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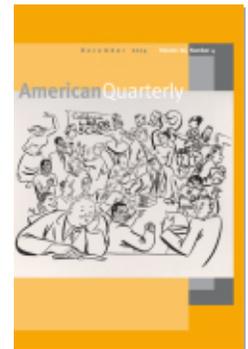
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Visualizing "The Misfit": Virtual Fitting Rooms and the Politics of Technology

Minh-Ha T. Pham

"Algorithms don't think about race."[1] That was the response I got when I asked the lead investigator of the Cornell Body Scan Research Group, Susan Ashdown, whether the virtual fitting room that her team had been developing since 2003 accounts for cultural differences in fit preferences. The idea that "algorithms don't think about race" is evocative of how fashion's latest technologies and its linked culture of technical expertise are giving rise to a new understanding of the fashionable body as an abstract form and universal object of analysis. For this researcher, processes that technologize and rationalize the body operate outside historical frameworks and experiences of racial difference. The virtual fitting room's digitalization of the body, Ashdown implies, renders race technologically meaningless.

In a way, there is a certain logic to this. The material body has been a key conceptual frame through which we have come to understand social formations. From the foundational work of Michel Foucault, Judith Butler, and many other phenomenological theorists of the body, we know that the material body is the site in which power has been historically realized. Through both mundane and ritualized modes of punishment and reward, as Butler has shown us, the material body bears and reproduces the economic, cultural, and bureaucratic processes of social reproduction. The corporeal body gives materiality to the social meanings and relations of race, gender, class, and so on by acting out (or "performing," as Butler would put it) a normative script of behaviors. Following this logic, the virtual body seems positioned to escape precisely the social meanings with which the material body is burdened to represent and reproduce.

The notion that technical constructions of the fashionable body free us from social schemas that shape and limit the visualization and interpretation of style has reached popular consciousness. From virtual fitting rooms and other related try-on devices that convert the fleshed body into biometric data points and anthropometric measurements to popular television shows that offer an explicitly pedagogical approach to style complete with a detailed list of fashion rules (e.g., *What Not to Wear*, *Queer Eye for the Straight Guy*, *Tim Gunn's Guide*

to Style) to the proliferation of self-anointed fashion gurus in career centers, professional associations, YouTube, and the fashion blogosphere, the fashionable body has been thoroughly rationalized in the twenty-first century. The social and subjective notions of what the fashionable body might mean for different people are increasingly subsumed by a scientific objective certainty about what it is for everyone. Tim Gunn's universal lesson about dressing well represents a clear articulation of the language and logic of the scientization of style: "No matter how big you are or how small you are, if silhouette, proportion, and fit are in harmony and balance, you will look great."[2]

New fashion technologies that use mathematical models to determine clothing fit and the development of greater technical expertise about the relations of bodies to garments are understood by fiber and textile engineers and other fashion experts to be reducing the barriers to fashionability for more people despite race, color, class, and body size. According to Cathy Horyn, formerly a fashion critic for the *New York Times*, a strong grasp of fit and proportion among fashion designers (and tacitly, consumers) can equalize the fashion quotient between a person wearing a dress from Wal-Mart or from Barneys.[3] The scientization of style is thought to rationalize out of being the social constructions and constraints of what and who constitutes the fashionable body. Virtual fitting rooms and a clear, concrete rubric for determining right fit, proportion, and silhouette are representative of the kinds of technical solutions that many believe can solve the problems of racism and elitism that are pervasive in fashion industries and cultures.

On the runway and in fashion magazines, the thin white body is the sign and standard of fashionability. Consider as an example New York Fashion Week, one of the most influential fashion events in the world. From 2008 (the first year that runway diversity was recorded) to 2014, white models account for about 80 percent or more of "runway turns."[4] All other nonwhite models share the remaining 15 to 20 percent of turns. An even higher degree of disparity exists in print. In the nearly ninety-eight years of American *Vogue*,[5] considered the paper of record among global fashion industries, only 31 of about 1,118 covers featured a black model, actor, or public figure (e.g., Michelle Obama). That number includes the horribly racist April 2008 cover with LeBron James and Giselle Bündchen. No Asian or Asian American model has ever appeared solo on an American *Vogue* cover—or any international edition of *Vogue* save for the January 2013 cover of *Vogue Italia*. Print editorials and ads that appear inside fashion magazines are glaringly white as well. In 2010 the all-important September issues of *Vogue*, *Harper's Bazaar*, *Cosmopolitan*, *Lucky*, and *Marie Claire* did not include even one nonwhite model in their pages. In magazines

where nonwhite models were represented that year such as *Elle* and *Allure*, their numbers added up to less than 1 percent of the total number of models.[6]

Despite fashion's observable racial asymmetries, the industry generally sees itself as a creative bastion of liberal color blindness. Ashley Mears's ethnographic study of the fashion modeling industry indicates that the maintenance of normative whiteness in fashion is not due to explicit racial preferences and prejudice but to visual and aesthetic codes for bodies and markets. The primary factors given for why some models are booked while others are not are (1) the specific demographics and desires of the target market, (2) designers' visions of their collections, and (3) the technical design of the garments.

Some of the casting directors and bookers that Mears interviews use terms like *petite*, *down-market "big booty,"* and *flat face/nose* ("which look humongous in the photograph") to explain why black and Asian models are routinely passed over.[7] Such coded assessments rely on a scientific discourse about physiognomy and anatomy that at once establishes and obscures the racial logic underlying judgments about fashionability. Barbara Nicoli, casting director for high-end labels including Burberry, Marchesa, and Saint Laurent, articulates a similar understanding of the ideal fashionable body as a scientifically supported tax-onomy of anatomical parts and shapes. Nicoli explains, "Caucasians have a specific body type, black girls have a specific body shape, and Asian girls have a specific body shape," which she goes on to describe as "more flat and less sexy, in a way. Asians . . . are not curvy, [they have a] baby body shape."[8]

Mears is clear that casting directors and bookers would like to hire nonwhite models, if not out of a sense of social political ethics then at least for public image. Consistently, industry insiders express that they "love Black girls,"[9] "love Asian girls,"[10] and "love flavor."[11] But for them, the reason that nonwhite models are so rarely hired relative to white models is not an issue of racism (of *disliking* nonwhite models) but of the high preciseness of anatomical and physiological standards of fashionability. In addition to this casual science of racial typology, they point to the market as another rational force and limiting structure. As one booker explains to Mears: "Okay let's say Prada. You don't have a huge amount of black people buying Prada. They can't afford it. Okay so that's economics there. So why put a black face? They put a white face, because those are the ones that buy the clothes."[12]

The privileged few black and Asian models who have succeeded have bodies and faces that defy racialized categories of physiognomy and anatomy. These models are highly sought out because they are perceived as exceptional and distinctive. As one modeling scout reveals: "It's really hard to scout a good black girl. Because they have to have the right nose and the right bottom. Most

black girls have wide noses and big bottoms so if you can find that right body and that right face, but it's hard."[13] Another booker insists, "People want a white black girl." Someone who is "not *dark* dark . . . that Leah Kabetty [*sic*] type of girl, you know a gorgeous girl, but a little bit lighter, or I would say, whiter."[14] Mears's research helpfully and importantly captures the racial logic of fashionability that guides the industry: it is not white bodies that are the racial ideal but *the look of whiteness*, an assemblage of physical features (e.g., skin color, physiognomy, body size, and height) and social meanings (e.g., up-market, right nose, sexy).

The meanings of fashionability in a modeling casting call and in virtual fitting rooms (or other sites of rationalized style) are not the same. In fact, they are sharply opposed. The quality of fashionability in fashion modeling industries is a technical rarity based on a complex valuation of ideal physical features, current fashion and beauty trends, and perfect market timing. What is so complex as to be practically cryptic and understood by only a small cadre of experts is precisely the thing that virtual fitting rooms and popular fashion experts intend to demystify. The promise of the scientization of fit, proportion, and silhouette is that now anyone can be fashionable.

Despite the divergent meanings of fashionability in professional and mainstream contexts, both interpretative systems are premised on the same racial logic. Just as the fashionable body for casting directors is not necessarily a white body but *the look of whiteness*—"a white black girl" being a clear expression and example of this logic—the reference standard for the perfect fit is the *look of whiteness* via clothing.

The perfect fit is a racially unmarked and seemingly neutral category of dress style consistent with aesthetic norms of middle-class respectability. It depends for its meaning on the social construction of a binary other, the classification of the bad fit that has historically included the oversized zoot suit, the too-tight "hoochie" dress, the too-voluminous burqa, the saggy jeans, and the extra-large hoodie sweatshirt. (Hoochie likely references Carmen Miranda, who famously wore bright-colored, form-fitting dresses and is credited with one of the first uses of the term *hoochie coochie* in her 1944 hit song "Give Me a Band and a Bandana.")

While saggy jeans, too-tight dresses, and so on are styles of clothing and dress, they have become closely linked to styles of racially gendered embodiment. In cultural, social, and political contexts from popular films to feminist and NGO movements and missions to "save" Muslim women, to the rash of ghetto parties and cholo parties thrown by white fraternities that have recently erupted on university campuses across the United States from Johns Hopkins

University to the University of California at San Diego, these styles of dress have been inscribed with racially gendered meanings. They are sartorial markers that function as both a sign and a symptom of racial deviance.

The bad fit has been a salient aspect of the visualization of otherness. As a visual cue, it indicates a mis-fit of the individual to the social norms, practices, and values that clothing signifies. Fox News pundit Geraldo Rivera's claim that there is an inherent relation between oversized hoodies and criminality is as outrageous as it is widely accepted. As we saw during the murder trial of George Zimmerman (who admitted killing Trayvon Martin, an unarmed black teen wearing a hoodie), bad fit garments are seen and treated as material expressions of the misfit other, a racialized figure that warrants heightened scrutiny, suspicion, surveillance, and discipline. Rivera has publicly stated that Martin's choice to wear a hoodie led to his death.

Virtual fitting systems maintain but also proliferate the link between the bad fit and the misfit. Saggy jeans and too-tight tops are precisely the styles of dress these machines are designed to flush out. In identifying these fit preferences as bad, as a style of dress irredeemably outside the normative perfect fit and thus in need of correction, virtual fitting systems automate processes of racialization. Judgments about too loose or too tight garments are techno-scientifically rationalized and standardized by virtual fitting systems. Not simply a matter of personal style or even bad taste, a bad fit in the context of virtual fitting rooms is an issue of bad math, of a *measured and disproportionate relation of body to garment*. In this way, virtual fitting room algorithms codify the social meanings associated with the bad fit. They render sartorial expressions that have been historically linked to racialized embodiment (e.g., "thug wear," "ho wear") as quantifiably irrational. Thus the algorithms that govern the machine's functioning do not simply "think about race"; they produce racial effects based on a calculus of body difference and differentiation. This is one way in which virtual fitting systems operate as a technology of racialization.

As well as maintaining and regulating the sartorial look of whiteness, virtual fitting systems operate as a technology of racialization in another way: they facilitate new ways to look at and assess racial difference as information. The amount of data that virtual fitting systems collect from consumers is relatively modest (name, birth date, e-mail address, zip code, anthropometric and biometric information), but the informational potential of these data is far-reaching.

The content analysis typical of all data systems—namely, data inference, data reduction, and analysis—makes it possible for virtual fitting systems to cross match virtual fitting room data against data files maintained by other commercial, governmental, medical, and legal organizations to build a profile

of consumers. These data profiles, as Karl Palmås underscores, represent people not as individuals but "as patterns and propensities of behavior distilled from large data sets."[15] The goal is to determine behavioral probabilities based on external attributes including the neighborhoods that individuals live in, the online social networks they participate in, their purchasing history, employment status, and "lifestyle." Data management systems visualize consumers not as individuals but as data groups or clusters. More precisely, as Oscar Gandy puts it, data systems engage in "social sorting" intended to produce "representations of normality and deviance derived from general statistics."[16]

Data systems manage the massive amount and variety of data (or Big Data) collected from and on individuals by organizing them into categories of projected risk, value, and status. Retailers and marketers use these data—data not readily available to individual consumers or indeed even to the government, as we saw in 2012[17]—for two contradictory but complementary purposes: to attract and maintain highly valued groups of consumers and to disincentivize low-value consumers through price and service-quality discrimination. In effect, data analyses and reduction that virtual fitting systems share with other data systems have the paradoxical effect of serving fewer *individuals* but more people. As Irma van der Ploeg explains, biometric "systems are not catering to the needs of individuals, but instead [are] built to 'process' (sometimes extremely) high numbers of people as possible. . . . These requirements of scale and speed make for a highly standardized technology, that presupposes a 'standard' human person"[18]—or in the context of virtual fitting rooms, a standard perfect fit, a mathematically defined relationship of the interface between body and garment.

A critical examination of virtual fitting room systems reveals a key insight about the nature of the work they do. While the technical discourse about virtual fitting systems emphasizes freedom (consumer freedom from actual fitting rooms, from the scourge of "the bad fit," and from the social limits and biases associated with the fashion retail industry and culture with regard to body size and social class), they are more accurately understood as regulating devices.

Rather than provide consumers "free rein" in retail spaces to make choices based on their individual style tastes and fit preferences, virtual fitting rooms narrow consumer choices by restricting them to a list of (partnered) clothing brands, styles, and sizes that have been deemed appropriate for their body types. The garments and sizes on the shopping list are generated from mathematical algorithms designed to approximate as closely as possible the perfect fit—a racially unmarked and presumed universal sartorial look of whiteness. If clothes are technologies for producing and presenting identity, virtual fitting rooms

enforce what Lisa Nakamura calls "menu-driven identities."[19] Like the digital media sites Nakamura is concerned with, virtual fitting rooms foreclose rather than enhance the possibilities for more freedom in the imagining and making of identities. The automatic size selection of virtual fitting rooms overrides consumer agency with technological agency. As an Eddie Bauer store manager at the King of Prussia mall puts it, "Nine times out of 10, if left on their own, [shoppers] will choose the wrong size pant." With the virtual fitting room, "if it says they're a 4 or a 6, they're a 4 or a 6."[20]

Virtual fitting systems limit consumer choices and consumer sovereignty in another crucial way as well. As a data management system, its analytic processes interpret and render information that enables marketers and retailers to "generate certainty about [some] people" and "discriminate in their treatment of [others]."[21] As a consequence, virtual fitting systems function as highly sophisticated mechanisms of social profiling through market segmentation.

The purpose of this article is to detail the racializing functions of virtual fitting systems. Before doing so, though, it is helpful to understand the political economic context conditioning virtual fitting systems' research and development. What follows is a brief history of virtual fitting rooms that is focused especially on how social formations inform and co-constitute technological formations.

The History and Futures of Virtual Fitting Rooms

The technological design and operations of virtual fitting rooms are like those of full-body laser imaging security scanners found in most large commercial airports. Both use one of two types of scanners. The first, a millimeter wave scanner, bounces electromagnetic waves off the body to produce a three-dimensional image of the body; the second, a backscatter system, projects X-ray beams over the body to create a two-dimensional image. While some medical experts argue that there is no "safe" level of radiation exposure, the TSA insists that both types of scanners emit a low level of radiation, equivalent to 1/1000 the strength of a cell phone frequency.

In addition to their appearance and function, virtual fitting rooms and airport security scanners share a military history. The scanning technology was created at the Pacific Northwest National Laboratory (PNNL)—a research arm of the US Department of Energy—where the technology was being applied to detect enemy submarines. In 2002, in the wake of the September 11 terrorist attacks, PNNL began granting commercial licenses. Two of the first licenses went to Intellifit (a Philadelphia-based company with a Canadian

CEO developing a virtual fitting room that was then called My Best Fit and is now called Me-ality for "Measured Reality") and SafeView, Inc. (a supplier of high-tech security products specializing in airport scanners).[22] While these companies seem totally different—one in the business of fashion retail and the other in aviation security—they are unified in their shared interest in predicting human behavior as well as in the belief that the monitoring and regulation of human behavior are effective strategies for achieving this goal. Thus, while Intellifit and SafeView are private commercial entities, they both perform a governmental service that was intensely significant in the immediate aftermath of 9/11: surveillance.

It should come as little surprise that the federal government is a major investor in the research and development of full-body laser imaging technologies. SafeView, then and now, is largely funded by Batelle Industries, a finance group headed by Jeffrey Wadsworth, a principal player in the White House Transition Planning Office for the new Department of Homeland Security. Tellingly, SafeView has its own in-house Office of Homeland Security and receives funding from the FAA as well as the Department of Homeland Security. Other virtual fitting rooms also have federal funding. For example, the Human Solutions virtual fitting room being developed at Cornell University is funded in large part by a five-year grant from the US Army Natick Soldier Systems Center in Massachusetts.[23] Today, virtual fitting room researchers have made such impressive strides in the technological development of these scanners that PNNL—the original developer of the full-body scanning technology—is studying virtual fitting rooms to discover how airport security scanners can be made more effective. In particular, they are hoping to create security scanners that do not require passengers to remove their shoes.[24]

Despite the deeply intertwined history and future of airport security scanners and virtual fitting rooms, the general perception of them could not be more divergent. One is associated with the enhancement of freedom (a consumer's freedom from fitting rooms, a bad fit, etc.) while the other is associated with the curtailing of freedom (of travel, of privacy, etc.). Even individuals who have a less adverse reaction to airport security scanners characterize them as a necessary inconvenience. We stand in line for airport security scanners because we are obligated to do so, not because we want to. In contrast, consumers enthusiastically seek out and volunteer to stand in line for virtual fitting rooms.

This was starkly born out in March 2007 when Intellifit installed a beta version of My Best Fit in the Philadelphia International Airport between terminals A and B (nowhere near retail stores even within the airport). That

Intellifit chose to do this at the height of the public protest against the intrusiveness of airport security scanners indicates the company's awareness of the different public perception of virtual fitting rooms. (At the time, the ACLU's charge that whole-body scanners constituted "virtual strip searches" dominated headline stories.) Public concerns about privacy and bodily safety that continue to plague airport scanners are all but nonexistent with respect to virtual fitting rooms. Almost immediately after My Best Fit appeared in the Philadelphia International Airport, hundreds of people voluntarily lined up to be scanned. A "mommy blogger" who identifies herself as Mrs. Owens tried out the virtual fitting room with her pre-teen daughter. In a rave review posted to her blog, she writes: "I'm sure I probably exposed my body to some kind of radiation—but in my mind it was worth it . . . Mommie needs a new pair of jeans!"[25] The popularity of virtual fitting rooms prompted other airports to install them, including Baltimore's Thurgood Marshall International Airport and Newark Liberty International Airport in New Jersey.

At Lane Bryant (the first US retailer to use the technology in 2005), Gap, Banana Republic, Talbots, Levi's, American Eagle, and Macy's as well as at higher-end retailers like Brooks Brothers, TopShop, and Bloomingdale's, long lines of consumers wait for their chance to be scanned, happily anticipating, as one Philadelphia-area woman named Lauren VanBrackle put it, the moment when "that machine, in a 30-second scan, tells you what to do."[26] Today, virtual fitting rooms are slowly but steadily expanding their markets within North America and around the world. They are now popular features in shopping malls in US states including California, Illinois, Maryland, New Jersey, New York, and Pennsylvania as well as in Canada, China, Japan, the UK, and elsewhere.

As consumers step into a virtual fitting room, a "vertical wand" scans their entire (and fully clothed) body in about fifteen seconds, recording two hundred thousand measurement points that are converted into body measurement data such as left armhole depth, inseam, knee circumference, seat elevation, and seat circumference. Drawing together consumers' biometric data with the initial personal information provided to a virtual fitting room kiosk attendant who enters and saves the data (typically: name, birth date, e-mail address, zip code), the system generates a paper receipt of sizes and styles selected from partnering brands and retailers determined to provide the appropriate fit. (Me-Ality boasts partnerships with over 150 brands and retailers.) As I have already mentioned, the biometric and personal data collected and cross matched by the virtual fitting system are not shared with or available to the consumer. This has not

deterred consumers' interest in virtual fitting rooms. As one consumer explains, "The company has that data about you, but you don't see it. The point is that you don't need it because they do the size matching for you."[27]

The prevailing public opinion and media attention for virtual fitting rooms emphasize that these technologies ease the sometimes-onerous task of self-fashioning. For consumers who are overwhelmed by the quantity and variety of retail garments—not to mention the disparate and nonstandard sizing rubrics of individual brands—virtual fitting systems are particularly appealing. Their algorithmic applications are based on scientific studies that have analyzed how clothes move and adjust to a dynamic body, how clothes move when the body is at complex angles, and what is happening with the garment at stress points all around the body. Virtual fitting systems are designed take the guesswork out of finding the perfect fit by scientifically establishing the optimal "relation between the individual body and the particular garment."[28] What is more, they literally help consumers find the perfect fit by systematically mapping out the best shopping route and behavior, telling them where to go and what to buy. Recall that VanBrackle describes the computer-generated printout of appropriate sizes and styles as a set of instructions that "tells consumers what to do." Virtual fitting rooms thus help consumers achieve not only the perfect fit but also the perfect shopping experience.

This is the sum and substance of the feature story that *Good Morning, America* (*GMA*) ran about the My Best Fit virtual fitting room. Addressing women viewers specifically, the reporter Sharon Alfonsi praises the device for eliminating women's "dressing room meltdowns" and restoring the "swagger of a girl who likes her jeans."[29] Alfonsi's assessment that My Best Fit will not only ease women's lives but also increase their self-worth and self-image ("swagger") is suggestive of the general perception of virtual fitting systems as technologies of feminist empowerment. By locating women's self-worth and self-image in the market, as marketized practices of rational consumerism, Alfonsi implies that virtual fittings are acts of feminist agency.

The benefits that virtual fitting rooms provide to retailers are not emphasized in the popular discourse, but they are considerable. According to the National Retail Federation, Americans returned about 10 percent or $194 billion worth of clothing in 2010.[30] In the e-commerce culture of liberal return policies, return rates are even higher—about 12 to 35 percent. Merchants typically assume the costs of return shipping, restocking, and rock-bottom (or no) sales for items often returned after-season. Companies developing virtual fitting rooms intend to help retailers lessen the costs and inconvenience of returns. Helping consumers find and buy "the perfect fit" is expected to boost sales

and reduce returns (especially of online purchases) because of poor fit, a cost to retailers of about "$10 to $15 per garment return."[31]

The *GMA* story is consistent with the scholarly literature on virtual fitting technologies that posits a link between clothing fit and body image/satisfaction.[32] Indeed, the guiding hypothesis of the Cornell Body Scan Research Group is that "for women to look their personal best and have positive feelings towards their bodies, it is imperative for women to dress in well-fitting clothing."[33] It is toward the understanding and managing of this link that participants being considered for inclusion in studies of virtual fitting technologies are routinely surveyed about their self-perceptions with respect to their bodies and appearances. The attention to the psychosocial dimensions of study participants is indicative of the dual purpose that virtual fitting systems are intended to serve, first, as a technology of customer service, and second, as a way to provide a social service and good.

The computer-generated list of brands and clothing sizes aims to improve the shopping experience by reducing the physical, emotional, economic, and time-based labors of apparel shopping that contribute to "dressing room meltdowns." The impact of the virtual fitting also goes beyond the immediate shopping experience, since providing better-fitting clothes is understood as not solely about providing consumer products and services. Better-fitting clothing, researchers believe, will reduce the rates of body dissatisfaction and, in turn, lessen the negative effects on women's self-esteem that adversely affect their personal and professional lives. If airport security scanners produce anxiety about being looked at (by the state, by strangers, and by other travelers), virtual fitting rooms provide pleasure in looking at our own bodies as sites of opportunity for increasing agency, knowledge, and social capital.

It is not only fiber and textile engineers and researchers that view sartorial style as a determining factor of personal and professional success. This is now the commonsense understanding about fashion. From daytime talk shows like Dr. Drew Pinsky's *Lifechangers* that includes episodes with titles like "My Style Is Keeping Me Single" to professional gatherings like the Chicago Bar Association's "What Not to Wear" runway show—now a regular feature of the organization's activities—the fashionable body is increasingly looked at as a space and strategy to accumulate (financial and social) capital.

The popular and scholarly discourse about virtual fitting rooms aligns them with the ever-broadening horizon of neoliberalism based on a core belief in, as Inderpal Grewal puts it, "the self-actualizing and identity-producing possibilities of consumption."[34] Under neoliberalism, Grewal explains, the market is the site and source of liberal democracy because it "promot[es] endlessly the

idea of choice."[35] Key to neoliberal conceptions of identity formation is that self-making is mutually constitutive and coextensive with making consumer choices. In Grewal's succinct formulation, neoliberal progressive feminism is premised on "the idea [that] 'having choices' [is] the opposite of 'being oppressed.'"[36]

The printout of appropriate clothing sizes and styles that virtual fitting systems generate is itself a form of neoliberal subject-making. Providing individuals with a rationalized and precalculated set of consumer choices, these printouts or instructions effectively teach consumers how to self-manage and self-regulate their bodies and images in and through the market. Underpinning the operations and logics of virtual fitting systems is the idea that the source of women's body dissatisfaction—and consequently, myriad other professional and personal failures—is in their failure to choose the right clothing sizes and styles. Rather than the massive ecosystem of idealized and largely unattainable women's body images reproduced and reinforced in mass media, neoliberal feminist discourses about self-fashioning make women responsible (and to blame) for their economic, social, and mental well-being. The guided shopping list that virtual fitting rooms provide is the path to and of feminist happiness. It is little wonder that consumers drive long distances and wait in long lines for a virtual fitting.

In effect, neoliberalism is the "operating system" of virtual fitting rooms. Its prevailing principles of self-governmentality via consumerism structure their design and utility. Recall Mrs. Owens's remark that running the chance of radiation exposure from the virtual fitting room "was worth it . . . Mommie needs a new pair of jeans!" Within the logic of neoliberalism and the current "risk society" characterized by a widespread feeling of perpetual uncertainty under the shadow cast by long periods of under- and unemployment, global economic recession and restructuring, and transnational and national terrorism, Owens's glib remark is not necessarily cavalier or reckless. Scholars of the so-called lifestyle industries argue that Americans have increasingly turned to an expanding and welcoming market of self-help literature, makeover programs, time-saving and self-empowering consumer goods, and life coaches in an attempt to alleviate their anxieties and regain some sense of individual empowerment and consumer agency. Owens and the millions of users whom commercial virtual fitting room companies have reportedly scanned are risking the possibility of a little radiation for the promises of the perfect fit, the perfect shopping trip, and tacitly, the perfect feminist experience.

If neoliberalism provides the conditions of human-to-virtual fitting room interface, virtual fitting rooms also bolster neoliberalism. Indeed, as David

Harvey has argued, information technologies have a crucial role to play in the expansion of neoliberalism. Their "creation and capacities to accumulate, store, transfer, analyze, and use massive databases to guide decision in the global market place" is invaluable for maximizing the reach, frequency, and domain of the market that neoliberalism holds is the primary site of liberal democratic freedoms.[37]

So far, I have discussed how the September 11 attacks and neoliberalism create an environment for the research, development, and appeal of virtual fitting rooms. I want to turn now to a discussion of how the perfect fit is scientifically determined and what are the social implications of the perfect fit. Much of the research on virtual fitting systems and software is protected as proprietary information and so is not available for public study. I have been granted some access to the work and methodologies of the Cornell Body Scan Research Group by its lead investigator, Susan Ashdown, who shared some of her insights, time, and published research with me. The Cornell Research Group is developing a virtual fitting room for commercial use called Human Solutions. This project serves here as a representative case study. While it is certainly not meant to be taken as a comprehensive example of all virtual fitting room research and development methods, it provides a useful illustration of how scientific and social logics are intertwined and embedded into the design of virtual fitting rooms.

Diversity and/as Exclusion in the Virtual Fitting Room

The Cornell research project began in 2002. Initially, the study was funded by My Virtual Model (MVM), a software program that allows users to "try on" clothes using a customizable avatar. The garment chosen for the study was a low-rise, boot-cut jean called the STAR jean produced by the fast-fashion retailer H&M. It is not, strictly speaking, a virtual fitting room but a virtual try-on program. Instead of scanning users' bodies, MVM asks users to take and input their own measurements. Simple measurements such as height and weight, and users' conceptions of their body shape (e.g., hour-glass, pear-shaped, "boyish") are recorded to create a parametric avatar.[38] Specifications of racial difference—adjustments to eye shape, hair color, skin tone, and so forth—can be submitted after the avatar is created. As such, the program treats race as an aesthetic feature that personalizes the user experience but does not "color" the technological operations of virtual fitting rooms in any significant way. Such operations seem to validate and maintain the integrity of technological color blindness. Yet as Tara McPherson reminds us, technological color blindness is

not an escape from but a mystification of racial logics in which the operations of racial differentiation are moved from the overt to the covert.[39]

In the research and development of the MVM try-on device and the Human Solutions virtual fitting room, the "look of whiteness," the sartorial expression of a racially unmarked, middle-class ideal of respectability, covertly structures the limits of the techno-scientific imagination. Put simply, the assumption underlying studies to discover the perfect fit is the notion that a standard universal fit preference exists. As I show, the construction and formalization of the perfect fit as a standard ratio of garment to body is constituted through and at the limits of the misfit.

For the MVM study, twenty participants were chosen. All were women of traditional college age. Study participants are described as "represent[ing] a variety of different interests and geographic origins . . . from a range of academic majors and . . . different parts of the country."[40] Researchers further report that the participants represented body sizes with waist measurements ranging from twenty-six inches to thirty-five inches. One woman whose waist measured thirty-six inches was eliminated from the study, "as she did not fit into any of the jeans in the range."[41] The emphasis on the geographic, size, and academic diversity of the participants operates as a scientific claim about the inclusiveness of the study sample. It is an implicit assertion about the unbiasedness or objectivity of the data set being produced.

But the scientific discourse of sample diversity obscures the racial homogeneity of the study. What is more, it elides the cultural logic of whiteness shaping the research methods and practices conditioning the development of the virtual try-on program. Diversity in the MVM study signifies not the inclusion of racial others but a rationale for their exclusion as well as for the elimination of considerations of the ways that virtual fitting devices are race-based technologies that reinforce the universality of whiteness to represent all people. Aesthetic controls that would allow users to customize the race of their avatars were deemed of little significance by the study group. "Correcting the size of the lips or the style of hair was of minimal interest to the participants."[42] As a study result, it reinforces what Nakamura terms the "default whiteness" of virtual worlds.

In the MVM program, the attainment of the perfect fit is the attainment of white embodiment. This is an impossible ideal, even for white women. As Richard Dyer suggests, white embodiment is a transcendent ideal. White skin is never truly white. What is more, white embodiment is a concept, not an actual thing.[43] For Dyer, whiteness is an "absence of being," a "no-thing-ness" that depends on the binary logic of "the corporeality and thingness" of racial

embodiment.[44] As I show, the perfect fit as a style of nonracial and decorporeal-ized embodiment ("no-thing-ness") is also a largely unreachable ideal.

At the conclusion of the MVM study, only half of the participants rated the fit of the jeans suggested on the basis of their body measurements as "excel-lent or good." The other half rated the fit as "mediocre, poor, or very poor."[45] Surely guessing would have produced similar results. A significant factor of participants' dissatisfaction had to do with the pant sizes that the program chose for each individual. Sizes selected for fifteen of the twenty participants were one to three sizes larger than they usually wear. The researchers explain that the larger sizes correct for the appearance of "excess flesh from a tight fit."[46] In the size selection process, then, the technological calculus of the perfect fit based on a mathematical model of the optimal relationship between body and garment constructs an ideal style of embodiment that disappears excess flesh or does away with deviant corporealities.

This ideal is built into the look of the avatars themselves. Over and over, participants remarked that the avatar body, absent of color and texture, was "too smooth" to be realistic. Rather than a problem of representation, researchers concluded that the problem has to do with users learning to see themselves in and as these virtual forms. "It may take some time to get accustomed to this new, three dimensional view of ourselves."[47] Just as the look of whiteness that is the benchmark of physical attractiveness for fashion models is unreachable for most women, so too is the sartorial look of whiteness an unattainable ideal—even for many white women.

Following the MVM study, the Cornell Group began working on a virtual fitting room called Human Solutions that, as I have already mentioned, has funding from the US Army. It is an ongoing study whose mission is to help apparel companies understand the clothing fit needs of consumers. The initial study included 36 participants—significantly more than the MVM study. This group was culled from a respondent pool of 313 traditionally college-age women, 39 percent of whom identified as nonwhite. Based on a set of eligibility criteria not disclosed to me, 89 percent of respondents were eliminated. The final participants were distinct from the larger group of respondents in several ways. They were among the thinner women to respond. Full-body scans using the Human Solutions virtual fitting room indicated that their average waist size was about twenty-seven inches—about a woman's size four (maybe six depending on the brand)—and their body mass index (BMI) averaged 21.57. This is on the low end of the BMI scale that ranges between 19 and 35. A questionnaire also revealed that the study participants had a higher level of fashion consciousness and brand awareness. Each participant owned on aver-

age six to seven pairs of jeans including "premium denim." And finally, all the remaining 36 participants were white.

While wearing the study jeans, study participants discussed the fit with researchers using a mirror. They evaluated clothing fit at nine body–garment interface points: knees, ankles, calves, legs, waist, buttocks, thighs, hips, and abdomen. As a group, they overwhelmingly preferred the tighter-fitting jeans with the "skinny" pant leg and a low-rise crotch inseam—a popular fit preference for this age demographic. A second round of fit analysis was conducted without the study participants. Researchers examined 3-D body-scan images of participants in the study pants and compared their stated fit preferences with the degrees of stress to the garments at the nine points of contact.

Like the modeling casting directors and bookers whom Mears interviews, Ashdown is also concerned with the issues of race and representation. She readily acknowledges that the racial homogeneity of the participants is a limitation of the study. Moreover, she tells me, the current anthropometric data used as a baseline measure by most apparel companies and researchers in the fiber-textile industry (including those developing virtual fitting rooms) has not been updated since the 1940s. This means that the last time a national study was done on the changing size and shape of the US population, national origins quotas that favored western European immigrants and largely excluded immigrants from Latin America, Asia, and Africa were still in effect. It was not until the 1965 Immigration and Naturalization Act that these quotas were abolished.

To address the initial study's limitations, in 2005 the Cornell Group in collaboration with researchers at multiple universities and research organizations began scanning consumers in a greater variety of retail and geographic locations. Their goal is to produce anthropometric data that are more representative of the contemporary US population. Larger samples, researchers believe, will provide a more accurate visualization of the diversity of the nation through clothing fit evaluations.

Paradoxically, though, the scientific discourse and methods aimed at increasing sampling diversity occlude critical considerations of racial bias—specifically, the bias built into virtual fitting systems. The production of larger samples and data sets assumes that full-body laser scans are neutral technologies. They are not. They are designed to favor certain styles of dress and styles of embodiment. As Langdon Winner succinctly puts it, "The technological deck has been stacked."[48] Like the MVM program, virtual fitting rooms are race-based technologies that reinforce the universality of whiteness to represent all people.

In a report prepared for the National Textile Center, members of the Cornell group describe the Human Solutions scanner (a millimeter wave device) as

"optimized in terms of the light source."[49] This characterization of the technology has significant social implications. When the vertical wand in the Human Solutions system rotates around a person, 196 small antennas send and receive low-frequency vibrations that go through clothes and are reflected off the skin. The radio waves emitted are part of the broader electromagnetic spectrum of light that spans from radio waves to gamma rays. In fact, radio waves have the same properties of light, though they have much longer wavelengths and a lower frequency.

Full-body scanners are thus a type of light media. When their light sources have been "optimized," they have a low capacity for adjusting to differences in lighting conditions and, subsequently, to differences in skin color (since the visible differences in skin color are due to the amounts of light absorbed and reflected by skin). Scholars including Richard Dyer and Jonathan Beller as well as the artists Adam Broomberg and Oliver Chanarin have identified similar problems of racist spectrometry in the photographic camera, film camera, and their associated light technologies.[50] The scanner's inability to adjust for different skin tones is why researchers routinely ask participants (of all races) to wear a light-colored Lycra scanning suit. The suit controls for scan quality and scan results by removing the variable of skin tones. In effect, the technology's capacity to serve diverse populations depends on the whitening of their bodies using a light-colored scanning suit. That white participants are often asked to don the scanning suit as well underscores Dyer's point that whiteness is a transcendent concept of embodiment, an ideal that is unattainable.

As well as the narrow light range of the scanners, their 3-D scan systems "capture only XYZ coordinate data, and no color or texture information."[51] The images created from the scans are stripped of racial markers of identity. The scan images, a visual representation of the two hundred thousand data points collected, are bluish green or shiny charcoal. Facial details (e.g., the shape and color of eyes and noses) are sketchy at best. As such, these highly personalized (and personal) data bodies are no less constituted and constrained by default whiteness than the MVM avatars that, while customizable, are based on a template.

Effectively, virtual fitting systems' technical processes for determining and establishing the perfect fit rationalize out of being racial difference. The mathematical algorithms designed to help consumers find better-fitting clothes and subsequently better self-images are not programmed to enhance black and brown styles of dress or to represent bodies that are other to the default whiteness of digital media. To the contrary, they are designed to expunge them. Black and brown styles of dress and embodiment only pre-appear as bad

fits in the research and development stages before mathematical models and computational algorithms are created to rationalize them out of being. In so doing, they exclude—by design—consumers whose styles of dress have historically and now technologically mark them as misfits. Though external to the operations of virtual fitting rooms, the bad fit is also deeply essential to them.

Fashioning Data Bodies

The failure of virtual fitting rooms' technological imagination to visualize styles of dress and corporealities other to the racially unmarked perfect fit does not imply that virtual fitting systems have failed to function properly. In fact, even when virtual fitting systems fail to find consumers the perfect fit (which, as I have shown, happens just as often as not) it succeeds in one crucial way: as a means of dataveillance.

Virtual fitting rooms are designed to enhance consumer experiences by reducing the time and effort that apparel shopping can take. The computer generated, personally customized list of appropriate clothing sizes and styles is intended to ensure that consumers will not leave retail sites empty-handed or frustrated. Armed with a rationalized shopping list based on scientific data, we are more likely to buy because we believe we are making good, reasonable decisions about clothing styles, fit, and sartorial self-presentation. An eased shopping experience increases the likelihood that consumers will continue to shop and make future visits. But even when virtual fitting rooms fail to complete a sale, they succeed as a data-collecting tool.

Virtual fitting rooms' extensive databases suggest that their most important use may not be body/garment size-matching at all. A significant clue to their function is that consumers do not pay to use virtual fitting rooms. To paraphrase Andrew Lewis's by-now famous observation, "if you're not paying for something, you're not the customer; you're the product being sold."[52] And the product is just as good to the actual customers of virtual fitting rooms—its information-sharing partners—whether consumers buy the selected clothes or not. The information gained from a nonsale is perhaps more valuable to the virtual fitting room company and its information-sharing partners.

While researchers and engineers continue to improve on the machine's capacity to predict and prescribe the perfect fit for greater numbers of consumers, virtual fitting rooms are already providing a highly valued service to their information-sharing partners. For large fees, a wide variety of commercial, financial, public service, and government organizations buy personal information that will help them find new customers; entice highly valued current

customers; and disincentivize low-value, no-value, or high-risk customers (the terminology varies from organization to organization).

The sale of personal and consumer information is an increasingly well-known, if still incredibly opaque practice. A 2007 study conducted by researchers at the University of California at Berkeley asked eighty-six companies to disclose their information-sharing practices under the privacy policy called SB 27 (also known as the "Shine the Light Law") that California governor Gray Davis signed in September 2003 and that took effect on January 1, 2005. This bill, sponsored by the California Public Interest Research Group, intended to promote greater transparency in the direct marketing use of personal data. "SB 27 allows any Californian to contact a business and request that it disclose all the parties to whom personal information was sold in the previous year. . . . Businesses have 30 days to respond to an individual's request."[53]

Of the eighty-six companies contacted, seventy-six responded in some way (e.g., with explanations of their opt-in/opt-out policies, to ask for more time to respond, and with statements that they would not be complying with SB 27 for various reasons), and ten did not respond at all. Only two of the eighty-six companies disclosed their list of information-sharing partners: Walt Disney and the home furnishings chain Restoration Hardware. The third-party companies they identified as partners included companies specializing in news media, educational software, automobile manufacture, hotel and travel, food/restaurants, beauty products, household goods, marketers, book publishers, electronics companies, video streaming/rental companies, and credit and financial institutions. The breadth and diversity of information-sharing organizations is not only typical; it is increasingly inevitable as database systems become more and more integrated and cooperating. The particular character of a data system—medical, financial, consumer, and so forth—is, as Oscar Gandy argues, "a distinction without a difference."[54] File-matching programs now draw on data files maintained across government, commercial, and nonprofit organizations, matching social security records against medical records against criminal records against employment records against consumer and social media records against social service records, and so on. Data analyses work to construct and classify consumer profiles in predefined, precoded, and hierarchical geodemographic categories such as (by Claritas/PRIZM) "Back-country Folks," "Blue Blood Estates," "Public Assistance," "Money & Brains," "Blue Collar Nursery," and (by Axciom)[55] "Downtown Dwellers" and "Flush Families."[56]

The information that users provide to virtual fitting room databases (name, birth date, e-mail, zip code, biometrics) is perceived as not highly sensitive. In fact, all but the biometric data is the type of information that consumers

are most often asked to provide when signing up to participate in some of the more banal activities of everyday life: registering for an e-mail account, a social network account, or a commercial mailing list. But these data have potentially rich informational content. Gandy shows that zip codes can be made to reveal a neighborhood's average household income, ethnic mix, crime rates, unemployment levels, and rates of alcoholism. These statistics are used to predict individuals' "risk" levels based on "the character of the communities in which they live."[57]

Data analysis methods help organizations control the behavior of consumers by offering them incentives to consume (e.g., coupons, promotional offers, rewards for high levels of activity) as well as incentives to leave. Highly valued consumers are offered—by e-mail, pop-up ad, and regular mail—coupons, promotional offers, and rewards for high levels of activity. Low-value or sometimes "low-margin" consumers are subject to an array of "weblining" practices, a sophisticated system of market discrimination in which they are offered no advertising and no coupons, and are subject to practices that actively price them out of the market, forcing them "to settle for products of lesser quality."[58]

Retailers are just as concerned with getting rid of low-value consumers as they are with attracting and keeping high-value ones. This business practice is based on a central tenet of the Pareto principle: "eighty percent of any firm's profit is derived from twenty percent of its customers."[59] Data miners sift through and analyze information to discover and identify this much-coveted class of consumers while marking out consumers who are "avoidable risks" (including those who are in a statistical category determined to have a propensity for not consuming whether because of habitual window-shopping, shoplifting, or product returning). "The easiest thing" for companies to do, explains Fredrick Newell, is "to entice [low-value] customers to leave."[60]

The critical literature on database management systems is clear. The classification of people based on statistical estimations is a form and practice of power. Gandy, Palmås, Norval Morris, Marc Miller, James Rule, Vincent Manzerolle, Sandra Smeltzer, Susanne Lace, and others characterize network database systems and analytics as linchpins of social control and social differentiation in the digital age. As predictive technologies of power, data-mining procedures do not simply identify "deviance" and "normality": they give these terms meaning by enlarging and foreclosing the horizon of social, economic, and consumer possibilities for individuals. In Lace's formulation, data-mining systems "sort and sift populations more intensively and efficiently than ever before, enhancing the life chances of some and retarding those of others."[61]

Here, we see more points of overlap and divergence between virtual fitting rooms and similar technologies. Like airport security scanners, virtual fitting rooms are technologies for visualizing bodies and silhouettes for the purposes of predicting behavior and predetermining differential treatment. But unlike airport security scanners, the body is not the ultimate object of visualization in the virtual fitting room. The use and impact of the virtual fitting room databases suggests that virtual fitting rooms have more in common with consumer and financial data management systems. In the virtual fitting room, the body scan is not the end product but a front-end user interface to a broader data system. Rather than map "the interior spaces of the bodies," as Shoshana Magnet and Tara Rodgers observe about airport security scanners, virtual fitting room scans map bodies to economicized social categories (e.g., plus size, junior size, mass-market consumer, elite consumer) that theoretically enhance consumers' experiences in the marketplace.[62] This is why the loss of privacy to personal information in the context of virtual fitting rooms is not considered a violation but a volitional act to enhance one's body, image, and life. The promise of the perfect fit and all the social, financial, and emotional benefits linked to it are enticements—opt-in incentives—for allowing the visualization of consumers' bodies and the determination of their value.

Privacy advocates contend that the aggregate data from driver's licenses, credit cards, and closed-circuit television (CCTV) monitors now ubiquitous in nearly all retail and public spaces enable retailers, mall security, and other agencies to know who consumers are as soon as they walk into a store. With virtual fitting rooms, surveillance begins well before consumers enter a store. Through the processing of personal, biometric, and consumer data (actually or tacitly) provided by the consumer, virtual fitting rooms' predictive surveillance maps, manages, and controls certain behaviors—including preventing them before they happen. But rather than the traditional modes of policing, virtual fitting rooms selectively distribute opportunities and rewards based on statistical assumptions about group-level differences. In virtual fitting rooms, data-driven ways of seeing, knowing, and classifying bodies serve to enhance and inhibit the life chances of the privileged few over the many others.

Virtual fitting rooms are a part of the broader surveillance culture, but they also mark its diffusion through the feminization of surveillance technologies, practices, and sites. Virtual fitting rooms, niche social networks with a strong fashion focus like Pinterest and Polyvore, fashion apps, and other similar kinds of fashion technologies exemplify how far surveillance technologies have expanded away from the masculine spaces of discipline and punishment (e.g.,

military and prisons). Today, they are increasingly central to the feminine spaces of self-expression, social interactivity, and consumerism where surveillance is popular, pleasurable, and desired. Consumers look forward to being scanned (and rescanned as they find necessary to keep up with their fluctuating body sizes because of weight changes, pregnancy, etc.).

Virtual fitting rooms are not the same kinds of security projects as even their most closely related technological counterpart, airport security scanners. Their associations with freedom, self-expression, and choice and their emphasis on service over application, consumption over production, and pleasure over practicality may locate these technologies more squarely within digital age consumption studies. Yet, as I have suggested throughout this article, the very qualities that might be the reasons "feminine" or "soft" technologies like virtual fitting rooms are generally omitted from surveillance studies are precisely the reasons that they make for such effective surveillance technologies. Indeed, it is the "softness" of these technologies—their ease of use, their fun attributes, and their attention to personalizing the user experience—that make them such effective instruments for doing the hard work of surveillance.

Notes

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