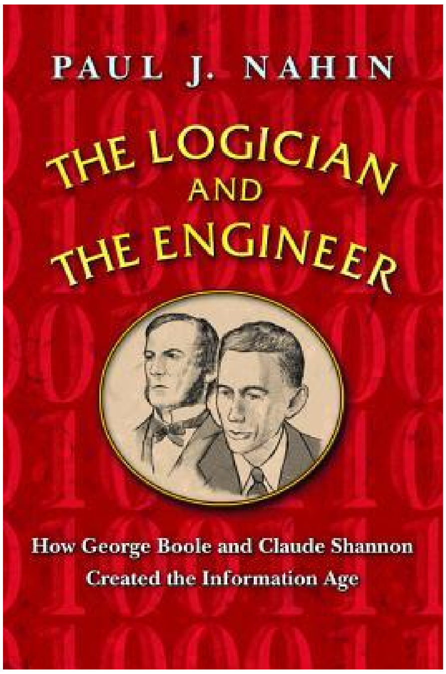

The Logician and the Engineer: How George Boole and Claude Shannon Created the Information Age

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Boolean algebra, also called Boolean logic, is at the heart of the electronic circuitry in everything we use--from our computers and cars, to home appliances. How did a system of mathematics established in the Victorian era become the basis for such incredible technological achievements a century later? In *The Logician and the Engineer*, Paul Nahin combines engaging problems and a colorful historical narrative to tell the remarkable story of how two men in different eras--mathematician and philosopher George Boole and electrical engineer and pioneering information theorist Claude Shannon--advanced Boolean logic and became founding fathers of the electronic communications age. Nahin takes readers from fundamental concepts to a deeper and more sophisticated understanding of modern digital machines, in order to explore computing and its possible limitations in the twenty-first century and beyond.

The Logician and the Engineer: How George Boole and Claude Shannon Created the Information Age Details

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From Reader Review The Logician and the Engineer: How George Boole and Claude Shannon Created the Information Age for online ebook

Paul says

The biggest problem with this book in general is that I'm not at all sure what the audience for it is. I was expecting something of a dual biography with some information about information theory. In fact, there's a brief chapter at the beginning that's a bio, but then it's about 8 chapters which are basically just a light textbook on electronics and information theory - kinda like a series of lecture notes for a 1 or 2 week introductory summer school course. The book ends with a terrible introduction to quantum computing (the author drags up old tropes about "spooky action at a distance" - which are half a century old and almost certainly designed to make you try to not understand what's going on), followed by some kind of weird, not very good short story about a "language de-clarifier" that I think the author himself wrote. The short story actually gets a lot of the underlying science *wrong* as far as I can tell, despite apparently being authored by someone writing basically a textbook on the subject.

I think that people with a casual interest in the subject will quickly get lost in the proofs and diagrams and whatnot, and people with a more sustained interest should probably read a better textbook. I think all the same information and more is contained in the eminently readable Quantum Computation and Quantum Information by Isaac Chuang and Michael Nielsen - one of the only textbooks in my years of education that I actually sat down and read cover to cover. Admittedly that book has more of a quantum information skew, but that just emphasizes how light on details this book actually is.

As for the audiobook specifically, it is a complete mess. **DO NOT USE THE AUDIOBOOK VERSION OF THIS BOOK**. The book is like 30% mathematical equations, and the person reading it doesn't even know how to pronounce a mathematical equation - for example P(A) is pronounced "P parenthesis A" rather than "P of A", lim(k->Inf) is pronounced "limit k right arrow infinity", it's very, very distracting. He mindlessly reads out 8x8 matricies as if we were rain man, able to mentally fill in a 64-position chart in our heads. I was able to follow what was going on only because I've taken classes in this subject and was familiar with the proofs. There is a reference guide accompanying the book which might help (though in that case you're basically going to have to ignore the guy speaking as he reads out all the values on a table or whatever), but if you're going to be sitting there looking at figures (the book relies HEAVILY on figures) the whole time, you might as well not listen to the audiobook at all and just get it on Kindle or something.

The only good thing about it is that except for the last two chapters, he's not really wrong about anything, he just goes into too much detail. At first I thought I was going to like this book, since usually these types of books have the opposite problem. That said, I don't recommend this book because as I said before, I can't imagine who would want to read it.

Ross Nelson says

Like others, I found the title deceptive. The book is more about electronics than the rise of the information age, and there's only a few chapters devoted to the men named in the title. Disappointed.

Peter Mcloughlin says

Nahin always picks topics I am interested in. He understands where the jewels are in Math and Physics. But I always find his writing overly dense and demanding. I studied this topic for a semester and had an understanding of the concepts involved already but he makes his books too dense seems to think everybody wants to read their college mathematics textbook for leisure. He could get the same ideas across and make it something different than a slog through a book that seems to model itself after a textbook on the subject.

Roberto Rigolin F Lopes says

This is an unusual book. About two unusual thinkers, Boole (1815-1864) and Shannon (1949-2001). Boole established logic as a branch of mathematics. Shannon used Boolean logic to design electronic circuits and ignited Information Theory. We are in 2012, Nahin is connecting together the achievements of both thinkers to our information age. To do so he describes with some depth a wide range of topics starting with Boolean logic and digital circuits. Passing through probability theory, information theory and Turing machines. To end up with thermodynamics of information and quantum computing. Out of my comfort zone therefore unusually fun. Thus demanding an unusual curious reader. Is that you?

Mark says

I picked this up on a whim with no research. Shannon is trendy in these days of "Big Data" for his theory of information, and skimming the book it looked like a general history with maybe a bit more technical details than normal. This is more about Shannon as an engineer, though, and Boole of boolean algebra fame as a theoretician.

The early bit is biographical, but it's really just the first bit. Writing is good and full of nice tidbits about two geniuses. Favorite story: Boole got a bad cold that he got after getting soaked in the cold rain then teaching a class in his soaking clothes. His wife was into homeopathy so she figure the best cure was to treat it with more cold and wet, wrapping him in wet blankets. He didn't recover.

After the biography there as a bait and switch. There's are wiring diagrams and a nice chunk of math, and even if the math is sub-calculus I had to pull out a pencil and paper many times before I "believed" an interesting passage. You can get through it with just motivation and high school math, but I feel like a lot of the material was written as if it was intended for a freshman engineering student.

Or perhaps for a 40-something occasional programmer who never really worked through the circuit design of a memory bit, which is coincidentally exactly what I am. And I'm kind of happy that I now could work out how to design digital memory circuits if I ever were sent back in time. (There's actually a very short windows where this would be useful, maybe a few years on either side of 1925, but still.) So I kind of feel like I was tricked into reading a book that was really well suited to me. Four stars from me, praise for the author, but not really recommended to most friends or strangers.

Brian Clegg says

For its target readership this is an excellent book – and I have to say as someone outside that market I really enjoyed some parts – but the fact remains it is aimed at a pretty narrow segment. There's even a little section at the front of the book that effectively says 'read this to see if you can cope with the rest.'

The bits I found particularly appealing were a few introductory logic problems (though I'm not sure I agreed with all the conclusions) and the pocket biographies of mathematician George Boole and information engineer Claude Shannon. However, while technically qualified to deal with the other parts of the book, in truth I couldn't be bothered – it was too much like hard work.

For bits of it I would have to wade through far too much grunt maths, and for other bits would have had to think far too hard about electronic circuits and the logic circuits beloved of basement dwellers on computer science courses. (Or was it just my university that confined the computer scientists to the basement?)

I think the author makes the mistake that many academics make when trying to write for a broader audience: they carry through too much of the textbook, and find that the aspects that often encourage people to remember things in that context (often because they involve repetitious grunt work) actually prevent popular science readers from getting the message. It's a shame, because the subjects are interesting, but unless you are the kind of person who designs logic circuits for fun, this is probably not the book you'd want to see.

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Robert says

In October 2009, Claude Shannon was a featured Innovator of the Month in "A World Perspective" newsletter. He is considered to be the father of information theory. Through his work, Shannon informed engineers that when a message is properly encoded, it could be transmitted across a noisy channel with an error rate below any predefined level. Common examples of noisy channels to be overcome include static on a telephone line and cosmic rays inducing a mutation in a strand of DNA.

I followed this feature a year later with an October 2010 article on George Boole as the Innovator of the Month. His groundbreaking work on logic led him to develop a different algebra: one where algebraic operations were performed on symbols representing entities or classes. Boole possessed an uncanny knack for perceiving that the symbols of operation could be separated from those of quantity and then treated as distinct objects of calculation.

Claude Shannon studied this Boolean algebra almost a century after it appeared and developed the idea of encoding logical relationships (such as OR and AND relations) in an electric circuit. He recognized that Boole's work could form the basis of mechanisms and processes in the real world of communications. In 1937, Shannon wrote his master's thesis at MIT, showing how Boolean algebra could optimize the design of electromechanical relay systems, then used in telephone switches to direct phone calls. Shannon also demonstrated that circuits with relays could solve Boolean algebra problems. By using the properties of electrical switches to process logic, where ON = 1 or TRUE and OFF = 0 or FALSE, the basic concept underlying all modern electronic digital computers was developed. Hence Boolean algebra became the foundation of practical digital circuit design. It could be said that George Boole, via Claude Shannon and his successors laid the theoretical basis for the Digital Age.

Paul Nahin’s 2013 book, The Logician and the Engineer: How George Boole and Claude Shannon Created the Information Age, was an intense read, but follows the same line of thinking as above. He links the displaced-in-time contributions of George Boole and Claude Shannon who, together, set the wheels in motion for the ongoing digital information revolution. Nahin writes, “Modern engineers view Shannon’s ‘Mathematical Theory’ as his Principia, an achievement even greater than his switching theory use of Boolean algebra . . .” The transmission of digital data, which is common today with the ever-increasing use of the Internet, for example, is at the heart of Shannon’s work. In “Mathematical Theory,” he lays out for engineers, as Nahin describes, “the theoretical limits on the transmission of information from point A (the source) to point B (the receiver) through an intervening medium (the channel) . . . In a perfect world the digital stream would arrive at the receiver exactly as it was sent, but in the real world the channel is noisy and so, occasionally, a bit will arrive in error. That is, now and then a transmitted 0 will arrive as a 1, and vice versa.”

But that, as it turns out, is not a major difficulty. “There exists,” as Nahin writes about Shannon’s findings, “at least one source encoding procedure such that, no matter what the channel noise may be, the error rate at the receiver can be made arbitrarily small. But even with an arbitrarily small error rate, it isn’t zero, and thus there will be errors. So, at the very least, the receiver would find it useful to be alerted when an error does occur . . . That can be done quite easily with what is called parity.”

We won’t get into the details of how “parity” is implemented and used in digital design, suffice to say that parity violations produce and alert that something is wrong with the signal. That is good, but as Nahin writes, “wouldn’t it be even better if our digital logic could fix errors? Of course it would! . . . In fact, however, error correction is possible and, indeed, it’s not even particularly hard to achieve.”

Shannon’s work didn’t include developing source encoding-decoding schemes with associated error correction schemes, but many others followed in his footsteps. In the almost 70 years since the publication of Shannon’s “Mathematical Theory,” a number of coding schemes – Reed-Solomon codes, Hamming codes, BCH codes – have achieved error rates very close to Shannon’s defined theoretical performance limits.

Brush up a bit on your high-school algebra, early college statistics, and refresh yourself on basic electric circuitry and you’ll appreciate the work Nahin has done in presenting the synthesis of Boole and Shannon he brings forth.

Those involved in the field of computing and engineering leveraged this knowledge during the middle of the 20th century, and today, society benefits from the ubiquity of digital appliances that pervade our lives. As Nahin writes, “What Boole and Shannon created, together, even though separated by nearly a century was without exaggeration nothing less than the fundamental foundation for our modern world of computers and information technology.”

It's a Good Read!

Maurizio Codogno says

Il titolo del libro sembrava promettente, anche se non riuscivo esattamente a capire cosa avessero in comune George Boole e Claude Shannon oltre che essere stati scienziati. All'atto pratico, però, la parte più strettamente biografica è davvero ridotta, e Nahin si mette a scrivere di elettronica di base, da ingegnere qual è, non perdendo occasione di ricordare che la matematica è una scienza arida... citando James Gleick (*L'informazione*) che è sì un giornalista ma scientifico, e quindi direi non certo prevenuto. A un certo punto mi è sembrato di leggere un libro di testo, anche per le note del traduttore Ciro Castiello che ha spesso aggiunto i passaggi logici che venivano dati per scontati. Devo però riconoscere che nella parte finale del testo la spiegazione dell'entanglement quantistico è la più chiara che abbia mai visto: ma che ci azzecca con i due (almeno in teoria...) protagonisti? In definitiva, un libro per ingegneri ;)

Jim Razinha says

Deceptive title..I should have read the reviews...thought I was getting a semi-biographical piece. If I wanted a book on logic, I would have picked a book on logic. One chapter on the two and very loose references to them during the remainder electronic/logic discussions. Look elsewhere if you actually want to read about those two fascinating men.

Karthik Shashidhar says

Started off promisingly with biographies and puzzles, but then ended up being virtually a textbook of electrical engineering!

Andy Plonka says

As a non mathematician, this book would have worked better for me had I read it versus listened to the audio version. There were lots equations explained which would have been more comprehensible to me if I had seen them written. That being said, George Boole and Claude Shannon certainly made huge contributions to the fields of electronics and engineering.

Jigar Brahmbhatt says

While replete with challenging mathematics, what the writer attempts here is to place George Boole and Claude Shannon at the forefront of the information age.

Boole famously invented the Boolean algebra in early 1800s, supplying mathematical symbolism to logical arguments so that the limitations of classical Aristotelian logic (all men are mortal, Socrates is a man, so Socrates is mortal) could be turned into a formal useful system.

Boolean algebra had to wait for hundred odd years until a young American electrical engineer could find an application of it in electrical circuits. Claude Shannon envisioned that electrical circuits could be made to perform logical operations. The book delves into the technical aspects of how that happens, because to appreciate the beauty of what Shannon achieved one has to be aware of some technicalities. That seems to be the off-putting aspect of this book for a lot of readers. Because the mathematics and electrical notations used can be heavy for non-technical readers, and they can miss out on learning about a very interesting man. I was wondering whether all of it could be reduced into an easily understandable language sans the mathematics, but that seems impossible too. No matter how obvious Shannon's invention sounds today it was a feat of imagination. The logical gates that form the core of computers were very much the brainchild of this curious man, who spent his free time inventing useless gadgets (search for Ultimate Machine by Claude Shannon on youtube if you can. It is a machine whose only purpose is to switch itself off, and if you spend more time with it you will start thinking that there is a dark, mysterious force residing inside it.)

The book is a bit odd though. People who are technically inclined have already learned most of it in colleges or through proper course books, while the curious layperson has to struggle to penetrate it. My take is that it made me saw something that I had missed for so long: that combining electrical circuits with something as far fetched as Boolean algebra was no minor feat. Shannon's 1948 paper "A Mathematical Theory of Communication" is called the Manga Carta of the information age, but when asked in an interview about his achievements he modestly said that not many people were aware of both these fields at the same time then. Well, how simple he made it sound!

Diego says

Me pareció una lectura muy interesante. Es un recorrido a través de los aportes del matemático George Boole y el ingeniero Claude Shannon: el álgebra booleana y su aplicación para el diseño de circuitos digitales respectivamente. Hace un recuento de las aplicaciones de estos aportes: detección y corrección de errores en sistemas de comunicación, el diseño de hardware, la resolución de problemas de lógica, etc. Al final del libro expone sobre computación cuántica, y cómo podría ser usada la lógica booleana en este caso.
No es un libro fácil de leer, a pesar que el autor diga en el prólogo que solo es necesario conocimientos de matemáticas de educación media superior.

Bob says

This is a book about logic more than anything else. It seems to be an attempt to introduce readers to the subject material, but I am not so sure this is a good source for someone who wants to learn about propositional calculus, etc. This book may generate a distorted understanding, which would have to be unlearned later.

Chris Esposo says

This is a very good book with one caveat: it's really not best consumed in audio format. Although one may try, and it would be a good practice in listening-comprehension skills, to really grasp the book, you need the diagrams and printed formulae, which are provided in a 170-page pdf attachment (not all full pages).

That being said, "The Logician and the Engineer" is a well-written tour of elementary Boolean Algebra and Shannon Information, and how the two of those subjects inform the building of the Turing machine and the digital computer, with all predicative material required, built or explained included with either a formal proof (more or less always in specific small tuple/small index cases), or an illustrative example. The book does go into some decent detail into what it means for there to be infinite numbers in a computer system, what it means for numbers to be dense, to be computable, and even goes through the Cantor diagonalization argument to show different number system cardinalities, which usually stumps the math student taking intro to analysis for a little while, so it's not the easiest material.

Most of the basics of Boolean algebra, however, can be proven by constructing a truth table, and the only topic really covered with respect to the Shannon Information is Shannon entropy. So its a good intro to that material, but not a thorough one. That being said, the material is only watered down, when it's practical to do so. Thus for someone that is totally new to this subject reading this text, if they get it all, they will come away with a workable knowledge of the subject.

I can't say I got everything the first time I listened to it, as the reader does a literal read of the material which becomes very challenging when the author goes through say an equational proof and the reader reads out each component of the equation, parenthesis, ellipsis, and all, at each step. With all the symbol accounting, including a reduction to terms, and whatever algebraic sleight of hand that may pop up, you'll have to keep a lot of terms in your head while listening. Things get hairier when a graph or circuit diagram is explained.

The sections on error detection and how sequential state machines work were especially interesting to me, with the latter being useful as a basic backgrounder for computer system builders and hobbyist who like to overclock their machines, and how that works in computers.

A brief foray is made at the end on information destruction (basically surjective mappings of data) and how that bridges Shannon entropy with thermodynamic entropy - what is meant physically for information to be destroyed. That was interesting. And the other final topic is quantum information, which I'm not sure anyone who hasn't seen that material would get easier, especially since the author throws in terms like self-adjoint and uses the bra-ket notation, with the only explanation being "I presume all high schools now cover matrices, and therefore will proceed in that manner". Lazy assumption to make, given the unfortunate decline of secondary school education over the past 10 - 15 years. Nonetheless, the material was interesting.

I still recommend this book, it's about 1/3 history 2/3 mechanics, written to be as accessible as something like this could be, and could also be useful to people working with the material professionally for reinforcing comprehension.