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Women in Audio: contributions and challenges in music technology and production

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ABSTRACT

Even though there is a persistent gender gap, the impact of women in audio continues to grow. The achievements of pioneering women in audio go back to the mid-twentieth century. Their accomplishments in the entertainment and academic sectors have helped pave the way for a record number of women in the next generation of women in audio. This paper presents recent contributions as well as discusses the representation of women in audio, the gender gap and challenges women face in this field. Various options, policies and initiatives are also proposed with the goal towards gender parity. The authors hope to provide a valuable contribution to the research on women in audio, and in particular women's representation in audio engineering, production and electronic music.

1 Introduction

The terms 'music' and 'technology' are often perceived or categorized to be male domains. When these two terms are combined to refer to audio engineering or electronic music, the gender stereotyping is enhanced [1]. Music technology is a very diverse field, which includes audio engineering, electronics, consulting, sales, design, sound mixers, film sound recording, broadcast technicians, post-production, instructors, acousticians, researchers and developers. There is a large gender gap in music technology and despite this persistent gap, women's involvement in this field continues to increase. When discussing women in a male-dominated environment it is important to take note of the valuable contributions they have made in the past or are currently making. Given that the audio field has many specialties, for this paper, we will concentrate on the achievements of women in audio engineering, electronic music and production. This paper also addresses the issues and challenges that they face. Policy changes and initiatives in order to make the audio field more inclusive to women are also proposed.

2 Contributions

Women's contribution in music technology and production can be linked to the growth of academic, computer music and commercial electronic studios [6].

The success of the pioneering women in audio has significantly expanded in the past several decades. They have created pathways for subsequent generations of female audio engineers, electronic musicians including researchers and developers. The prominent women in audio named in the following sections were selected as an indication of their level of accomplishments and involvement in this field. Their achievements, as well as those not mentioned, show that women "can and do belong in the audio field" and have the capability to learn the technology and cope with "the intellectual demands of the field" [5].

2.1 Women's contribution in Electronic music

Numerous women have contributed to the development of electronic music improvisation, composition and performance systems. Examples of those include: **Pauline Oliveros** who has published numerous books and articles on electronic music and is still very active in electronic music performance, improvisation and composition. **Laurie Spiegel,** a composer, programmer and electronic music pioneer, created computer graphics programs and the Music Mouse intelligent music software. **Suzanne Ciani** is a composer, recording artist and pioneer in the field of electronic music and sound design. **Mara Helmuth,** an electronic music composer has developed software for composition and improvisation involving granular synthesis, user interfaces and Internet2. **Laurie Anderson, Daria Semegen, Alice Shields, JoAnn Kuchera-Morin** and **Mary Simoni** all composers, have and still contribute to the electronic music field.

Most recently, advances in interactive performance and performance systems have been made by: **Carla Scaletti** whose research interest lies with computer generated music, designed the *Kyma* sound generation computer language, which is very popular among sound designers today. **Mari Kimura** is at the forefront of violinists who are extending the technical and expressive capabilities of the instrument and is developing the violin bow controller. **Margaret Schedel,** a composer and cellist specializes in the creation and performance of interactive media, emphasizing gesture in music, and the sustainability of technology in art. **Rebecca Fiebrink** researches Human Computer Interaction (HCI) and its application of machine learning to real-time, interactive, and creative domains. **Marije Baalman** is an artist and researcher/developer working in the field of interactive sound art. Her research involves the use of wireless networks for live performance (such as dance and music), installations and interactive environments. **Freida Abtan**, a multi-disciplinary artist and composer, work involves inter-sensory composition and multimedia performance. **In-Sook Choi** is a composer and researcher in semantic computing, creative media architectures, interaction design, algorithmic composition, and computational media. **Pamela Z**, an electronic musician, performs primarily with voice, live electronic processing and uses her own developed MIDI controllers to create special effects. Other prominent female electronic musicians include **Amy X Neuberg**, **Dafna Naphtali**, **Erin Barra, Tara Rodgers**, **Miya Masaoka, Maggi Payne** and **Jessica Rylan**.

2.2 Women's contribution in audio engineering

The number of women in audio engineering and recording has risen in the past thirty years. Among the most notable women each with valuable contributions are: **Leslie Ann Jones, Trina Shoemaker, Gwendolyn Yates Whittle** and **Marcella Araica. Lora Hirschberg** and **Anna Behlmer** are award winning sound engineers who work mainly in the film industry. **Christina C. Miserendino** and **Pud Cusack** are also sound engineers/designers working in the movie industry. **Theresa Leonard** has produced and engineered award-winning recordings for many labels.

Other notable female producers and audio engineers include **Susan Rogers, Leanne Unger, Sally Browder, Valeria Palomino, Emily Lazar, Terri Winston** and **Ann Mincieli**.

2.3 Women's contribution in production and development

In the field of audio production and development, the number of women involved in recording and product development research has also risen over the past thirty plus years. The most notable women are: **Anne-Marie Bruneau** whose work on electrodynamic loudspeaker design explores motion impedance and radiation patterns; **Jamie Angus** who has worked in studio acoustics, and new approaches to filters in analog/digital converters; **Ingrid Linn** whose work contributed to the design of audio plug-ins and acoustics; **Poppy Crum,** head scientist at Dolby Laboratories whose research involves computer research in music and acoustics; **Anna Perelman** of Stelle Audio Couture who has developed audio speakers and combined them with high fashion items such as clutches and accessories; as well as **Marina Bosi**, whose work includes the development of standards for audio and video coding and digital content management. Other exceptional women who have done valuable work in the various specialties of the audio field are: **Bozena Kostek, Valerie Tyler, Helen Meyer, Agnieszka Roginska** and **Eva Arato-Borsine.**

3 Current state of women in audio and engineering

When outlining women's accomplishments in audio-related fields, emphasis is usually placed on the most successful ones. Though it is encouraging that more and more women are becoming active in audio, it is equally important to explore what the overall statistics and current trends are in this field. Women generally make up a small fraction of the engineering workforce. Peterson, who conducted research over 30 years ago on women in engineering, described the trend as 'distinctly bad' [5]. Even though there has been an increase of women in Science, Technology, Engineering and Math (STEM) fields in the past 30 years, they still make up less than 15% of the audio engineering field. The U.S. Congressional Joint Economic Committee claims that the percentage of female engineers in the workforce increased from 5.8% in 1980 to 14% in 2012 [15] [16].

When looking at university admission statistics, it becomes apparent that very few women enter universities for music technology or recording engineer degrees. The University of Colorado, for example, does not usually have more than 6 women who apply for its Recording Arts Program each year out of 50-75 applicants [7]. At American University the percentage of females in both the Audio Technology and Audio Production programs is less than 35%. Nevertheless, there has been a small increase in female students over the years. Ana Cetina, director of the Audio Technology program, says "it's a small increase every time but it has been consistent" [13]. There is also a gender gap in enrollment at audio engineering schools that do not offer a degree. At the Recording Engineers Institute (REI) in New York, "the female to male ratio is usually 2 to 10. This ratio has not changed for at least 5 years" says Matthew Einsidler, instructor at REI [8].

According to the U.S. Labor Department Statistics data for 2015, women made up 46.8% of the total U.S. workforce, however they are much less represented in STEM fields. Women hold less than 25% of STEM jobs [4]. For example, only 12.5% of electrical and electronics engineers, 8.3% of mechanical engineers, and 14.7% of chemical engineers are women. In 2015, women made up only 9.2% (Fig 1.) of the total Broadcast and sound engineering technicians and radio

operators workforce, which is down 3.8% from 2014. As shown in Fig. 1, over the past 10 years the percentage of women in the field has been hovering around 9% with a maximum of 15.6% in 2008 and a minimum of 8.4% in 2012.

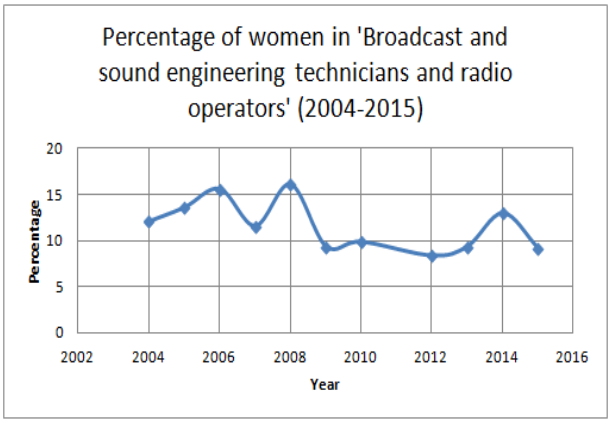

Figure 1. Percentage of women in Broadcast and sound engineering technicians and radio operators (US Labor Department)

3.1 Membership in Professional Organizations and Societies

Professional audio organizations and societies are good indicators to provide insight on the proportion of women to men in the audio field. For this paper we have chosen to focus on membership information from two international organizations, which combined, cover a wide range of music technology-related topics, namely the International Computer Music Association (ICMA) and Audio Engineering Society (AES).

The ICMA is an international organization of individuals and institutions, which serves composers, computer software and hardware developers, researchers, and musicians interested in the integration of music and technology. An overview of the percentage of women ICMA members reveals a wide gender gap. Female membership percentage rates consistently lie below 20%. There has been a slight increase in female membership in the past 10 years, however the actual numbers remain very low, ranging from 14.5% - 19.6% (Fig. 2).

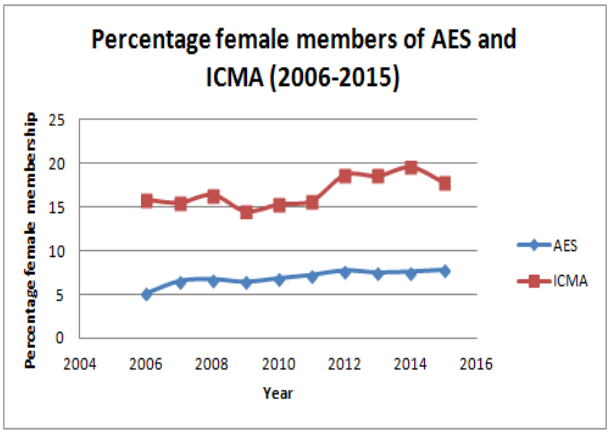

Figure 2. AES and ICMA Membership

The percentage rates of female members are even lower for the AES organization. AES is an international organization of audio engineers, scholars, and researchers who share interests in audio-related technologies. As shown in Figure 2, women in audio make up less than 10% of all members worldwide. Nevertheless, a slight increase can be once again noticed in the past 10 years. AES officials report that "while not necessarily correlating directly to the industry at large, of the AES members who have shared their gender, 7% are female" [9]. It is also worth noting that the gender gap appears to be wider in AES than in ICMA reinforcing the well established observation of women's underrepresentation in STEM related fields.

3.2 Challenges for women in technology?

Women's achievements in engineering in general are often trivialized or undermined, which could be a deterrent for them to enter or remain in the field. This could certainly the case in any field where women are

the minority; however it seems more prominent in the technology/engineering field.

Various research findings show that social and environmental factors also contribute to the under representation of women in science and engineering [10], thus also affecting music technology and production. When there is a belief that men are better at math, science and technology it may make women and girls feel that they may not excel at STEM careers and therefore are quickly discouraged.

Societal beliefs and stereotyping can lead to a lack of encouragement and poor preparation. Audio engineering and production may not considered by some to be a stable, professional and high paying job or profession unlike a doctor or lawyer and thus, parents or teachers who believe this, may not encourage their children to pursue careers in audio. Each person's socialization can vary, and when some young girls have access to technologies via their families or other opportunities it allows them to imagine themselves as composers, sound artists and producers [3].

Another contributing factor in the underrepresentation of women in technology is a dearth of role models or mentors [12]. Most women tend to look to instructors or other female professionals who are aware of the differential experiences of women and men.

Issues of work-life balance can be more significant for women than for men. When women in professional occupations have children, "their commitment and competence are questioned, and opportunities start drying up" [14]. There may be an assumption that women with children may not be reliable, because they may have to tend to child issues that could make them show up late for work, cancel engagements, becoming easily distracted etc. This mentality may be a reason why many companies do not offer flexible work-life policies.

4 Current Efforts and Future Initiatives

While it is valuable to recognize the gender discrepancy and report on the inequalities that are occurring, it is important firstly to create awareness of what is being done to counteract the imbalance of women in audio, and secondly, to try and pinpoint the cultural source of said inequities. As we are able to realize the challenges that women are facing, we will become more enabled to move these initiatives towards a more normalized cultural practice.

From the recent efforts of non-profit organizations, educational and governmental institutions, and anthropologists/sociologists, we can trace a few major approaches to undo-ing inequities for women in audio. Notable non-profit organizations have been working towards creating equal access to audio production skills, technological education, and jobs for women. Others have focused primarily on making visible the work women are already contributing and is rendered inaccessible and invisible within the fields of audio research, production, education, and the arts.

4.1 Non-profit Developments

WAM (Women's Audio Mission), a non-profit 501-3c organization based in San Francisco, has provided education and training for women and girls who want to learn audio production since 1985. They believe that through participatory efforts, the face of sound will shift to be more representative of the women involved. Their programs include WAM Workshops and Events, which provide free and low-cost training in the recording arts and audio technology, and WAM Studio, which delivers affordable recording and live sound services to independent artists while providing career counseling and job placement services for women pursuing careers in audio and digital media. WAM also sponsors a Youth program, for young women interested in audio engineering and production, reaching over 600 middle school and high school girls/year [27].

The *International Alliance for Women in Music (IAWM)* is a global network of women and men working to increase and enhance musical activities and opportunities and to promote women's music. The IAWM builds awareness of women's contributions to musical life through publications, website, free listserv, international competitions for researchers and composers, conferences, and congresses, concerts, the entrepreneurial efforts of its members, and advocacy work [30]. *Women in music* is another non-profit organization in New York City that focuses on careers for women in music and audio industries through increased awareness, equality, diversity, heritage, resources, support, empowerment, networking and recognition [28].

4.2 Government Efforts

On the U.S. Federal government level, the Excellence in Science, Technology, Engineering & Math (STEM) Education Initiative in collaboration with the White House council on Women and Girls, is dedicated to increasing the participation of women and girls — as well as other underrepresented groups — in the fields of science, technology, engineering, and mathematics. Efforts have involved the engagement of girls with STEM subjects in formal and informal environments, encouraging mentoring to support women throughout their academic and professional experiences, and supporting efforts to retain women in the STEM workforce" [26]. In 2009, President Obama's "Educate to Innovate" Campaign for the STEM Initiative included the observation of *Women's Audio Mission* facilities to pinpoint the best creative methodologies for programming and assessment in educating young girls.

5 Discussion

As sexism still runs rampant in any field, much of the problem stems from social and cultural normalization of power dynamics and gender roles. Women's path in audio is designed to be much more convoluted. Rather than simply being able to pursue their music or audio career, it becomes complicated by subtle and sometimes obvious external barricades. The term "gender negotiation" has been coined to describe the sort of emotional and social monitoring women have to perform in male-dominated environments to gain respect. Balancing, mediating, and remaining strongly diplomatic are behaviors women have found to help avoid conflict and be taken seriously [17]. Interactions with men, the formation of what people refer to as "bro" culture, "mansplaining", constant questioning by male co-workers and professors of their skill and ability, unequal treatment in the educational process, unapproachable male-dominated environments in which women are unacknowledged and talked over, sexism and sexual assault are all accepted facets of audio culture.

When women walk into a store to buy an audio device, they are pinned as "the girlfriend" or "the vocalist" [22]. When they are experienced in their career as an engineer or producer, they are questioned multiple times. When they speak about their professional research, they get talked over by male peers [21]. And when a woman can actually do her job without distraction, much of the popular audio content is sexist and much of the money made from music is due to women's sexuality, her brands and not her musical achievements. Women film composers, editors, producers, engineers are rarely visible or credited.

In such a technological society, it is dire that we move past traditional nature/nurture debates, trying to find justifications that women are just not simply as interested or skilled in audio, and instead, focus on achieving an anthropological awareness of the challenges women face in a daily work and social settings that limit their development in the field. By analyzing existing environments and social relations surrounding audio, we are able to create new, safe ones. The formation of education that promotes anti-sexist, feminist-minded education to daily interactions

as to dismantle sexism and the power structures that fundamentally create the unequal treatment are gaining momentum.

5.1 Moving Forward

> "But now I wonder if it will take more than simply encouraging women to get involved in audio, to be comfortable with the gear and confident in the studio. I wonder if the root of the problem is in how we raise women and men. In the constant judgment and criticality we place upon women's bodies, women's work, women's potential. For once, may we not tell women that they need to change their behavior, rather boys, men, institutions, society need to become aware that women are still not guaranteed equal rights in this country. Even if we tell our girls that "they can do anything", this sentiment means nothing if the reality outside of them does not adjust. So, as pertinent organizations like this are working hard to create new, safe spaces for women in audio, I think it is just as important to work on those that already exist. And that begins in feminist-minded philosophy becoming an integral part of education and recognized in our own interpersonal interactions."
>
> –Women in Sound, Women on Sound

It has been argued that simply having girls interact more with technology will not solve the socialization issues around it. Linda Braskin, a feminist educator, suggests that by taking an "antisexist" approach to audio education, that identifies the social reality and various relationships people have to technology based on race, class, gender, sexual orientation, etc., current patterns in the classroom and studio will be less perpetuated [19].

Anthropologist's Margaret Rodman's multilocality framework for looking at "place" illustrates that the technology itself or the interest in technical subjects does not differ much between girls and boys, rather, it is the connections we have to our environment and the groups that form within it that dictate how we mediate and interact with it [18] Based on a study done in a classroom in Toronto, Canada with various audio stations from Recording, to Composition, to Sequencing, etc. where girls and boys could play out different roles in audio production, the girls favored Recording the most and the boys Composition. While approaching these stations individually and in a group, interaction with the technology and styles of negotiation differed, and though various conclusions could be made about some sort of general gendered preference, it became clear that much of the preferences were based on sense of well being and social relations in certain locations in the classroom [18]. For years, the conversation has harped on women tending toward the social over the technical, but this simply needs to be dismantled. It is just that in certain circumstances, women tend to have a more socially diplomatic approach to negotiation, whilst in other circumstances they prefer to work independently. If one's environment is telling one to be quiet, to speak and be judged, or to be looked at as prey, then why would one make an effort to engage in said environment? We must embrace the idea that genders are also not fixed categories to make assumptions about as they exist with multiple relations in dynamic contexts [18].

To make spaces safer for women, we must acknowledge sexist behavior in daily settings and hold institutions more accountable. Many men, and women will not admit that sexism exists, and do not realize its subtle damage [20]. Instead of women accepting unequal treatment, perhaps Human Resources managers can devise plans to encourage women to speak up. Perhaps companies, just as they have

workshops on diversity and various topics, would have workshops on equality in the workplace. Perhaps production studios could enforce anti-harassment policies, rather than propelling existing practices. The stigma against feminism must disintegrate with the realization that women's bodies and careers are on the line every day. If we truly want equal opportunities and treatment for women, feminism as both philosophy and practice needs to be embraced in this country's education systems, governmental and economic policy, and work environments. Then women will be enabled to spend less time thinking about their gender and more time creating and being respected for their actual work in audio.

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