Catalyzing Breakthroughs: Imagination and its Immediacy in Realizing Scientific Possibilities

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Scientific breakthroughs are not just limited to empirical observation and analytical prowess but remain at the forefront of imagination. Speculation and storytelling, hallmarks of imagination, may be powerful means for realizing scientific possibilities long before they become technological realities. In the process of envisioning a breakthrough, imagination can embolden researchers to go beyond existing paradigms and promote creativity into reality. Visionary daydreaming can often be key to catalyze breakthrough discoveries.

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Dreaming as the Primary Mover & Shaker for Discovery

Many children, if not all, have engaged in daydreaming, a platform often filled with fantastic creations and visions that are rich in hope and wonder. Yet, these grandiose engagements tend to wither and die as we mature, often replaced by a more acceptable and professionally contextualized scientific dialoguing in which we struggle with the scientific method to interrogate hypotheses and the evidence for or against them. *Yet, the child-like sense of daydreaming that subsides may really be THE forgotten catalyst for the broader scientific enterprise.* I contend that human imagination is the engine that has stalled out for many of us AND is the prime mover & shaker we should re-cultivate for discovery. Indeed, science fiction and literary art are not just entertainment, but are the conceptual think tanks where we can transcend boundaries to, in the words of Gene Roddenberry's 1960s *Star Trek* series, "boldly go where no man has gone before".

In general, we too often accept and celebrate scientific progress as part of an incremental advancement strategy. However, what if we cultivated a willingness to ask fundamental "what if" questions that extend our understandings beyond the increment? *If we can dream it, maybe we can do it* is not naive optimism; it is an observation of how human curiosity and technical capability can and should interact. Imagination makes the mental blueprint while empirical science builds the structure.

Curiosity Can Drive Discoveries

Our youth was a time when a passion for daydreaming could lead to a lifelong curiosity and inspiration. We may look to historical figures who dared to construct narratives out of pure imagination: Think Isaac Asimov, Ray Bradbury, Mary Shelley, Margaret Cavendish, Leonardo da Vinci, and Edgar Allan Poe. These exemplars bridged the creative with the analytical. Well before robotics or communications networks, Asimov, for example, conceived ideas that foreshadowed AI and robotics. Bradbury

envisioned technological renaissance and societal consequences, often challenging how we approached technological adoption and its greater implications. Shelley, long before biochemistry, tissue engineering, or organ transplantation were real things, combined concepts such as galvanism (bio-electricity) and anatomy with fiction. Her work was the first to integrate "creation" in experimentation rather than magic or spiritualism, thus pioneering speculative bio-ethics. Cavendish produced *The Description of a New World, Called The Blazing World* in 1666. This was one of the first known works of science fiction in which she integrated a critique of contemporary natural philosophy into a fantastical yarn of an alternate dimension in which speculative beings were conducting scientific inquiry.

Even earlier, da Vinci drew flying machines, submersibles, and mechanical devices that were seemingly out-of-this world; yet they laid the groundwork for future engineering and innovation. Even the great American writer and poet Poe was able to anticipate cryptography, sleuthing, mentalism, cosmology, and psychology, bedrocks for many of the technological innovations of the 20th century. All these luminaries we able to concoct narratives seemingly out of thin air that eventually materialized. They showed all of us that pure imagination is an avant-garde of technical innovation.

Reimagining the Future

What I have espoused in this editorial is that we should consider imagining possibilities that can transform the enterprise of science, especially when it comes to sustainable science, in which bio-based materials, energy, and ecological engineering can make immense progress in our well-being to the exclusion of non-renewable and often polluting fossil fuels. Confronting global challenges in sustainability, resource depletion, and climate change more often than not requires more than incremental adjustments. We need imaginary leaps to envision how we all can flourish. We need to imagine, for example, the possibilities of self-healing materials, ethical cyborg assistants, free energy, circular bioeconomies, and even organisms capable of remediating environmental contaminants to drive innovation.

As a conclusion, science fiction and daydreaming allow us to explore such aforementioned possibilities, anticipate risks, and catalyze the work necessary to realize them. By re-cultivating imagination as a catalyst adjacent to empirical research, we can inspire the next crop of scientists to dream passionately and transform speculative possibilities into realities.