A Conceptual Research Agenda and Quantification Framework for the Relationship Between Science-Fiction Media and Human-Computer Interaction

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Abstract. The use of science-fiction movies and series to stimulate and generate real-world technological innovations and devices is often utilized by Human-Computer Interaction researchers, user experience professionals and science educators. It is widely acknowledged that science-fiction has had an impact on the development of interactive technology. However, this impact has neither been fully conceptually developed nor quantitatively determined. This research aims to provide a conceptual research agenda for the relationship between science-fiction and Human-Computer Interaction. To advance this agenda, we introduce a possible quantification framework utilizing scientometric analysis, in particular, citation- and keyword analysis of peer-reviewed publications in Computer Science to quantify the reciprocal connection of science-fiction media and Human-Computer Interaction.

Keywords: Creativity · Design fiction · Foresight · Future visions · Human-computer interaction · Interaction design · Science-fiction · Science-fiction prototyping · Scientometrics · STS · Technology assessment

1 Introduction

The relationship and synergy between popular science-fiction (Sci-Fi) movies and series and real-world Research and Development (R&D) has been acknowledged within the scientific community, with the latter often using the earlier as inspiration for its projects and endeavors. In this study, we discover traces, identify evidence and review relevant state-of-the-art research in media and academia to recognize synergy effects of this bi-directional relationship Sci-Fi visualizations and real-world science.

In particular, we focus on the field of Human-Computer Interaction (HCI) located within the extensive Computer Science area. In the first part of this research, we give an account of the relationship between Sci-Fi and R&D through explicit referral and examples of Sci-Fi movies and series in popular news as well as scientific proceedings

and publications, extending notions of anecdotal evidence. We further mention applied professional associations and computer science education studies to substantiate an account of the undeniable impact of Sci-Fi media on the inspiration and creativity of scientists and vice-versa. We then condense these recent efforts in a comprehensive, but conceptual research agenda to study, advance and systematically put a figure on this relationship. To do so, we propose a quantification framework and outline measurements to study the charted relationship and conceptual research agenda of HCI and Sci-Fi media.

2   Background

Sci-Fi movies and series have depicted innovative devices and technologies well ahead of their initial conceptualization in R&D. In this section, we draw upon the broad fields of Science, Technology, Engineering and Mathematics (STEM), and in particular the field of Computer Science and HCI to show how these utilize and intersect with Sci-Fi movies and series in a variety of ways.

For instance, Metropolis, a German Sci-Fi dystopia from 1927 shows one of the earliest depictions of a video phone call. Stanley Kubrick's movie, 2001: A Space Odyssey, reportedly engaged multiple science advisors on the production of the movie. According to Kirby's research [12], anthropologists, aeronautical engineers, nuclear physicists as well as statisticians advised on the production of the space epos. In parallel, more than 50 consultations with private companies, government agencies, university groups and research institutions were undertaken by the production staff. The goal was to accurately depict space science and technology, supercomputers, future interfaces and the possible event of a technological singularity. Spielberg's Minority Report is yet another example of this mutual relationship, with the movie depicting highly personalized technologies, such as targeted advertising and biometrics as well as innovate gestural interfaces. The latter are attributed to John Underkoffler, a MIT researcher, whose gestural interfaces in Minority Report have been adopted by Boeing as a "*spatial operating system featuring gestural input and high-definition graphical output to analyze large data sets in real time*" [18]. Christopher Nolan, the director of Interstellar, recently collaborated with the world-renowned theoretical physicist Kip Thorne [25]. Thorne, collaborating as technical advisor and executive producer, helped to accurately portray what life on a Mars space station would be like. Contemporary Sci-Fi movies, such as Her and Ex Machina extend depictions of artificial intelligence, consciousness and humanoids in future societies to both, illustrate forthcoming science, technology and society (STS) issues and question the ethics of probable robot-human relationships.

The improvement and availability of special effects technologies for movies and post-production techniques, such as chroma-keying, computer-generated imagery, computer animation and virtual cinematography become an everyday tool for movie productions. Depending on the budget, Sci-Fi movie productions can draw on an unlimited and unprecedented number of visualizations toolkits and techniques to showcase future societies in Sci-Fi movies and series. For instance, Schmitz et al. [20] determine three key factors contributing to the applicability of interaction design in Sci-Fi movies which are: (i) the available special effects technologies, (ii) the available

budget and (iii) the overarching importance of the role of technology within the movie itself. Academic research has gradually recognized the interdisciplinary intersection of HCI, interaction design, Computer Science and STEM fields with Sci-Fi media. As Perkowitz [19, p. 215] states: *"interactions between science and science-fiction involve books as well as movies. Books are better than films at conveying complex ideas [...] but the enormous power of films to reach millions can't be downplayed."*

In conjunction with these links, Kirby [13] presents a series of qualitative studies on the collaboration of film-makers and real-world scientists. Further studies have discussed the emergence of HCI and Sci-Fi movie collaboration frameworks [12, 20] as well as the growing liaison of scientists and filmmakers [22]. Additionally, empirical studies on the topic found correlations between classroom creativity and Sci-Fi media [15] as well as the potential value of Sci-Fi media for computer-science higher education [8].

Likewise, the importance of stories and constraint-free reasoning is discussed extensively by Bleecker [4], Tanenbaum [24], Dunne and Raby [6] and Lindley and Coulton [16] concluding in the emergence of design fiction. Design fiction, although a contested term is generally understood as a method of critical design to develop fictional and narrative scenarios to envision, explain and raise questions about possible futures for design and society while neglecting any technical constraints or feasibility.

In many regards, the technical feasibility of a Sci-Fi technology has not prevented scientists from deductive reasoning and action towards possible real-world implications. For example, physics students calculated the energy necessary for a 'death star' planet destroyer from the world-wide known Star Wars franchise [5]. In a more applied sense, the practicality of the technologies, devices, interfaces and interactions portrayed in Sci-Fi movies and series have been investigated as means to delineate Sci-Fi heuristics and design patterns in multimodal, fictional interfaces [21].

Moreover, professional HCI and interaction design associations, such as the User Experience Professionals Association (UXPA) [26] as well as STEM periodicals, such as the Biochemist Society [3], have published special issues on Sci-Fi and interaction design, design fiction and the utility of Sci-Fi in the classroom and elsewhere.

3   Conclusions

In conclusion, we present both, a conceptual research agenda that combines Sci-Fi media and HCI in addition to a quantification framework of the said agenda.

The center of this agenda constitutes the growing relationship between HCI and Sci-Fi media, which gives an account of a bi-directional synergy between both fields, as outlined in section two. This bidirectional relationship is enclosed in six distinct items. We present and discuss each of these item briefly to reflect on their importance in facilitating innovative HCI research.

In addition, we propose a quantification framework to measure the relationship between Sci-fi movies and series and real-world R&D to quantify and assess aspects of this conceptual research agenda to, for instance, highlight specific fields within STEM which have a stronger or weaker correlation with Sci-Fi production in terms of inspiration, collaboration, economies, pedagogic opportunities and scientific production.

3.1 A Conceptual Research Agenda of HCI Advancement and Sci-Fi Media

First of all, the audiovisual presentation of technologies, interfaces and interactions within a strong narrative to depict potential applications, technologies and futures build the core of our proposed research agenda. The interchange of scientists and film-makers can both, facilitate representations of technology and devices for inspiration and evaluation in HCI research and advance real-world technology as well [18, 21].

Second, we acknowledge and built upon concurrent research programs on this core relationship of HCI in conjunction with Sci-Fi movies and series as well as vice-versa [12, 13, 20]. However, these agendas neglect, or do not consider, any potential methodology, in particular a quantification framework, to measure these relationships across, for instance, Computer Science subtopics.

Third, our research agenda recognizes educational and pedagogical opportunities of Sci-Fi for innovative HCI and Computer Science schooling as evidenced in evolving university curricula, such as Sci-Fi based prototyping courses [14] as well as the advent of new methods, for example design fiction [16] and Sci-Fi prototyping [9].

Fourth, we identify emerging economies and job markets for scientists as the new role of researchers as part of movie productions has been poorly researched. In the context of previous studies which show long-lasting and general collaboration arrangements of scientists and movie producers [12, 13, 22], we identify specific and incremental developments. For example, standardization efforts of the position titles of scientists on Sci-Fi movie credits currently range from 'technical advisor' to 'science consultant' to 'futurist' despite the fact that scientists are occasionally not referred at all.

Fifth, the broader socio-technical impact of Sci-Fi on emerging HCI technologies and subtopics through studies of STS. For example, emerging R&D areas, such as artificial intelligence, robotics or cybersecurity [14] and the cinematic depiction of the said may well be related to the perceived technology readiness of the audience. For instance, Sci-Fi movies and series stereotypically depict either a utopian future vision with seamlessly integrated technologies which benefit the many or society as a whole or – in stark contrast – a dystopian setting, where information and communication technologies are appropriated by a few for base motives such as surveillance or oppression.

Sixth, the recognition and consideration of the dominance of western Sci-Fi movie productions or 'Hollywood' neglecting niche productions from, for instance India, Russia, China or Japan as well as independent studios [17]. The notion of this cultural bias is part of our conceptual research agenda while in the meantime the impact on scientists, audiences and the whole popular culture may well be studied through STS research.

3.2 A Quantification Framework of HCI Research and Sci-Fi Media

Current research lacks of an effective methodology to quantify the outlined bidirectional, multi-faceted relationship between HCI and Sci-Fi in all its aspects and evolutions. Among others, the primary aim of this exploratory study is to establish a ground truth for a quantification framework of the link between HCI and Sci-Fi movies and series. To address this imminent research gap, we aim to deliver a first of a kind

measure of the central research question of our conceptual research agenda, that is to say a quantification of the mutual relationship between both fields.

To do so, we propose to use a combination of tools in a pilot study of a selected sample of HCI relevant, peer-reviewed collections. Specifically, we propose using keyword analysis, text mining and citation analysis of a sample of referred publications of established HCI collections. The process is roughly outlined below:

1. In a first step, we propose title and key-word/meta-data analysis through a dictionary (for example Sci-Fi, future visions, movie titles, advisor titles etc.) to identify and filter very closely related papers who inform on the relationship of HCI and Sci-Fi media.
2. In a second step, we intend to use text mining and qualitative content analysis of the sampled papers to understand the context of the cited Sci-Fi concept in relation to the HCI research more detail. For example, we can determine which subtopics of HCI, such as mobile computing, robotics, wearables or virtual reality more frequently refer to Sci-Fi media in comparison to other fields. This should allow us to explore why certain subfields are more prone to mention Sci-Fi movies and series than others.
3. In a final step, we suggest citation analysis of identified publications in the previous steps to trace related research in the publication itself and the domain under review and link, for example, research curricula of authors or institution affiliations to our analysis.

In summary, we believe that a combination of the afore-mentioned approaches will - in an ideal case scenario - provide us with an improved and measurable understanding of the impact and mutual relationship of Sci-Fi media and HCI research.

References

1. Bates, R., Goldsmith, J., Berne, R., Summet, V., Veilleux, N.: Science fiction in computer science education. In: Proceedings of the 43rd ACM Technical Symposium on Computer Science Education (SIGCSE '12), pp. 161–162. ACM, New York (2012). doi:10.1145/2157136.2157184
2. Bergman, E., Lund, A., Dubberly, H., Tognazzini, B., Intille, S.: Video visions of the future. In: Dykstra-Erickson, E., Tscheligi, M. (eds.) Extended Abstracts of the 2004 Conference, p. 1584
3. Biochemical Society: The Biochemist. Science Fact and Science Fiction, vol. 34
4. Bleecker, J.: Design Fiction: From Props to Prototypes (2010)
5. Boulderstone, D., Meredith, C., Clapton, S.: That's no moon. J. Phys. Spec. Top. **9**, 195–196 (2010)
6. Dunne, A., Raby, F.: Speculative Everything. Design, Fiction, and Social Dreaming. MIT Press, Cambridge (2013)
7. Figueiredo, L.S., Gonçalves Maciel Pinheiro, M.G., Vilar Neto, E.X., Teichrieb, V.: An open catalog of hand gestures from Sci-Fi movies. In: Begole, B., Kim, J., Inkpen, K., Woo, W. (eds.) The 33rd Annual ACM Conference Extended Abstracts, pp. 1319–1324
8. Goldsmith, J., Mattei, N.: Fiction as an introduction to computer science research. Trans. Comput. Educ. **14**, 1–14 (2014)

9. Johnson, B.D.: Science Fiction Prototypes Or: How I Learned to Stop Worrying about the Future and Love Science Fiction. In: Callaghan, V., Kameas, A., Reyes, A., Royo, D., Weber, M. (eds.) Intelligent Environments 2009 – Proceedings of the 5th International Conference on Intelligent Environments, pp. 3–8. IOS Press, Barcelona (2009)
10. Johnson, B.D.: Science fiction prototypes or: how I learned to stop worrying about the future and love science fiction (2009)
11. Kaye, J., Dourish, P.: Special issue on science fiction and ubiquitous computing. Pers. Ubiquit. Comput. **18**, 765–766 (2014)
12. Kirby, D.A.: Lab Coats in Hollywood. Science, Scientists, and Cinema. MIT Press, Cambridge (2011)
13. Kirby, D.: The future is now: diegetic prototypes and the role of popular films in generating real-world technological development. Soc. Stud. Sci. **40**, 41–70 (2010)
14. Kohno, T., Johnson, B.D.: Science fiction prototyping and security education. In: Cortina, T. J., Walker, E.L., King, L.S., Musicant, D.R. (eds.) The 42nd ACM Technical Symposium, p. 9
15. Lin, K.-Y., Tsai, F.-H., Chien, H.-M., Chang, L.-T.: Effects of a science fiction film on the technological creativity of middle school students. Eurasia J. Math. Sci. Technol. Educ. **9**, 191–200 (2013)
16. Lindley, J., Coulton, P.: Back to the future. In: Lawson, S., Dickinson, P. (eds.) The 2015 British HCI Conference, pp. 210–211 (2015)
17. Marcus, A.: The history of the future. Interactions **20**, 64 (2013)
18. Overby, S.: Boeing Adopts Sci-Fi Data Manipulation Mode. http://www.cio.com/article/2395557/business-intelligence/boeing-adopts-sci-fi-data-manipulation-model.html
19. Perkowitz, S.: Hollywood Science. Movies, Science, and the End of the World. Columbia University Press, New York (2010)
20. Schmitz, M., Endres, C., Butz, A. (eds.): A survey of human-computer interaction design in science fiction movies (2008)
21. Shedroff, N., Noessel, C.: Make It So. Interaction Design Lessons from Science Fiction. Rosenfeld Media, Brooklyn (2012)
22. Smaglik, P.: Entertaining science. Scientific advisers for films and television help to bring credibility to the screen — and take some tangible and intangible benefits back to the lab. Nat. Careers **511**, 113–115 (2014)
23. Stalenhoef, P.: Should films be scientifically accurate? In: RiAus Australia's Science Channel
24. Tanenbaum, J.: Design fictional interactions. Interactions **21**, 22–23 (2014)
25. Thorne, K.S., Nolan, C.: The science of interstellar (2014)
26. User Experience Professionals Association (UXPA): Science fiction. User Exp. Mag. **13**(2)