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Can Computers be Non-Binary?

Studying the role of gender in the four research areas of VRVis Vienna

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At the moment of writing these acknowledgements, 11th of March 2021, it is almost exactly a year ago that Austria went into its first lockdown in response to the developing COVID-19 infections in the country. At the time, I viewed the six-week lockdown that followed as a quick fix to a situation that would return to normal shortly after. Little did I know that I would not have another physical class or see my student peers in real life for the rest of my masters. The pandemic made many aspects in life more challenging, and writing a master thesis was no exception to this. Therefore, in this time where many people had to adapt to quickly changing situations, a sincere thank you to those who helped me throughout the thesis process is in its place.

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1. Introduction

Contemporary society leaves hardly any aspect of human lives untouched by technology. Visibly, we constantly carry around tech in our pockets and spend most of our working days behind a computer screen. On the other hand, invisibly, through datafication and algorithms, decisions are constantly made for and about us. The COVID-19 pandemic has further made visible the reliance of society on technology. Examples include the medical interventions that were quickly developed during the pandemic, and allowing education at all levels, different types of industry, conferences, and social happenings to function whilst people were confined in their homes during the lockdowns. Although technology tends to offer a sense of neutrality and objectivity because it was developed through computer programming and raw calculation (Bath, 2014), this definitely is not always the case. A big topic within the field of science and technology studies (STS) is showing how technology can both be shaped by and reinforce negative social structures such as harmful racial and gender stereotypes.

When it comes to developing technology, even though men and women have differing needs, end-products are often skewed towards the male-default. For example, female drivers have a 47% higher chance to sustain severe injuries during car crashes because crash dummies are based on average male proportions (Bose, Segui-Gomez & Crandall, 2011). This also shows in other technologies such smart phones on average being too large for female hands and Virtual Reality (VR) headsets being too large for female heads (Criado Perez, 2019). An explanation that is given for the development of this male-skewed technology is because people active within the Science, Technology, Engineering and Mathematics (STEM) fields are predominantly male. "When it comes down to the tech that end up in our pockets, it all comes down to who is making the decisions. And like the world of venture capitalists, the tech industry is dominated by men" (ibid, p. 180).

Because awareness about such gendered factors in science and technology is rising, a growing number of initiatives vouch for including sex and gender analysis in innovation processes. Research shows that including sex and gender analysis in experimental and technological design "[…] foster[s] scientific discovery, improve[s] experimental efficiency and enable[s] social equality" (Tannenbaum et al., 2019, p. 137). Therefore, frameworks such as Responsible Research and Innovation (RRI) are of increasing relevance. Furthermore, gender is also becoming an important topic in other layers of science such as funding agencies. These agencies put external pressures on scientific and research institutes to incorporate sex and gender analysis into their research design. Since these criteria are at times handled quite rigorously, ignoring them can therefore have negative consequences such as the loss of funding.

In line with these initiatives and types of research, VRVis Zentrum für Virtual Reality und Visualisierung forschungs -gmbh, a visual computing company located in Vienna, was looking for a master student who could write their thesis about the role of gender in the technology development at the company. Part of the reason being that this was strongly encouraged by the funding programme VRVis is part of. The funding programme, called COMET, aims to fund projects that carry out high-quality collaborative research between industry and science that is situated more on the industry side than university groups would normally be. It was by request of COMET to encourage research about the possible role of gender within the projects it funds. Within VRVis, the work and projects are divided between four different research areas: Visual Analytics, Smart Worlds, Multiple Senses, and Complex Systems, and COMET funds projects in all four of these areas. Therefore, this thesis aims to uncover the answer to the question: *Does gender play a role within the development of technology in each of the four different research areas at VRVis? And if so, how?* In order to answer this question, separate subquestions will focus on the conceptualizations of gender the VRVis researcher hold, what steps they take in order to prevent or counteract potential gender issues in their work, how much importance is given to gender considerations in projects, and where in the project process they identify possible gender aspects playing a role.

Structure of thesis

This thesis is structured along seven main chapters. The next chapter sets out different strands of STS literature that serve as a context in which the research in this thesis can be placed. It explores the historical emergence of and defines the concept of gender. Then it engages in an exploration of specific STS literature that focuses on the role gender plays in the development of science and technology, and how science and technology can have an influence in determining gender relations in society. The chapter finishes with an explanation of the Responsible Research and Innovation framework, which, amongst others, has a focus on developing gender inclusive research and innovation.

Chapter 3 of this thesis elaborates on existing methodologies for analyzing sex and gender in specifically computer science and engineering fields. These methodologies come from three specific pieces of literature: (1) two Gendered Innovations reports written by the European Commission describing specific case studies in which sex and gender analysis led to more socially robust research and innovation, (2) a publication in Nature by Tannenbaum et al. (2019) that describes when and how to engage in sex and gender analysis in research, and (3) a book chapter from Corinna Bath (2014) describing four 'pitfalls' computer scientists could fall in which leads to the development of gendered technology.

Chapter 4 gives a broad elaboration of the materials and methods utilized for the research in this thesis. It starts with a description of the visual computing field and the VRVis company. This is then followed by the research questions asked in this thesis, and by a description of the method used to answer them, namely qualitative interviews.

Chapter 5 features the empirical analysis of the conducted interviews. It starts with a broad description of the specific practices and projects within each of the four VRVis research areas, which is then followed by an elaboration of the findings ranging from the conceptualizations of gender the VRVis researchers have, to specific practices they employ to circumvent any possible gender bias in their work.

Because it was a specific wish of VRVis to look at each of the four different research areas instead of one specific one, chapter 6 will tie the findings to each of the specific areas, and elaborates how they associate with the literature described in chapter 3.

Finally, chapter 7 shortly summarizes the main findings of this thesis, and makes some suggestions for possible future research. Then it reflects on the experiences I have had as a researcher during this thesis process, as the COVID-19 pandemic has had overall influences that I think are relevant to share for anyone who reads this thesis after these challenging times.

Abstracts

English version

Research has shown that incorporating sex and gender analysis into experimental design improves scientific and technological innovation and increases its social robustness. Furthermore, because scientific institutions such as funding agencies and the European Commission are increasingly bringing gender inclusivity to the foreground, the popularity of engaging in such analysis is additionally on the rise. This master thesis in the field of Science and Technology Studies aims to uncover through the means of qualitative interviews if and how the topic of gender plays a role within the four different research areas of the visual computing company VRVis in Vienna. Utilized for the analysis are existing methodologies for uncovering potential gender aspects in computer science research projects. Within the four areas (Visual Analytics, Smart Worlds, Immersive Analytics, and Complex Systems) the importance of considering gender varies substantially related to how directly the work in that area affects humans. Furthermore, compared to the three gender equality dimensions of the Responsible Research and Innovation (RRI) framework, within the reflections of the VRVis researchers a heavier focus existed on the first two dimensions, which include stimulating the increase of the number of women active within computer science research projects, and less on the third dimension which includes a focus on the effects of sociocultural conceptions of male and female on the development of technology. Lastly, because VRVis is a research institution that is often involved in the development of prototypes and is therefore not in a position to develop all its technology to the fullest, an open but important question exists on when and by whom gender should be reflected upon in the entire trajectory of the innovation process.

German version

Die Forschung hat gezeigt, dass die Einbeziehung von Sex- und Gender-Analysen in die Versuchsplanung wissenschaftliche und technologische Innovationen verbessert und ihre soziale Robustheit erhöht. Da zudem wissenschaftliche Institutionen wie Förderorganisationen und die Europäische Kommission Gender-Inklusivität zunehmend in den Vordergrund rücken, steigt die Popularität der Beschäftigung mit einer solchen Analyse zusätzlich an. Diese Masterarbeit im Bereich Science and Technology Studies hat zum Ziel, mit Hilfe von qualitativen Interviews herauszufinden, ob und wie das Thema Gender in den vier verschiedenen Forschungsbereichen des Visual-Computing-Unternehmens VRVis in Wien eine Rolle spielt. Für die Analyse werden bestehende Methoden zur Aufdeckung möglicher Genderaspekte in Informatik-Forschungsprojekten herangezogen. Innerhalb der vier Bereiche (Visual Analytics, Smart Worlds, Immersive Analytics und Complex Systems) variiert die Bedeutung der Berücksichtigung von Gender wesentlich in Abhängigkeit davon, wie direkt die Arbeit in dem jeweiligen Bereich Menschen betrifft. Im Vergleich zu den drei Dimensionen der Geschlechtergleichstellung des Rahmenwerks für verantwortungsvolle Forschung und Innovation (Responsible Research and Innovation, RRI) lag in den Überlegungen der VRVis-Forscher außerdem ein stärkerer Fokus auf den ersten beiden Dimensionen, die die Stimulierung der Erhöhung der Anzahl der in Informatik-Forschungsprojekten aktiven Frauen beinhalten, und weniger auf der dritten Dimension, die einen Fokus auf die Auswirkungen soziokultureller Vorstellungen von männlich und weiblich auf die Entwicklung von Technologie beinhaltet. Da es sich bei VRVis um eine Forschungseinrichtung handelt, die häufig an der Entwicklung von Prototypen beteiligt ist und daher nicht in der Lage ist, die gesamte Technologie in vollem Umfang zu entwickeln, besteht schließlich eine offene, aber wichtige Frage: Wann und von wem das Geschlecht im gesamten Verlauf des Innovationsprozesses reflektiert werden sollte.