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USING SCIENCE FICTION TO MOTIVATE LEARNING AND INNOVATION

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This paper discusses innovative approaches for the space industry to contribute to space education through partnerships with the science fiction industry. Unlike any genre, science fiction inspires imagination, innovation, and positive progress. It draws young people to the disciplines of science, technology, engineering, and math, and challenges them to make artistic visions into scientific reality. Among science fiction's creators, Jules Verne first imagined electric submarines, television newscasts, and video conferencing in his works. Arthur C. Clarke imagined modern-day telecommunication satellites. Isaac Asimov's works influenced our expectations for robotic technology. No doubt many space missions were also influenced by science fiction. The paper provides a brief history of space and science fiction industry partnerships, and explores new partnership opportunities for the coming decade. In particular, the paper will discuss how the space industry and the world's first comprehensive science fiction museum are working together to promote space education through science fiction.

The paper presents an overview of the new Museum of Science Fiction's educational mission with emphasis on the role of industry partners in contributing to its programming and outreach efforts. The Museum of Science Fiction's educational mission is to use science fiction to inspire and motivate careers in science, technology, engineering, arts, and math. The scope of the museum's educational program is broad and designed to reach learners of all ages, from pre-kindergarten through higher education. Through interactive exhibits, project-based learning, and in-house programming, the museum leverages donations of talent, artifacts, and funds. The museum's partnership efforts also include concerted community outreach and advocacy to increase: the quality of STEM education, support for early stage technology development, and hands-on technology projects for early career individuals. By supporting space education through science fiction, the industry could increase the STEM education and workforce pipelines, and improve workforce retention.

I. INTRODUCTION

This paper explores reasons and ways the space and science fiction industries can partner to motivate learning and innovation. To provide a basis for this discussion, the paper will first present the various definitions of science fiction as well as characterize the space and science fiction industries in terms of scope and demographics.

This paper will then demonstrate the connection between science fiction and the space industry. First, an overview of previous collaborations between the industries will be provided. Next, the paper will provide examples of technologies and scientific breakthroughs inspired by, or otherwise related to, technologies or phenomena depicted in a form of science fiction.

This paper will then explore reasons for the science fiction and space industries to partner—overarching benefits, as well as specific benefits for the space industry. Benefits to science fiction include increased technical feasibility and relevance of art, as well as others. Benefits to the space industry include workforce retention, increasing the STEAM pipeline (leading to an improved future workforce), and spurring innovation.

This paper will look at historical science fiction and space industry collaborations through the lens of those potential benefits. Some historical collaborations include contributions to film or literature by individual space experts; contributions to science and technology by science fiction creators; support of science fiction productions; and collaborations on content for educational offerings. This paper will describe these contributions and describe exemplars of these collaborative approaches.

Next, this paper will explore ways for the space and science fiction industries to implement partnership ideas. Some of the implementation topics discussed include consultative or promotional agreements. It will also discuss working with non-profit organizations and educational institutions versus the science fiction industry directly as individuals in the space community and as groups, such as companies, government agencies, or associations.

To illustrate these potential collaborative strategies, the paper will provide an introduction to one potential partner, the Museum of Science Fiction (MOSF). The paper will describe the museum's overarching mission as well the scope of it educational programs. The paper will outline various partnership opportunities.

Finally, the paper will discuss the challenges and potential solutions to measuring the success of science fiction and space industry partnerships.

II. BACKGROUND

II.I The Science Fiction and Space Industries

This section characterizes the science fiction and space industries in terms of scope and demographics. However, before describing those industries, it is first necessary to explore the definition of science fiction.

Defining science fiction with a one-size-fits-all description is challenging. A new non-profit, MOSF, states in its 2014 Prospectus, "Through story, science fiction has the potential to transform, motivate, and educate. In one sense, science fiction is fun, but in another sense, it explores the themes of ethics and morality in evolving societies and inspires its audiences. Science fiction is the art of the possible.

In line with the MOSF definition for science fiction, this paper will define science fiction as any form of media that uses an element of science to enrich or make possible a story that encourages innovation or provokes thought about different "could be" states of society, science, or technology.

II.II The Science Fiction Industry

The Science Fiction Industry is both broad and diverse. It includes segments such as media, events, and products.

The core of the industry includes all individuals and organizations that develop or assist in the development of science fiction media. These representatives of industry may be writers, producers, artists, digital effects specialist, modellers, or a member of another profession. The Science Fiction media includes:

- Film,
- Television,
- Literature,
- Online and print publications,
- Comics,
- Anime,
- Games, and
- Music.

In addition to science fiction media, the industry also includes events and product merchandising. Events include comic conventions, like the San Diego Comic-Con. Product merchandising includes licensed merchandise from media franchises, like the *Big Bang Theory*, *Star Wars*, *Doctor Who*, *Star Trek*, *Firefly* and many others. Merchandising also includes generic or otherwise unlicensed, but clearly science fiction-themed products, such as t-shirt or novelties.

II.III The Space Industry

For the purposes of this paper, the space industry is defined broadly to include commercial and public enterprises and activities conducted in, reliant upon, or geared toward creating new markets in space. This includes, but is not limited to:

- The satellite industry, which spans satellite manufacturers, launch providers, servicers, and on-Earth commercial ventures such as television and GPS industries;
- The commercial space industry, which spans commercial tourism, microgravity research, and other ventures;
- Space exploration, which includes efforts and projects aimed to extend human or robotic presence in the universe;
- Scientific discovery, which overlaps significantly with space exploration, but focuses more on understanding Earth from space, or understanding space to protect Earth's assets in space;
- Industry associations, which advocate for space industry initiatives and support industry professionals.

II.VI Connected to Science Fiction

It can be difficult to say for certain whether fact inspired fiction or the reverse. This section provides examples of technologies and scientific breakthroughs that have been influenced by science fiction. This section will also demonstrate the reverse scenario: fiction inspired by science.

Many scientific and technological phenomena and innovations can be traced to the imaginings of a science fiction creator. For example, the prolific French author Jules Verne first imagined electric submarines, television newscasts, and video conferencing in his works. Arthur C. Clarke, both scientist and science fiction author, imagined modern-day telecommunication satellites and geostationary orbit. Isaac Asimov's works influenced our expectations for robotic technology. Technology depicted in Gene Roddenberry's *Star Trek* is directly credited with inspiring disruptive technologies such as the cell phone, and more recently, a non-invasive medical device called the "tricorder."[*]

Finding examples of science fiction visions that inspired discovery and innovation are easy to find. Equally simple to trace are the influences that the science of the day has had on science fiction creators. Edgar Rice Burrough's *John Carter of Mars* book series was set on a dying planet with canals and a vanishing atmosphere, which matched scientific understanding at the turn of the 19th century when he penned the works. More recently, the 2002 film *Minority Report*, which was based on a Phillip K. Dick 1956 short story of the same name, depicted with stunning accuracy the near-state-of-the-art technology of gestural interfaces.

[*] Pultarova, Teresa. "Finalists of the Tricorder XPrize Announced." The Institution of Engineering and Technology. 29 August 2014.

The book and film creations of Clarke's *2001 Space Odyssey*, is example of a science fiction product that inspired, and was inspired by, the space industry. The story showed visions of supercomputing, Space-Earth communications, and space vehicle design. Minute technical details of the production set it apart from "space operas"—Many of these details were advised by a technical advisor from NASA named Fred Ordway.[†] These examples show that science fiction and science fact are subjects that fuel one another.

III REASONS TO PARTNER

This section discusses reasons for the science fiction and space industries to partner. There are two overarching benefits to these industries partnering: Innovation in general and increased learning that leads to a stronger workforce pipeline for the space industry. Benefits to the science fiction industry are not the focus of this discussion, but could include increased technical feasibility and relevance of the art, as well as others. Benefits to the space industry are largely related to workforce, including talent acquisition, retention, and satisfaction. Other benefits may include innovation at the workplace as well as more traditional business benefits like tax deductions and marketing returns.

III.I Overarching Benefits: Innovation and Learning

The overarching benefits of science fiction and space industry partnerships include increased innovation as well as a strengthening of the education-workforce pipeline.

Innovation is a broad term that has many implications, but is generally accepted as a positive driver for industries. An absence of innovation, especially in the space industry, could mean a collapse of an industrial base or market. "Innovation generally refers to changing or creating more effective processes, products and ideas, and can increase the likelihood of a business succeeding. Businesses that innovate create more efficient work processes and have better productivity and performance."[‡]

Science fiction and space industry partnerships can have indirect influence on innovation as a whole in the space industry. The comingling of arts and sciences blends imagination with technical capabilities, leading to innovation. In Section V, this paper will address ways to measure innovation and its applicability to these partnerships.

The second overarching benefit of science fiction and space industry partnerships pertains to workforce. Specifically, science fiction and space industries can partner on outreach and educational efforts to encourage students to pursue paths in STEM. According to Rob Zitz,[§] writer for *Washington Technology*, there is an imperative for industries to partner to inspire the next generation workforce. "With so much riding on a STEM pipeline, it is more critical than ever for industry to join forces with government and academia to help increase STEM awareness, offer assistance and engender the kind of support needed to encourage K-12 students to learn about and pursue STEM degrees and career fields."(Zitz)

However, the power of science fiction and space industry partnerships related to education and outreach extends beyond the STEM pipeline. These industries, together, can demonstrate the vast career opportunities for individuals who can creatively apply STEM skills. These partnerships dissolve a false dichotomy between the humanities and the sciences.

III.II Specific Benefits to the Space Industry

The space industry stands to gain specific benefits from partnering with science fiction. The section above discussed the overarching benefits, such as innovation and a strengthened workforce pipeline. In addition to these long-term benefits for the industry, companies or organizations that partner with science fiction may enjoy other positive impacts, such as employee retention, tax deductions, and marketing returns.

IV IMPLEMENTING PARTNERSHIPS

IV:I General Strategies

The science fiction and space industries can create a number of mutually beneficial partnership arrangements. This section describes ways for these industries to collaborate for their own benefit, as well as to inspire and motivate learning and innovation.

Partnerships between these industries can be formed between individuals and organizations and take many forms, including:

- Consultative agreements to advise on art or science;
- Marketing partnerships that allow sponsorships and co-promotional arrangements;
- Licensing agreements;
- Informal agreements to participate in event or share content; and
- Open-ended agreements or memoranda of understanding with third-party educational or non-profit organizations.

[†] Leovy, Jill. "Fred Orway dies; Prominent NASA Engineer and '2001: A Space Odyssey' Adviser." LA Times. 1 Jul 2014.

[‡] http://www.business.gov.au/business-topics/business-planning/innovation/Pages/default.aspx

[§] Zitz, Rob. "Contractors Have More Than One Pipeline to Worry About." Washington Technology. 14 Apr 2014. http://washingtontechnology.com/Articles/2014/04/14/Insights-Zitz-stem-education.aspx?Page=1

IV:II Partnership Exemplars

This section presents two examples to illustrate the diversity of collaboration opportunities for the space and science fiction industries. The first example is a partnership among an industry association, a space agency, and the entertainment industry. The second example is one between a space agency and a museum.

In May 2013, the Aerospace Industries Association crowdfunded a promotional trailer to be aired before the *Star Trek: Into Darkness* film in 56 theatres across America. NASA provided footage to create the trailer. A notable voice actor lent his talent to the voice over component. The purpose of the trailer was to advocate for space exploration.[**] It showcased some of the finest historical milestones of space exploration and posed the challenge to continue exploration.

In a second example of science fiction and space industry collaboration, a space agency entered an agreement with a third party non-profit institution to deliver science fiction-themed programming for educational purposes. In 2013, The NASA Innovative Advanced Concepts program coordinated participants for lecture series called, "From Science Fiction to Science Fact" at the Chicago Museum of Science and Industry. "The NASA Innovative Advanced Concepts (NIAC) Program nurtures visionary ideas that could transform future NASA missions with the creation of breakthroughs — radically better or entirely new aerospace concepts — while engaging America's innovators and entrepreneurs as partners in the journey."[††] In this program, NASA arranged for fellows of the NIAC program to speak at the Chicago Museum of Science and Industry to large crowds of adults and children.

In addition to these examples, there have been many other partnerships where members of or space industry companies have participated in science fiction-themed events for marketing or outreach purposes. These partnerships vary in formality and may be as simple as sending representatives to attend a Comic Convention.[‡‡]In some instances, partnerships require participants to collaborate and plan to a much larger extent, or to provide funding, like the European Space Agency and Moonfront's sponsorship of the Clarke-Bradbury International Science Fiction Competition.[§§]

IV:III Opportunities to Partner with MOSF

This section introduces a third-party non-profit educational and cultural institution that creates opportunities for the science fiction and space industries to collaborate. The non-profit is called The Museum of Science fiction, or MOSF. MOSF was established in Washington, DC in 2013. According to the MOSF 2014 Prospectus, "The museum's main mission is to create a center of gravity where art and science are powered by imagination. The museum will offer visitors opportunities to experience and learn about some of the most important science fiction artifacts and achievements. In doing so, the museum will preserve important cultural icons and create an environment that perpetuates higher levels of creativity, imagination, and thoughts about our future."

One of MOSF's key operating principles is partnering with progressive industries to enhance its educational offerings. The Museum of Science Fiction's educational mission is to use science fiction to inspire and motivate careers in science, technology, engineering, arts, and math.

The museum's programming will support learners across the lifespan. MOSF is developing programs that reach young learners from kindergarten through high school, as well as adult learners in college programs. Further, MOSF will support professionals, not limited to early-career professionals, in STEM fields that contribute to cutting-edge work that will take science fiction to reality. This programming will take the form of project based learning, support and training for educators, interactive exhibitions, virtual communities, speaker panels, courses, and more.

The museum leverages donations of talent, artifacts, and funds to deliver this programming. The museum's partnership efforts also include concerted community outreach and advocacy to increase: the quality of STEM education, support for early stage technology development, and hands-on technology projects for early career individuals.

Space industry partners can participate in museum programming in the following ways:

- Support employees in volunteering as committee members, advisors, or project team members;
- Sponsor an event, program, exhibit, or gallery;
- Provide content for exhibits, online and physical; and

[**] Kramer, Miriam. "Next Star Trek Film Gets NASA Video Trailer In Crowdfunding Project." Space.com. 1 Apr 2013. http://www.space.com/20465-star-trek-nasa-movie-crowdfunding.html.

[††] NASA NIAC Web site. http://www.nasa.gov/directorates/spacetech/niac/index.html. Accessed 7 Sep 2014.

[‡‡] Hill, Kyle. "Seth Green and Buzz Aldrin Make NASA's Prescence Known at Comic-Con." The Nerdist 25 July 2014. http://www.nerdist.com/2014/07/seth-green-and-buzz-aldrin-make-nasas-presence-known-at-comic-con/

[§§] http://www.itsf.org/contest/sponsors.html. Accessed 9 Sep 2014.

- Attend or participate in programs for students, entrepreneurs, or lifetime learners.

MOSF typically enters one of two types of partnership agreements. The primary form of agreement is a non-binding memoranda of understanding that specifies the length of the partnership (typically one to two years in duration), the roles of each partner, and their goals for collaboration. In the past year, MOSF has entered into such agreements with the Science Channel and the DC Public Library.[***][†††] MOSF has also allowed corporate sponsors to engage in co-promotional and co-marketing agreements. An example of MOSF corporate sponsors include Google, ebay, and Dreamhost.[‡‡‡] For all agreements, MOSF announces the partnership with a press release and other public relations activities to increase public awareness of the partnership.

V MEASURING SUCCESS

This section discusses challenges to measuring successes of science fiction and space industry partnerships and ways to overcome those challenges. The benefits of these industries collaborating are difficult to tabulate. The majority of these partnership benefits are long-term and correlated to other factors. This section will focus on the benefits to the space industry, as well as influences on innovation and learning in general.

This paper's overall assumption is that by pairing science fiction and space industry professionals through partnerships, individuals will be inspired to innovate. Innovation could, in theory, be measured at a company, in a country, or globally. However, quantifying innovation at either of these three levels would not likely be practical.

Measuring innovation at a company empirically is a problem faced by more than just the space industry. Ilan Mochari in an article written for Inc. Magazine presents a way to measure innovation as suggested by Alan Michael Kane. Kane is the cofounder of a firm called Phunware. Kane's metric "measures how much new products are contributing to overall revenues, over time". Assuming a space industry firm could use this metric to characterize its level of innovation, understanding how science fiction inspired that innovation may not be as easy.[§§§] There are other limitations to this metric's application for measuring innovation in the space industry. As defined earlier in this paper, the scope of the space industry extends beyond companies that create revenue-generating products. In short, it may never be clear how much innovation contributes to the success of the space industry, or to what extent that success is correlated to influence like science fiction. However, it is easy to see connections and correlations even if there is no standard metric to capture them.

This paper also posits that science fiction and space industry partnerships could positively improve the workforce pipeline in two ways: motivating students to pursue relevant degrees; and providing students with awareness of space industry careers. Measuring this benefit would require a longitudinal study that tracks both partnership activities, as well as students' interests and career choices. While not impossible to conduct such a study, it would require an organization to commit to the research over a long period of time and would ultimately rely on self-reported information by individuals. The findings, that could be available in a decade or so, could be interesting and ultimately confirm instincts about how powerful education and outreach can be at the nexus of science fiction and space. This research would best be conducted by a university or non-profit organization, such as MOSF.

Other benefits that are specific to certain space industry companies are simpler to demonstrate. Employee retention, for instance, is easily measurable. Employee surveys can capture self-reported data from the workforce to understand the offerings and qualities of the company that enrich or otherwise compel the employee to remain with the company. Other benefits, such as tax benefits and marketing return on investment can be characterized with standard methodologies already in use by professionals in accounting and marketing fields.

In summary, there are two benefits of science fiction and space industry partnerships that are difficult to isolate and measure. These benefits are innovation and workforce pipeline. Other more direct benefits to specific companies in the space industry would be easier to demonstrate. For instance, workforce satisfaction and/or retentions, tax benefits, as well as marketing return on investment could be determined without need for specialized methodologies.

[***] "Museum of Science Fiction Names Science Channel as Exclusive Media Partner." 25 Feb 2014. http://www.museumofsciencefiction.org/presspacket/

[†††] "Museum of Science Fiction and DC Public Library to Host Film Festival and Use Science Fiction to Raise Child Literacy" 19 Jul 2014. http://www.museumofsciencefiction.org/presspacket/

[‡‡‡] "International Architectural Design Competition Awards Ceremony with eBay, Google, and Dreamhost." 28 Aug 2014. http://www.museumofsciencefiction.org/presspacket/

[§§§] Mochari, Ilan. "A Metric for Measuring Innovation". Inc.com. 9 Jul 2014. http://www.inc.com/ilan-mochari/innovation-metric.html

VI CONCLUSION

By supporting space education through partnerships with the science fiction industry, the space industry could contribute to increased innovation and learning as well as improve the STEM education and workforce pipelines.

Benefits to the space industry include an improved workforce pipeline, enrichment and retention of existing workforce, as well as benefits such as tax benefits and marketing returns.

The science fiction and space industries can leverage many forms of partnerships to collaborate. These partnerships can take the form or formal or informal agreements, be low to no-cost arrangements, or include marketing or sponsorships. One effective means of collaborating is to engage a third-party non-profit educational institution such as the Museum of Science Fiction, which can relate science fiction and science fact to inspire and motivate learning.

The Museum of Science Fiction will facilitate partnerships that connect science fiction and the space industry with the goal of inspiring learning and innovation. MOSF is a new non-profit based in Washington, DC that is developing programming and content for the soon-to-be opened preview museum and full-scale museums. In the meantime, the space industry can work with MOSF to collaborate on exhibits, programs, and other facets that support goals for education, workforce pipeline and enrichment, as well as receive tax benefits and marketing returns. In addition, MOSF will lead the charge in measuring the impacts of science fiction and space industry partnerships.