a mathematician, finding in mathematics a certain beauty, power, and permanence which he could not realize in the arches, domes, and columns of St. Paul's.

Geoffrey Chaucer

Six hundred years ago, England had a citizen who was always at her beck and call for any odd jobs of state. He was a chafe and errand boy who could be entrusted with all kinds of minor responsibilities which must be done faithfully. He would work at any assignment at home or abroad. Today he would be in London Town, tomorrow at Cambridge, next week in France, next month in Holland. Now he would be negotiating a minor trade agreement; at another time he would be checking timber purchased for His Majesty's navy. He was supervisor of this forest, guardian of that bridge, collector of this revenue, dispenser of that fund, recipient of this stipend, that annuity. Like Martha, sister of Mary, he was troubled about many things. Sometimes his salaries and pensions promised to make him rich; then his circumstances would change and he was suddenly in want.

In the midst of all these activities, he found time to be a prolific writer. He translated literature from other languages into English; he wrote original tales, narrative poetry, and lyrics. Once when his finances were in an especially bad way, he wrote a Complaint To My Purse as a hint to the king to deal more generously with his servant, which appeal the king heeded.

This was Geoffrey Chaucer, great contributor of some of the most delightful poems in early English literature. Amid all his busy-ness he found time to write the Canterbury Tales which began:

Whan that Aprille with his shoures soote
The droghte of Marche hath perced the roote
And bathed every veyne in swich licour,
Of which vertu engendred is the flour;
Whan Zephirus eek with his swete breath
Inspired hath in every holt and heeth
The tendre croppes, and the yonge sonne
Hath in the Ram his halfe cours y-ronne,
And smale fowles maken melody,
That slepen al the night with open ye,
(So prinketh hem nature in hir corages)
Than longen folk to goon on pilgrimages,
And palmers for to seeken straunge strondes,
To ferne halwes, southe in sondry londes;
And specially, from every shires ende
Of Engeland, to Caunterbury they wende,
The holy blisful martir for to seke,
Than hem hath holpen whan that they were seke.
When he was fifty years old, Chaucer felt himself old, weary, and disillusioned before his time. Perhaps he needed a long vacation; perhaps he needed another pilgrimage to Thomas à Becket's Tomb at Canterbury; perhaps he needed contact with something deeper than poetry, more permanent than a king's favors, more secure than international treaties. He turned to mathematics. To be sure, he did it half apologetically as a man goes to the circus so that his children may see the elephants, but he did devote himself to the subject quite wholeheartedly for a while. He wrote a book on the astrolabe "for litell Lowis My Son." Do not be deceived, it was written by Geoffrey Chaucer for Geoffrey Chaucer.

Better books on applied mathematics have been written but none that bears more eloquent testimony to the power of mathematics to contribute to the spiritual necessities of man. A busy, harried man, a poet with a constant stream of beautiful ideas running through his mind, took time out to make contact with one of the permanent sources of man's strength, and wrote on mathematics.

**Galileo**

One day in the year 1585, word spread among the faculty of the University of Pisa in Italy that a young man of the city, twenty-one years old, had discovered a new and extremely useful and simple scientific principle. The principle was that of the hydrostatic balance. The young man was Galileo Galelei, son of an impoverished nobleman. Letters and traveling scholars carried the news all over Europe and Galileo was widely and immediately famous. The Marchese del Monte of Pesaro sent for him and offered all the financial support and social sponsorship which the young man might need. Three years later Galileo wrote a book on the center of gravity of solids which further directed the eyes of the scientific world to him as a great leader. There followed two years of remarkable experiments and demonstrations culminating in the famous gravity demonstration at the Tower of Pisa, with its proof that what the great Aristotle had taught, and the world for two thousand years had accepted, was an important scientific error.

In 1609 Galileo began the construction of telescopes which he used to reveal other scientific truth and to show men the grossness of certain prevalent scientific errors. Theologians discovered that their doctrines and Galileo's science were not in agreement. He was warned to make his science conform to their religion. How can one make science conform to the requirements of any man's command? Galileo went on with his researches. In 1623 he was cited to The Inquisition at Rome where he was tried under threat of the torture chamber, found guilty, and sentenced to spend the remainder of his life in retirement.

What are the thoughts of a scientist who must live in seclusion the last ten years of his life under the sternest requirement to say nothing, write nothing, think nothing of which entrenched authority does not approve? Perhaps it is his opportunity to evaluate all truth which he has known, that which others have found and passed on, and that which he himself has discovered and revealed. In this review he will find some tenets that are contestable and some that are undeniable. He may well take pride in having contended for truth which others denied, but he must have a greater feeling of confidence and security and mental peace in that which no one has found it possible to challenge.

During the last ten years of his life it may well be that Galileo often recalled that day in his seventeenth year when he accidentally overheard a teacher giving a lesson in mathematics. The inherent power and beauty of the subject struck him so forcibly that he went at once to his father and asked to be allowed to drop his medical studies and take up mathematics. From that day on he had devoted much time to the subject. He had made some wonderful discoveries which had brought great satisfaction and never a
moment of conflict or humiliation.

Why had no tribunal summoned Galileo and commanded him to cease teaching that a thrown ball follows a parabola, or that a cycloid is stronger in many structures than a circle? Why had no authority ever challenged his assertion that "Nature's great book is written in mathematical symbols"? The answer lies in the nature of mathematics itself, its firm resistance to every attack, its strong endurance, the eternal life which it has to take root and to sustain itself and to grow. Let us hope that in his last harried years Galileo realized to the full the very real spiritual benefits which mathematics can confer.

Christian Huygens

In the year 1655 the stout Dutch burghers of The Hague filled the streets with the murmur of a great piece of news concerning a discovery made by one of their young fellow townsman. "They say he has invented a wonderful new way of grinding lenses." "They say new life will be put into our industry of lens making, and The Hague will become world leader."

"It is said the lenses produced by the new method are so perfect that it is possible to make telescopes with which one can see the satellites of Saturn and can study the details of the nebula in Orion." "Just imagine the son of our old friend in the next street has done this great thing, young Chris Huygens."

That was the sensation of the year 1655 in The Hague. The next year there was another. "Have you heard? Chris Huygens has made another great invention; this time it is a new kind of clock, a more perfect one than the world has ever seen; no more burning of varicolored candles to tell time; no more measuring time by the dropping of water; no more depending on sundials. Chris Huygens has made a clock as accurate as the stars by causing it to be regulated by a vibrating pendulum. This will bring a great new industry for the city; prosperity and wealth such as we have never known. I tell you, the city may be justly proud of this citizen."

These were not the last of the occasions when the citizens of The Hague became excited about the achievements of Christian Huygens. In fact the whole of Europe soon heard about his achievements. The king of France heard about the young scientist and inventor and conceived the idea of taking him to Paris as an adornment of that city. He held out the bait of a liberal life pension, and Huygens went to make his home in the French capital for fifteen years. That was all right, because such a genius as his soon outgrows the boundaries of any state, and the accident of postal address means little.

How shall a man spend his time when he has acquired world fame and independent wealth before he is thirty years old? He can buy a string of race horses; he can gamble at Monte Carlo; he can eat, drink, and be merry; he can travel, live at ease, and bore himself to death.

Or he can do as Christian Huygens did. Huygens knew that the mathematicians of his time were bringing in such a day of power and glory in the subject as the world had never known. As a scientist he had learned to use mathematics as a powerful and indispensable tool. He knew that the mathematicians always have more than their share of pleasure. Furthermore he knew that people of real culture must know something of mathematics just as they know about music, art, and drama. Consequently he devoted himself to mathematics so effectively that he lives in the pages of the history of that subject as one of the great original contributors. Furthermore he was the inspirer and encourager of Leibnitz and thus made an indirect contribution to the development of mathematics.

Huygens invented the theory of evolutes and proved that the cycloid is its own evolute. He was one of those who proved that the tautochrone is the cycloid, and made use of this fact and his knowledge of evolutes to design the cycloidal pendulum.
clock. He made contributions to the mathematical theory of probability.

Mathematics has lost none of its power to catch and hold the interest of men which it exerted over Huygens. It requires only to be presented in a favorable light for the consideration of intelligent persons.

**Pierre de Fermat**

Beginning about the year 1635, the citizens of the French city of Toulouse became accustomed to a reserved man who each morning walked un hurriedly and quietly along the streets to the parliament building, up the steps, and through the tall doors. At the end of the day, he could be seen regularly descending the steps and following the same streets to his modest home. “Who is he?” one would say. “He is the new councillor,” another would answer, “one more to consume our substance and take bribes for giving counsel favorable to those who rule over us.”

But as years passed if a stranger in Toulouse should ask a citizen, any citizen, who the dignified man might be, he would get a quick smile and an enthusiastic reply. “Ah, that is our councillor, a just, honest, and fearless man, a good citizen, a hard worker, Pierre de Fermat. Every morning up the streets and up the steps to the parliament and to his duties at the same hour; every evening down the streets and up the steps to his home at the same minute. And when his house door closes behind him—what? Who knows? He does not come out again to eat, or drink, or talk with others. Perhaps he dozes by the fire; perhaps he drinks himself drunk. Who can tell? Who cares so long as he is just and honest?”

Fermat’s long evenings, holidays, and Sundays were his own to employ as he chose, either to drink, or to sleep by the fire, or to visit the gaming rooms, or to talk politics, to practice alchemy, or to dress and seek bright lights and gay companions. He did none of these things. Perhaps he may have considered all of them one by one and weighed judicially the stimulations and satisfactions which each had to offer. It is not impossible that he tasted many or all of these experiences. If he considered or tried them, he compared them all with one more attraction which offers its own peculiar delights to the minds of men. At thirty years of age, Fermat began to read mathematics. From that time on, there was no doubt in the mind of Fermat concerning the source of the deepest satisfactions in his life. It was mathematics; not mathematics which one learns for the purpose of using it in science or technology; not mathematics which one masters in order to teach it, or to publish it, or to debate about it, or to claim credit for its discovery; but mathematics as the revealer of law, the satisfier of the hunger to know truth and be free.

Fermat wrote little and published almost nothing during his life, but a few persons knew of his epoch-making contributions to mathematical knowledge. As time went on, more and more persons knew of his work, his freedom from mathematical error, and his “last theorem,” the world famous proposition of intriguing simplicity which no one has yet succeeded in proving.

The experience of Fermat is one more example of the inherent power of mathematics to capture and retain the interests of men and to bestow generous rewards upon those who devote themselves to it.

**Maria Agnesi**

In the year 1802, a group of scholars in Milan met at the home of Agnesi, professor of mathematics in the University. They had been meeting thus for a number of years, taking their turns at reading research and philosophical papers which became bases for general discussion. A frequent contributor was Professor Agnesi’s brilliant daughter Maria. When she was fourteen years old, she delighted and astonished them with her first paper. This had been followed by many others which showed her rapidly maturing philos-
ophy. She was at once accepted as an equal among the scholars.

As they gathered on that evening in 1802, they anticipated another paper by the precocious child, now a mature woman. One of the scholars surrendered his long cloak to a servant and greeted his host. “Ah, Professor Agnesi, your daughter will read again this evening, of course?”

“How shall I tell you?” said Professor Agnesi. “Maria will never read again. She will appear among us no more forever. She will never again come and go through that door.”

“What!” the scholars exclaimed. “You do not mean she is dead?”

“No, no,” said Professor Agnesi. “Not dead, but alive no more to the concerns of this earth. Maria has vowed to live in absolute seclusion from this time forth. For years she has begged to be allowed to become a nun. I have stood firmly against this and have hoped against hope that maturity would bring to her the realization that she is by nature fitted for the scholarly life. Yesterday she retired permanently to her rooms for a life of meditation and prayer.”

Thus at twenty years of age, Maria Agnesi withdrew from the world without taking the usual accompanying step of entering the church as a nun. She had to find her own interests and activities, to fix her mind on such thoughts as would seem to her to be the most complete compensation for all she was giving up. To what can one turn at such a time? One could do much worse than to do as Maria Agnesi did. She turned to mathematics. For fourteen years it was her companion in seclusion, one of the two great compensations for her loss of human contacts and the material interests of the world. She read it daily, did research to learn what had been done previously, and made original discoveries. It became her work and her play, her labor and her amusement, her sacrifice of ease and her full reward. Perhaps no one ever lived so intimately and exclusively with mathematics for so long.

Maria Agnesi made the great test of the subject as a power to fill a life with beauty and truth when every other interest (religion alone excepted) has been severed.

One of the special curves studied in analytical geometry bears the name of Maria Agnesi; it is called the Witch of Agnesi.

When she was thirty-four years old, Maria was persuaded to leave her seclusion to teach for a while her father’s classes at the University. Then she devoted her life to the work of the church which she served for forty-seven years. Perhaps it is not an unreasonable surmise that during that half century she sometimes put aside beads and prayer-book and sought again the consolations of mathematics.

**Sonja Kowalewska**

One of the outstanding literary events of the year 1889 was the publication of a novel by a new writer, Sonja Kowalewska. Although the novelist was a Russian, the novel was not first printed in that language. It was issued simultaneously in Swedish and Danish. Soon it was translated into the novelist’s native Russian and, as sales and appreciation of the book mounted, it was translated into other languages. Literary critics unanimously declared that Kowalewska was the equal of Russia’s greatest writers both in thought and literary style. A brilliant literary career was predicted for her, but Sonja Kowalewska never wrote another novel.

Kowalewska was thirty-eight years old when she achieved sudden international fame with her one literary production. Why had she waited so long to exhibit this remarkable talent, and why did she at last turn to fiction? There is one answer to both questions, a one-word answer; it is mathematics.

As a young girl, Sonja Corvin-Kroukowski was exceptionally beautiful and exceptionally talented. So far as we know, she was not seriously tempted to follow any career making use of her asset of beauty. However, having equal talent in literature
and in mathematics, she hesitated briefly between devotion to one career or the other. Before she was eighteen years old, the pull of mathematics won. It even compelled her to enter into an early marriage of convenience as a necessary prerequisite to study abroad. As Sonja Kowalewski, she went to Germany and studied privately under Weierstrass in Berlin. This noted mathematician and teacher cultivated her, encouraged her, and goaded her into full development and application of her powers. With some interludes of idleness she moved from one triumph to another until she became the outstanding woman mathematician of the nineteenth century and one of the greatest of all time.

At the age of thirty-eight she won the Bordin prize of the French Academy of Sciences in competition with the best mathematicians of the world. Not only that, but her paper was of such exceptional merit that the prize was doubled.

The strain of producing the paper and the excitement of winning overtaxed Kowalewski, and the flesh cried out for rest. As a means of relaxation she turned to fiction with the result already noticed. After producing one novel, she returned to her mathematics to which she remained devoted until her death two years later.

Here is another example of the power of mathematics to win the interest and devotion of an individual in even contest. It offers all the romance fiction can give, all the thrill, all the beauty.

Conclusion

There are those who believe that mathematics is for mathematicians. There are also those who believe that a mathematician should devote himself to mathematics exclusively because the nature of his major interest unfits him for any other activity. The evidence (a small part of which is cited in this paper) is against both of these conclusions. Mathematics is for the millions, including lawyers, statesmen, architects, recluse, and artists. On the other hand, mathematicians often step out of the role to become successful statesmen (Leibnitz), inventors (Huygens), writers (Carroll), humanitarians (Nightingale), and masters of the mint (Newton). These facts seem to indicate conclusively that some knowledge of mathematics is and should be only one form of general culture. It is high time that it should be accepted as such. Why should a cultured individual regard it as essential that he know that Lewis Carroll is the author of Alice in Wonderland and not trouble to know that he was also an accomplished mathematician? By what line of reasoning can one come to regard it as culturally necessary to know that Christopher Wren was a great architect and not know that he was also a recognized mathematician? Or why should one blush to have to confess that he knows nothing about poetry and smile complacently on the admission of complete ignorance of geometry?

If mathematics is to become an element of general culture, teachers of the subject will need to present it in such a way that it can make its cultural contribution. This can be done by conscious attention to the enrichment of teaching, one phase of which is the devotion of a little time to acquaint pupils with the experiences of persons who have studied mathematics as they read their novels or their Bible, for intellectual, cultural, and spiritual benefits.

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