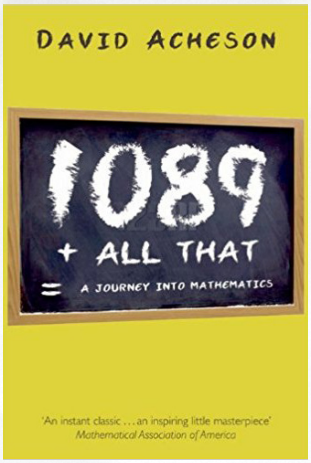
1089 AND ALL THAT: A JOURNEY INTO MATHEMATICS

by David Acheson

Reviewed by Venkatesh Onkar



Let's say that you are a high school student, studying primarily the humanities and social sciences. Perhaps, in your middle and high school years, your experience of mathematics was something like that of the brave student Molesworth in a book called *Down with Skool* (as you can make out, Molesworth can't spell very well). Molesworth is at this moment approaching his teacher with his opinions about algebra:

> 'Sir sir please sir sir please?'
> 'Yes molesworth?'
> 'I simply haven't the fogiest about number six sir.'
> 'Indeed, molesworth?'
> 'It's just a jumble of letters sir i mean i kno i
> couldn't care less whether i
> get it right or not but what
> sort of an ass sir can hav written this book.'
> *(Maths master give below of rage and tear across room with dividers. He hurl me three times round head and then out of the window.)*
>
> *Down with Skool!,*
> *by Geoffrey Willans and Ronald Searle*

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David Acheson in his marvellous book *1089 and All That* quotes Molesworth (as above), adding that it strikes him as "rather sad" that there are students for whom algebra is just a "jumble of letters." Indeed, the whole book seems written to redress this feeling of sadness; there is an attempt to convey, through all the pages and the examples, the beauty and power of mathematics, in as simple a manner as possible. Even students with an elementary grasp of the discipline are shown some shining glimpses of the landscape, enough to evoke a desire to learn more. This is why, even though I teach mainly the humanities and the social sciences, I recommend this book highly to all you high school students out there (and indeed to anyone who has been somewhat intimidated by the subject).

Among the many rich chapters in the book, one in particular – *Great Mistakes* – stands out in terms of a potential attitude towards learning mathematics. As lay people, we tend to think of mathematics as a rather static body of knowledge, proven for all time. This chapter deals with subtle problems that have been misunderstood by even the great mathematicians, and it demonstrates something of the openness of mind necessary to look at problems (perhaps non-mathematical ones as well?) afresh. For instance, the author describes *Kakeya's problem:* "Find the smallest region in which a needle of unit length can be reversed, i.e., manoeuvred so that it rotates completely through 180 degrees." After walking us through the various figures through which the needle can be reversed (a circle with radius $\frac{1}{2}$, an equilateral triangle with height 1, for example), the book drops a bombshell by suggesting that the area of the figure in which the needle is to turn can be as *small as we like*, as long as we construct it given certain criteria. Obviously there is no proof offered, as the problem must be a complex one, but this example certainly grips us by suggesting that old problems have to be looked at afresh, and that there is certainly nothing to be taken for granted in learning mathematics. This attitude of wonder and freshness in exploration permeates the book as a whole.

A lot of the book deals with applied mathematics. In the chapter titled *The Heavens in Motion*, Acheson explains how the ancient Greeks constructed ellipses, and how they understood that an ellipse can be created by slicing through a cone; how Kepler discovered that the orbits of the planets are ellipses with the sun at one focus; and finally how Newton completed our understanding by proposing that the force F on a planet (moving in an elliptical orbit) is inversely proportional to the square of the distance from the sun (this also elegantly predicts that planets move faster when closer to the sun). For good measure, there is also a chapter that introduces the calculus in, the author suggests, "a concise and uncompromising way."

In a more contemporary slant, the author discusses chaos theory: "the study of irregular erratic motion which is extremely sensitive to initial conditions." The examples involving chaos theory are too subtle to summarize quickly (and, obviously, any summary here will spoil your pleasure in reading about them in the book itself!), but, needless to say, they are drawn from everyday life, the realm in which chaos theory operates, and they show us the mathematical power and beauty that underlie the perfectly ordinary world. And there is a stunning chapter on the transcendental number e, which explores the practical applications of "this strange number," as the author calls it, in all manner of problems from the spreading of disease to understanding how a milk droplet splashes on a smooth surface!

Apart from the applied angle, obviously the book discusses the realm of pure mathematics in lucid and elegant language. The classic example, Euclid's proof of the infinity of primes, is explained wonderfully clearly. Acheson also considers imaginary numbers (the mysterious notion of the square root of negative numbers) and shows, through an examination of history, how dealing with these counter-intuitive mathematical entities *as though they were real* led to perfectly correct mathematical solutions to problems.

And, in a final chapter that I have by no means fully grasped, the author leads us, with obvious relish, to what he calls "the most stunning result in the whole subject, so far" – the equation

$$e^{i\pi} = -1.$$

While I will have to sit at some length with my mathematically talented friends to understand this result even in the very simplified form Acheson presents it, the author's awe at the process leading to this result is palpable:

> Firstly, we have obtained it by putting together a whole variety of relatively sophisticated mathematical ideas,including calculus, infinite series and imaginary numbers.
>
> Secondly, the formula is of great practical value; it is the sole reason, really, why virtually any engineering or physics book on oscillations has both e and i . . . all over the place, greatly simplifying many of the calculations.

Both at the beginning and at the end of the book, Acheson characterises mathematics in the following ways:

1. Wonderful theorems
2. Beautiful proofs
3. Great applications

1089 and All That, short and simple though it is, captures the spirit of the above points marvellously. Often I found myself wishing that the book explored a particular idea in more depth, and this is, I think, the sign of a successful and exciting introduction to an intellectually vast, deep and complex field.

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