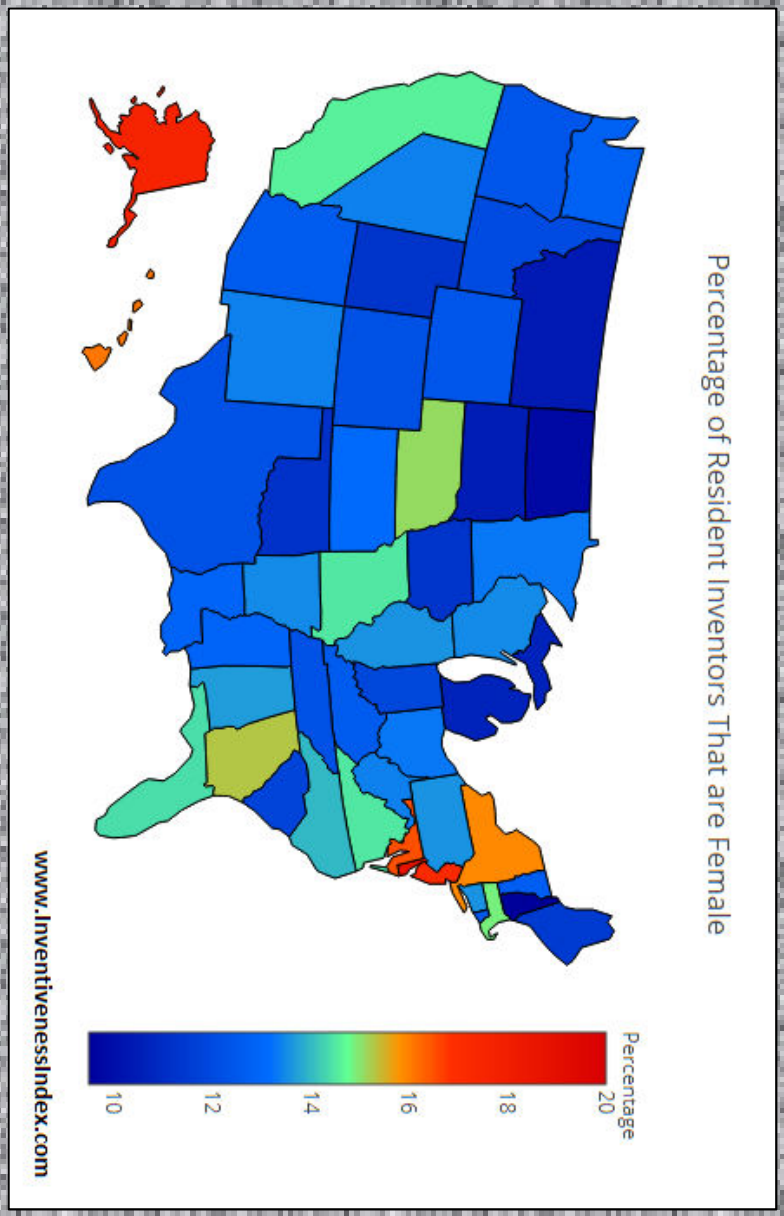
An analysis of 3 million US patents from Jan '05 - May '17, and the gender of their 1.5+ million resident inventors.

Gender in Invention

Are Females Gaining Ground?

Answering these questions and more: What percentage of all US-Based inventors are female? Is representation increasing? Do some geographies do better than others? Are there patent classes that are 'friendlier' than others? Are there employers that are 'friendlier' than others?

www.InventivenessIndex.com
with Joe Chiarella
August 2017



Gender in Invention

Introduction:

What percentage would you guess that females represent among all US-based inventors? Or of patents? How many patents have females as the "first-named" or Primary Inventor? Do these percentages vary from metro to metro or state to state? Are there particular patent classes where females do better than males? Are there companies that are more "female inventor friendly" than others? How does the US compare to other nations?

The **Inventiveness Index** recently examined invention in the United States through the lens of gender. It asks how well are women represented among the inventor population? This introductory document, and its companion four documents, highlight some results of that examination. The goal is to aid a conversation in the public square about female representation in invention; as a facet of the larger females-in-STEM-careers topic.

Three prior studies all looked at similar aspects of this issue:

- **Who Invents IT?** – Women's Participation in Information Technology Patenting commissioned in 2012 by the *National Center for Women & Information Technology*
- **Intellectual Property and Women Entrepreneurs** commissioned in 2012 by the *National Women's Business Council*
- **The Gender Patenting Gap** commissioned in 2016 by the *Institute for Women's Policy Research*

The Inventiveness Index, without any specific policy agenda, seeks to contribute to these prior quality efforts through a careful analysis of the data.

This study used patent data from the US Patent and Trademark Office (PTO). Our corpus consists of a little over 3 million domestic patents from Jan 2005 to May 2017. The Inventiveness Index also employed data sets for geographic, census and more. Like prior efforts, a first name database facilitated the gender identification process. See the appendix to this document for more details on the gender identification method.

Patents have one or more inventors which can be of the same gender or mixed. The issued patent lists these inventors. In our corpus of data (2005 to May 2017) we found that 29.2% of all patents had a single named inventor, or about 71% have more than one. In fact, 91.6% of all patents had five or less inventors and 99% were nine or less. One lucky winner had 132 inventors named, but that is a literal isolated case.

There is a plurality of ways to look at gender as it relates to patents. One way is to simply count the inventors without regard to the patents. This is a way to see what the overall invention talent pool looks like. We call this the "inventor population lens." Another way to examine this is through the lens of the patents themselves as a discrete unit and compare a patent and their "inventor team" against another. We call this the "patent team lens." Finally, it is customary for US PTO applications to list the primary inventor first. This is called the "first named" inventor. This study also looked at gender representation in that special case and will refer to that analysis as the "first named lens."

In the above noted prior studies, most analysis focused on the question through the patent lens, as opposed to the inventor population lens. This study looks at the data both ways. In addition, this study goes deeper into the question of geography as it relates to the inventor population lens. This is to help illuminate the more and less "female inventor friendly" geographies – if any. If there are, and indeed, yes there are, then sharing this information can catalyze a deeper conversation on why one area is more female inventor friendly than others – and thus replicate that best practice.

One of the prior studies also looked at this question through the lens of patent classes. This study also does that – both deeper and more broadly. For example, are there any general or specific STEM disciplines where females are on a positive trajectory? If we can identify any, then we can promote and extend them into other disciplines. Growing from a position of existing strength rather than trying to generate advances in every discipline at once.

Another of the prior studies examined, in a single point of time, the "first named inventor" data to assess gender dominance or balance. This study takes a more longitudinal approach to this question and makes a deeper examination of the inventor team compositions as a whole.

One significant finding is that the number of mixed-gender patent teams has definitely been on the rise, at the cost of all-male teams. When inventor teams have representation from both genders, about 42% of the time today a female is the lead or first-named inventor of that mixed gender team. To temper that gem a bit, this percentage has only grown about 2% over the 12 years in the study. So, females are nearly as likely to be a first-named inventor as a man is – when they are part of a team of inventors – but actual parity will take another 40 years or so at this pace.

When looking at the question in the broader inventor population lens, females still have a long way to go to reach population parity (140-170 years).

This study also looks at the companies (assignees) that employ these inventors to see if there are any patterns there with regard to gender in invention. And, indeed, yes, there are some patterns. There are also some surprises for those who think the USA is leading in this regard, we are not.

This document shares a few topline findings about Inventor & Teams, Geographies, Patent Classes and Employers. For a deeper dive on each of those areas, there are four companion documents that drill down deeper. These are:

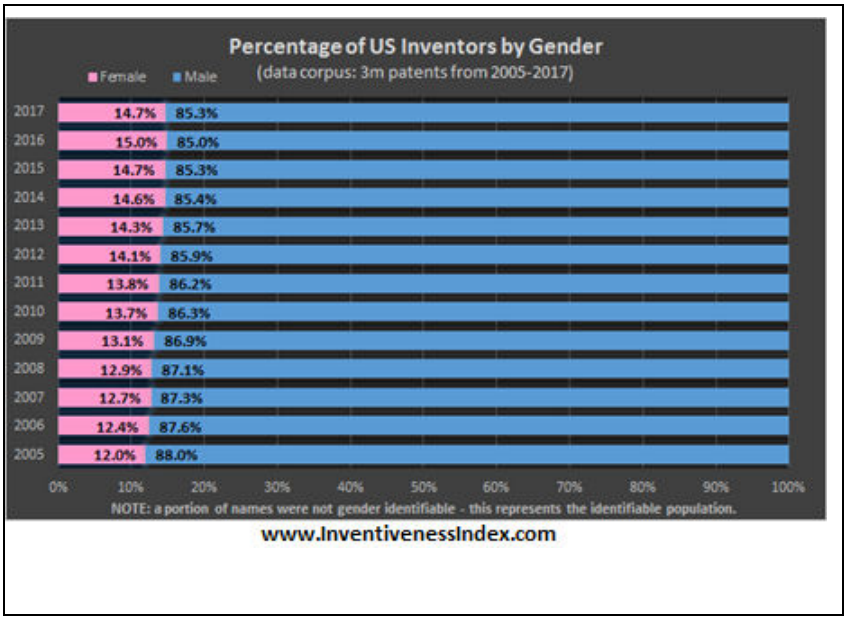
- Gender in Invention: Diversity in Inventor Geographies (coming in August 2017)
- Gender in Invention: Inventors and their Patent Classes (coming in September 2017)
- Gender in Invention: Inventors, Teams and Leadership (coming in September 2017)
- Gender in Invention: Companies and the Inventors they employ (coming in October 2017)

All will be available at www.InventivenessIndex.com

Join the conversation!

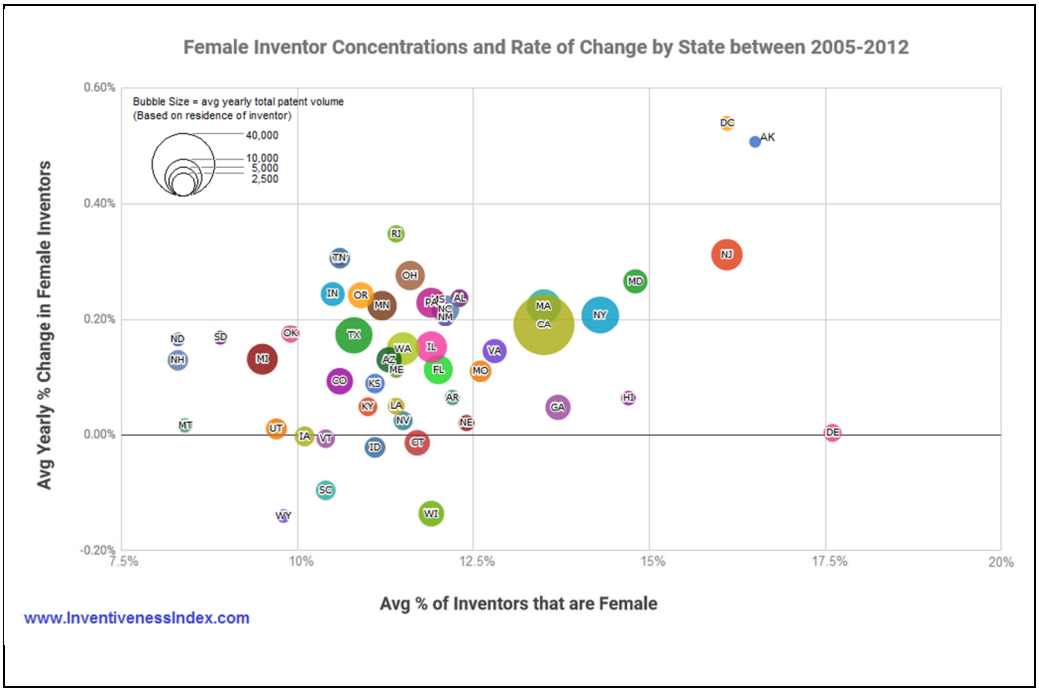
Key Findings:

National Counts:



- In 2005, female inventors accounted for 12% of all inventors. In 2016, they were 15% of all inventors. The rate of year over year increase is relatively consistent at about 0.25%. If this rate remains steady, female inventor counts will equal male inventor counts in the year 2157.
- 29.2% of all patents from 2005 to 2016 had only one named inventor. For all single-inventor patents, female representation rose from 30.1% in 2005 to 37.4% in 2016. If this rate remains steady, females will reach parity with males for single-inventor patents in the year 2036.

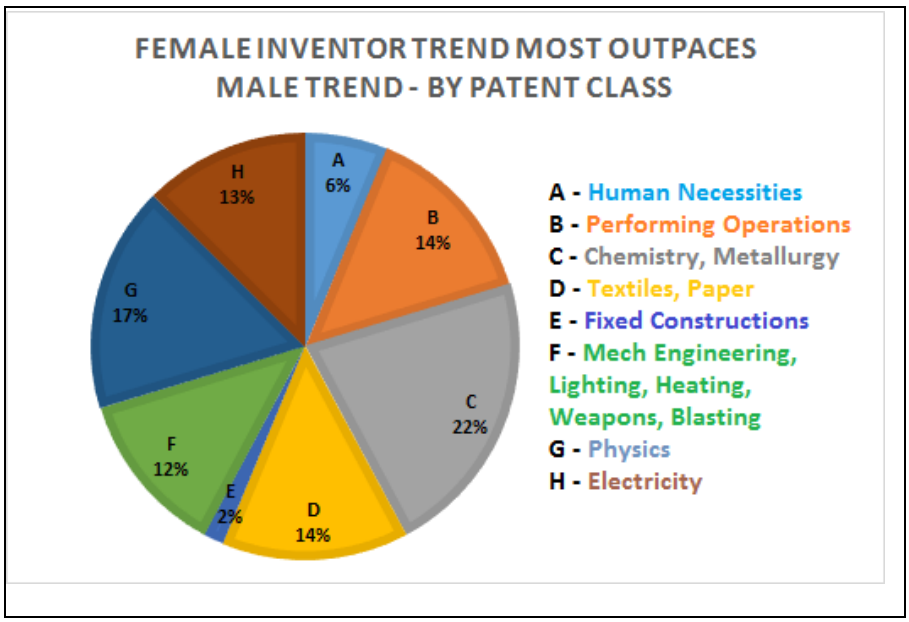
Geographies:



- Of the 250 metro areas, 35 had female percentage representation that was above (better) one standard deviation from the mean. 42 communities were below (worse) one standard deviation from the mean.
- Nearly two thirds (164 or 65.6%) of the 250 metro's tracked show an increasing trend in female percentage of inventors over the 12 year period of the study. The balance (86 communities) showed a decreasing trend.
- Three adjoining communities in Wisconsin were particularly notable as being above the standard of deviation for females as a percentage of inventors – and also showing a material year over year increasing trend. Those communities are: Oshkosh, Neenah and Appleton. However, paradoxically, Wisconsin overall showed the next-to-the-most declining female percentage (contracting by 1% every 7 years) exceeded in the nation only by Wyoming.

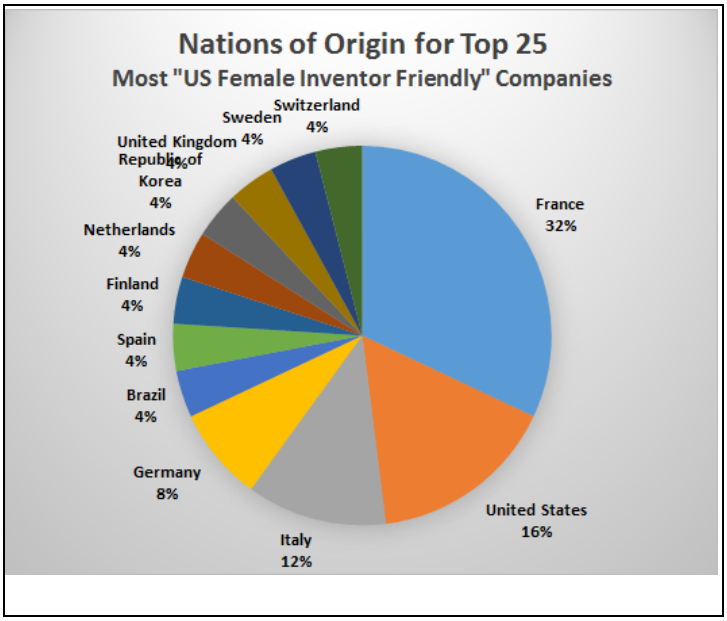
- On a state by state basis 44 states (of 51 incl Wash DC) had female inventor percentage trend lines that were increasing over the study period. Seven states stood out for being more than one standard of deviation better than the mean relative to overall female inventor percentage (regardless of trend). Those states are: AK, DC, DE, HI, NJ, NY and MD. Conversely, there were eight states that were more than one standard of deviation below the mean relative to trend (7 of the 8 were declining): CT, DE, IA, ID, SC, VT, WI and WY. It may appear contradictory that DE appears on both lists. DE showed an average female inventor percentage of 17.6% which is substantially above the range (9.8% to 13.8%) and is in fact – the highest in the nation on a statewide count basis. However, measured in terms of trend, DE showed a meager 0.003% positive slope over the 12 year period, which falls below the normative range of (0.005% to 0.280%).

Patent Classes:



- Of the 615 patent classes (using the CPC or Cooperative Patent Classification system) measured, there is only one patent class where females outnumber males (57.7% or 266 vs 195) is class "A41C" which is labeled as "CORSETS; BRASSIÈRES".
- Of the 615 patent classes measured, 433 of them (70%) show an inclining trend for both males and females. In other words, there are 433 patent classes that are expanding. 74 classes showed a declining trend for both males and females (contracting patent classes). 54 classes showed an incline in females and a decline in males. 54 classes showed (not a typo) the exact reverse: an incline in males and a decline in females. Of the 433 classes where both genders showed an incline, in only 10 of those classes (2.3% of the 433) did the female trend outpace the male – for an average female gain of 0.53 persons per year in those classes.
- In the 64 classes (10.4% of all classes) where the female trend is outpacing the male trend – 22% of those are in patent section "C" (Chemistry, Metallurgy) with balance as:
  - 17% in "G" (Physics),
  - 14% each in "B" (Performing Operations) and "D" (Textiles, Paper),
  - 13% in "H" (Electricity),
  - 12% in "F" (Mechanical Engineering, Lighting, Heating, Weapons, Blasting)
  - 6% in "A" (Human Necessities) and
  - 2% in "E" (Fixed Constructions).

Employers:

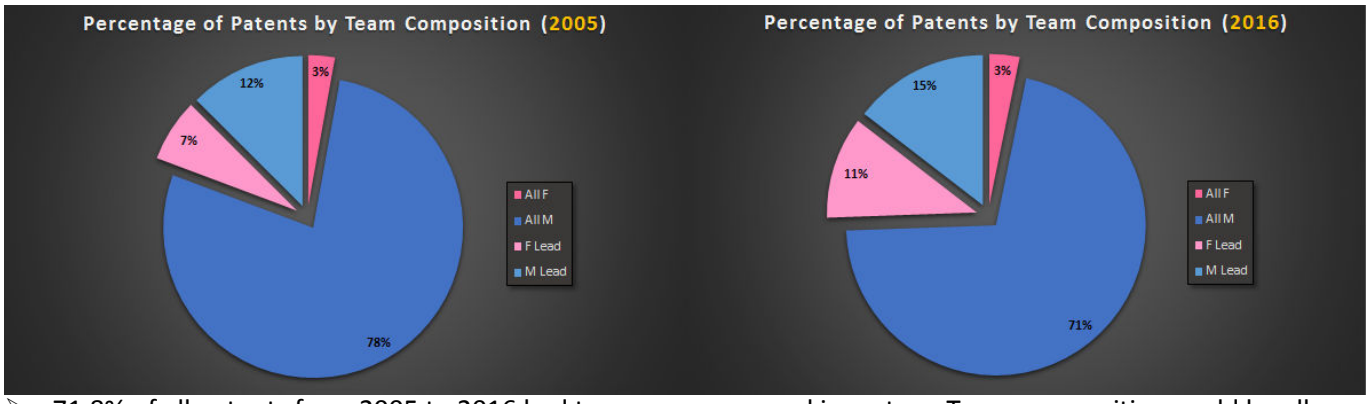


➢2762 companies that employ US-based inventors were tracked over the 12 year period. Ignoring time and just looking at totals: the largest cohort (897 or 32.5% - essentially one third) employ female inventor populations of between 10% and 15% of their total inventors. The second largest population (615 companies or 22.3%) employ female inventors at the rate of 15-20%. Only a total of 784 companies (28%) employ more than 1 female inventor for every 3 male. One company tracked employs 1 female inventor for every 1 male. This happens to be an Italian company that employs 185 US-based female inventors to 181 US-based males. It is a medical science company.

➢Broadening the list of companies from the top 25 to the top 100, the US-based companies represent 30% of that 100 and France drops to second place at 15%.

- When ranking the individual companies for "female inventor friendliness" the 21 of the top 25 companies are actually non-US companies. The four US-based companies in ranked order are Ameriprise Financial (13th), American Greetings Corp (15th), City of Hope (20th) and The Secretary of State for Defense (21st). Seven of the top 25 are French companies.
- Examining the companies over time to see trends by company yields some other results. For example, a Finnish forest industry company shows a trend line whereby they are adding female inventors at twice the rate of male ones (but still only employs 57 female inventors to 109 male ones). In another specific case, a Spanish company is adding 7 female inventors for every 1 male thus quickly closing the current 205 to 354, Female to Male gap. In ten of the top 25 companies, the rate of Female additions is outpacing the Male additions – but in eight of the ten cases – it is a negligible difference.

Team Compositions:



- 71.8% of all patents from 2005 to 2016 had two or more named inventors. Team composition could be all-male, all-female, or mixed-gender. All-male inventor teams fell from 78% to 71%. All-female inventor teams remained steady at 3%. Mixed-gender inventor teams rose from 19% to 26%.
    - Of the mixed-gender teams, females were the lead inventor 36.8% of the time in 2005 and 42.3% of the time in 2016. If this rate remains steady, females and males will have equal odds of being the lead inventor on a team in the year 2034.
    - Excluding all-female, all-male and single inventor teams on patents – and looking at only patents having mixed-gender teams of two or more inventors – the number of patents awarded to majority male teams has increased at an average rate of 0.07%/year while the number of patents awarded to equal male & female teams has declined by an average of 0.22%/year. Teams having a majority as female, increased by the average rate of 0.15%/year growing from about 3.8% to 5.6% over the study period.
    - In the top 25 most common team compositions, 10 had all male representation, 2 had all female representation and 13 had both genders represented.

Conclusions:

These topline findings are the proverbial scratch on the surface of the tip of the iceberg. Each detail report shares more and the reader is encouraged to review those individual reports.

In nearly all measures, it is clear to see that females are making gains as inventors of patented technologies. With that said, it is also clear that those gains are very, very slight in year over year terms. Reaching "parity" with males will take many decades or even more than a century.

The obvious question is why there is such a disparity? That full and complete answer is outside the scope of this study. But this study may, we hope, stimulate research into the causes for the improvements the data shows, as well as the inertia that is restraining faster gains.

That said, a few short notes are appropriate.

The US Patent and Trademark Office does not, at any point, ask an inventor or applicant for their gender. It is thus highly unlikely that the USPTO is gender biased in its patent awards process. In other words, the USPTO does not, indeed cannot, award or deny patents on the basis of gender.

What about commerce? Companies are generally motivated by products and profits. It is unlikely that they would discriminate against any intellect (male or female) that is able to produce a product that is profitable. This does not mean it doesn't happen. Logic would guide us to think that a company doesn't care as long as the product is useful for generating revenue and profits.

This leaves one speculative conclusion; females simply do not to go into roles amenable to producing patents. This is somewhat consistent with the larger problem of female representation in STEM fields in general. This report by the US Dept of Commerce reports that females occupy 48% of the workforce, but only 24% of the STEM roles (2009). (http://www.esa.doc.gov/sites/default/files/womeninstemagaptoinnovation8311.pdf)

Assuming that all inventions are in some way STEM inventions, then this suggests that the highest representation we could hope to achieve for Female inventors is 24%. With female representation rising 0.25% per year from the current 15%, this means female inventor percentage will max out around the year 2053 unless there is a material increase in women in STEM roles.

Our society starts to lose females in STEM around the 8th grade and this is well documented. Until we can solve that problem – it is reasonable to conclude that female invention will also remain under-represented.

Appendix: About the Gender Identification Methodology for this Report

The data for this report is from the corpus of 3 million patents issued from 2005 to present (though most measures did not include the partial year of 2017). This data is merged with the geographic and census data that the **InventivenessIndex** maintains for this purpose.

For this analysis, the **InventivenessIndex** had to solve the very hard problem of inventor gender identification. That required the development of a new corpus of data: first names and their common gender association.

The identification of a person's gender by their first name turns out to be more complex than one might think. First, there is no global name/gender database. Second, there is an increasing trend to name children with a name that has historically been reserved for the opposite gender (this trend began to emerge around 1980). Finally, there are some cultures (Asian, in particular) where it is not conventional to name a child by gender. The Chinese culture, in particular, tends to give children a name that is more akin to a title (like "strong wind" which is clearly not gender-specific). Thus, identification of Chinese names was limited.

Several data sources were identified, loaded and reconciled in the database to generate the necessary name/gender database. The US Census Bureau provided a starter dataset, but the Social Security Administration provided the most robust dataset. Four other datasets were also used. Our name database holds over 130,000 unique names and their gender affinity.

In those situations when an inventor has a first name that is found in the database to have both gender associations, the gender with the greater gender volume was chosen as the most statistically likely gender of the inventor. For example, the name Beverly is associated with males and females, but the male usage (according to the SSA) is only 0.48%. Thus, when matching an inventor with the first name of Beverly, the algorithm selects the female gender because it is 99.52% likely that it will be right. This is not foolproof, but is a statistically valid approach.

Firstnames like "A." or "A.J." were excluded since there is no way to gender-identify these names.

After eliminating firstnames like "A.J.", there were 1,748,307 uniquely named inventors to be gender-identified. Of these, 1,449,596 (82.9%) were successfully gender-identified. It was this population of roughly 1.5 million inventors that was used in this report.