PopCo

Reviewed by Alex Kasman

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Scarlett Thomas
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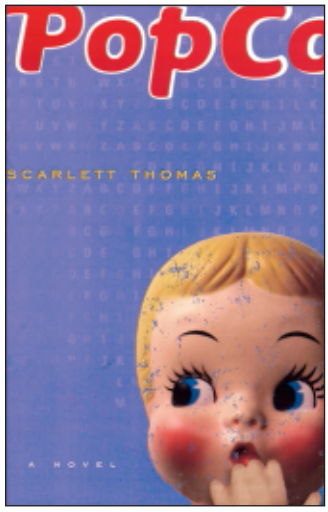
The novel *PopCo* by Scarlett Thomas is many different things at once. It is a psychological study of the social pressures on a teenage girl in a new school. It presents a sort of "conspiracy theory" about the manipulation of consumers by advertisers and manufacturers (and a "counter-conspiracy" by an underground movement). It parodies the events at a corporate retreat, where workers are forced to participate in morale building exercises. It also tells an adventurous story of pirates and the modern rediscovery of long hidden treasure. Surprisingly, *PopCo* is also a particularly good example of "mathematical fiction".

The protagonist in this book is Alice Butler, a young British woman working as an inventor of products for introverted teenagers at the multinational toy corporation, PopCo. Her product line includes toys involving code-breaking, spying, and puzzle-solving. In fact, Alice has a very good background for this sort of job because of her grandparents. After her mother died and her father left, she was raised by her grandparents who were both mathematicians. Her grandmother, who was a codebreaker at Bletchley Park during World War II, spent



all of her spare time attempting to prove the Riemann Hypothesis. Her grandfather, Peter Butler, who was not allowed to help Britain with the war effort due to his early antiwar activism, writes a column on mathematical puzzles for a science magazine. (At one point the book mentions Martin Gardner and his column in *Scientific American*, calling it an "American version" of Butler's "Mind Mangle" column.) However, because he was not allowed to work at Bletchley Park, Peter Butler still feels that he has something to prove to the world. So, Alice's grandfather spends his time trying to decode famous mysterious documents like the Voynich Manuscript and the Stevenson/Heath manuscript.

While the Voynich manuscript is a real document whose original purpose remains unknown (see, for instance, mathematician John Baez's page on it at `http://math.ucr.edu/home/baez/voynich.html`), the Stevenson/Heath manuscript is supposedly known to be the key to a pirate's hidden treasure and was invented for this book. When Alice was still very young, Peter Butler broke the code of the Stevenson/Heath manuscript and

Alex Kasman is associate professor of mathematics at the College of Charleston. His email address is `kasmana@cofc.edu`.

discovered the location of the treasure. However, for reasons both personal and environmental, he decides not to retrieve it or tell anyone else where it is. (It was this decision that prompted her father to leave.) Instead, he encodes a secret message in a locket that he gives to young Alice which will serve as proof that he was indeed the first to break the code and discover the location of the treasure.

The locket has in it the expression "2.14488156Ex48" and the Hebrew letter "aleph" with a subscript zero, Georg Cantor's notation for the cardinality of a countably infinite set. Alice learns the mathematical significance of the aleph early on in her childhood, entertaining her grandparents by answering questions such as "How many biscuits would you like, Alice?" with "Aleph-null, please". However, the significance of the other clue on the necklace eludes her and becomes the main focus of her own hunt for the pirate's treasure.

Mathematics is everywhere in Alice's world, not only in those portions connected to her mathematical grandparents. In those scenes that take place when she is in school, mathematics gets mentioned frequently. In part, this is because she has an interest in mathematics, but most of the focus is on her sexist teacher who refuses to allow girls to excel in his math class. Later, a speaker at the PopCo retreat talks to the workers about networks and asks if anyone there has heard of Paul Erdős. Alice is able to say that she has—her grandmother had an Erdős number of 2—but she is not alone. A coworker who has aleph-one (the next "size" of infinity) tattooed on his hand demonstrates detailed familiarity with Erdős and also with networks. And, when the workers are divided into teams for a sailing competition, Alice is elected as her boat's navigator because of her mathematical skills. Clearly, mathematics is something one needs to know about in the fictional world of *PopCo*.

The list of mathematical topics discussed in the book, some addressed in depth and others just casually, is quite broad. Among them are: Cantor's transfinite cardinals, prime numbers, public key encryption, the Monty Hall problem, the Riemann Hypothesis, Pythagoras' numerical analysis of pleasing musical tones, Gödel's incompleteness theorem, the Continuum Hypothesis, logical paradoxes, Conway's "Game of Life", and the Fibonacci sequence. The novel even includes as an appendix a table of the first 1,000 prime numbers and relates anecdotes about mathematicians such as Turing, Erdős, and Hardy.

Thomas' ability to include mathematics in her fiction is impressive on several counts. She avoids two of the most common problems of mathematical fiction: awkwardly including technical prose that seems out of place, and relying too heavily on stereotypes. The common stereotypes of mathematicians in fiction (as male, as schizophrenic, as antisocial, as unfeeling, etc.) are all avoided here. And her ability to fit mathematical ideas into a story without the result seeming forced is quite amazing. In the world of *PopCo*, sophisticated mathematics can arise in a casual conversation and not seem at all out of place. Of course, I am a mathematician, and so I might not be reacting to the mathematics the way a non-mathematically inclined reader might. However, that I could comfortably read through Alice's frequent discussions of homeopathy testifies to Thomas' literary skill. Because of my own skeptical inclinations, I would not normally choose to read about someone trying to decide which homeopathic remedy one should take when one "feels like glass". Though reading this book has not changed my mind about homeopathy, it has given me a better understanding of those who feel differently. And I would like to think that the same might be true of readers who would not normally want to read about someone discussing math.

Thomas also comes very close to avoiding one of the other pitfalls of mathematical fiction. Often authors have such a poor understanding of the mathematical objects they choose to include in their fiction that the result is unreadable by mathematicians. Although her writing is not entirely mathematically correct, Scarlett Thomas does basically understand the main ideas and conveys them well. For instance, without getting into any details about modular arithmetic, she really gets across the significance of public key encryption in the form of an analogy about locked boxes. Since Alice has been factoring numbers in an attempt to help her grandfather with the Voynich manuscript, she appreciates the difficulty presented by factoring very large numbers, which also helps the reader appreciate modern number theoretic methods in cryptography. Thomas also does an excellent job discussing Gödel's method for encoding mathematical expressions as numbers. However, she becomes a bit confused in her explanation of the proof of his incompleteness theorem, leaving out the key point of its meta-mathematical recursiveness. In her version, Gödel writes logical statements only about arithmetic properties (she suggests that "If $1 + 1 = 2$ then $1 + 1 = 3$" is akin to the key step in the proof), and so she seems to conclude that mathematics is inconsistent. Fortunately, this is not true or we might all be out of a job! If she had explained that it was also possible to encode statements about whether something was provable, she could have more correctly used "This statement cannot be proved" as her simplified example of Gödel's key step, since the ability to make such a statement in arithmetic terms leads either to the conclusion that arithmetic is inconsistent (because proving this statement would contradict the statement itself) or that it is

incomplete (since if it could not be proved then this would be an example of a true but unprovable statement). Her poetic description of the Riemann Hypothesis also borders on being mathematically incorrect, and one of the substitution ciphers in the book had two letters accidentally interchanged. However, I do not want to dwell too much on these small problems when the book is so successful and appealing otherwise.

Of course, whether one likes a novel or not is largely a matter of taste. *PopCo* has a subversive and lively style that appealed to me. One aspect of my personal taste in fiction is that I like to see an ending in which all of the mysteries and dilemmas are resolved, especially if it is able to achieve that "Aha!" feeling that one gets after solving a difficult problem or proving a mathematical result. Others may prefer an ambiguous ending, such as the ending of David Auburn's play *Proof*, which leaves everything to the audience's imagination. An ending that is conclusive and satisfying is very difficult to achieve, and *PopCo* succeeds here as well. In the end, there is a resolution ("Aha!") that ties together all of the loose threads. Mathematically inclined readers may also appreciate the self-referential implications towards the end of the book, when Alice begins talking about how she would like to write a book about her experiences.

PopCo is an entertaining and satisfying novel that embeds real mathematical ideas into a story about toys, trends, and fashions. That this improbable sounding combination is so successful may explain why Scarlett Thomas was the winner of a 2002 style award from *Elle* magazine.

For more information, visit Scarlett Thomas' homepage at `http://www.bookgirl.org` *(where you can find two very mathematical chapters that were cut from the book) and* `http://math.cofc.edu/kasman/MATHFICT/` *where you can read more about* PopCo *and other works of mathematical fiction.*