DEMOCRATIZING ACCESS AND IDENTIFYING INEQUALITIES: GENDER, TECHNOLOGY, ARCHITECTURE

Shelby Doyle, AIA[1], Nick Senske[1]
[1]Iowa State University, Ames, Iowa

ABSTRACT: While technology has rapidly become more accessible to more people, its benefits are not always evenly shared. This paper searches for methods of identifying and defining gender inequality in architecture as it relates to digital technology and computation. The authors begin by documenting and then questioning existing metrics for measuring women's participation in architecture, then look outside the field to STEM disciplines, educational research, and economic theory as means of framing this research agenda. By examining and critiquing current patterns of technological distribution and academic culture, the authors seek to foster greater equality in education, architecture, and, consequently, the built environment.

KEYWORDS: computation, education, equality, methods

"The future is already here, it's just not very evenly distributed."
-attributed to William Gibson (See References)

INTRODUCTION

While many believe that technology is a way to create equality and provide opportunities, in practice this is not always the case (Servon, 2008). Particularly in architecture, access to technology and knowledge about technology continues to be unevenly distributed, which can result in the perpetuation and intensification of existing inequalities. Technology is a broad term but used here to indicate those digital technologies specific to architecture. While many types of inequality exist with respect to technology and architecture, such as race and class, this paper will focus on the issue of gender inequality. As technology is now essential to the practice and discipline of architecture, the ability to create with and shape technology is critical. This paper highlights the issue of gender inequality with respect to technology in architecture. It identifies the existing research gaps and argues that architectural education, in its role of affecting disciplinary culture, is essential to advancing technological equality. What follows is the beginning of a research agenda rather than its culmination.

WHO COUNTS?

Architecture as a discipline has been slow to fully acknowledge, incorporate, and integrate women into architectural practice and discourse. These past and present inequalities appear to be at work in the under-representation of women in technology. However, acknowledging the scope of the issue is difficult because, presently, specific data are not being collected about technology and gender in practice or in academia. To successfully argue for gender equality, detailed and accurate statistics are needed to move beyond anecdotal evidence. The current understanding of gender in architecture remains limited, as does our understanding of how women access and influence technology. One reason for this is the challenge of determining whom to study and how to measure. With regards to technology, how should participation be defined? As Matthewson writes, "It is easy to slip into anecdote and colloquial understandings of gender discrimination in architecture and much more difficult to parse out 'who counts'" (Matthewson, 2014).

While architecture now recognizes its problems with gender equity, accurately measuring the nuances of women's participation has remained elusive. The question of who is an architect is more complicated than it might first appear. For example, in 2013, 43% of students enrolled in NAAB-accredited architecture programs were female; 45% of architecture graduates were female (Chang, 2014). NCARB's "By the Numbers" report indicates that 42% of 'record holders' are women (NCARB, 2016), indicating an intention to pursue licensure, while the number of licensed women hovers around 18% in 2016 up from 9% in 2000 (Business of Architecture, 2012), but still far from parity as indicated by the 'The Missing 32% Project' (Dickinson, 2017). These numbers seem to indicate a dramatic loss of women in architecture, post-graduation, and low representation in the workforce, but there are other factors to consider. Architecture is more than the profession and those who strictly practice within the profession. NCARB numbers exclude university instructors, urban designers, writers and critics, and many others who identify as architects (Matthewson, 2014). In order to better understand the true state of gender inequality, more data from more sources is needed.

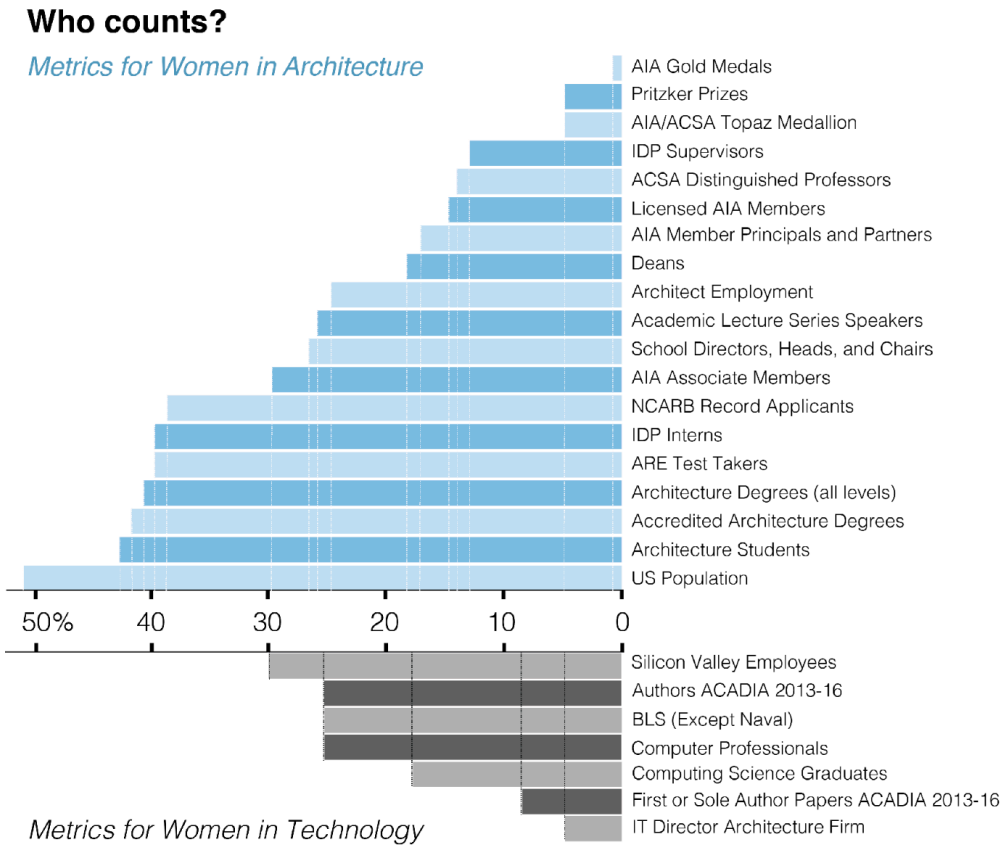

Figure 1: Adapted by authors from the ACSA article 'Where are the Women?' (Chang, 2014). Additional references are within the text. This is not a complete list of metrics but rather an effort to establish those metrics available to measure women in technology as it relates to architecture.

While, anecdotally, there seem to be fewer women than men in architecture, exactly how few is difficult to say with certainty. Data about graduation rates and licensure are an incomplete representation of the discipline. At higher levels of achievement, the gender gap becomes even more stark (Fig. 1). At AIA firms, just 17% of principals and partners are women (Hurley, 2017). The percentages of women awarded the Pritzker Prize for Architecture and the Topaz Medallion for architectural education is even lower: both 5% (Chang, 2014). These numbers indicate further inequality in the influence and recognition of women, which is disproportionate to their representation. Counting women is an important step in acknowledging and reducing inequality, but as a methodology, it has its problems and its limits. There are lessons to be learned and further questions to be asked.

MEASURING PARTICIPATION IN TECHNOLOGY

In Science Technology Engineering & Mathematics (STEM) disciplines gender inequality is a recognized and quantified problem. Data from STEM is relevant to the discussion about women's participation in architectural technology for two reasons. First, the field of computing bears many similarities to the ways that technology is used in architecture. Developing and modifying computational software and systems for design has many parallels in computer science research and practices. Indeed, some of the training (learning programming, etc.) is the same. Second, there is significant data collected by computing academics and professionals on the issue of gender diversity as well as research into how to address the problem.

According to the STEM data, women are significantly underrepresented in computing. Women currently earn only 18% of all Computer Science degrees (AAUW Report, 2013). Indeed, it is the only STEM major to report declining representation of women over the last decade. This gender gap extends to academia and industry where research has found that 70% of authors on published technology papers are men (Macaluso, 2016). A 2013 report found that just 26% of computing professionals were women -- a percentage which is about the same as it was in 1960(AAUW Report, 2013). Collection of this data has been an important step in helping to highlight and address this issue, though it has not led to gender parity in STEM.

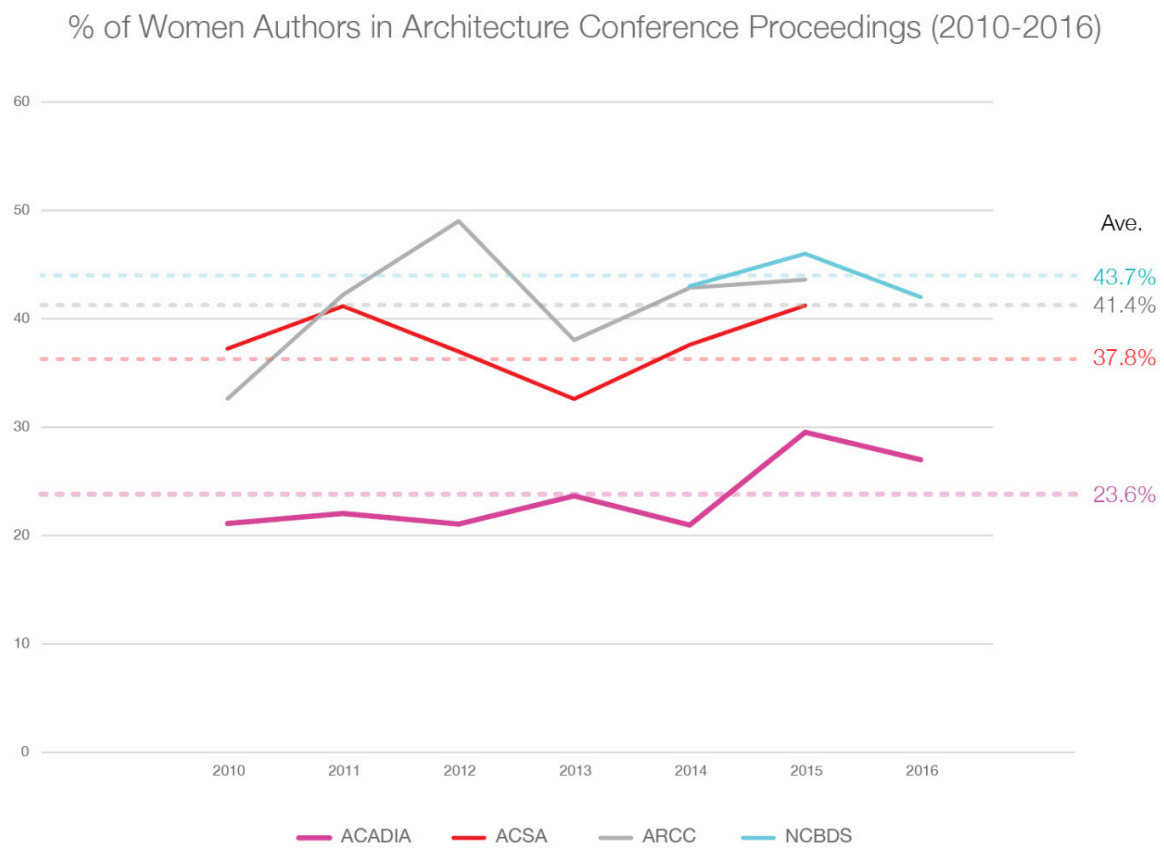

Figure 2: The above graph indicates the number of papers authored or co-authored by women in a selection of popular architecture conferences. Gender was identified by the pronouns used in author biographies. ACADIA has approximately 20% fewer women co-authoring papers than ARCC or NCBDS. This percentage has changed very little during the last decade. Data collection and graph by authors.

While STEM fields recognize a gender gap in their enrollment and workforce, architecture has yet to acknowledge that its gender equity problem also extends to those who engage with technology. A reason for this could be that there is no data which proves that such a gap exists; it remains an anecdotal circumstance. One metric that does exist is the representation of women in technology publications in architecture (Fig. 2). The authors' study of Association for Computer Aided Design in Architecture (ACADIA) papers from 2010-16 found that 26% of authors were women. (This percentage is strikingly similar to that of STEM computing fields and professionals.) Only 8% of papers had women as the first or sole author. Gender participation in technology is not typically measured within institutions. However, a brief study of the authors' own department over the past year (2015-2016) found that, while 49% of architecture students are women, on average, they comprise only 19% of the students attending digital technology and computation electives. While the number of women participating in architecture is not at parity, the number of women participating in technology in architecture appears to be lower still.

Unfortunately, architecture does not yet measure participation in technology. This is a challenge of legitimate scholarship; the problem must be clearly named and defined (Boyer, 1990). While many have anecdotes about the use of technology by women in the practice of architecture, at the moment it is difficult to produce the empirical evidence necessary to study and address inequality. Moving forward, we propose that better measurement is needed and that data collection efforts from STEM fields could serve as a model. In this case, we are using technology as a proxy for power in the architectural discipline and, by measuring technology use, aim to better understand the grain of women's participation in developing technologies (Denardis, 2017).

GENDER GAP

Why does a technology gender gap exist? Research in STEM fields has identified several possible causes which may parallel those in design. These causes may have been inherited by architecture in the transfer of knowledge and technique. In a speech given at the Grace Hopper Celebration of Women in Computing Conference, Susan Wojcicki (CEO of YouTube), proposed two possible reasons women choose not to study computing: they think it is boring and they do not think they would perform well at it (Wojcicki, 2016). From the outside, working with technology can

seem unexciting. Because they lack access to mentoring, clubs, courses, etc. many young women have not had the opportunity to learn firsthand how technology can be creative and empowering. Women who are exposed to technology in K-12 education are much more likely to participate in STEM (Rogers, 2013). The second reason, concern about performance, may be caused by 'stereotype threat,' which is when an individual fears that they will confirm a stereotype about a group to which they belong. This has been shown to affect performance and to impact decisions. In this manner, negative stereotypes about women's performance in math and science are thought to be a factor in the inequality found in computing fields (Corbett, 2015).

There is no evidence that women are less capable users or creators of technology. To the contrary, data shows that women have the qualifications and test scores to join STEM-related subjects and perform well when they do (Fisher, 2002). Furthermore, history is filled with great pioneers of computing such as Ada Lovelace, Joan Clark, and Margaret Hamilton who demonstrate women's capabilities in the field. Ability is not the deciding factor. Many women choose not to study technology because they find its values to be insular and antisocial. They do not feel that a career in computing will allow them to collaborate with other people or make things which create social good (Mossberger, 2007). Another aspect of this is the male-centered gamer culture of today that emerged out of early personal computing, which can appear inaccessible to women 'outsiders' (Fisher, 2002). As Wojcicki explains, when it comes to technology, many women today feel that they do not belong, and because of this, they do not want to belong. The problems discouraging women from participating in technology are cultural and institutional. Education, which has traditionally held the power to shape culture and produce equality, is part of the solution.

WHY DOES IT MATTER?

The gender gap in technology is harmful not only to women, but to everyone. Women often see themselves as consumers of technology, rather than its creators. This has consequences in architecture, when being left behind in technology can limit one's participation in the design process (Williams, 2014). The importance of gender diversity in architecture is more than fairness or opportunity (although these are critically important, as well). When women are underrepresented, there is a risk of their needs being overlooked as design decisions are based upon the experience and opinions of only men. In the past, this has resulted in costly problems such as voice-recognition systems that do not recognize women's voices because they were calibrated for male voices (McMillan, 2011). However, the potential impact of under representation is more than mere inconvenience. Early airbags resulted in the deaths of women and children because they were not considered as end-users (Why Carmakers Always Insisted on Male Crash-Test Dummies, 2012). The stakes for democratizing access are high. Thus, inequality in digital design education has far reaching implications for the discipline.

DOES TECHNOLOGY HAVE A GENDER?

Although progress has been made to measure the participation of women in the architectural profession, as a subset of architecture, technology has been categorically overlooked in studies on gender equity. While research in documenting gender disparity often champions progressive ideas of who can be 'an architect', organizations such as Equity by Design [EQxD] (Equity in Architecture, 2011), Parlour (see References), and Architexx (see References) tend to overlook the professional presence of technology in favor of more conventional metrics: degrees, licensure, salaries, and awards. This conservative definition is likely because technology is often seen as infrastructure rather than integral and defining and measuring the users and influence of digital technology is a complex and difficult task. However, because digital technology is so important to the future practice of architecture, reflecting upon its current state (and possible role in promoting) gender inequality within the discipline must be critically examined.

One could argue that the low numbers of women specializing in digital design technology is unsurprising given that the practice combines fields that have historically been lacking in gender equity: management, information technology, computer science, engineering, and architecture (Davis, 2016). However, the importance of this gap in today's technologists cannot be understated. Historically, a technologist in an architecture firm played an auxiliary role, limited to maintaining computers and equipment. Concurrently, technology courses in architecture schools are often relegated to specialized electives rather than integrated into design courses. Today, as computers have become essential to the processes that define contemporary practice, the role of the design technologist has also become central to architectural means, methods, and concepts.

"Computer-aided design is about creativity, but also about jurisdiction, about who controls the design process," says Yanni Loukissas, a researcher who has studied the adoption of technology by architecture firms (Davis, 2016). At the moment, control over computer aided design – who develops the tools and who administrates them within the profession – rests overwhelmingly with men. This creates a condition where inequalities can become institutionalized, even as other aspects of the profession become more diverse. As Lieberson wrote, dominant groups remain privileged because they write the rules, and the rules they write, "enable them to continue to the write the rules" (Lieberson, 1985). As a result, they can change the rules to thwart challenges to their position. While technology presents an opportunity for women to challenge stereotypes and privileges, it is also a site of gender imbalance within the profession:

consequently, the implementation of technology is not general neutral.

The design, distribution, use, and education of technology can either challenge or reinforce existing gender structures. Now that technology dominates the design process, the technologist – he or she – defines how the profession works and who works within it. The promise of technology as a medium is that it can allow an individual to be empowered in ways that are not pre-ordained by an institution – the state, the university, the discipline – and as such creates space for a multiplicity of voices to resonate within architectural discourse (Tapscott, 2008). How inequality is defined plays an important role in how an institution, such as the university, can work to undo that inequality.

DIGITAL DIVIDE + INHERITING BIAS

This research also looks to economic theory as one way to define inequality and the accompanying concept of redistribution as a means of addressing it. Economic inequality serves as a proxy for technologic inequality as a means for bringing this discourse into architecture where there is currently little theory to rely upon. Economic inequality is relevant to notions of equity, equality of outcome, and equality of opportunity (Fletcher, 2013). This definition stems from Thomas Piketty's *The Economics of Inequality* (Piketty, 2015). The notion of inequality implies the concurrence of redistribution through institutions - economic, political, or social mechanisms. In the case of digital technologies, education and specifically the university, is the system of redistribution. Piketty's work on schools, for example, postulates that disparities among different schools, especially class sizes, is a cause for the persistence of inequalities in wages and the economy (Piketty and Valdenaire, 2005). Additionally, digital technologies are uniquely positioned to disrupt the very systems which are imposing the original inequalities. Indeed, there exists a certain consensus in regard to fundamental principles of social justice: if inequality is due, at least in part, to factors beyond the control of individuals, such as inequality of initial endowments owing to inheritance or luck, (that which cannot be attributed to individual effort), then it is just for the state (or university) to seek in the most efficient way possible to improve the lot of the least well off (that is, of those who have had to contend with the most adverse factors). In this case, the 'university' functions in lieu of 'the state' as an institution which redistributes knowledge.

The redistribution of digital knowledge is particularly fraught as it has so little context upon which to rely. Nicholas Negroponte, founder of the MIT Media Lab writes that 'a man-machine dialogue has no history' Therein lies the myth of the new unburdened language of technology: technology may promise new equalities but instead is recreating existing hierarchies (Negroponte, p. 79). It is therefore disconcerting to observe much of the architectural discourse around the computerization and software-driven design ignoring these dialogues. As Sanford Kwinter writes in The Computational Fallacy:

> *"These developments are either extolled as 'exciting', 'new' and 'full of new freedoms and possibilities' (by those most blissfully unconcerned of what is being so celebrated is but an extension of all that is oldest and most repressive in our political and corporeal history), or these are seen a posing an unavoidable or even welcome challenge to an already weakened or near-obsolete domain of cultural practice, namely the slow, grave, viscous world of matter. (Kwinter, 2003)"*

Kwinter's charge returns this discourse to the question of ethics: what is architectural technology, who defines it, who teaches it, and who disseminates it? If the internet can be used as a proxy for other technologies, then there is much to learned by aligning this work with architecture. The rise of the Information Society has come with the promise of altering the way society works and in doing so has produced deeply opposed ideas about the future of our collective and individual relationship to technology. Optimists assert that the Internet has the capacity to reduce inequalities between the information-rich and –poor. Pessimists expect that digital technologies will fortify and intensify existing disparities (Norris, 2001).

One of the reasons discussions about technology inspire highly contested images of the future is the that new technology might act a 'great leveler' by restructuring the dissemination of knowledge and communication (Norris, p. 237). These are questions which disrupt the very existence of the university as the mediator of knowledge. As the Internet and digital technologies have become increasingly embedded in nearly every aspect of daily life it becomes more important to establish how and whether certain groups are excluded from this resource: "whether poorer neighborhoods and peripheral rural areas, the older generation, girls and women, ethnic minorities, and those lacking college education" (Norris, p. 245). Specifically, how are these technological exclusions occurring in architecture?

CONCLUSION

The 'digital' has a relatively short history in architecture when compared to the previous two thousand years of architectural education models (this assumes Vitrivius' Ten Books of Architecture (100 BC) to be the beginning of architectural educationa and discourse). If we accept Mario Carpo's dating of the digital turn around 1992 then there are barely twenty-five years of pedagogy and practice from which to mine for information. Therefore, it is necessary to look outside the discipline for questions of how to describe and address the digital divide (Carpo, 2012).

Defining technological exclusions in architecture, providing theoretical rigor and context, then proposing methods for redistributing technical literacy are the goals of this research agenda. The text here does not endeavor to produce solutions but rather searches for ways to create and position the discourse necessary to ask the right questions. Architecture's disciplinary struggle for the ideal of equity – class, race, gender – is innately tied to contemporary social, political, and economic milieus. The promise of technology as a medium is that it can allow an individual to be empowered in ways that are not pre-ordained by an institution – the state, the university, the discipline – and as such creates space for a multiplicity of voices to resonate within architectural discourse. In this case, the university is presented as the actor necessary to redefine, redistribute, and rethink technological literacy in pursuit of a more just built environment. The next digital turn, defined by inclusiveness and equity, begins here.

REFERENCES

William Gibson Quote: "The future is already here. It's just not evenly distributed yet" — this quote is often attributed to Gibson, but scholars disagree on whether he is the original source. http://www.nytimes.com/2012/01/15/books/review/distrust-that-particular-flavor-by-william-gibson-book-review.html Accessed January 2017.

AAUW Report 2013. Solving the Equation: The Variables for Women's Success in Engineering and Computing. Retrieved on February 4, 2017 from http://www.aauw.org/research/solving-the-equation/

ARCHITEXX is an independent, unaffiliated organization for women in architecture that seeks to transform the profession of architecture by BRIDGING THE ACADEMY AND PRACTICE. We are a cross-generational group of academics and practitioners. http://architexx.org/

Boyer, Ernest. (1990). Scholarship Reconsidered: Priorities of the Professoriate. The Carnegie Foundation for the Advancement of Teaching.

Carpo, M. (2012). The Digital Turn in Architecture 1992-2012. Chichester, England: Wiley.

Chang, L. C. (2014). Where Are the Women? Measuring Progress on Gender in Architecture. Association of Collegiate Schools of Architecture. Retrieved February 01, 2017, from http://www.acsa-arch.org/resources/data-resources/women

Corbett, C., & Hill, C. (2015). Solving the Equation: the variables for women's success in engineering and computing. The American Association of University Women.

Denardis, Laura. Internet Architecture as Proxy for State Power. Retrieved February 4, 2017 from https://www.cigionline.org/articles/internet-architecture-proxy-state-power

Dickinson, Elizabeth Evitts. The Missing 32% Project Survey Results Reveal Gender Inequity in Architecture. Now What? Architect Magazine. Retrieved February 04, 2017 from http://www.architectmagazine.com/practice/the-missing-32-project-survey-results-reveal-gender-inequity-in-architecture-now-what_o

Equity in Architecture: Metrics, Meaning & Matrices http://eqxdesign.com/ The Missing 32 percent resulted from an incubator event conceived and produced in 2011 by the AIA SF Communications Committee. In turn, "Ladies (and Gents) Who Lunch with Architect Barbie" was inspired by a partnership between AIA National and Mattel on "Architect Barbie" whose place on the toy manufacturer's line-up was insured by Despina Stratigakos and her colleague, architect Kelly Hayes McAlonie. At the event, fellow practitioners Dr. Ila Berman, Cathy Simon FAIA, Anne M. Torney AIA, and EB Min AIA joined for a lively panel discussion on the state of women's participation in the profession, including the impact of "Architect Barbie".

Fisher, A., & Margolis, J. (2002). Unlocking the Clubhouse: the Carnegie Mellon experience. ACM SIGCSE Bulletin, 34(2), 79-83.

Fletcher, Michael A. (March 10, 2013). "Research ties economic inequality to gap in life expectancy". Washington Post. Retrieved March 23, 2013.

Hurley, Amanda Kolson Would There Be More Women Architects If There Were More Women Developers? Retrieved February 4, 2017 from http://www.architectmagazine.com/design/would-there-be-more-women-architects-if-there-were-more-women-developers_o

Kwinter, Sanford. “The computational fallacy.” Thresholds (2003): 90-92.

Lieberson, Stanley. Making it Count: The Improvement of Social Research and Theory, 1985.

Macaluso, B., Larivière, V., Sugimoto, T., & Sugimoto, C. R. (2016). Is Science Built on the Shoulders of Women? A Study of Gender Differences in Contributorship. Academic Medicine, 91(8), 1136-1142.

Matthewson, G. (2014). Counting Women in Architecture. Or: Who counts?. Architecture Australia, 103(5), 55.

McMillan, Graeme. It’s Not You, It’s It: Voice Recognition Doesn’t Recognize Women. Retrieved on February 4, 2017 from http://techland.time.com/2011/06/01/its-not-you-its-it-voice-recognition-doesnt-recognize-women/

Mossberger, K., Tolbert, C. J., & McNeal, R. S. (2007). Digital Citizenship: The Internet, Society, and Participation. MIT Press.

NCARB By the Numbers Report 2016. Retrieved February 4, 2017 from http://www.ncarb.org/Publications/~/media/Files/PDF/Special-Paper/2016-NBTN.pdf

Negroponte, Nicholas. Toward a Humanism Through Machines p 79.

Norris, Pippa. Digital Divide: Civic Engagement, Information Poverty, and the Internet Worldwide Pippa Norris, Harvard 2001. Page 234

PARLOUR: Women Equity Architecture http://archiparlour.org/ PARLOUR: a space to speak – bringing together research, informed opinion and resources; generating debate and discussion; expanding the spaces for women in Australian architecture.

Piketty, Thomas. The Economics of Inequality. The Belknap Press of Harvard University Press, 2015.

Piketty, Thomas and M. Valdenaire, L’impact de la taille des classes sur la réussite scolaire dans les écoles, collèges et lycées français – Estimations à partir du panel primaire 1997 et du panel secondaire 1995, Ministère de l’éducation nationale, 2006.
Rogers, Megan. Why Students Study STEM. Retrieved February 4, 2017 from https://www.insidehighered.com/news/2013/10/01/study-finds-math-and-science-exposure-has-significant-impact-intent-study-stem

Servon, L. J. (2008). Bridging the Digital Divide: Technology, community and public policy. John Wiley & Sons.

The Business of Architecture: 2012 AIA Survey Report on Firm Characteristics, Copyright 2012, The American Institute of Architects http://nbtn.ncarb.org/demographics

Why Carmakers Always Insisted on Male Crash-Test Dummies. Retrieved February 4, 2017 from https://www.bloomberg.com/view/articles/2012-08-22/why-carmakers-always-insisted-on-male-crash-test-dummies

Williams, G. (2014). Are You Sure Your Software is Gender-Neutral?. interactions, 21(1), 36-39.

Wojcicki, S. (2016). Closing the Tech Industry Gender Gap. Retrieved February 05, 2017, from http://www.huffingtonpost.com/susan-wojcicki/tech-industry-gender-gap_b_9089472.html