



# **Seeing Vs. Being: Film Representations of Women in Engineering**

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## Seeing vs. Being: Popular Film Representations of Women in Engineering

In media representations of engineers and engineering, concerns of diversity and inclusion ordinarily start with a simple yes or no question: Among our onscreen engineers, are women and people of color represented alongside white men? [1] Implicit in this question is the central logic adopted as a slogan by The Geena Davis Institute on Gender in Media: “If She Can See It, She Can Be It” [2]. Indeed, this is often the first conclusion of studies on STEM’s continued gender gap: we need “more female role models” [3].

The Davis Institute, which focuses on representations of women and girls throughout mass media, has recently focused on representations of STEM professions in particular, beginning with a study performed in partnership with the market research firm J. Walter Thompson Intelligence. “The ‘Scully Effect’: I Want to Believe in STEM” presents the 1990s paranormal mystery TV series *The X-Files* as a landmark in representation of female science and technology professionals. As engineering educators who work in the cultural interpretation of film and TV, we’re both interested in the core goals of this study and skeptical of its limitations. In particular, we are struck by the fact that minimal interpretation of *The X-Files* accompanies the formal statistical and qualitative assessments of audience responses. Respondents assign descriptive adjectives (“strong,” “intelligent,” “confident”) to the character of Dana Scully, but neither those respondents nor the study’s authors otherwise interpret the series’ dialogue, visual construction, or narrative structures. While it is understandable that many discussions of STEM representations would reflect the empiricist, positivist epistemologies of the disciplines themselves, we maintain that the interpretive lenses of cultural and media studies are at least as urgent. One cannot measure the impact of cultural artifacts like these without also making an argument about what they mean.

In planning this argument, we considered many fictional representations of technoscience in film and television (some of which we may address in subsequent work), but ultimately narrowed our scope to the recent films *Hidden Figures* and *Black Panther*. Pairing a historical docudrama with a serial franchise blockbuster allows us to cover distinct parts of major studio Hollywood filmmaking; these films also helped us keep our focus to be on engineering and technology development, when “women in STEM fields” are more often depicted in the life sciences and in medicine. Finally, both films have been sufficiently prominent in discourse about “STEM role models” that through them, we can also show and engage with claims about female representation and its effects.

### “The Scully Effect,” Role Model Representation, and Girl Power

The Davis Institute report links popular culture to the STEM gender gap, and introduces *The X-Files* as the beginning of a shift toward stronger female STEM role models, as follows:

*Among the factors identified as contributing to this gender gap is a stereotype frequently rendered in entertainment media: that of a lone, “nerdy” scientist in a lab coat, commonly portrayed as a “mad scientist” or a socially awkward white man. ... Children start implicitly pairing men and math as early as age seven, a bias that continues into adulthood.*

*In the 1990s, Scully was a sharp departure from the gendered stereotype of a scientist. Her character blends traditional norms of femininity and masculinity to portray a brave, even-keeled field agent who serves as a counter-balance to her quirky and sometimes erratic partner, Fox Mulder. She is the logical and skeptical half of the duo, constantly defying the ‘damsel in distress’ stereotype by saving the day with her wits and weapon.*

*Scully’s media depiction of a high-achieving woman in STEM asked a generation of girls and women to imagine new professional options. Commentators have speculated about the “Scully Effect” for two decades ... but this is the first research study to evidentially confirm it [2].*

The study starts with a relevant, arguable interpretive insight—that “Scully ... blends traditional norms of femininity and masculinity”—but quickly subordinates interpretation of the character and the series to the results of a survey of women who came of age during *The X-Files’* initial run. The argument rests on a host of assumptions about how we ought to look at representations of women in science, engineering, and math, all reflected together in the Geena Davis Institute’s tagline, “If She Can See It, She Can Be It”:

- The central objective is to recruit women into STEM professions, and the success of the fictional representation is adequately measured by its influence.
- Representing women as engineers requires no fundamental transformation of STEM professions’ dominant values and norms.
- The decisive evidence comes from audience response research, and the relevant evidentiary questions concern methodological validity and statistical significance.

None of this should surprise us: the study was in fact performed by a market research firm working with an entertainment industry advocacy group. It nevertheless reflects common habits of thought in discussing diversity and inclusion in engineering and its related professions. Naturally, we ought to be concerned with the number of women that we can recruit into our programs and institutions, and to take seriously findings about gendered perceptions of engineering fields and technical competencies. In this paper, we complement—and sometimes question—this type of inquiry with a vantage point from humanist cultural criticism (and gender studies criticism in particular). In so doing, we want to emphasize some other dimensions of engineering and technology in the popular imagination—their definition and shaping by historically contingent values and social configurations. These are likely both causes and consequences of engineering’s historical demographics.

In many cases, though, popular depictions of female engineers and scientists are relatively uninterested in this complex causality. Instead, the preferred narrative focuses on the ability of the exceptional woman to join the world of technology and to thrive within its existing competitive, agonistic values. Indeed, those values make for great Hollywood stories of striving and overcoming. The world of high technology is often depicted (with ample historical basis) as militaristic and cutthroat; thus, earning her place within it shows a woman’s toughness in addition to her exceptional, intrinsic genius—literal “girl power.” However, “girl power” replicates rather than alters power structures; “girl power reconceives both of the fundamental concepts of second-wave feminism: Individual achievement now trumps collective struggles and an individual’s choice has now replaced the structural system as the focus of critique” [4]. In Hollywood films the “girl power” version of the story seldom shows a transformation of the

values themselves. Indeed, adopting those values herself may be part of the woman's demonstration of her *bona fide* identity as an engineer or scientist.

*Hidden Figures*: "a person with an engineer's mind should be an engineer"

*Hidden Figures* (2016) depicts African-American women working as "computers" at NASA's Langley Research Center in the early years of Project Mercury, the first United States human spaceflight program. Before *electronic* computers supplanted women's labor, NASA and other organizations held spaces in which computation was women's work, a fascinating reversal from our contemporary situation. The central characters of the film—engineer Mary Jackson, programmer Dorothy Vaughan, and mathematician Katherine Johnson—encounter persistent and overt discrimination, but nevertheless enjoy a degree of professional opportunity and prestige unusual for black women in the South. Their experiences provide some insight into an interesting historical moment, when some areas of STEM were not so wholly identified with men. Several vignettes explore the possibility within this moment of inverting power differences. Near the beginning of the film, a white highway patrolman not only praises the value of the women's work, but provides a police escort to help them get to work on time. Toward the end, Dorothy Vaughan's expertise in FORTRAN has elevated her above the female white supervisor who had previously controlled her professional opportunities.

Ultimately, though, *Hidden Figures* most often adheres to the "girl power" playbook. Understandably enough, the well-known racist institutions of the Civil Rights era figure prominently, with the protagonists' efforts hindered by segregated restrooms and classrooms and by their lack of access to classified information and meetings. The film is often criticized for unduly crediting Al Harrison, the crusty (and fictional composite) NASA manager played by Kevin Costner, for his heroic white savior efforts in removing such obstacles. Perhaps most striking is the moment in which Harrison removes a "Colored Ladies Room" with a crowbar. Not only does Harrison smash the sign "with such fanfare it is as though he were dismantling segregation itself," but this dramatic and false scene "also undermines Johnson's agency...in real life Johnson simply ignored the signs and never used the colored bathrooms, which in and of itself is a form of resistance that deserved inclusion" (5). Even that assistance, though, is presented as the result of Harrison's awe at Katherine Johnson's abilities.

The cold open that shapes the entire film presents Johnson's childhood, directed by her preternatural mathematical ability and progressing naturally through her scholarship to "West Virginia Collegiate Institute...the best school for Negroes in the state." The structural conditions of the segregated South are given their due: WVCi may be an elite academy, but it is also "the only school past the eighth grade anywhere near here." Nevertheless, the emphasis is on the mind of the profoundly gifted child, culminating in her solution to a vexing equation on an Institute chalkboard. Closeups of the child convey a mind transported to a realm of mental abstraction, made visible by the mathematical expressions reflected on her oversized glasses. The magnitude of her achievement and ability are suggested by a classroom chalkboard that dwarfs the child, just as the one at NASA Langley—requiring a ladder to climb—will dwarf the adult Katherine Johnson. The film is true in many ways to the Civil Rights era in which it is set. Martin Luther King, Jr. dreamed of "children... judged not by the color of their skin but by the

content of their character”; *Hidden Figures* establishes Johnson’s worth by making her mind as visible as her skin.

The film here employs a standard cinematic vocabulary for representing scientific geniuses; the shots of that cold open, for example, closely resemble those of mathematician John Nash in *A Beautiful Mind*. The liberal gesture of representation is thus accompanied by a conservative impulse, suggesting that traditional conceptions of and criteria for technical ability would be perfectly sound if judged in a color-blind way; institutions like NASA need only recognize that women and people of color are equally likely to realize existing archetypes of scientists, engineers, and mathematicians. In contemporary terms, the film pleads for diverse representation, but not really for diversity of thought as an intellectual boon; one never sees the Langley women’s human experiences of injustice as informing their technical insights.

*Hidden Figures* most directly confronts this question in a scene explicitly endorsing Mary Jackson as a gifted engineer who lacks only official credentialing. She and her mentor, Karl Zielinski (a fictionalized version of NASA engineer Kazimierz Czarnecki), stand below a prototype Mercury capsule, assessing mechanical means for sufficiently securing its heat shields:

Zielinski: Mary, a person with an engineer's mind should be an engineer. You can't be a computer the rest of your life.

Jackson: Mr. Zielinski, I'm a Negro woman. I'm not gonna entertain the impossible.

Zielinski: And I'm a Polish Jew whose parents died in a Nazi prison camp. Now I'm standing beneath a spaceship that's going to carry an astronaut to the stars. I think we can say we are living the impossible.

This is one of several moments in the film openly reflecting on the Mercury program’s technical heritage in the wake of both the Holocaust and the American Jim Crow era. Zielinski’s relish at “living the impossible” quietly expresses the film’s liberal triumphalism: even the first-time viewer can likely sense that Jackson will obtain the formal engineering education in the film’s happy ending. Instead of interrogating specific historical questions, though—what events or structures made NASA a potentially transgressive site of intellectual exchanges among marginalized groups?—the film finds easy answers in a supposed universal kinship among those with “an engineer’s mind.” As with the child at the chalkboard, viewers are directed inward: the body may be an interface between the self and the outer world, but the identity of the technical genius may reliably be found in an internal essence.

Judith Butler, building on the work of Michel Foucault, has diagnosed such appeals to the primacy of interior identity, showing how we tend to see our social realities reflected and validated by the truths of inner essences that define the self. “The figure of the interior soul understood as ‘within’ the body is signified through its inscription *on* the body, even though its primary mode of signification is through its very absence, its potent invisibility” (“From Interiority to Gender Performatives” in *Gender Trouble*). Following Butler, we see “an engineer’s mind” not as an intrinsic reality recognized in Jackson by Zielinski, but rather as a “surface signification” produced within a disciplinary community; that is, her reading might

emphasize not Jackson's authentic inner self but Zielinski's position of social and professional power to grant it recognition. Most often, Butler analyzes rhetoric that finds gender to be an internal reality; in this way of speaking about "an engineer's mind," gender (like race) is at least temporarily treated as an external bodily contingency that can be dismissed as irrelevant to professional standing. This is admittedly a useful way of thinking at times, and surely seems preferable to commentators who still explicitly defend engineering and technology as empirically if not essentially male domains of inquiry. (Recently, James Damore's infamous memo to colleagues at Google used this position to argue against diversity initiatives.)

*Hidden Figures* suggests, but never quite assesses explicitly, the embeddedness of NASA's personnel diversity in the social and political situations that define its entire enterprise. Zielinski alludes to Nazi genocide having driven him to the U.S.; although this is a fictional embellishment for the character, it's certainly true that American technology was advanced in crucial ways by intellectuals who fled Central and Eastern Europe in the 1930s and 1940s. (This was not wholly benign: such major figures in the space program as Wernher von Braun were Nazi affiliates rather than persecuted victims.) The film doesn't ever call to mind quite as directly the relationship of Civil Rights victories to American anti-communism—i.e. that many Americans were motivated to improve race relations in order to disarm embarrassing Soviet critiques of racism in the U.S. Instead, the film enlists the Langley women as good faith contributors in the American Space Race effort. At the beginning of the film, they seem merely to exploit patriotic sentiment to avoid racist menace. (When the white highway patrolman insists that "We have-ta get a man up there before the Commies do," we understand why Dorothy Vaughan must reply, "That's for certain.") By the end, though, nothing calls into question the explicit nationalist sentiments repeatedly offered for American space exploration. When the characters tune in to the televised broadcast of President Kennedy characterizing the Space Race as a clash between "a hostile flag of conquest [and] a banner of freedom and peace," they seem to take him at his word. We should probably question Harrison's apparent zeal to have Americans "calling the shots in space," but the film generally plays his tough motivational speeches straight.

In short, *Hidden Figures* champions the opportunity for women and people of color to join the American technoscientific establishment, but never follows up with any sense that their presence ought to make a particular difference to that establishment's values or objectives. The few lines alluding to the underlying militarism of the Space Race refer to nefarious Soviet plans: there is a mention of needing to keep "a 1.6 megaton RDS-37 thermonuclear warhead" from hitting "the middle of Des Moines," but never any acknowledgement of comparable aims of military conquest within the U.S. space program. Needless to say, then, the film stops well short of a more thoroughgoing examination of the kinds often done in academic technology studies today—for instance, in Blue, Levine, and Nieusma's investigation of "how the subtler connections between engineering and militarism implicate ... engineers in advancing militaristic values and goals, even though they do so indirectly and unintentionally" (*Engineering and War* 2).

### *Black Panther* (2018) and Technological Utopianism

The much-anticipated Marvel movie *Black Panther* was more than a box office success; it became the highest grossing superhero film in North America [8]. It served as "proof that a

depiction of a reality of something other than whiteness can make a ton of money” [9] and was also “hailed as a turning point in Hollywood’s representational politics” [10]. Critics and some scholars have raved about these depictions that break with stereotypical Hollywood depictions of African Americans and women. Within Wakanda the women hold positions of power and influence. While T’Challa is king, he depends most closely upon four women—his undercover spy and romantic interest Nakia; head of the all-female special forces Dora Milaje and bodyguard Okoye; his mother Ramonda and his sister, Princess Shuri, who serves as technological director for Wakanda. Many reviews describe these women as intelligent, strong, and talented. While sexually attractive women, they are not sexually objectified.

In particular, many media sources celebrate Shuri for being a different representation of the technological inventor: “The mastermind behind Wakanda’s most astonishing innovations is none other than a brilliant, cheeky-as-hell teen girl,” [11] “a confident creator of advanced technologies, a young dynamo with unlimited potential” [12]. Shuri has been compared to Q in James Bond and is supposed to be smarter than Tony Stark in the Marvel Universe. Some media sources explicitly describe her as a role model: “Shuri provides a science-y role model for black women, a group distinctly underrepresented in STEM fields” [13].

Some scholars are more critical of the representations of the Wakandan woman. Faramelli states: “Despite the dominant roles that women play, it is a deeply patriarchal society ruled by a male monarch who has absolute power. The nation’s celebration of masculinity is most explicit when considering the line of succession.” In part, women hold powerful roles in Wakanda because men of royal blood can challenge T’Challa to ritual combat, and so he must depend upon loyal women. In addition, the film “reinforces Western ideological hegemony through its gendered representations of women. ...the main female characters approximate a Westernized gendered sensibility—that of physical strength and athleticism, characteristics normally associated with men” [10]. Meanwhile, the women who cultivate the sacred flower, and their labor, remain in the background [10]. Currently, “it is considered more progressive to encourage institutions such as Hollywood to offer people of colour problematic roles that they were previously denied, rather than to envision new roles that can empower everyone” [14].

While the depiction of Shuri at first seems to adhere to the “girl power” playbook, the narrative complicates the portrayal. In the first introduction of Shuri’s character, she radiates a “girl power” image. While always stylish, she appears particularly girlish in this scene, wearing a casual, modern, three-quarter-length baseball t-shirt and her hair in two Princess Leia-like buns. She teases her brother and gives him the finger behind her mother’s back. In her next appearance, she defies tradition during the ritual combat, irreverently declaring, to her mother’s chagrin, “This corset is really uncomfortable, so can we all just wrap it up and go home?”

In her next few scenes, her character displays classic masculine engineering tropes and values. She is seen tinkering in the lab, showing off her latest inventions to T’Challa and later to American agent Everett Ross. There’s also a loud, high-speed car chase in which Shuri projects herself from the lab into the car and is the driver. In these scenes Shuri is confident yet playful. Once Killmonger arrives to challenge T’Challa, her demeanor becomes more serious, clarifying her roles as weapons director and as protector of T’Challa. When she goes to the Jabari tribe for aid and brings T’Challa his necklace, she declares: “The Black Panther lives. And when he fights for the fate of the Wakandan nation, I will be right there beside him.” She does fight with

T'Challa to prevent Killmonger from distributing Wakanda's vibranium weapons--her inventions--to operatives across the world.

The Marvel Cinematic Universe (MCU) consistently equates technological prodigy with the creation of advanced weapons, and intermittently reflects on the implications of the resulting heroic identities. The MCU versions of Tony Stark and Peter Parker—Iron Man and Spider-Man, respectively—incorporate some STEM era stereotypes of male tech figures. One might see Peter Parker representing the well-intentioned misfit male engineering student, and Tony Stark the Silicon Valley entrepreneur sometimes seduced by celebrity and wealth. Ultimately, of course, the weapons that they create are the foundation for mass combat as entertainment spectacle. On occasion, the MCU films invite us to think about the darker side of its armaments: *Iron Man*, the first entry in the MCU, sets Tony Stark up to experience the moral awakening needed to abandon his own amoral tendencies as a globetrotting arms dealer. Even in the more recent Marvel films set after Stark's death, plots often revolve around efforts to control his bleeding-edge tech weapons. The moral stakes, of course, are handled with the lightness one would expect in comic book films. *Spider-Man: Far From Home*, for instance, plays it for laughs when Peter Parker inadvertently calls in a Stark Industries drone strike on a high school romantic rival.

In this respect, *Black Panther* departs from the rest of the franchise: it not only moves the potentially world-changing weapons tech to a secret Central African superpower, but also contemplates the moral and political prospects of using it to arm black liberation movements around the globe. Killmonger's worldview of inverted colonialism ("the sun," he declares, "will never set on the Wakandan empire") is in the end villainous but understandable. The audience is led to reject his visions of conquest, but also to recognize in them the echo of real colonial geopolitics.

This global complexity provides the complex moral shadowing that might make Shuri's role more interesting than those of the Langley women in *Hidden Figures*. *Hidden Figures* was willing to look away from the less savory aspects of the American space program: for instance, it never asks viewers to consider whether Katherine Johnson's trajectory calculations might ever have been exported from NASA's rockets to make plans for those in the American nuclear arsenal. Shuri seems to bear far more responsibility for what happens with the weapons that she has designed. Her growth into eventual superheroism—the films will likely follow the comic books in having Shuri succeed her older brother T'Challa as Black Panther—seems to consist in part of a more sober examination of her technical work and its implications. Shuri had been content to joyride with her brother through James Bond-style "missions," mimicking 007's imperial cachet. After facing and rejecting Killmonger's more explicit aspirations to empire, though, this adventurism is no longer viable.

*Black Panther* rejects both the technological conquest that Killmonger espoused as well as the isolationism of T'Chaka. At the end of the film, T'Challa shares with Shuri that they are establishing a Wakandan Outreach Center in Oakland, in the building where their father killed their uncle. She will be the director of science and information exchange, and Nakia will oversee the social outreach. Then he touches a bead on his bracelet and a spaceship descends from the sky, impressing the black and Latino youths playing on the basketball court, who imagine arriving at school in the ship or breaking it apart to sell on eBay. After a cut to the title of the



film, T'Challa announces at the U.N. General Assembly that for the first time Wakanda will be sharing its "knowledge and resources with the outside world."

The film suggests that Wakandan technology will improve the lives of youth in Oakland and foster peace in the world. However, we are left with many questions; the fruits of Wakandan research that we have seen have all been weapons and espionage gadgets. In this light, the last moments of technological utopianism in *Black Panther* seem to be just a mild revision of Killmonger's imperialism. If technical superiority is sufficient to drive a military conquest, it must be sufficient for humanitarian outreach, too; that task is implicitly assigned to Shuri's genius, but the film doesn't show us what it looks like. (This is a common problem for the MCU's depictions of its superheroic technology: it's contrived for maximum impact in epic battles, but daily life for ordinary humans remains fixed to the technical status quo of the 2010s.)

### Representation and Engineering Education

Ultimately, it is unsurprising that the ideological horizons constraining representations of engineering in general constrain its female characters as well. Featuring characters like Shuri and the Langley women, and the creation of films like *Hidden Figures* and *Black Panther*, may be a necessary condition for the inclusion of women in STEM in the popular imagination. Such representation, though, is not yet sufficient to enable new visions of engineering (or technoscience more broadly) transformed by their presence. Similarly, integrating women and students of color into engineering education requires more than highlighting their faces on marketing promotional materials. While it is necessary to signal that a program is welcoming in its media materials, it is only the first step.

The limitations of this strategy are reflected in the stagnant numbers of women and students of color in engineering education programs. The number of women in engineering lags around 20%, and Hispanic, Black, and Native American students account for less than 10% of awarded bachelor's degrees [15]. Gender harassment is pervasive in the STEM fields in academia [16] and for women who graduate and enter the engineering profession, 37% leave because of the workplace climate [17]. Simultaneously, engineering and tech industries either fail to design for women and people of color or create technology that exacerbates inequalities [18, 19]. Equity involves not just "broadening participation" but "critically engaging the racial and sociopolitical contexts" of technology in education and making "cultural and political changes" in industry [20]. While the achievements of women and people of color in STEM should be recognized, engineering programs must move beyond simply celebrating STEM role models. In addition to making our programs more inclusive and equitable, we also need to prepare STEM professionals who strive to make technology and its applications more equitable and just.

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