"…Snap it, work it, quick, erase it, write it, cut it, paste it, save it…"

When I was a kid, I loved to see what was inside electronics, like toys or radios. I remember my dad gave me a toy car for my birthday. It was attached to a controller via a simple cable. I apparently was more interested in how it worked than to play with it, because I smashed it (much to the dismay of my parents) to open it and see what made it move. Needless to say that its fate was the same as Humpty Dumpty's. I was 6 or 7 and wasn't aware of tools that I could use to tease it apart and put it back again. Now I know better. However, I became intrigued by the simplicity of the mechanism: the remote was a repository for a battery which was connected to a simple motor. The rest of the car was a system of small rods and plastic. Through opening (now with specialized tools) other devices I found a recurrent pattern, the motor was the leitmotif that governed movement in other toys as well. Radios and TV's were much more complicated in comparison, with green flat plates with tiny cylinders painted with colorful stripes. They were everywhere, from TVs and radios to game consoles and computers. One day I visited my cousin, who was studying electrical engineering and was impressed at how he was using these tiny cylinders with colorful stripes (there I learned they're called resistors) from an old radio to fix his guitar distortion pedal. I was amazed! These were tools I've never seen, it allowed him to transplant these resistors from one completely different device onto another. Not stopping there, and tired of wasting money on batteries, he bypassed the power source to use a power adapter. He effectively edited the system, and now having a fixed and more reliable pedal, not dependent on batteries, we proceeded to jam all night (much to the dismay of his parents). Had I tried doing the same thing, I would've probably reached the same conclusions, if the resistors work in one thing, they sure will do in another or using an adapter to provide power instead of batteries. Yet, I would've probably used a resistor with the wrong ohms or the wrong amperage. I also did not have the tools he had.

This idea can be extended to biology: plants can be regarded as a system, except that instead of a motherboard or circuits, these *systems* are controlled by a multilayered network, with DNA being arguably one of the central layers.

One major tipping point in human development was agriculture. Since then, we have found ways to change plants to our benefit. The ancestor of maize (called *teosinte*) is quite different from the corn we know and love. An extreme example is broccoli, cauliflower, kale, Brussel sprouts (among others): they're so different between them and yet they are the same plant species (*Brassica olaracea*). Through selection (over many years) of different characters (leaves, flowers, etc.) the same species of plant can have striking differences. Being the same species means their DNA is virtually identical (ie, same number of chromosomes, position of the genes), save minute differences. These small variations in the genome can mean the difference between overgrown flowers (like in cauliflower) or leaves (like kale). Yet, the timespan and effort it took to take the original, wild plant to broccoli or Brussel sprouts must have been monumental. Breeding techniques have allowed to speed up the selection process, but still takes a long time. This selection is based on specific genes that control crucial traits in the plants that make them ideal for agriculture.

A relatively recent technological breakthrough is the CRISPR/Cas9 system. This system allows, with almost surgical precision, to modify the DNA of a plant (or any living organism for that matter). With this system, there is the potential to directly modify any (provided some requirements) gene of interest. CRISPR now enables plant scientists to target specific DNA regions for editing. This means that major changes in crops can be achieved in less time. Just this year, a group of researchers from different countries "re-domesticated" the wild relatives of tomatoes by using the CRISPR system to edit only a few genes[1]. What had taken a considerable amount of time was now achieved in a significantly less period of time. Similarly, a more recent report from scientists at UC Davis reported the engineering of a system in rice which allows for asexual propagation[2]. In plant (and also in animals) breeding, *hybrid vigor* is a phenomenon in which the seeds of a cross between two different lines perform better than either parent. However, this increase in performance is lost in the next generation (due to recombination, which can be thought as a remix of the genes: the overall genome is the same, but with slight differences between the parents and progeny at the sequence level); the importance of this breakthrough means that, at least in rice for now, varieties with great performance (i.e., increased yield even in poor nutrient soils) can be maintained indefinitely.

However, all is not yet solved. The ability to edit a specific region of the DNA with great precision can have unexpected consequences. Because we don't *exactly* know how each gene interacts with each other to produce the traits in an organism, unforeseen consequences can occur. This is why a responsible approach to this technology is necessary.

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The title of this writing was taken from the song *Technologic* by Daft Punk.

References

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