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# Case: the Wood Pencil

The evolution of the wood pencil helps understand the concept of [balance](#) in design.

Consider the design of the [wood pencil](#), a simple design that hasn't really changed, conceptually, in about **500 years**. And yet, even a cursory review of its history shows that there were significant changes to the materials used, manufacturing methods, and extra features (e.g., attached erasers) over time.

Why did these changes happen?

The basic *discovery* behind pencils was the property of graphite - that it was so soft that it left dark marks on pretty much anything you scratched with it.

Until then, the most common writing instrument was a [quill](#) and ink, which were quite delicate. Graphite, though “soft,” was much more robust - and erasable! - than quills and inks. No one really had a problem with quills till then, because no one knew an alternative was even possible. But as soon as graphite's properties became known, its advantages as a writing instrument became immediately apparent, including:

- Graphite could write on many more types of surfaces than quills.
- Graphite didn't spill or dry prematurely like ink did.
- Graphite could be erased; ink couldn't.
- Graphite was fully self contained; you had to carry the quill separately from the ink.
- Graphite was easy to mine and shape into usable writing instruments.

Graphite extended the range, ease, and robustness of one's ability to write. As a result, more people *could* write, no matter where they were, on whatever they had lying around. This meant writing became more popular. Manufacturers could now easily mark parts that had to be cut, as well as dimensions and layouts *in situ*. This caused a significant increase in the use of writing, which increased the need for education as well as starting whole new industries (pencil making, and the manufacture of all kinds of related drawing instruments intended for use with pencils).

Before graphite's introduction, the need to write (a situational “force”) was balanced by the inherent difficulties of using quills and ink (a situational “counterforce”) - though, at the time, people didn't recognize them as *difficulties* because they had nothing to compare them. The introduction of graphite altered the counterforce but did nothing the forces driving people to write. So more people were able to write, and in fact they did write more. This changed the whole balance of the situation by substantially increasing the number of people who were writing. This increased the amount of communication between people, which led to an increase in overall education, productivity, quality, etc.

Because graphite is so soft, people needed some way to encase it to provide strength and to prevent the user's hands from becoming blackened with the stuff. At first, sticks of graphite were wrapped in string on animal skins. It took only a few years, however, for people to invent the wooden covering we still use today.

Note that the technology of **encasement** was already known at this time. Putting a wooden body around a stick of graphite was therefore a fairly trivial development, but expanded the usefulness of pencils enormously. One may wonder whether pencils would have ever become popular if encasement technology had not *already been known* at the time. The order in which things are invented can greatly influence which inventions are successful and which ultimately fail.

Now, with wooden covers, people who worked in settings requiring their hands to be reasonably clean - office workers, tailors and weavers, shopkeepers generally,... - could take advantage of pencils too. In this case, one situational force was that of keeping one's hands clean; the other force was the staining that resulted from using bare graphite. The clean hand force prevented pencils from being used in some settings: this was the stable balance point. Introducing wood covers for pencils changed one of the forces, allowing the other to push the situation to a new stable balance point in which many more people could write via wood-covered pencils.

**Exercise for the reader** For each of the technological changes below, identify the forces that were re-balanced by their introduction.

- Adding an eraser to one end of a pencil.
- Discovering how graphite dust and clay can be compressed into usable pencil "leads."
- The development of the mechanical pencil sharpener.

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