Failure: A reflection

Failure is often realized after it has happened. Nobody in their right mind works towards failing at something. The goal is to succeed. The process that led to failure was not designed to achieve failure. A lot of thought process goes into designing the process. If it fails without excuses, it opens a window of opportunity to better the understanding of the problem at our hand. The author, Stuart Firestein argues that failure in science is one of the pillars of the development of science, along with it's equally looked down upon best friend ignorance.

The author argues that success is overrated in the success of science. All the stories or papers that we read delineate a linear successful approach to the discovery. Such an easy depiction of the process of discovery gives failure its bad name and role of failure is undermined. The author also describes good kind of failures, which need no excuse. This idea stems from the quote "A real failure does not need an excuse. It is an end in itself." by Gertrude Stein. The author put forwards an impactful idea that all science is, in fact, a good failure; a failure which leaves with new and valuable. This also puts forth this idea that science is provisional continuously evolving. Newton was wrong about gravity but he was not completely wrong. So were the many others discoveries which were proven to be wrong later were not completely wrong and added to the development of science. That is how science is supposed to succeed: failure by failure. Failure is a part of succeeding but it is not true of all human endeavors and nothing stands on failure like science does. In real life, failure happens more often than one thinks it happens: an interesting example would be given the diversity of the flora and fauna we have had on earth 99% have failed to survive for long on this planet.

As we know by now that failure is a part of science, the author urges one to fail better than last time. This is advice is taken from Samuel Beckett and means that with every successive failure one to leave the circle of what is already known, to discovering one's ignorance, and to finds new realms of mysteries and expand one's circle of thought than to shrink it. Success in traditional may require one to focus and develop skills applicable to narrow circle, but failing better expands the horizon of thought. Another misconception or I would say a wrong expectation of success is that once one succeeds one is never expected to fail. Science is driven

mainly by hard work, curiosity and perseverance and only a little bit of serendipity and luck. Once a success can be termed as a failure later as science evolves very often.

The second law of thermodynamics comes in handy while explaining why failure is inevitable. Entropy makes sure that things are messy, failures are bound to happen as more probable to fail than succeed. Success can happen in one way whereas there are so many ways to fail. Failures give feedback on what went wrong and could help us succeed or rather fail better next time. Many modest Nobel laureates credit their success to serendipity and luck but if it was not for their keen outlook and learning from their previous failures their success would have been impossible to come by. Science works not on the "charms of serendipity but crashes of failures and a lot of repair work". All said and done one cannot argue with success but failure gives rise new arguments and avenue to further expand our knowledge base.

Looking at the current state of development in science and technology there is no doubt that science has been widely successful. A quote by Isaac Asimov “The most exciting phrase in science is not “Eureka” but, “Hmmm, that’s funny…” drives home the point that when things work as they are supposed to work the job is done and there is no new adventure left. The real excitement is when things don’t go as planned. Another attribute that makes science this successful is that how work in an unrelated field can help to solve problems in another field. Prominent examples Nernst equation and cable theory helped to understand the workings of neuronal action and communication. Many things proved today could be proved wrong, but science for sure progressed because of these wrong theories in the first place. One does not have to be right about everything. Science is very fragile and but this attribute makes it so successful. Another things which makes one ponder upon is the motivation behind science. The modern western science strives to be find out the truth. Only if truth was simple to find or if there was a singularity of the truth. There could be different motives of science like Arabic science wanted to understand the world created by God to understand God better and they may have reached their goal. We have made so much progress in the mulch of puzzlement, skepticism, and experiment. Any other way leads to the end, to ossification and unfounded beliefs.

Failure is key to science because it contributes to the integrity of science. Failure is more important than things that worked. Failure also serves as a test of dedication.
Generally, things that go wrong make a strong effect on us making us understand the failure better. Teaching failures should be an integral part of science teaching. Otherwise, if no history about how various scientists had to fail in order to make that one sentence which we read is a mere fact, is understated. This brings the issue of coverage. Just knowing facts does not make scientifically literate. If a deep understanding of concepts is not gained it is impossible to create new knowledge. Being said that there are essential things about science that one should absolutely know about and this list may be different for different people. But studying science without how it is done would be similar to studying cliff notes about novels instead of reading them. This shortcut to teaching is not that common in the teaching of other fields like music, literature, art etc. Not knowing the fun parts of science and maths there is no doubt students have dwindling interests in science and fear of equations. Such a narrow view of science harms the image of scientists who are thought to be moving forward only with screams of joy. Science stumbles upon and if one succeeds once though there is an expectation to always succeed that never happens. Science is a hard-won battle and is build on failure.

Major discoveries are often painted as linear arcs and seem too obvious from our vantage point. But the thing to realize is it took the smartest people of their times to come up with these advances and it took ages to come up a fact which seems trite now like blood flows through our body in arteries and veins. History of science is different than histories because these histories are still alive and continue to grow with recent discoveries. There has been a Newton-Einstein arc of development of physics and an equally compelling story has been about the physiology of blood and heart. Authoritative figures ruled how science was done and what was correct in pre-modern times. Such authority figures were Galen and Erasistratus who believed in the theory of pneuma, that arteries circulate vital life force-pneuma. This belief was held up for many centuries without being questioned until Harvey questioned it and described the physiology circulation of blood and functioning of the heart. This points to a problem that we face today as well that dead scientist are revered and living scientists are looked down upon as some weirdos. Painting of scientists who were able to earn a name for themselves as heroes takes a toll of the recognition of thousands of

years of no progress or failures that lead to new discoveries. Science is being done and is not dead and is growing through every failure that happens.

The author has an interesting take on the Scientific method that we rote learned in high school. He calls it a pale description of what scientist actually do. The author also divides science into daytime science which is more pragmatic and night-time science which is full of curiosity and free-flowing. Daytime science may involve something like the scientific method which makes doing science as a very passionless, emotionless endeavor which has fixed step making success sure. But doing science comes out of passion and curiosity and there is no set of instructions that will lead to success. Thus doing nighttime science is free of restrictions and leads to creative discoveries and comes without an instruction manual. Of course, nighttime science does not mean when the sun sets, but when the mind is free and can wander along different trajectories.

Big impacts of failures are seen in clinical failures. When a patient passes away, it is always investigated what could have been done to prevent the death. Sometimes doing nothing could have been better than doing something, which also brings up the discussion of placebo as a possible cure for patients. It’s a tough decision to make when any medication working or not working is probabilistic and not deterministic and involves human error and thus relies on humans to make these calls. But discussions about failures is of utmost importance as it would lead to awareness amongst the medical community about things that could go wrong which were previously not thought about. In a related field, pharma industry failures have the investors doubting their faith in the enterprise. Though the investments in the industry have been increasing, it has become more and more difficult to bring new drugs to the market. 1 out of 20 drugs which are based on solid ideas and years of research only make it to the patients. This situation will eventually lead the pharma companies on concentrating on low hanging fruits and might end up cutting funds on developing drugs for Alzheimer's, Parkinson’s and other high impact disorders. The scientists working in these fields know the importance of failure in discovery, but its awareness needs to be widespread to prevent the downfall of new drug development for crucial diseases.

Failures in science can be thought of as negative results, which are as important as the positive results, but we have no record of these

negative results which is saddening. If we had a negative results repository as the author suggests with a measure of reliability measure of the negative results, type II negative results could be weeded out more easily by the future generations of scientists. Such an advance would really help save time and resources and learn more from the failures and is very interesting structure to have in the scientific community. Having such an outlet for the failures, would also enlighten the funding agencies about the commonplace of failures in science, and could make them more susceptible to funding high risk/high impact projects. High risk/ high impact projects if taken out of the grant application pool, leaves with assured successes and then money is been invested in projects which have already reached somewhere, and no new knowledge can arise from it. From philosophical perspective anything which is not fallible is not scientific. If a hypothesis cannot be proved false, it probably cannot be proved right either. So it is important to give scientist breathing space with failures.

Another interesting idea that was discussed was pluralism as opposed to monism in science. Pluralism gives the space for two opposing views to be true at the same time, which is often the case is science. Many discoveries in the western world because of monistic view in science. Contrary to that in Japan which is not monistic in its religious view was more accepting of Darwin's evolution theory and thus could incorporate the opposing ideas that animal can be controlled to show some behavior and that animals have mental states similar to humans were used together leading some fundamental studies in primates, which was a hard dilemma for the western world to solve. Pluralism has space for failures and can be costly, but gives richer insights into working of the world. The existence of various disciplines is based on pluralism that everything though can be explained by physics, cannot be studied just with a physical view towards the problems.

Thus the book emphasizes that failures are central to science and doing better science. It was a cathartic read about feeling frustrated over failures and helps to put things in better perspective and is a must read to cope with failure with a more positive attitude and bring richness to one's science, which is a very personal thing to a scientist compared to other professionals. Science progresses failures by failures and we need to welcome failures than frown upon them.