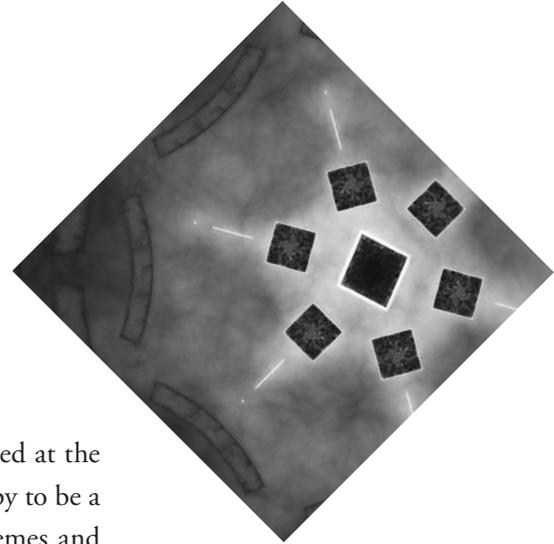


INTRODUCTION *Thomas Banchoff*



Flatland: A Romance of Many Dimensions is my favorite book and, as I stated at the end of my extra feature on the DVD of *Flatland: The Movie*, I am very happy to be a consultant on an adaptation that will introduce new generations to its themes and messages.

For those readers who are not yet familiar with the original book, I encourage you to read the story that inspired the film. The author of *Flatland*, Edwin Abbott Abbott, was a master teacher and educational reformer. His story is both a social satire confronting some of the most important issues of his day and an introduction to the challenge of coming to terms with geometry of higher dimensions. Through carefully crafted dialogue and satirical references to social issues in Victorian England, Abbott told a story that challenged readers to open their minds to new ideas. First published in 1884, the book sold out immediately and a second edition, with a new introduction by the author, was published a month later, and that is the edition included in this volume. More information about the background of the novel and its remarkable author can be found in the introduction to *Flatland: A Romance of Many Dimensions* in the Princeton Science Library edition, or one of the many other introductions that have appeared over the years in the dozens of editions in English, not to mention the more than twenty translations into foreign languages.

This introduction is aimed at readers who have read *Flatland* and who would like to compare it with the screenplay of *Flatland: The Movie*. When Abbott wrote the original, he had to rely on the imaginations of the readers for visualizing the universe he was describing. He provided only a few hand-drawn diagrams in the book. By contrast, the movie is full of richly textured images, and audiences will delight in

discovering new details in repeated viewings. Just as we do not have to imagine what Harry Potter or Albus Dumbledore look like, or the details of the interior of the Great Hall at Hogwarts, we no longer have to rely on our imagination to picture the home or workplace of Arthur Square. The personalities of the characters were purposefully left undeveloped in the book, and they emerge in a much different way in the movie, both because of the rendition of the pictures and because of the power of the characters' voices.

Adapting this classic as a computer animated film challenged the creative team of *Flatland: The Movie* to engage a contemporary audience accustomed to modern conventions. As usual, writing a screenplay based on a book involves making a great many choices, not just what to include or leave out, but ways of introducing the characters and the world they live in, both in terms of the physical description of the surroundings and with regard to the issues and concerns that shape their society. Some viewers will look in vain for a favorite scene omitted from the final version, while others will delight in new elaborations of ideas only vaguely indicated in the book.

Both the book and the movie take on the task of presenting a new universe that probably was more strange in Victorian England than it is now. Two-dimensional worlds are more familiar to those who grew up with movies, television, and computer screens, even though the precursors of motion picture films were already in existence when the book first appeared. As animation techniques have evolved, audiences expect more and more from the visual effects in any modern adaptation, and *Flatland: The Movie* provides some great spectacles as background for a modern version of the story. Fractals adorn the two-dimensional landscape, and Arthur Square wonders, "Where in the Mandelbrot Set am I?" Even though he can't appreciate it from his original two-dimensional viewpoint, he might note the same repeated fractal patterns in the insides of his compatriots, upsetting as that might be: "I can see their insides and I'm going to be sick." The beautifully intricate cityscapes that we can see from our three-dimensional vantage point are even more impressive to Arthur, and eventually to Hex when they are brought up into the third dimension. The psychological message is made clear by Spherius: "Who would obey (the Circles') rules if they could see what you see?"

The temptation both in the book and in the movie is to take very seriously the questions about the details of a two-dimensional universe. How is it that Flatlanders move and carry things and eat and express affection? Abbott deals with a number of these questions in his book and then explains why he is not going further. Halfway through *Flatland*, at the beginning of Section II, the narrator explains his decision:

"It is high time that I should pass from these brief and discursive notes about things in Flatland to the central event of this book, my initiation into the mysteries of Space. That is my subject; all that has gone before is merely preface."

“For this reason I must omit many matters of which the explanation would not, I flatter myself, be without interest for my Readers: as for example, our method of propelling and stopping ourselves, although destitute of feet; the means by which we give fixity to structures of wood, stone, or brick, although of course we have no hands, nor can we lay foundations as you can, nor avail ourselves of the lateral pressure of the earth; the manner in which the rain originates in the intervals between our various zones, so that the northern regions do not intercept the moisture from falling on the southern; the nature of our hills and mines, our trees and vegetables, our seasons and harvests; our Alphabet and method of writing, adapted to our linear tablets; these and a hundred other details of our physical existence I must pass over, nor do I mention them now except to indicate to my readers that their omission proceeds not from forgetfulness on the part of the author, but from his regard for the time of the Reader.”

That list of things that the narrator chooses not to explain in the book includes a number of challenges that the creators of *Flatland: The Movie* had to face. Each time a viewer sees the film, new images come into focus. As some questions are answered, others suggest themselves. Viewers of the film and readers of the screenplay will find many topics for discussion and possible projects for groups or individuals in a class that uses the book and the movie to stimulate imagination. Although the story itself did not choose to tackle all the questions about the physics and physiology of Flatland, many readers of the book have taken up the challenge to imagine two-dimensional analogues of three-dimensional counterparts. Many very good examples of this exercise are included in *The Planiverse*, a novel by Alexander Dewdney inspired by a column he wrote for *Scientific American* on two-dimensional science and technology. Teachers often suggest to their students the project of designing something for the plane world that would correspond to an amusement park or a chemistry laboratory. The creators of *Flatland: The Movie* obviously enjoyed devising analogues of a fishbowl or a Tiffany lamp or a subway car, or the entire furnishings of a Flatland Victorian home. Like Abbott, they do not overly concern themselves with what keeps the water in the bowl or how tasers work in the plane. Not all of the questions can be answered in the film of course, and some readers will have a field day pursuing any number of them.

There are some major differences between the story in the book and the story in the film, some occasioned by the differences in our current attitudes toward societal issues and some that represent necessary abridgement of the occasionally detailed story line.

Most obvious is the treatment of women. A close reading of the original book makes it clear that the author is on the right side of this issue although the narrator’s

words reflect the prevailing Victorian habit of ignoring one whole dimension of women's existence. Debates in the popular press argued whether or not women should be allowed to attend college, and Abbott, as an educator, worked hard to provide educational opportunities for women as well as men. He was blocked in his efforts by the university establishment of his day, and that frustration is mirrored in the satirical treatment of Flatland society. A. Square firmly believes that men are intellectually superior to women, especially in rational argument, and he discounts and dismisses the qualities that are associated with women, for example compassion, loyalty, and affection. It is clear that Abbott is a believer in education that encompasses both the rational and the intuitive, and the artificial separation of these two ways of knowing is taken to absurd lengths in his novel.

So, how does the creative team of *Flatland: The Movie* approach the problem? Unfortunately there is still discrimination against women, even in our day, but the straight line motif does not work as well as a satirical device. More pertinently, it does not work from a cinematographic viewpoint since it is very difficult to get a one-dimensional creature to express emotions visually or to interact with a polygonal being. (Witness the encounter of Arthur Square with the jive-talking King of Lineland.) In this movie, men and women are all polygons. Arthur Square's wife Arlene is also a square, even though she still is the one in the household who shows compassion and understanding to a much greater degree than her authority-worshipping and somewhat impulsive husband. These are modern stereotypes of course, and can it be mere chance that Arthur is blue and Arlene pink? An even bigger change is the fact that the precocious grandchild in the story is now a granddaughter, Hex. Her color is yellow-orange, possibly in deference to the experience of whole generations of students who grew up using yellow hexagon blocks in kindergarten.

There are implied social rules in this new version of Flatland; for example, when Hex describes the rules of inheritance so that the children of two squares will be pentagons and a pentagonal married couple will produce hexagonal sons and daughters. Why should a husband and wife have the same number of sides? Is it a biological necessity, or social convention, or some law?

Another major difference between the film and the book has to do with the Isosceles class. In the original Flatland, there was a separate hierarchy amid the lower classes, all of them isosceles but distinguished by the size of their vertex angle. The butler would certainly lord it over a footman or trash collector, and this class consciousness at all levels was a popular feature of Victorian literature.

In the movie, this entire substructure is eliminated. All isosceles triangles seem to have approximately the same angle. Hex says, "Isosceles parents have equilateral children," as the first step in the upward social mobility in both the book and the movie,

stating that a child has one more side (at least) than the parent. In the book, only an isosceles triangle with angle nearly equal to sixty degrees could expect to sire an equilateral son who then could be eligible to enter an entirely new level of society. In the movie, one might wonder where isosceles children come from. Presumably only some of the progeny of isosceles parents are equilateral and most of them are again isosceles, in order to account for the larger numbers of individuals in the lower classes. What Hex says is not wrong, just not completely accurate (assuming that we can discover the implied and unstated rules by deduction from observations).

Another major difference is that the figures in the movie have personalities, something deliberately downplayed in the book. Abbott purposefully made his Flatland society dull, whereas *Flatland: The Movie* is definitely rich in texture. The most obvious manifestation of this is the soundtrack, with a sweeping musical score and the recognizable voices of professional actors. Even before we see them in the extra features on the DVD, we recognize levels of intonation and emphasis, excitement and perturbation, in their interactions. This is true for the minor characters as well as the star, for example when Arthur's circular supervisor, Ms. Helios, speaks so threateningly (reminiscent of Roz, the supervisor in *Monsters, Inc.*, whose voice happened to be provided by a male actor). One of the great virtues of a DVD is being able to see the interviews with the actors and to connect them with their voices. The DVD of *Flatland: The Movie* has the additional advantage that we hear the principal actors commenting on the story and about their own commitment to educational communication. Watching the body language of Tony Hale reading the part of the solipsistic King of Pointland adds incredibly to the experience of seeing the movie again. When Kristen Bell says, "Sweet," you can feel her appreciative excitement even more for having seen the interview. Seeing the interviews of real-life brothers Martin Sheen and Joe Estevez definitely makes their movie dialogues more meaningful, and Michael York's British delivery presents a properly superior, although not perfectly sympathetic Spherius.

One cinematographic device is initially disconcerting to a mathematician watching the film, and that is the apparent reversal of orientation that makes it possible for Arthur and Abbott Square to face each other at one time and to be looking in the same direction other times. In order to get from a picture of a right hand on a page to its left-handed mirror image, it is necessary to take up the figure from the plane into three-space, turn it over, and then to replace it on the plane. How can it happen in the movie that a figure can be looking left at one time and right at another? It is clear that it is desirable from the point of view of social interaction that a figure should not have to turn upside down in order to face another figure. Dano Johnson solved that problem in a particularly effective way—that he describes in his comments—namely

that in fact each polygon has one eye, roughly in the center of one side, and two mouths, only the lower one of which is open at any particular time, so that the closed mouth is not apparent. That is really clever.

Another device that enables the cinematographer to inject some emotion is the blinking of the eyes, something that can't technically be done since an eyelid in Flatland would be a one-dimensional membrane that would come down over the exposed arc of the circular orb, not something that would "cover" the interior of the eye. One can imagine a defense for this, by saying that what really happens is that the eye clouds over occasionally, something mathematically possible that is represented by what looks like an eyelid covering the eye. Or one can just remind the reader that not all details can be dwelt upon.

Perhaps the largest difference between the book and the movie is the ending. Abbott's hero is definitely in a depressed state as he writes his memoir, languishing in a jail cell for seven years, only occasionally being visited by his brother, a fellow convict who can't really appreciate any of A. Square's attempts to express what he experienced in his brief visit to the third dimension.

The movie, on the other hand, ends on an up-note, with Hex revealed as the Apostle of the Third Dimension, quite confident that she can give a full account of her Spaceland visitation, as well as the theoretical underpinnings of the theory of three dimensions as developed by her absent mother (shades of Harry Potter?). The ending does come swiftly, with all its hope for a new world order.

Abbott's models for the end of his story are more in line with Plato's dialogue, "The Apology," where Socrates is condemned to death by the leaders of a society that cannot accept his message, or the accounts of the disciples of Christ who suffered imprisonment and martyrdom when they tried to spread their message of a transcendental life. This religious and philosophical theme was very important to Abbott but it is not pursued in the movie, "except for the brief dialogue between A. Square and Spherius where Arthur Square asserts, "But surely in Spaceland beings from the fourth dimension have come to proclaim their existence?," and Spherius replies, "There is only rumor and myth . . . sightings of 'spirits' that appear and disappear at will." When Arthur asks, "Have you seen such beings?," Spherius dismisses his question with, "I find the very idea of a fourth dimension utterly inconceivable." In the final scene of the movie he dismisses the possibility of a universe higher than his own even as we pass below the Stonehenge artifact in Area 33H to see the spinning cubes and contorting framework that represent the slices in three-space of a four-dimensional "hypercube." Explicating that scene will be a stimulating challenge to any teacher who wishes to discuss the notion of higher dimensions with her or his students.

In my interview at the end of the DVD, I introduced some of the geometry behind the appearance of slices of the cube in Area 33H and the analogues in the next dimension. There is so much to learn. It is my hope that viewers of this movie will be encouraged to look as well at the book that inspired it and, to fulfill the aim of its author, to contribute to “the Enlargement of the Imagination and the possible Development of that rare gift of Modesty among the Superior Races of Solid Humanity.”