

### What was the challenge?

The Visual Communications program at Washington University culminates in a seminar project to be completed during your senior year. The only parameters for the project are that the final deliverable will be an informational book.

### What was the solution?

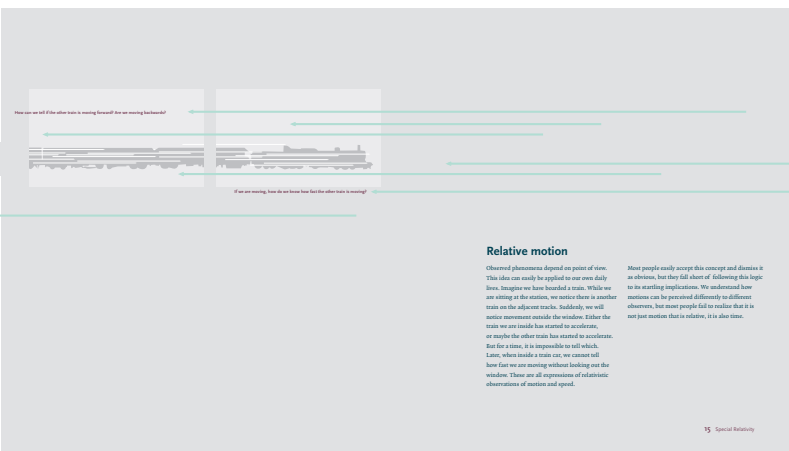
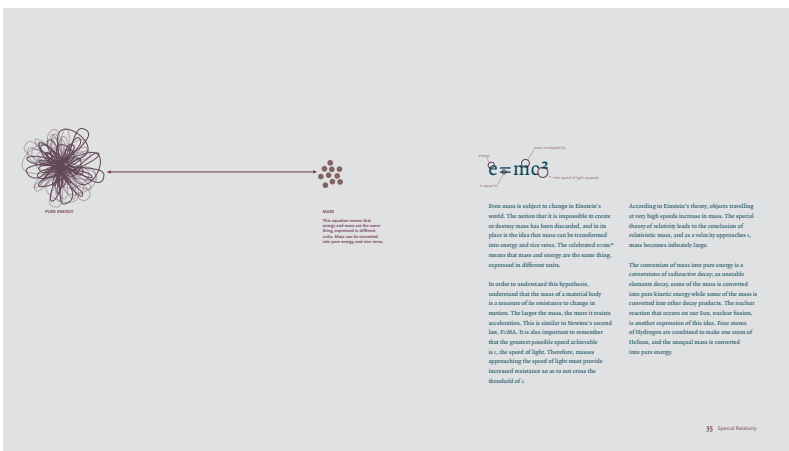
I was interested in the power of clear informational graphics to make complex ideas understandable, so I deliberately decided to focus on an obscure, esoteric topic: Einstein's Theory of Relativity. After many long, excruciating nights in the library, I proclaimed myself an expert on Einstein's theory of Relativity, and I wrote and designed this book. It uses clear language, appropriate pacing, and visual models to explain the scientific concepts.

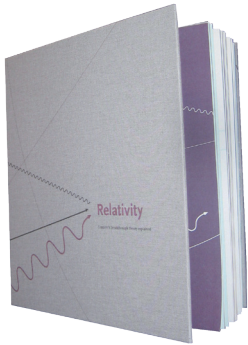
### What was the effect?

This book calcified my belief that visual models are an extremely powerful way to clarify complex ideas. It was very well received by the faculty and it is now part of the Special Collections of the Library of Washington University.

### Contact:

name:  
company/organisation:  
e-mail:  
website





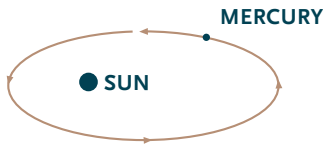
$$E = mc^2$$

energy

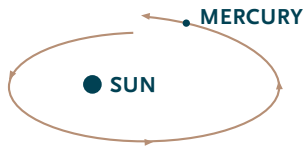
is equal to

mass multiplied by

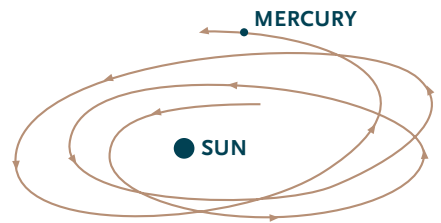
the speed of light squared



According to Newton's theory of gravity, Mercury should have a perfectly elliptical orbit, like this.



But it is not perfect. It does not return to the same point from which it started.



As a result, its orbit looks like this. This seemingly erratic orbit is caused by the curvature of space.

**LARGE MASS**  
Large masses cause spacetime to curve and stretch around them.

**SMALLER MASS**  
Smaller objects move towards larger objects because of the curvature of space. This movement is interpreted as gravity.

**Curved space**  
Whereas the special theory of relativity reimagined the concept of time, the general theory of relativity reimagines the physical structure of spacetime. When Einstein presented the general theory of relativity, he introduced new mathematical formulas that define space. These advanced partial differential calculus equations are used to derive mathematical lines that describe the shape of space. Remarkably, these perfectly sound mathematics produce results that most people find impossible and outrageous: curved, four-dimensional space.

To help conceptualize this theory, picture a bowling ball on a stretched rubber sheet. The large ball will cause the rubber sheet to sag under its weight. If you dropped a baseball onto the sheet, it will roll toward the bowling ball. Einstein theorized that smaller masses travel toward larger masses not because they are "attracted" by a mysterious force, but because the smaller objects travel through space that is warped by the larger object. This movement is interpreted as gravity.

The general theory of relativity began with the formulation of the fundamental equations by Albert Einstein in 1915. It unifies Einstein's earlier theory of special relativity and Newton's law of universal gravitation. The equations introduced by Einstein are used to derive an imaginary line called a metric tensor. A tensor is like a vector that describes the shape of space.

In Einstein's world, masses move along lines known as geodesic paths. A geodesic path is the shortest distance between two points in a curved four-dimensional space. We can think of the baseball rolling towards the bowling ball as moving along a geodesic path.

The presence of matter changes the geometry of spacetime, which affects the motion of objects in space, this motion being interpreted as gravity. Phenomena that in classical mechanics are attributed to gravity represent inertial motion within the curved geometry of spacetime.