René Descartes:
The Greatest French Mathematician of the 17th Century

Paul Shute

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Abstract

This paper focuses on René Descartes, the 17th century mathematician. The paper summarizes important facts about his childhood, his education, and his traveling after college. This paper also contains information about the three dreams he claimed to have in one night, where his philosophy came from. This paper addresses his most important findings in mathematics, including exponential notation, relationships in functions, and Cartesian coordinates. Finally, this paper explains why Descarte's thought process and method of examination makes him the greatest mathematician of his time.

1 Who is René Descartes?

Born on March 31st, 1596 in the town of LaHaye Touraine, France, now known as Descartes, France, René Descartes will spend his fifty-four years attempting to understand both himself and the world around him. Descartes' father was a judge in the courts; this allowed him to live a life of privilege. When Descartes was born his mother was sick with a whooping cough, and likely had tuberculosis. A year after his birth, his mother died giving birth to what would have been his younger brother. Descartes never knew about the fate of his brother, and it is not known if any family member ever told him [1]. Author Rodis-Lewis suspects that the fact that his mother died during childbirth caused the rest of his family to resent him. Following this, it is also suspected that this is why Descartes formed such an intimate bond with nature, starting from his early childhood years [1]. Descartes suffered from a cough much like his mother, and this cough prevented him from leaving the house during much of his childhood. However, this cough might have also been a gift, because instead of attending local schools, he was taught by his grandmother and private tutors who would come to his house.

2 College

Descartes was only eleven years old when he began his stay at the College of La Fléche in 1607 He would then go on to graduate in September 1615. Although Descartes did have private tutoring prior to college, they were novices. Up until 1612, mathematics at the university level was also taught primarily by novices. While there were some specialized professors, they were lacking in numbers. [1] The arrival of Father Jean Francois initiated the change [1].

Francois prepared future professors, beginning with second year philosophy and mathematics students. While Descartes had no intention of becoming a professor, his understanding for mathematics allowed him to be invited to these meetings [3]. At this time college was free to everyone, and the diverse group of around fifteen hundred gave Descartes the feeling that he "had been traveling" [1]. Of the school's diversity, Descartes remarks that "hardly treating the highest born any differently from the most humble, was an extremely good invention" [1]. The notion of a society's order as an "invention" may be a brief glimpse into the mind of Descartes. Descartes continued to battle with his lung disease, and for the most part tried to hide it from the public. In order to combat the pain, he was known to lock himself in his room, open all his windows, and meditate while lying on the floor. Before the discovery of antibiotics, this was the most common way to relieve the pain of tuberculosis [1].

Towards the end of his college career, Descartes began to focus on only the most difficult problems in the sciences thought of as "the most difficult and most rare" [1]. Instead of being taught by professors, Descartes mission was to figure things out for himself, to show himself why something was true. The admiration of his professors led them to loan Descartes books on alchemy and astrology, which, at the time, were for the most part, undiscovered [3]. In his journal, Descartes remarks that "while still young, I made every effort to find things out by myself" [1].

3 Life After College - The Travels

Upon graduating college, Descartes spent the next two years studying law, and in 1617 received a degree in both civil and cannon law [2]. Descartes then proceeded to Paris, where he would begin to question his life [2]. While in Paris, Descartes wondered what his education meant, and began to become reclusive and depressed. Because he saw no immediate use of his education, he began to think of it as useless and frivolous [2]. Descartes spent about two years in this depression, and decided, at the age of twenty-two, that the solution to his depression was to travel the world. Fed up with academia, Descartes joined the Dutch army in 1618 [2]. It should be noted that Descartes' life centers around the 30 Years' War, a religious war between the Protestants and Catholics, involving most of Europe. Descartes did not join the Dutch army for religious reasons, but rather because of the Dutch's school of military architecture and engineering [3].

While enlisted in the army, Descartes was deployed to Breda, where he would encounter a man that would forever change his life. In Breda, while staring at a poster on the side of the street, Descartes met Isaac Beeckman [3]. Beeckman was a physician who left medicine for teaching, and earlier in his life discovered, independent of Galileo, the principle of inertia [3]. Beeckman engaged Descartes in intelligent debates, something Descartes had not experienced outside of the university [3]. While Beeckman was seven years older and likely more intelligent, he lacked Descartes inclination to mathematics [3]. Beeckman would later note of Descartes that he had never seen anyone approach mathematics like Descartes [3]. In order to help Descartes learn, Beeckman would set out problems for Descartes in the field of physics, giving him a rough outline of the solution, and expecting

Descartes to do the rest [3].

Being in the Dutch army allowed Descartes to not only travel, but also to reflect. When Beeckman had to go back to his university, Descartes began to develop philosophies that he would carry throughout his life. It is during this time that Descartes ascertained two key ideals that shaped his world. The first was that natural sciences, such as physics and biology, must be as certain as mathematics was [2]. The second was that any form of knowledge must be based on simple ideas, none of which can be doubted [2]. While the second belief tends more towards mathematics, the first seems to imply that Descartes saw the world as a functioning machine, where every aspect of the world could be figured out.

4 The Three Dreams

What happened to Descartes the night of November 10th, 1619 forever changed who he was and the things he would discover. Descartes would later stand strong behind the idea that what happened to him was supernatural [6]. Upon awakening from these dreams, Descartes recorded a minute by minute detailed description of what happened to him. For the few days prior to November 10th, Descartes locked himself up in a stove heated room to be alone with his thoughts, without conversation, and without any passions or troubles [3].

In Descartes' first dream he remarks that he initially felt a terrible wind whirling him around in the street. In the dream Descartes was making his way to the church at his old college, La Fleche, to say his prayers. As Descartes turns to greet a man he previously did not see, the wind violently pushes him against the wall of the church [6]. While Descartes is being thrown about by the wind, he notes in his journal that everyone he sees in the dream appears steady and balanced [3]. Before awakening from this dream Descartes hears someone from the middle of the college courtyard yell that one of his friends has a gift for him, a melon. Upon awakening from this dream Descartes feels a pain in his side and prays to God for protection from what happened to him in the dream [6].

Descartes spends the next two hours meditating on his life before falling asleep again. In his second dream he is immediately awoken by a terrible noise, and when he opens his eyes he sees sparks of fire scattered everywhere in his room [6].

Falling asleep once more, Descartes has his third and final dream. In his journal Descartes describes the dream as peaceful, with nothing evil happening to or around him. In this third dream Descartes is presented with a table containing two books, one a dictionary and the other a collection of poems. The collection of poems is opened to a passage that reads, "What path shall I follow in life?" [6]. As Descartes is reading this a stranger appears with a poem. Although Descartes cannot read all of it, the words "yes and no" catch his eye [6]. Descartes remarks to the man that he knows a more beautiful poem, but suddenly the book of poems is just pictures, and then both the man and book disappear [3]. While still dreaming the third dream, Descartes decides that he is dreaming, and while dreaming begins to interpret the dream [6].

Descartes concludes that the dictionary signifies "all the various sciences together," the book of poems is representative of the union of philosophy, and the phrase "yes and no" represent truth and falsity in knowledge and achievements [6]. Furthermore, Descartes also interprets the other two dreams during this dream. He concludes that the wind was an “evil genius” trying to force him to go somewhere [6]. The melon he is promised represents solidarity, and the flashes of fire was the Spirit of Truth [6]. The dreams Descartes had that night springboarded him into realizing his goal of becoming a great philosopher and mathematician. The dreams gave him the confidence and direction he needed to realize his own potential.

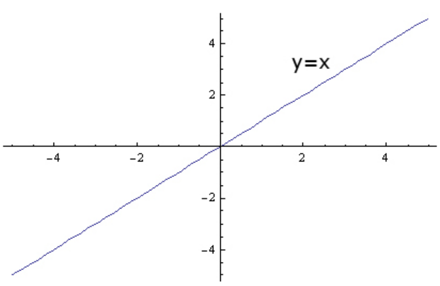
The most obvious effect of these dreams is in the immediate development of his method for discovering and interpreting. First, Descartes vowed to never accept anything as true unless he could find its truth by himself. Second, when he encountered a problem he would divide it up into the smallest pieces possible, so that he could see how it worked at its most basic level. Third, he would start understanding simpler things first, and then continue adding more difficult elements until he had knowledge of the most complex system. Finally, Descartes hoped to make his calculations and reviews so complete that they could never be questioned [3].

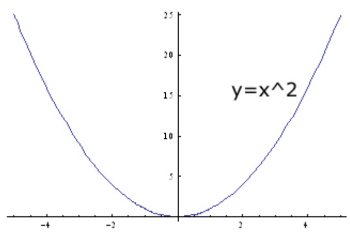
These dreams shaped Descartes’ world from the moment they happened. He accepted them as a vision, and accepted the message that the dreams showed him. This philosophy of questioning everything shows Descartes’ drive to understand the world completely. This tedious way of life also shows his devotion and connection to a purely mathematical way of thinking. While some mathematicians devote some of their time working to progress mathematics, Descartes devoted his whole life and all of his being into the field.

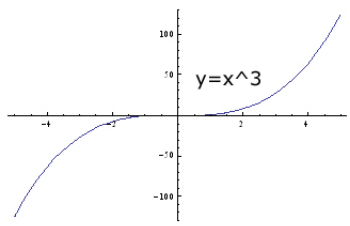
5 Mathematical Legacy

Descartes made advances in many fields of mathematics. While some of his discoveries may seem trivial to a reader four hundred years later, these discoveries were made during a time when alchemy was still a science. Furthermore, many of Descartes’ discoveries are used today in fields ranging from 4th grade geometry to advanced mathematics in college, and beyond.

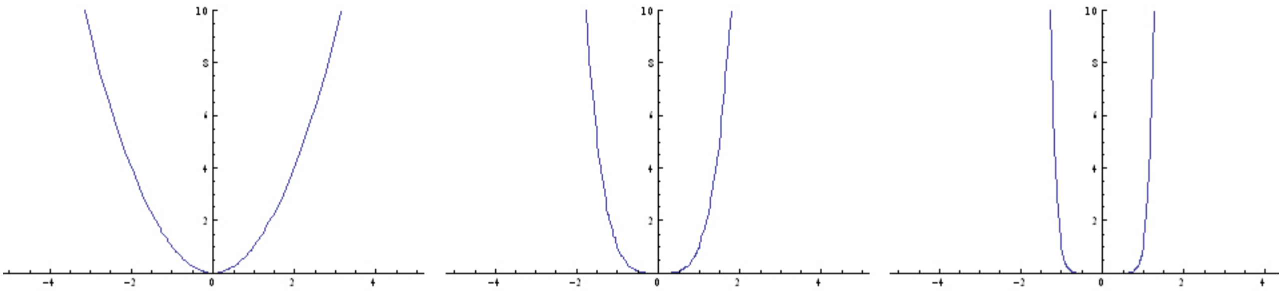
In his investigation of powers, Descartes discovered that powers could be represented as lines or curves. In doing so he also invented the notion of exponents. Descartes created the representation of raising a number to another number. For example, a^x as a relation of a raised to some number, x [1]. More specifically, 2^3 being equivalent to $2 * 2 * 2 = 8$. Descartes also showed that the higher the degree of the power, the more complex the curve will be [4]. An example of this is given in the following graphs.



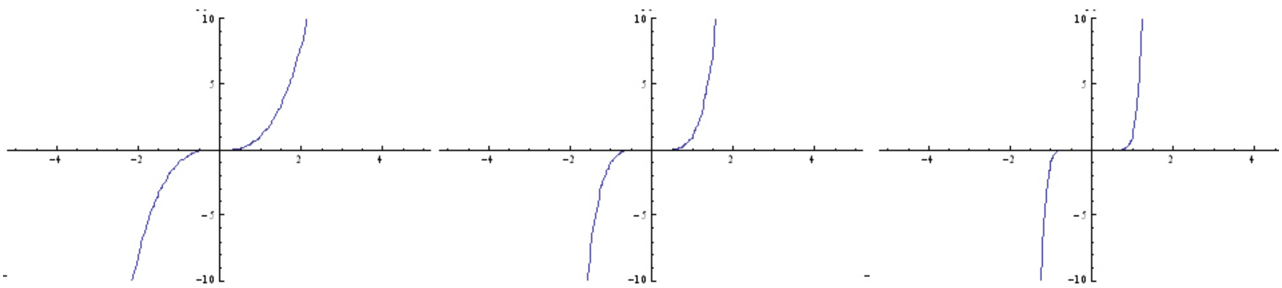




In examining the graphs of $y = x$, what Descartes means by a more complex curve is how the graph of $y = x^1$ forms a straight line, and through the increasing of the power, the graph ceases to act as a straight line, and the way it does act becomes more complicated. This is important in not only solving geometric problems, but also in developing an understanding of some basic behaviors of graphs. For example, the graph below depicts the functions $y = x^2$, $y = x^4$, and $y = x^{10}$, respectively.

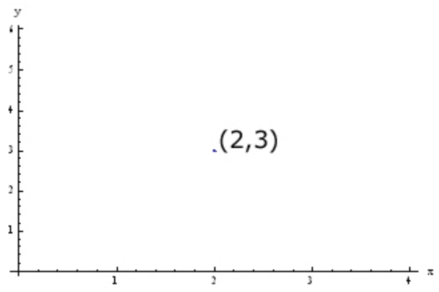


From here it can been seen that for functions raised to even powers, for extreme values of x, y points in the same direction. This also shows graphically that any number raised to an even power is positive, for example 2^2 and $(-2)^2$ are both positive numbers. However, if we plot odd functions, we can see that this does not hold true for numbers raised to odd numbers. For example, consider the odd functions $y = x^3$, $y = x^5$, and $y = x^{11}$, respectively.



In comparing these graphs to that of the even functions, we can see that the extreme values are different. For an odd function, a negative value for x gives a negative value for y. This is a graphical representation of the fact that for x^n, where n is odd, then if x is negative, x^n is also negative. For example $2^3 = 8$, and $(-2)^3 = -8$.

Descartes did not only explore the graph of exponents. From his work with exponents, Descartes generalized his graphs to allow any arithmetic idea to be expressed geometrically. This notion of representing algebraic formulas geometrically helped to ultimately give rise to Calculus by Leibniz and Newton [4]. The system is now known as the Cartesian Coordinate system [1]. More commonly known as rectangular coordinates, the Cartesian Coordinate system places related numbers in specific places. Cartesian Coordinates uses the notation (x,y) for 2D systems. For example, the point $(2, 3)$ has a distinct x coordinate (2) and a distinct y coordinate (3). An example of this system is displayed below.

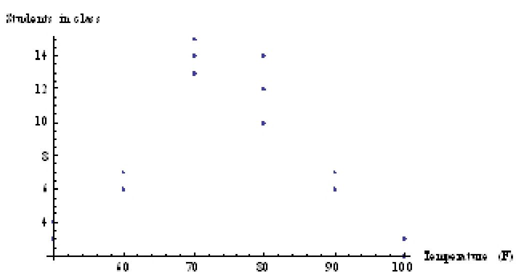


As seen in the graph above, in order to plot the point $(2, 3)$, you first move 2 down the x, then 3 up the y. Geometry made tremendous progress through the discovery of this process, since now anyone studying geometry could represent their problems graphically [4]. However, this discovery was not limited to those studying geometry. The Cartesian Coordinate system opened doors to anyone dealing with sets of possibly related numbers. The ability to visualize any related sets of numbers has endless possibilities, and is one of the greatest breakthroughs in the history of geometry. Without a system for visualizing sets of numbers, geometry would remain in our heads. The ability to construct actual images out of geometric functions allows us to visualize and interpret what the function is telling us in a much more conceptual fashion.

For example, imagine if you wondered whether the temperature outside had an effect on the amount of students showing up for class. If you were an instructor, you could record the temperature outside and the number of students showing up for class each day. Lets say you did so for a month that had a lot of temperature change, and you obtained the following set of data:

Temp.(F)	90	100	90	80	70	50	50	70	60	90	80	60	70	80	90	100	80	60	90
Students	6	2	7	14	13	4	3	15	7	6	12	7	14	7	6	3	10	6	6

While this may just look like a random collection of points, you can find interesting relationships if you graph this set of data using the Cartesian Coordinates. Letting temperature be our x-coordinates and the number of students be our y-coordinates, we obtain the following graph:



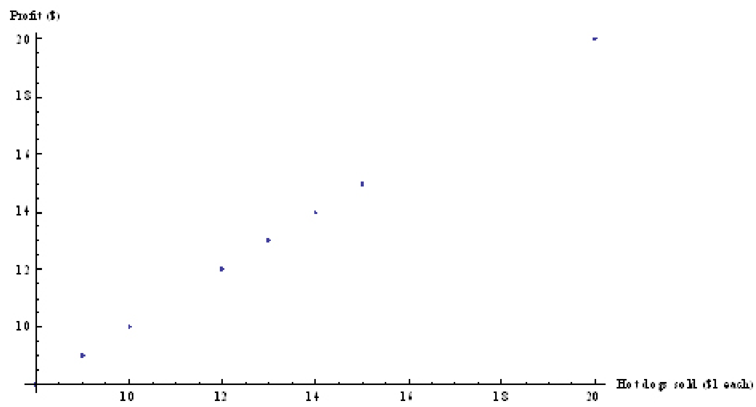
From this graph it appears that more students come to class when the temperature is between seventy and eighty degrees. Since humans are likely most comfortable between seventy and eighty degrees, one might assume that in that degree range people would be more willing to do things. This graph allows us to see that one of the things students are more willing to do is come to class. Descartes discovery of the Cartesian Coordinates helped people not only dealing with pure mathematics, but also people dealing with real world type situations, such as the one presented above.

Descartes also helped many mathematicians by describing a general strategy to solving any geometric problem. The method involves three steps: naming, equating, and constructing [4]. Step one involves naming all the lines that seem needed to solve the problem. Step two requires that the person working the problem finds relationships between the lines and points of interest. Finally, the third step involves combining all relationships into one equation by using known geometries, such as forming triangular relationships with the lines [4]. While this is explained in a geometric sense, Descartes is essentially laying the foundation for the first scientific method. Using a structured way of solving a problem allows the problem to be reproduced by anyone. Descartes first breaks the problem down to its most fundamental level. From there, he draws relationships between known and unknown lines and points, which ultimately leads to the formation of one equation, which relates all things known to unknown. Throughout his life, Descartes was determined to leave no doubt in anything. This is shown brilliantly in his description of a method for solving problems. If a problem could be broken down and explained logically step-by-step, then the room for error or doubt would become increasingly small.

In doing this Descartes also explains how a locus of points in a function shows the relationships that the two variables have with each other [4]. For example, consider the simple example of a hot dog vendor. If the vendor records the number of hot dogs sold and the amount of profit he gets, he might come up with a set of points something like this:

Hot dogs sold ($1 each)	10	20	15	13	9	12	14	13	12	10	8	9	10	9
Profit ($)	10	20	15	13	9	12	14	13	12	10	8	9	10	9

The graph of this relationship is shown in the following graph:



From this graph you can see that the relationship between hot dogs sold and profit is linear, because the locus of points follows in a straight line.

6 Conclusion

Descartes did not set out to make as many mathematical discoveries as he could. Beginning with his childhood, Descartes developed a deep and intimate relationship with nature and the world around him. The things he discovered seem to be motivated not by fame, but by a hope to gain a deeper understanding of not only himself, but the world. It is my belief that, due partly to his aptitude for philosophy, Descartes approached math in an almost religious sense, which allowed him to use math as his compass for life.

One of Descartes core beliefs in life was to take nothing for granted, and nothing at face value. Not simply related to geometry or numbers, Descartes believed that if something could be doubted, then it should be considered false. A great mathematician should be a seeker of truth, both in nature and within themselves. I believe that Descartes embodied this philosophy and saw it through to the end. Descartes seemed to have an unwavering devotion to mathematics, a field which many attempt, but few discover.

References

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