
Science and Technology Innovation: A Star Wars Retrospective

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It's a moment that a whole generation of kids have never forgotten. A simple phrase on a black screen, "A long time ago in a galaxy far, far away....," followed by a crash of cymbals and trumpets sounding the main title theme of Star Wars as the opening text streamed into the distance. And then we were swept into a different galaxy, one filled with technologies, characters, and worlds that captured the imagination and that inspired many of us to study math, science, and engineering and work towards making an impact on the world we live in.

Counting down to the opening night of "The Force Awakens," I took a moment to reflect on how our world has changed since "A New Hope" opened almost 40 years ago. And it struck me that a lot of the crazy, futuristic technologies in the movies aren't so crazy any more. We've succeeded in creating a science fiction world of our own, complete with cloning, computers, smart phones, renewable energy, lasers, drones, wireless charging, and cubesats. Here's a look at some Star Wars concepts that have become commonplace science and tech innovation areas:

Droids. Androids or robots, and artificial intelligence (AI), are burgeoning research areas, focused mainly on creating substitutes to performing "dull, dirty, or dangerous" duties [1] (<http://www.ge.com/digital/blog/dull-dirty-dangerous-its-robot-work>). In the Star Wars world, this is akin to R2D2 serving Jabba the Hutt and C3PO translating the binary language of moisture vaporators. In our world, [DARPA's Robotics Challenge](http://www.theroboticschallenge.org/) (<http://www.theroboticschallenge.org/>) has a mission of developing bots capable of assisting humans

in responding to natural and man-made disasters. IBM's AI made history when [Deep Blue](https://www.research.ibm.com/deepblue/) (<https://www.research.ibm.com/deepblue/>) won a chess match against a (human) world champion in 1997 and again in 2011 when [Watson](http://www.ibm.com/smarterplanet/us/en/ibmwatson/what-is-watson.html) (<http://www.ibm.com/smarterplanet/us/en/ibmwatson/what-is-watson.html>) beat two former (human) winners on the quiz show Jeopardy. [NASA's Robonaut 2](http://robonaut.jsc.nasa.gov/default.asp) (<http://robonaut.jsc.nasa.gov/default.asp>) has already been deployed to the International Space Station as the first dexterous humanoid robot in space. Google just open-sourced [TensorFlow](https://www.tensorflow.org/) (<https://www.tensorflow.org/>), the AI engine used in several Google products. Meanwhile, big data, parallel computing, and algorithm improvements are leading to even more AI improvements [2] (<http://www.wired.com/2014/10/future-of-artificial-intelligence/>). Are we there yet? No. I don't yet have a robot that will turn off the trash compactor to save my life. But I do have [SIRI](http://www.apple.com/ios/siri/) (<http://www.apple.com/ios/siri/>) - oh yeah I forgot another droid category: "entertainment." Enter C-3PO.

Automation in Vehicles. Ground-based driverless systems took off in the 1980's, and now we've come to expect automation in intra-airport transport systems and city metros around the world. And we're on the verge of the next big thing. DARPA's Grand Challenges, including the [2007 DARPA Urban Challenge](http://archive.darpa.mil/grandchallenge/) (<http://archive.darpa.mil/grandchallenge/>), spurred the development of autonomous ground vehicle technologies. Car companies are now incorporating basic driver-assist systems such as intelligent parking, and all signs point to full automation in the near future, if we can figure out the regulatory part. In fact, [Tesla's Model S](https://www.teslamotors.com/presskit/autopilot) (<https://www.teslamotors.com/presskit/autopilot>) boasts an autopilot mode that automatically steers on the highway, changes lanes, and adjusts speed in response to traffic. This is a far cry from the world we lived in when we watched Han and Chewie setting the autopilot during mad attempts to fix the Millennium Falcon, the memorable moment when Luke turns off his X-Wing's targeting computer, and more recently, young Anakin Skywalker's accidental autopilot flight during the Battle of Naboo in the N-1 starfighter. Back on Earth, commercial airplanes are increasingly flown by autopilot, and unmanned aerial vehicle (UAV) technologies have been advancing since the 1990's. The bottom line is that the faster you go and the more complex your system is, the harder it is to have a human "in the loop." Fast forward to [Elon Musk's HyperLoop](http://www.spacex.com/hyperloop) (<http://www.spacex.com/hyperloop>) concept, which will undoubtedly be automated. Hovercars? That's a whole other thing.

Prosthetics. In one of the most emotional lightsaber duels of the series, Luke Skywalker loses his right hand moments before learning that Darth Vader is his father. Spoiler alert: he gets a prosthetic hand with full functionality, goes on to fight in many more lightsaber battles, and learns to love his dad. Only in the last 10 years have advancements in upper-limb prosthetics led to near-natural control for amputees - enabling users to handle objects as delicate as a grape or as hefty as a power tool...or lightsaber [3] (<http://www.livescience.com/45533-darpa-prosthetic-arm-approved-by-fda.html>). This recent charge has been led by [DARPA's Revolutionizing Prosthetics](http://www.darpa.mil/program/revolutionizing-prosthetics) (<http://www.darpa.mil/program/revolutionizing-prosthetics>) program. Recreating life-like sensory-feedback to the user is a current research area. Remember the scene when Luke's new hand is being tested and his fingers twitch as they are poked? Research teams at Johns Hopkins University Applied Physics Lab and Caltech are some of the few working towards a near-natural sense of touch in prosthetics, which includes receptors able to detect texture, temperature, shape, pain, vibration, and a "sense of space" with signals that flow back to the correct part of the brain [4] (<http://www.nature.com/news/neuroprosthetics-once-more-with-feeling-1.12938>). And perhaps the most incredible advancement we've made: in 2011, Cathy Hutchinson, paralyzed from the neck down by a stroke, was able to mentally guide a robot arm beside her to reach across a table, close its grippers around a bottle, and lift it towards her mouth so that she could take a sip [5] (<http://www.nature.com/news/neuroprosthetics-once-more-with-feeling-1.12938>)[6] (<http://www.smithsonianmag.com/innovation/the-insane-and-exciting-future-of-the-bionic-body-918868/?all=>). Just by

thinking about it. If that's not the Force, I don't know what is.

Exoplanets. Short for extrasolar planets, these are planets that orbit stars other than our star, the Sun. Exoplanets are hard to find because they're so far away and are much darker than the stars in their vicinity. However, recent innovations in astronomy sensing and methods have led to this new field. The first extrasolar planet detection wasn't confirmed until the 1990's, more than a decade after A New Hope inspired so many with the Tatooine binary sunset scene. Since then, exciting "firsts" have hit the news: the first exoplanet found that orbits a main-sequence star, the first set of exoplanets in the same solar system, the first Earth-sized planet orbiting in the habitable zone of a Sun-like star, and the first exoplanet found orbiting a binary main-sequence star system (the real-life Tatooine) [7] (https://en.wikipedia.org/wiki/Exoplanet#Confirmed_discoveries). One of the most prolific planet hunters is [NASA's Kepler Telescope \(http://kepler.nasa.gov/\)](http://kepler.nasa.gov/), which uses the "transit photometry" method to detect planets. Basically, as a planet crosses in front of its star, the star's brightness, as we see it, decreases. Other methods of exoplanet detection include radial velocity (noticing the wobble that the planet's gravitational influence imparts as it circles the star), gravitational microlensing (noticing the distant star light being bent and focused by gravity as the exoplanet passes between the star and Earth), and direct detection (just now being made possible, at least for large planets far from the star, via advancements in ground- and space-based observation systems). As of this week, 2030 exoplanets have been discovered, with more being confirmed all the time. I'm holding out for an Endor. Complete with Ewoks.

The best part is that the innovations will keep coming, because we live in a society that encourages and incentivizes big ideas and hard work to solve the grand challenges of our time. What will kids today be dreaming of creating next? We'll get a glimpse tonight...

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