

Gendered Innovations: Harnessing the Creative Power of Gender Analysis

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Gender analysis is nothing new. Researchers are always looking for data that uncovers the differences in gender roles, needs, activities and opportunities. In an attempt to improve gender equality over the past several decades, governments, universities, and, increasingly, corporations in the U.S. and Western Europe have taken three strategic approaches:

1. **“Fix the Numbers of Women”** focuses on increasing the numbers of women participating in science and engineering. At this level, the National Science Foundation (NSF) implemented programs beginning in the 1980s aimed at jump-starting women’s careers by increasing funding to women’s research, teaching women how to negotiate for salary, setting up mentor networks and the like.
2. **“Fix the Institutions”** promotes gender equality in careers through structural change in research organizations. We might date this to the NSF’s 2001 ADVANCE program. This program supported institutions with large grants for five-year periods to implement deep and enduring reforms designed to overcome unconscious gender bias in hiring and promotion, support dual-career academic couples, promote work/life balance with programs to stop the tenure clock and the like.
3. **“Fix the Knowledge”** or “gendered innovations” stimulates excellence in science and technology by integrating sex and gender analysis into research. Gendered innovations (genderedinnovations.stanford.edu) harness the creative power of sex and gender analysis for innovation and discovery. This is the newest area of policy intervention and the most important for the future of science, engineering and innovation. The European Commission, a global leader in this area, called explicitly for sex and gender analysis in public-funded research in its Horizon 2020 funding framework in 2014.

Why are sex and gender analysis important? Doing research wrong costs lives and money. According to the U.S. General Accounting Office, between 1997 and 2000, ten drugs were withdrawn from the U.S. market because of life-threatening health effects. Eight of these posed greater health risks for women than for men. Not only does developing a drug in the current market cost billions—but when drugs failed, they caused human suffering and death.

Doing research right has the potential to save lives and money. A 2014 analysis of the U.S. Women’s Health Initiative Hormone Therapy Trial by Roth et al., for example, found that for every \$1 spent, \$140 were returned. The study also saved lives, adding 145,000 more quality-adjusted life years.

Why Does Gender Matter?

Once you start looking, you find that understanding sex and gender differ-

Sex and Gender Analysis

Enhances all phases of research

Sex and Gender Analysis

Setting Research Priorities

Making Funding Decisions

Establishing Project Objectives

Developing Methodologies

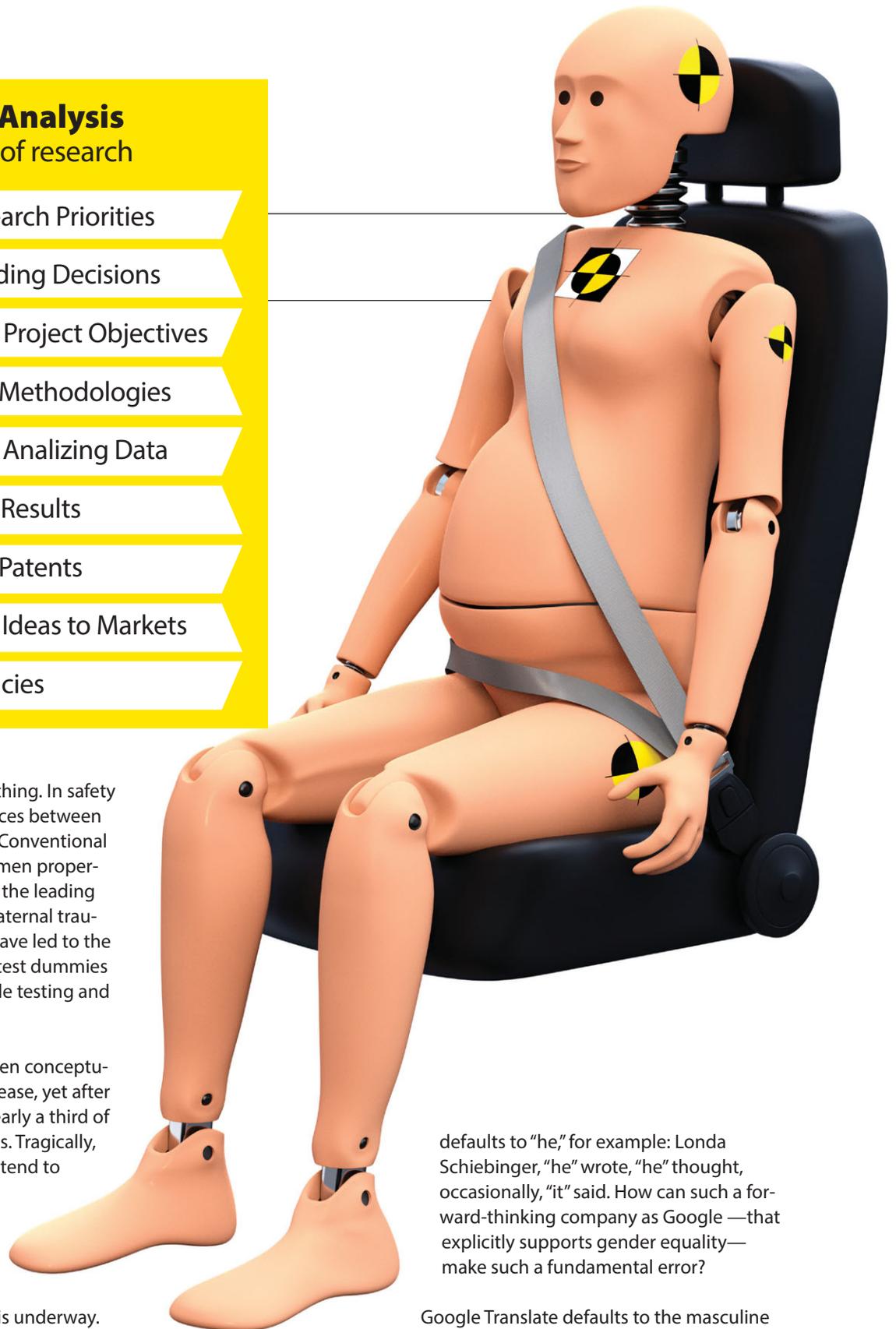
Gathering & Analyzing Data

Evaluating Results

Developing Patents

Transferring Ideas to Markets

Drafting Policies



ences can improve almost everything. In safety engineering, ergonomic differences between men and women are important. Conventional seatbelts do not fit pregnant women properly, and motor vehicle crashes are the leading cause of fetal death related to maternal trauma. Analyses of sex differences have led to the development of pregnant crash test dummies that enhance safety in automobile testing and design.

In medicine, osteoporosis has been conceptualized primarily as a women's disease, yet after a certain age men account for nearly a third of osteoporosis-related hip fractures. Tragically, when men break their hips, they tend to die. We don't know why. Analyzing the interaction between sex and gender in osteoporosis research has developed new diagnostics for men, and the search for better treatments is underway.

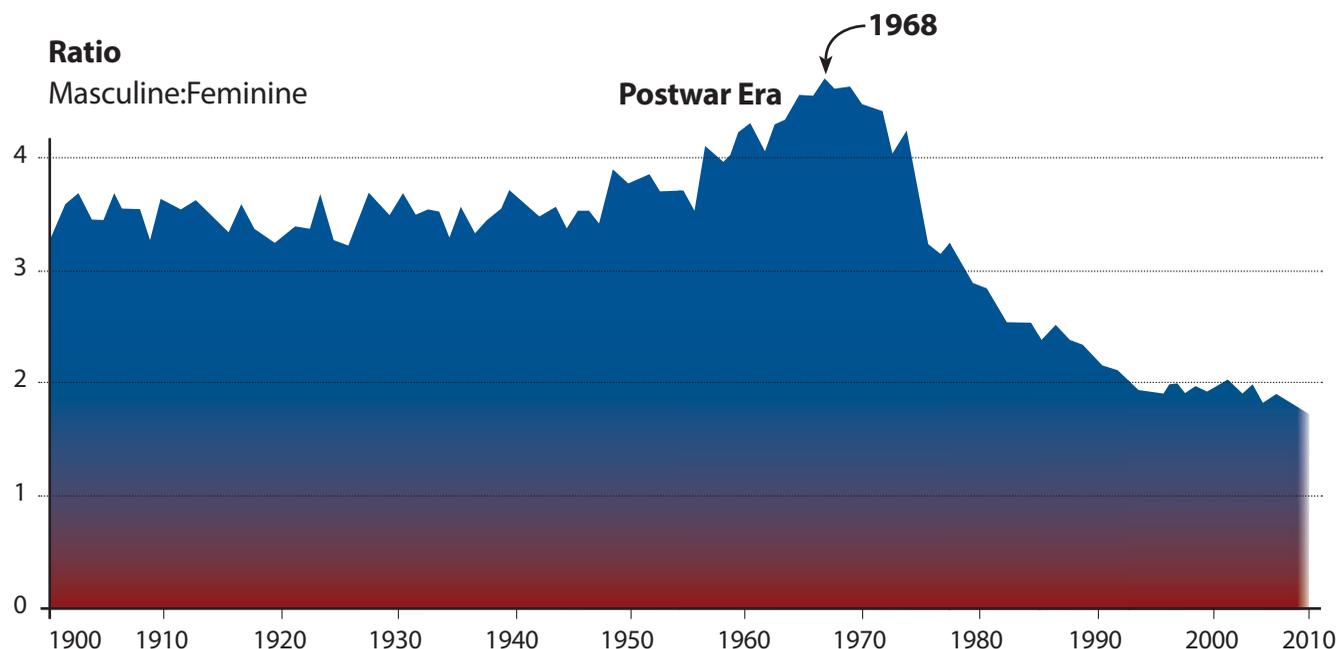
Let's take another example where gender analysis has a potential for innovation in machine learning, natural language processing and algorithms. Ever use Google Translate? What if you are a woman and the article is about you? The machine

defaults to "he," for example: Londa Schiebinger, "he" wrote, "he" thought, occasionally, "it" said. How can such a forward-thinking company as Google—that explicitly supports gender equality—make such a fundamental error?

Google Translate defaults to the masculine pronoun because "he said" is more commonly found on the web than "she said." This is where gender analysis kicks in. We know from NGram (another Google product) that the ratio of "he said" to "she said" has fallen dramatically from a peak of 4:1 in the 1960s to 2:1 since 2000. This exactly parallels

Ratio of Masculine to Feminine Pronouns in U.S. Books, 1900-2008

Changes parallel increases in women's labor force participation, education, age at first marriage, etc.



The ratio of masculine pronouns ("he," "him," "his," "himself") to feminine pronouns ("she," "her," "hers," "herself") peaked at over 4:1 in 1968. By 2000 the ratio dropped dramatically to 2:1 (Twenge et al., 2012).

Data from American English corpus of the Google Books database (~1.2 million books). Reproduced from Twenge et al., 2012

the women's movement and robust governmental funding to increase the numbers of women in science. With one algorithm, Google wiped out 40 years of revolution in language and they didn't mean to. This is unconscious gender bias.

Finding the Fix

The fix? A couple of years ago the Gendered Innovations project held a workshop where we invited two natural language processing experts, one from Stanford University and one from Google. They listened for about 20 minutes, they got it, and they said, "we can fix that!"

Fixing it is great, but constantly retrofitting for women is not the best road forward. What if Google, Apple, Microsoft and other companies started product development research by incorporating gender analysis? What innovative new technologies, software and systems could be conceived?

Unconscious gender bias from the past amplifies gender inequality in the future. When trained on historical data (as Google Translate is), the system inherits bias. It turns out that even though Google wanted to fix the problem, they have been unable to. One lab at Stanford worked on this problem for a year before giving up. It's often harder to fix something once the basic platform is set. Importantly, Google Translate is creating the future (technology, i.e., our devices, programs and processes that shape human attitudes, behaviors and culture). The masculine default in Google Translate reverses the cultural trend toward gender inclusive language. Google reinforced aspects of gender inequality when it did not intend to.

In other words, if we don't consider sex or gender analysis, past bias may be perpetuated into the future, even when governments, universities and companies themselves have

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implemented policies to foster equality. So the big question is: how can humans automate processes that also contribute to creating a fair and equal society?

Important gendered innovations are in progress here. Computer scientists are attempting to create mathematically rigorous definitions of fairness in order to develop and optimize algorithms that guarantee fairness. Such projects are Defining Fairness: On the Sociotechnical Algorithms and Systems of the Future headed up by theoretical computer scientist Cynthia Dwork at Harvard University, and the Fairness, Accountability, and Transparency in Machine Learning workshop at Carnegie Mellon University. Another project focused on race is headed up by Latanya Sweeney, director of Harvard's Data Privacy Lab and funded by the Ford Foundation. Yet another focused on age is headed up by Alvaro Bedova, director of the Center on Privacy and Technology at Georgetown University. These multidisciplinary teams are investigating how notions of fairness can be incorporated into the design of algorithms for classification and decision making. In other words, the goal is to design algorithms that optimize fairness.

What's to Be Done?

Sex and gender analysis is important to consider in assistive technology for the elderly, nutrigenomics, stem cell research and the design of public transportation—in the many areas of research with human outcomes. Funding agencies are encouraging researchers by asking for these elements in grant proposals. Since 2008, the Bill and Melinda Gates Foundation has required gender analysis in its agricultural research. In 2010, the Canadian Institutes of Health Research required investigators to consider sex and gender analysis in publicly-funded research. In December 2013, the European Commission designated 137 funding subfields where data showed that gender analysis could benefit research—these range from computer hardware and architecture to nanotechnology, oceanography, geosciences, organic chemistry, aeronautics, space medicine, biodiversity, ecology and biophysics, among others. In January 2015, the National Institutes of Health rolled out new policies for sex inclusion in research on

cells, tissues and animals. Sex and gender may add a valuable dimension to research and take research in new directions, creating new knowledge and areas of research.

Corporations are newly interested in the innovative potential of integrating these methods systematically into product design. At Stanford, we have launched a series of Tech Roundtables to coalesce action in Silicon Valley. Further afield, Microsoft has founded Hack for Her (hackforher.org) to inspire engineers and designers throughout the company to generate user experiences that meet both women and men's preferences, needs and motivations. This initiative simultaneously makes the company more responsive to social needs, enhances product safety and ensures a broad user base—all of which ultimately strengthen the company's bottom line.

There is much work to be done! Researchers need to learn sophisticated methods of sex and gender analysis. Universities need to incorporate these methods into their curricula. Corporations need to integrate these insights into product design. But eyes have been opened—and we cannot return to a world that ignores gender.

Innovation is what makes the world tick. Gendered innovations spark creativity by offering new perspectives, posing new questions, and opening new areas to research. We cannot afford to ignore such opportunities. 🌟

Londa Schiebinger is a leading international expert on gender in science and technology and currently directs the EU/U.S. Gendered Innovations in Science, Health & Medicine, Engineering, and Environment—a project aimed at harnessing the creative power of sex and gender analysis for innovation and discovery. She is a member of the American Academy of Arts and Sciences and the recipient of numerous prizes and awards. Schiebinger addressed the United Nations on the topic of "Gender, Science, and Technology" in 2011 and again in 2014.