What Can Universal Design Know?:
Bodies as Evidence in Disability-Accessible Design

By:

Aimi Hamraie
Ph.D.

Women's, Gender, & Sexuality Studies

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Rosemarie Garland-Thomson, Ph.D.
Co-advisor

____
Deboleena Roy, Ph.D.
Co-advisor

____
Sander Gilman, Ph.D.
Committee Member

____
David Serlin, Ph.D.
Committee Member

Accepted:

____
Lisa Tedesco, Ph.D.
Dean of the James T. Laney School of Graduate Studies

____
Date

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Abstract

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Universal Design (UD) is a movement to make the built environment accessible to a broad range of human diversity. UD emerged in the mid-1980s as an alternative to barrier-free approaches to disability access. Existing scholarship has largely taken UD for granted as the best, most inclusive approach to design. The design studies literature on UD focuses on evaluating specific designs, promoting accessibility to designers, or arguing that UD can result in better implementation of the requirements of the Americans With Disabilities Act. In the humanities and social sciences, critical disability studies scholars often cite UD as proof of the validity of social constructivist models of disability. These fields have neglected an in-depth exploration of UD's historical emergence through 19th and 20th century scientific research practices that have often been at odds with the goal of disability inclusion. This dissertation is the first major attempt to address this gap in existing knowledge about UD. Applying a methodology from the history and philosophy of science, called *historical epistemology,* I explore the history of UD as an *epistemic community* emerging from a number of scientific research milieus, including eugenics, rehabilitation, scientific management, and military human factors research. I argue that UD is made possible by epistemic regimes that make human bodies legible as evidence to designers, but that emerged from projects of standardizing, eliminating, or curing disability. UD performs epistemological activism within these regimes, intervening to challenge their epistemologies and methodologies, and creating new ways of knowing bodies that can make better disability access possible.

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Introduction: What Can Universal Design Know?

Decades of American legal efforts to de-segregate space have nevertheless left us with a built environment, developed through professional, social, and scientific norms, that *de facto* privileges the presence of certain human bodies over others. Since the late 1960s, civil rights advocates for women, people of color, and people with disabilities have framed the built environment as the litmus test of broader inclusions and exclusions in U.S. society, arguing that inaccessible cities, buildings, products, workplaces, and transportation make oppressed people less present and therefore less likely to receive protections or exercise rights of citizenship. At the heart of these framings are two important ideas: (1) that access to space is analogous to political recognition and freedom and (2) that built environments are entanglements of design practices and knowledge-based projections of likely or ideal spatial inhabitants and users.

While the bodies of people with disabilities have long been objects of medical experimentation and exclusion from the built environment, a contemporary design movement called Universal Design (UD) is combining scientific research on disability with architectural and industrial design in order to promote the broad inclusion of diverse bodies in the built environment. UD aims to maximize the built environment's accessibility to as many people as possible, regardless of ability, age, or sex. While the barrier-free design approach taken by the American's With Disabilities Act (1990) relies upon technical accessibility standards for a certain set of disabilities (such as wheelchair access), Universal Design aims to include bodies with varying abilities and disabilities in the built environment by design. UD responds to the way that existing built environment's privilege of able-bodied people as presumed, normal inhabitants of space. Designers working in the fields of architectural, industrial, product, web, and educational design have challenged this norm through designs that include a range of bodies.

In addition to its design work, UD constitutes an *epistemic community* of architects, industrial designers, and researchers at universities and non-profit organizations.[1] Throughout UD's history, multidisciplinary research projects in the fields of *environmental design research*, *human factors and ergonomics*, and *rehabilitation medicine and engineering* have created an evidence base and documented best practices for inclusive design projects.[2] Historically, the U.S. Department of Education's National Institute on Disability and Rehabilitation Research (NIDRR) has provided funding and institutional support for this work through grants for Rehabilitation Engineering Research Centers (RERC) and Rehabilitation Research Training Centers (RRTC).[3]

Philosophically, UD is an *aspirational ideal*[4] based on the premise that mainstream access treats people with disabilities as a special needs population rather than considering access to space to be a universal or collective need.[5] According to UD

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[1] Karin Knorr-Cetina's (1999) notion of "epistemic cultures" usefully describes the communities and norms of practice that emerge within particular groupings of scientists in the production and application of knowledge. See (*Epistemic Cultures: How the Sciences Make Knowledge*. Cambridge: Harvard University Press, 1999). On the need to study UD as an epistemic community, see Rob Imrie, "Universalism, Universal Design, and Equitable Access to the Built Environment," *Disability and Rehabilitation* 34.10 (2012): 873-882 and Aimi Hamraie, "Universal Design Research as a New Materialist Practice." *Disability Studies Quarterly* 32.4 (2012).

[2] Throughout the dissertation, I use italicized terms to indicate concepts, as distinct from direct quotations.

[3] Molly Story, Jim Mueller & Ronald Mace, *The Universal Design File: Designing for People of All Ages and Abilities*. (Raleigh: Center for Universal Design, North Carolina State University, 1998), 10.

[4] "Aspirational ideal" is a phrase I borrow from Rosemarie Garland-Thomson, who uses the term to explain that Universal Design is a worthwhile goal, even if seemingly unattainable, because it offers an ideal around which to theorize beneficial design and world-building practices. For a defense of a UD philosophy that emphasizes idealism and aspiration, see Edward Steinfeld and Beth Tauke, "Universal Design*ing*," in Jon Christopherson (ed), *Universal Design: 17 Ways of Thinking and Teaching* (Husbanken: Council of Europe, 2002).

[5] Ronald Mace, "Universal Design: Barrier-Free Environments for Everyone," *Designer's West* 33.1 (1985): 147.

proponents, making access a case of special needs segregates space. For example, when architects add a wheelchair ramp to the back of a building, they often force wheelchair users to enter through service doors next to alleys or dumpsters, rather than through the front door, where the general public enters. This reinforces the notion that disability is a condition of disqualification from public life and community.

This dissertation identifies three basic tenants of UD's philosophy:

1. *Broad accessibility* that keeps the range of people who can experience environmental barriers in mind. For example, design that claims to take "all people" or "as many people as possible" into account.[6] While members of this *all* may not be people who identify as or are labeled as having disabilities, they can still face spatial segregations that UD can address.

2. *Accessibility by design,* an approach to designing that prioritizes access and reduces the need for retrofitting. For example, when accessibility is already built into a design.

3. *Added value,* the notion that designs for disability access can also benefit a wider range of non-disabled users. For example, when designers claim, "everyone benefits" from accessibility, not just disabled users.

These ideas circulate in the evolving definitions and "Seven Principles of Universal Design" (1997) as well as emerging alternative definitions and frameworks of broadly inclusive design. However, as I show later, the Seven Principles are more methodological than ideological, leaving unexamined the different meanings invoked by "Universal Design*ing*."[7] Each of the three concepts outlined above has its own history,

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[6] Broad accessibility is a way of defining the scope of *universal.* For instance, some define UD as design that "benefits everyone, or, at least, a large majority." See Edward Steinfeld and Jordana Maisel, *Universal Design: Creating Inclusive Environments*. (John Wiley & Sons, 2012), 23. The focus on *all people* differentiates UD from barrier-free design approaches (further discussed later). See Yoshihiko Kawauchi, *Universal Design: A Reconsideration of Barrier-Free* (Boston: Institute for Human Centered Design, 2009), 37, 67-74). This claim is prevalent in UD definitions (Mace 1985; Center for Universal Design, "The Principles of Universal Design, Version 2.0" (Raleigh: North Carolina State University, 1997). It is also evident in the clarifications of UD proponents about its usefulness. For instance, industrial designer Jim Mueller claims that UD is about "creating designs that everyone can use and that everyone wants" (Mueller in Kawauchi 2009, 35).

[7] "Universal Design*ing"* is a term proposed by UD theorists Edward Steinfeld and Beth Tauke (2002) to differentiate UD as a method from UD as an ideology. Other UD proponents, such as Greg Vanderheiden

ideological commitments, and evidence-base. I explore these throughout the dissertation by showing that the definitions and methodologies for Universal Design emerge through epistemic regimes produced through multidisciplinary collaborations and epistemological debates. In addition to identifying the epistemologies of current UD research, this dissertation also situates the status of the figure of the *user*, and the concepts of *body* and *environment* as epistemic concepts with long-term historical trajectories.

UD as a political and material intervention

In order to explain the political and material contributions made by UD to making built environments accessible, it is necessary to explain the differences between UD and *barrier-free design* approaches taken by disability access laws, such as the 1990 Americans With Disabilities Act's (ADA).[8] The ADA is a *formal equality* approach that addresses direct discrimination by promoting "equality of opportunity, full participation, independent living, and economic self-sufficiency."[9] Titles II and III of the ADA address the built environment, requiring certain limited forms of access and accommodation for people with disabilities.

In order to receive ADA protections, a person must first prove that they qualify, under law, as a person with disabilities and then make an individual case for accommodations.[10] The ADA Accessibility Guidelines for Buildings and Facilities (ADAAG) define accessibility guidelines for new construction. However, by all

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and Jim Mueller, also endorse the notion of UD as a process of working toward a more accessible future (Kawauchi 2009, 136).

[8] Americans with Disabilities Act (ADA), 1990, 42 U.S.C. § 12101–12213.

[9] See 42 U.S.C. 12101(a)(8) ("the Nation's proper goals regarding individuals with disabilities are to ensure equality of opportunity, full participation, independent living, and economic self-sufficiency for such individuals.")

[10] See 42 U.S.C. § 12102(2)(A) ("The term 'disability' means, with respect to an individual…").

accounts, these are minimum requirements focusing on particular disabilities (such as wheelchair access or vision impairment) rather on more general ways in which the built environment creates barriers for people with disabilities.[11] The law only requires *retrofits*[12] to be "reasonable accommodations" that do not place excessive financial burdens on employers or places of accommodation, often preventing large-scale restructuring.[13] By contrast, as I show throughout the dissertation, UD aims to build broad accessibility into designs so that they do not require later, piecemeal retrofits.

Barrier-free design and federal guidelines

The ADA emerges from disability rights activism and the barrier-free design movement, which won significant legislative gains in the 1960s and '70s.[14] While efforts toward veteran rehabilitation existed in the U.S. since the Civil War, the standardization of disability access guidelines for buildings began in 1958 at a conference sponsored by the President's Commission on the Employment of the Handicapped, the National Easter Seals Society, and the American National Standards Institute (ANSI). This conference commissioned research that produced ANSI A117.1, the first set of disability access guidelines, in 1961.[15] In 1965, the National Commission on Architectural Standards, established to enforce amendments to the Federal Rehabilitation Act, conducted a survey of architects and builders that revealed widespread ignorance of the ANSI guidelines and

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[11] As I explain below, the existing guidelines are "minimal guidelines" that specify the minimum accessibility but do not require broad or meaningful access.
[12] That is, modifications to existing designs.
[13] This claim is further discussed in detail below.
[14] Polly Welch and Chris Palames, "A Brief History of Disability Rights Legislation in the United States," *Strategies for Teaching Universal Design* (Boston: Adaptive Environments Center and MIG Communications, 1995).
[15] For a comprehensive history of ANSI 117.1, see Steinfeld and Maisel (2012, 190); Welch and Palames 1995; Timothy Nugent, "Design of Buildings to Permit Their Use by the Physically Handicapped," *New Building Research* (Fall 1961).

outlined areas of improvement for the enforcement of these guidelines.[16] The results of this research both spurred work within the architectural profession to address designers' ignorance about access guidelines and also led Congress to enact the Architectural Barriers Act in 1968.[17] This Act would require accessibility in all spaces constructed with federal funds.

In 1973, Congress amended the Rehabilitation Act with Section 504, the first legal statute to define discrimination against people with disabilities.[18] The enforcement of Section 504 became the goal of much of disability rights activism in the 1970s, leading to protests and sit-ins in Berkeley, California and Washington D.C.[19] In the 1980s, federal agencies continued to refine technical access standards, with the Architecture and Transportation Review Board's first "Minimum Guidelines and Requirements for Accessible Design" (1981) and the inclusion of disability in the stipulations of the Fair Housing Amendments Act (FHAA) for multifamily dwellings.[20]

Until the early 1980s, federal access laws had focused on the provision of government protections and resources to people with disabilities. The ADA (1990) expanded protections to the private sector by requiring equality in employment and spaces of public accommodation, such as restaurants and theaters. The purpose of this expansion was to facilitate economic self-sufficiency and participation in society for individuals with disabilities.[21] However, the new protections also required extended negotiation with industry and employers, which created loopholes in the law and

[16] Welch and Palames 1995; National Commission on Architectural Barriers to Rehabilitation of the Handicapped, *Design for All Americans* (Washington D.C.: U.S. Government Printing Office, 1967).
[17] Welch and Palames 1995.
[18] Welch and Palames 1995.
[19] Kim Nielson, *A Disability History of the United States* (New York: Beacon Press, 2012), 168-169.
[20] Welch and Palames 1995.
[21] See 42 U.S.C. 12101(a)(8).

decreased its efficacy. These loopholes included the stipulations for "reasonable accommodations"[22] that do not pose an "undue burden" on businesses.[23]

The ADA and formal equality

The ADA's formal equality approach seeks to grant individuals with disabilities facing discrimination an "opportunity to compete on an equal basis" with non-disabled people.[24] This is why the ADA is a *barrier-free* rather than *Universal Design* approach. Under Titles II[25] and III,[26] the ADA attempts to remove barriers for people with disabilities by re-structuring the built environment and guaranteeing access to services.[27]

Unfortunately, the original text and approach of the ADA made few significant gains for persons seeking accommodations under Title III.[28] As a number of disability

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[22] See 42 U.S.C. § 12184(a)(2)(A) ("the failure of such entity to—(A) make reasonable modifications consistent with those required…").
[23] See 42 U.S.C. § 12182(b)(2)(A)(iii) ("For the purposes of…this section, discrimination includes…(iii) a failure to take such steps as may be necessary…unless the entity can demonstrate that taking such steps would fundamentally alter the nature of the good, service, facility, privilege, advantage, or accommodation being offered or would result in an undue burden."). See also *Todd v. Am. Multi-Cinema, Inc*. Also see *Arizona ex rel. Goddard v Harkins Amusement Enters.* (2008, DC Ariz) 548 F Supp 2d 723), the district court ruled that movie theaters do not need to provide films with captions or descriptions, which are beneficial to other audience members, as well, because such measures would alter the content of the service of showing a film. Instead, the court ruled, the theater should provide alternatives such as auxiliary aids or translation services that would only benefit individuals requiring them on a case-by-case basis. While these measures may provide limited access, they do so in a way that isolates persons with disabilities from the experience of watching the film.
[24] See 42 U.S.C. § 12101(9) ("the continuing existence of unfair and unnecessary discrimination and prejudice denies people with disabilities the opportunity to compete on an equal basis and to pursue those opportunities for which our free society is justifiably famous.")
[25] See 42 U.S.C. § 12131-12150.
[26] See 42 U.S.C. § 12182-12189.
[27] Federal regulatory guidance clarifies the titles with regards to architectural design and remodeling. See ADA Title II DOJ regulations, 28 C.F.R. § 35.102-35.178; Title III DOJ regulations, 28 C.F.R. § 36.104-36.505; United States Access Board regulations (for a list see: <http://www.access-board.gov/gs.htm>, accessed 4/10/10); Architecture and Transportation Compliance Board, "ADA Accessibility Guidelines for Buildings and Facilities (ADAAG)," Available at: <http://www.access-board.gov/adaag/html/adaag.htm>, accessed on 4/10/10.
[28] See Andrew I. Batavia, "Ten Years Later: the ADA and the future of disability policy," *Americans With Disabilities,* (2000), 283. Bhativa discusses the failure of the ADA to address interconnected issues of employment, education, social life, health policy, and equal pay. He also argues that the policy goals of

theorists and legal scholars argued, the ADA's case-by-case formal equality approach could only address specific instances of discrimination but could never institutionalize broad accessibility, create adequate shifts in the architectural profession, or address the interrelated social inequalities causing inaccessibility in the first place.[29]

These problems with the ADA are part of its foundational reliance on a formal equality approach. As disability geographers Rob Imrie and Peter Hall have maintained, targeted accommodations "are a necessary, but not sufficient, response in enabling disabled people to gain access to the built environment" and work by "reduc[ing] disability to the physiology of the body" or

> an individual, or pathological, medical condition which can be cured through treatment and rehabilitation. In turn, a disabling state is conceived of as less to do with the insensitive practices of, for example, architects, and more to do with the individual impairment.[30]

Because in most cases the ADA prescribes targeted (individual) solutions, such as assistive technologies, or additive accommodations, such as ramps, it runs the risk of making access an individual rather than collective issue.

The ADA's approach to targeted relief has resulted in what disability law scholar Ani Satz refers to as "fragmentation,"[31] which means that when employers or businesses provide accommodations to an individual with a disability, access becomes limited to that

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other anti-discrimination and welfare policies in the U.S. are not aligned with the ADA, and that "there has been little progress in addressing those policy issues that cannot be resolved fully by the ADA, such as access to health care coverage, personal assistance devices, smoke-free environment and full employment."

[29] See 42 U.S.C. § 12111(8). The ADA mandates an individualized inquiry into whether or not the person alleging discrimination is a "qualified individual with a disability." Also see 42 U.S.C. § 12102(2)(A) ("The term 'disability' means, with respect to an individual…"). See Ani Satz, "Disability, Vulnerability, and the Limits of Anti-discrimination," *Washington Law Review* 83 (2008); Samuel Bagenstos, "The Future of Disability Law," *Yale Law Journal* 114.1 (2004); Batavia (2000); and my discussion below on critiques of formal equality and case-by-case approaches.

[30] Peter Hall and Rob Imrie, *Inclusive Design: Designing and Developing Accessible Environments*. (Taylor & Francis, 2001), 100.

[31] See Satz 2008, 533. Also see Ani Satz, "Overcoming Fragmentation in Health and Disability Law," *Emory Law Journal* 66 (2010).

specific context and does not spill over to the broader systems that cause exclusion. This is largely because under the ADA (unlike any other civil rights law) a plaintiff must prove that they belong to the category "persons with disability" and sue for each violation of the ADA that they encounter. Winning one suit does not mean that they are legally entitled to accommodations in every space that they occupy. For instance, winning the right to accessible employment does not ensure accessibility in the systems of transportation or health care that enable an individual to participate in work. As a result, relief fails to take into account a systems perspective, making it intermittent and ineffectual. This is worsened, according to Satz and others,[32] by the fact that courts have only very narrowly interpreted the definition of who qualifies for an accommodation or what accommodations are reasonable.[33] As a result, insufficient plaintiffs win cases to bring about large-scale change.[34]

Congress attempted to address these limitations of the ADA in its 2008 ADA Amendments Act (ADAAA).[35] The congressional record cites findings of a new wave of discrimination preventing equal access to spaces of public accommodation, such as

[32] See Satz 2008; Bagenstos 2004; see also Michael Ashley Stein and Penelope J.S. Stein, "Symposium: Beyond Disability Civil Rights," 58 Hastings L.J. 1203 (2007).
[33] Satz 2008, 520.
[34] To broaden the ADA's overall reach (Satz 2008, 541) Satz establishes a universal vulnerability framework for addressing fragmentation. See also Martha Albertson Fineman, "The Vulnerable Subject: Anchoring Equality in the Human Condition," 20 *Yale J.L. & Feminism* (2008) (on a framework of universal vulnerability as the basis for legal obligations); Susan Wendell, *The Rejected Body: Feminist Philosophical Reflections on Disability* (Routledge: New York, 1996) (on the philosophy of embodied vulnerability). This framework demonstrates that the ADA's formal equality approach is exclusive of a more universal conception of accessibility. As Satz argues, the targeted formal equality approach not only results in net fewer protections, but also fragments the interconnected spheres of work, transportation, health care, and public spaces (Satz 2008, 550). The fragmentation thesis supports a move away from the ADA's slow and ineffective approach towards a more systematic treatment of accessibility as an issue that depends on multiple systems and institutions—as well as re-imagined design practices—to be effective.
[35] ADA Amendments Act of 2008, Pub. L. No. 110-325, 122 Stat. 3553 (2008).

restaurants, theaters, and doctor's offices.[36] The ADA's failure to address this new wave of discrimination points to an unconsidered distinction between *equitable environments* and *meaningful use* in discussions about disability discrimination and formal equality.[37] Under the ADA, an individual must prove that they are impaired in a *major life activity* to qualify for accommodations.[38] In the employment context (Title I), where most ADA litigation has occurred,[39] the difficulties of qualifying under the statute have led to an extremely low rate of success for plaintiffs, causing Congress to expand the definition of a "qualified individual with a disability" (QID) through the ADAAA.[40]

Regardless of the scope of QID, however, the ADA approach of targeted and individualized accommodations ensures a fragmented landscape of protections for plaintiffs.[41] Though the QID issue is less important for Title III plaintiffs, individuals face a challenge that the ADAAA does not address: under Title III, injunctive relief[42] for plaintiffs against places of public accommodation is limited to specific and piecemeal

[36] For example, see Sheila Jackson Lee, "Testimony before the House of Representatives hearing on the ADA Amendments Act (September 17, 2008) H8297" (testifying that courts have narrowed the interpretation of a "qualifying individual with a disability" such that "disabilities that had been covered under the Rehabilitation Act and that Congress intended to include under the ADA—serious health conditions like epilepsy, diabetes, cancer, cerebral palsy, multiple sclerosis—have been excluded.").
[37] Following critiques of formal equality by Satz (2008) and Ruth Colker, "ADA Title III: A Fragile Compromise," in Leslie Francis and Anita Silvers (eds), *Americans With Disabilities* (New York: Routledge, 2000). I use these terms to differentiate between the physical removal of barriers and the issue of whether barrier-removal results in meaningful use of built environments. For example, lower courts have found that the inability of an individual with a disability to use a service does not violate the ADA's equal access provisions if they can, for example, still enter the space in which the service is administered. See *Ass'n for Disabled Ams., Inc. v Concorde Gaming Corp.* (2001, SD Fla) 158 F Supp 2d 1353. Also see *Todd v. Am. Multi-Cinema, Inc.,* 2003 U.S. Dist. LEXIS 25317 (S.D. Tex., Aug. 5, 2003). UD proponents also differentiate between barrier-free access and meaningful use by emphasizing that UD promotes the "quality of experience" rather than just the availability of access (Kawauchi 2009, 3; Jones in Kawauchi 2009, 32).
[38] See 42 U.S.C. § 12102(2)(A) ("The term 'disability' means, with respect to an individual—(A) a physical or mental impairment that substantially limits one or more of the major life activities of such individual…").
[39] See Michael Waterstone, "The Untold Story of the Rest of the Americans with Disabilities Act," 58 *Vanderbilt Law Review* 1807 (November 2005). (Title I is the most litigated title of the ADA).
[40] See ADAAA.
[41] See Satz 2010.
[42] Injunctive relief means that the plaintiff does not receive monetary compensation, but becomes able to require a place to accommodate them.

retrofits rather broader structural changes. Furthermore, courts have held that only those entities that both "design and construct"[43] a facility are liable under the ADA, exempting most architects, construction companies, or other entities that only partially participate but still play a crucial role in the construction of a space.[44]

Combined, injunctive relief and the diffusion of responsibility for accessibility constitutes a unique type of fragmentation: one that not only limits coordination amongst responsible actors, but also makes it highly unlikely that there will ever be a legal penalty severe or large-scale enough to provide incentives against inaccessible design. Michael Stein and Michael Waterstone's account of Title I fragmentation highlights the problem of collective action failure for Title III:

> [I]ndividual claims to accommodate specific impairments in particular jobs have all but eclipsed a coherent theory of disability-related disparate impact law. Moreover, the class action device, which historically played a central role in group-based discrimination theory […] has been virtually nonexistent under the statute's employment provisions.[45]

Because Congress and the courts have directed ADA penalties at property owners, not designers or builders, additional costly and time-consuming steps are required to prevent or end inaccessible design practices. Real estate consumers could discontinue the use of a particular architecture or construction firm, but this is unlikely to be effective given that

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[43] See 43 U.S.C. § 12183(a)(1): "a failure to design and construct facilities."

[44] Lower courts are somewhat divided on this issue but most have decided that architects are not liable under the ADA. See *Paralyzed Veterans of Am. v. Ellerbe Becket Architects*, 945 F. Supp. 1 (D.D.C. 1996) (architects are not liable under the ADA because they do not both "design and construct"); *United States v. Days Inn of Am., Inc.,* 22 F. Supp. 2d 612 (E.D. Ky. 1998) (hotel licensors are not liable under the ADA because they did not "design and construct" the hotel in question); *United States v. Days Inn of Am., Inc.,* 8 Am. Disabilities Cas. (BNA) 491, 493 (E.D. Cal. Jan. 12, 1998) (liability is limited to owners, lessees, lessors, and operators); see also James P. Colgate, "If You Build It, Can They Sue? Architects' Liability Under Title III of the ADA," 68 *Fordham Law Review* 137 (1999). Colgate argues that holding architects liable under the ADA is consistent with Congressional intent but does not currently occur in the courts. Also see Adam Milani, ""Oh, Say, Can I See- And Who Do I Sue If I Can't?: Wheelchair users, Sightlines over standing spectators, and architect liability under the Americans With Disabilities Act," 3 *Florida Law Review* 523 (July 2000) (discussing the implications of holding architects liable under the ADA).

[45] Stein and Waterstone 2006, 864.

the relationship between a building and the architecture firm often ends after construction is completed, leaving the owners of the physical property with the responsibility to alter the space. It is not surprising, then, that so many physical spaces remain inaccessible or in violation of the ADA. Direct lines of responsibility are largely missing for the people who are most likely to control the outcomes of design in the built environment.

Title III provides targeted, injunctive relief to plaintiffs, meaning that the result of winning a suit is that the defendant must make an accommodation to the built environment.[46] Such relief is limited to the removal of barriers, and does not include financial damages for plaintiffs.[47] This means that the probability of incurring financial penalties for inaccessible spaces is low because plaintiffs would have to win a suit and demonstrate that the accommodation they are seeking is reasonable and would not place an undue burden on the place of accommodation.

Disability discrimination law scholar Ruth Colker characterizes Congress's approach to Title III as a "fragile compromise."[48] In order to cover a large number of entities, "civil rights advocates agreed to a limited set of remedies under Title III," necessitating the exclusion of financial remedies. Colker's study of Title III cases between 1990 and 2000 reveals that the lack of monetary damages played a large part in both the disincentive for plaintiffs wishing to bring suits and their ability to win them.[49] Unfortunately, there are only a handful of successful Title III cases in the federal courts

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[46] See 42 U.S.C. § 12188(a)(2) ("injunctive relief shall include an order to alter facilities to make facilities readily accessible to and usable by individuals with disabilities to the extent required in this subchapter.").
[47] While monetary damages would also be an example of targeted relief, they could have been an additional incentive for an "accessibility by design" approach and could have provided incentives for plaintiffs to enter into a greater number of lawsuits.
[48] Colker 2000, 293.
[49] Ibid, pg. 294.

and even fewer at the Supreme Court level.[50] Because so few cases are litigated successfully and most suits are settled (and thus do not establish future precedents),[51] it is exceptionally difficult to predict how future courts will evaluate Title III claims. The gap left by Title III's remedies constitutes a unique form of fragmentation: plaintiffs have few incentives to bring suits to address discrimination, but even when they do, they are not compensated for the cumulative personal and economic costs they face.

The defenses available under Titles II and III severely limit the ADA's scope of coverage and the potential societal restructuring that a more universal approach would take. Title III exempts accommodations that are not "reasonable accommodations,"[52] that pose an "undue burden,"[53] or that "fundamentally alter" the nature of a service.[54] In a number of cases, courts have curtailed the scope of remedies according to these defenses.[55] For example, in *Todd v. Am. Multi-Cinema, Inc.,*[56] a Texas district court ruled that closed captioning films in movie theaters constituted an undue burden because

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[50] Only two Title III cases, *PGA Tour v. Martin* 532 U.S. 661; 121 S. Ct. 1879; 149 L. Ed. 2d 904; 2001 U.S. LEXIS 4115 (2001) and *Spector v. Norwegian Cruise Line, Ltd.* 427 F.3d 285; 2005 U.S. App. LEXIS 21201 (2005), have been decided by the Supreme Court. There are a number of lower and circuit court cases, but these do not decide whether plaintiffs receive protections because those decisions are made by the DOJ's arbitration system. When ADA Title III cases do go to court, this is usually over questions of whether the plaintiff qualifies for protections or whether the federal government has authority over these issues. For this reason, I have limited my selection of cases here to those that deal directly with the statutory limitations of the ADA.

[51] Colker writes that although there have not been many successful Title III cases, there have been a few large settlements that have yielded significant barrier removal (Colker 2000, 305). Unfortunately, the number of settlements is still too few to produce large-scale changes. Also, the nature of settlement itself guarantees that restructuring is limited to the entity in question and does not leave a precedent or record of legal reasoning for future courts to follow. Injunctive relief for Title III suits, then, not only provides limited, targeted relief, but makes it highly unlikely that enough suits will be brought for the ADA to have a strong signal against inaccessibility in the built environment.

[52] See 42 U.S.C. § 12184(a)(2)(A) ("the failure of such entity to—(A) make reasonable modifications consistent with those required…").

[53] See 42 U.S.C. § 12182(b)(2)(A)(iii) ("For the purposes of…this section, discrimination includes…(iii) a failure to take such steps as may be necessary…unless the entity can demonstrate that taking such steps would fundamentally alter the nature of the good, service, facility, privilege, advantage, or accommodation being offered or would result in an undue burden.")

[54] Ibid.

[55] See *Todd v. Am. Multi-Cinema, Inc*., No. H-02-1944, 2003 U.S. Dist. LEXIS 25317; *Cornilles v. Regal Cinemas, Inc*., No. 00-173-AS, 2002 U.S. Dist. LEXIS 7025.

[56] See *Todd v. Am. Multi-Cinema, Inc.* No. H-02-1944, 2003 U.S. Dist. LEXIS 25317

technology was limited, sometimes unavailable, and so expensive as to "greatly exceed the defendant's capital."[57] Third parties responsible for closed captioning, such as filmmakers, do not often include them in the first run of the film, and theaters (as secondary consumers) cannot be held liable.[58]

There is a direct parallel between this rationale and the ineffective chain of responsibility for inaccessible architecture under Title III. Because architects in their standard practice often design spaces without maximum accessibility in mind, retrofits by eventual property owners could pose an "undue burden." While these property owners will not be liable because third parties designed and constructed the space, architects and builders are also not held liable because they do not both "design and construct" the space.[59] According to ADA experts, the lack of liability for architects has allowed them to claim ignorance of the potential results of inaccessible designs and resulted in fewer plaintiffs winning their cases.[60]

The ADA fails to require drastic overhauls of buildings that are often necessary to make them accessible. While Titles II and III characterize as discrimination the "failure to make alterations…to the maximum extent feasible,"[61] the "undue burden" defense mitigates the extent of relief that entities must provide.[62] "Maximum extent feasible" is intended to serve as a floor rather than a ceiling for protections.[63] However, UD

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[57] Ibid.
[58] Ibid.
[59] See 43 U.S.C. § 12183(a)(1): "a failure to design and construct facilities."
[60] Sanjoy Mazumdar and Gilbert Geis, "The ADA and Accessibility: Interpretations in U.S. Courts," in Wolfgang Preiser and Korydon Smith, *Universal Design Handbook: 2nd edition* (McGraw-Hill, 2011), 7.6.
[61] See 42 U.S.C. § 12183(a)(2) and 42 U.S.C. § 12147(a).
[62] See *Kinny v. Yerusalem,* Third Circuit, 9 F.3d 1067; 1993 U.S. App. LEXIS 30167.
[63] The terms *floor* and *ceiling* are commonly used in policy discussions about technical guidelines to indicate minimum and maximum protections and penalties. See 42 U.S.C. § 12143(f)(1) ("nothing…shall be construed as preventing a public entity—(1) from providing paratransit or special transportation services

considerations, which are more thorough and may pose an undue burden, do not have an opportunity to enter the design process, restricting all new construction and remodeling to the ADA's limited accessibility standards. For example, in *PGA Tour v. Martin*,[64] the Supreme Court ruled that under Title III, Martin could have a golf cart while participating in a golf tournament due to a condition that made long distance walking difficult. The Court's rationale did not, however, require the golf course to alter its terrain to accommodate those with mobility-related or other disabilities (for instance, by constructing accessible, smooth paths) because such accommodations would have created an undue burden or significantly altered the nature of the service.[65] From this it becomes clear that the ADA places the burden of change on plaintiffs such as Martin and their bodies rather than the environment.[66]

The ADA and meaningful accessibility

The UD concept of *accessibility by design* describes the process by which architectural design centers and privileges accessibility, rather than exclusively focusing on aesthetics or function.[67] *Broad accessibility* in this context is a spatial concept not limited to persons with disabilities but inclusive of any person who may otherwise be

in addition to those…required by this section, or (2) from providing services to individuals in addition to those individuals to whom such services are required to be provided…").

[64] See *PGA Tour, Inc. v. Martin*, 532 U.S. 661 (2001).

[65] The Court ruled that Martin's request would have placed an undue burden on the golf course. See *PGA Tour, Inc. v. Martin,* ibid. Cases under Title I, which also allows these defenses, demonstrate the extent to which they can whittle away any substantial means of addressing disability discrimination. For an example regarding employment, see *Skerski v. Time Warner Cable Company*, 257 F.3d 273 (3d Gr. 2001). The Third Circuit prescribed a minimally-effective but "reasonable" accommodation to a cable company worker because it would have placed a less severe burden on the employer than the alternative.

[66] As I explain in Chapter 1, targeting individual bodies rather than environments for transformation is part of the medical and individualistic models of disability produced by both clinical medicine and rehabilitation. Chapter 2 explains how these philosophies and approaches enter barrier-free design.

[67] This is a term that I am using to designate the specific highlighting of accessibility in design considerations.

excluded from a space.[68] The key reason that *accessibility by design* differs from the ADA approach is the order of operations: *by design* means that accessibility is achieved in the design process and before construction, while under the ADA model, it occurs as a secondary consideration. UD also prioritizes the continuity of access to prevent the need for future retrofits when, for example, a person's embodied needs change while they live in the same home or use the same product over a lifetime.

Because the ADA does not require *accessibility by design*, except in certain forms of new construction, UD proponents represent its ability to mandate broad access under Title III as extremely limited. For example, they argue that even in new construction, architects approach ADA codes with "grudging compliance," designing a building first and then bringing it up to code before construction.[69] One of the reasons that UD positions itself as an extra-legal alternative to the ADA is that the ADA provides architects few incentives to change their design practices. They can simply continue business as usual and then make additions that would provide limited access to persons with disabilities. This is not only due to architects' attitudes, but also the "overwhelming"

[68] See Harvey Miller, "Place-based versus people-based accessibility," in D. Levinson and K. Krizek, *Access to Destinations* (Elselvier, 2005), 15. A broader notion of accessibility supports a systems approach to disability discrimination and recognizes that the problem of access is universal. Miller discusses methods of spatial and geographic analysis to assess accessibility by looking at how populations use spaces over time. Longitudinally, this approach reveals inaccessibility where it does not appear on a day-to-day level but does appear systemically.

[69] Elaine Ostroff and Leslie Kanes Weisman, "Universal Design, Beyond the ADA: An Introduction to Creating Inclusive Buildings and Places," (2004), 3-4; Sanjoy Mazumdar and Gilbert Geis, "Architects, the Law, and Accessibility: Architect's Approaches to the ADA in Arenas," *Journal of Architecture and Planning Research* 20.3 (2003): 210; Courtney Abbott Hill, "Enabling the ADA: Why Monetary Damages Should Be A Remedy Under Title III of the Americans With Disabilities Act," *Syracuse Law Review* 59.101 (2008): 109-115. For a study focusing on the ADA non-compliance of interior designers and architects in particular, see Sarah Sherman and Jean Sherman, "Design professionals and the built environment: encountering boundaries 20 years after the Americans With Disabilities Act," *Disability & Society* 27.1(2012): 51-64.

lack of ADA Title III enforcement by the Department of Justice.[70] For example, the Architecture and Transportation Review Board guidelines that accompany the ADA[71] suggest a number of baseline measures for improving mobility in space, but there are no incentives to exceed their guidelines or think differently about the populations they are serving. This can often mean that the ADA guidelines result in sub-par accommodations that do not keep abreast of innovations in accessibility features. For example, Universal Design researchers at the Georgia Institute of Technology's Center for Assistive Technology and Environmental Access have found that while the ADA guidelines for grab bars are useful for young people or those with substantial upper body strength, they do not provide the additional supports necessary for use by elderly people.[72] These researchers have developed alternative grab bars for people with low upper body strength, but these grab bars are difficult to market because they do not obey the ADA guidelines.

Universal Design as an alternative to the ADA

Although Ron Mace, the architect who coined the term "Universal Design," worked for decades as a barrier-free design consultant and helped to write the ANSI and North Carolina State technical guidelines for accessibility,[73] he also recognized the need to go beyond the ADA's formal equality emphasis on barrier-removal to create

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[70] Elana Nightingale Dawson, "Lawyers' Responsibilities Under Title III of the ADA: Ensuring Communication Access for the Deaf and Hard of Hearing," *Valparaiso University Law* Review 45(2011): 1156.

[71] See United States Access Board regulations and Architecture and Transportation Compliance Board guidelines.

[72] Jon Sanford, Katharina Echt, and Pascal Malassigneacute. "An E for ADAAG: The Case for ADA Accessibility Guidelines for the Elderly Based on Three Studies of Toilet Transfer, Physical & Occupational Therapy," *Geriatrics* 16.3-4 (2000): 39-58.

[73] Wolfgang Saxon, "Ronald L. Mace, 58, Designer of Buildings Accessible to All," Obituaries, *New York Times*. July 13, 1998.

meaningful and substantial equality for people with disabilities.[74] While Mace was trained as an architect, his understanding of Universal Design included the integrated design of buildings and products as an essential strategy of creating access across all scales of use.[75] This crucial recognition of the power of design in all aspects of life, from home life to employment, transportation, and spaces of public accommodation, marks UD as a more expansive strategy than ADA Titles II and III, which focus on built environments alone. As I demonstrate later in the dissertation, the transformative impact of UD on the field of industrial design shows the way that it addresses access as an issue of both individual and collective need, focusing on products and technologies as part of the way that users interface with spaces. UD also refines the ADA strategy for accessible architecture by making explicit the way that the ADAAAG and other minimum guidelines do not go far enough to create meaningful access, by design, without the need for retrofit.[76]

These distinctions are not merely a matter of a difference in ideology or practical approach. Rather, they are questions of epistemology and methodology. In what follows, I establish a framework for understanding UD as an epistemic community of knowledge producers and users that is produced through 19th and 20th century efforts to understand and accommodate human bodies in certain spatial configurations, such as industry, military service, and rehabilitation. My historical approach will show that the question of UD's politics and efficacy go far beyond legal analysis or the evaluation of design approaches to include historical and ideological productions of bodies as sources of knowledge about societal inclusion and exclusion.

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[74] Mace 1985; James Mueller, Personal Communication, October 10, 2011. Atlanta, GA.
[75] Mace 1985, 148.
[76] Mueller 2011.

Theorizing Universal Design

The literature on Universal Design outside of the humanities and social sciences focuses on two primary areas: assessing the efficacy of specific designs and promoting accessibility to designers.[77] This literature, which is broadly undecided about the scope and definition of Universal Design, generally directs itself towards an audience of designers and architects. While the architectural and industrial design literature has provided needed assessments of UD as a design phenomenon, critics have focused on critiquing universalism as a value or assessing whether specific designs can be truly universal.[78] The criticism of UD is usually that it does not go far enough and is a false aspiration not worth pursuing.[79]

This dissertation departs from these prevailing foci in several significant ways. First, it does not focus on design exemplars or evaluate their efficacy. In limiting the analysis of UD to specific instances of design and ignoring its epistemic and research practices, scholars have diverted attention from the broader epistemological, ontological, and ethical possibilities of accessible design. Likewise, the policy focus on access has privileged final products over the processes through which design emerges. As a result, attention to cultural, material, and scientific understandings of embodiment and knowledge at broader scales are largely taken for granted in the practical UD literature in favor of arguing for the cost effectiveness or aesthetic qualities of accessible architecture.

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[77] Selwyn Goldsmith, *Designing for the Disabled: The New Paradigm*. (Architectural Press, 1963/1997/2000/2012); Hall & Imrie 2001; Oliver Herwig, *Universal Design: Solutions for Barrier-free Living*. 1st ed. (Birkhäuser Architecture, 2008). Wolfgang Preiser & Elaine Ostroff (eds), *Universal Design Handbook: 1st edition* (McGraw-Hill, 2001); Wolfgang Preiser & Korydon Smith (eds), *Universal Design Handbook: 2nd edition* (McGraw-Hill, 2011).

[78] Jane Bringolf, "Assistive Technology and Universal Design: Language and Links for Inclusion." 2006. ARATA National Conference. August 15, 2011; Imrie 2012.

[79] Imrie and Hall 2001, 17; Jim Sandhu, "The Rhinoceros Syndrome: A Contrarian View of Universal Design," in Wolfgang Preiser and Korydon Smith (eds), *Universal Design Handbook*, 2nd ed., (McGraw-Hill, 2011).

I contend that an understanding of the history and theory of UD is necessary to make design and policy evaluations of UD more precise and productive.

Second, this dissertation avoids the normative discourses used to justify UD to designers. Most of these discourses focus on the economic promotion of UD to designers, builders, and fabricators.[80] UD proponents' marketing discourses are strategically part of a political push to de-stigmatize accessibility for architects, many of whom assume that accessibility is an aesthetic constraint preventing creative or lucrative work.[81] However, marketing discourses often erode the precise meanings of UD, using it as a "trendy acronym for compliance with the [ADA]."[82] Combined, the emphasis on marketing and the erosion of meaning around UD make examination of its underlying concepts and histories not only less intelligible but also more difficult. By attempting to justify UD to designers on aesthetic or economic grounds, the design studies literature ignores the historical and material knowledge of the body that makes the built environment possible, (quite ironically) leaving assumptions about disability as a condition of disqualification intact. More importantly, marketizing justifications ignore UD's curiosity about the body and drive to produce knowledge as an intervention into the built environment.

Third, the dissertation adopts a critical approach toward designerly knowledge and education that better addresses the underlying ideological commitments of professional design practices. According to UD proponents, architects perceive technical approaches to accessibility under the ADA and other access laws as too rigid to allow intuitive design

[80] Kawauchi 2009, 83, 132; Story, Mueller, & Mace 2011, 32.10.
[81] James Mueller, "The Case for Universal Design- If You Can't Use It, It's Just Art," *Aging International* 22.1 (March 1995); Steinfeld and Maisel 2012, 23.
[82] Ostroff 2011, 1.6.

thinking and creativity.[83] Proponents have identified architectural education as a site for disseminating information about UD and persuading designers to think differently about users.[84] While intervening in the knowledge practices of UD education is meant to identify and address the prevailing ideological trends of mainstream design, a consequence of the prevailing focus on marketing or aestheticizing UD in education is that many of its foundational assumptions have not been identified as part of the broader discourses in which UD participates.

For example, throughout the dissertation I will refer to the claim made repeatedly in the UD literature that architects are overwhelmingly able-bodied, do not think about users or disability, and that this is a result of their training and the lack of market incentives for changing their practices. UD proponent Elaine Ostroff exemplifies these arguments when she writes,

> Until universal/inclusive design is infused in pre-professional and continuing education, the attitudes of designers will limit their understanding and appreciation of diversity. They will continue to shape their designs for a mythic average norm, creating barriers that exclude the contributions and participation of people all over the world.[85]

These claims, which I historicize throughout the dissertation as foundational to the very practice of inclusive and accessible design, are made based on UD proponents' experiences in the design professions. They have been empirically tested by some social scientists interested in documenting architects' attitudes and conceptions about

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[83] David Chapin and Clare Cooper Marcus, "Design Guidelines: Reflections of Experiences Passed," *Architecture & Behavior* 9.1 (1993), 103; Rob Imrie, "Architects' Conceptions of the Human Body," *Environment and Planning D* 21.1 (2003): 47-65.
[84] Steinfeld and Maisel 2012, 74-76.
[85] Ostroff 2011, 1.9.

disability.[86] Nevertheless, my focus in the dissertation is not to verify, endorse, or dispute this foundational assumption of inclusive design practices. Rather, I show how the impression that architects do not think about users and disability is a product of historical regimes of knowledge that make users and disability perceptible or imperceptible as objects of design. Rather than advocating for UD or its approaches to inclusive design, I use tools from feminist and disability theories and epistemologies to identify, critique, and develop language for the positions that UD is already setting forth.

I contend that in the context of UD, design scholars have not drawn upon tools from critical humanities fields such as disability studies, feminist theory, or the history and philosophy of science and medicine to consider the cultural, material, and scientific understandings of embodiment and knowledge at play in the phenomenon. As a result, the underlying ideological and epistemological work of UD is largely under-theorized or taken for granted. What is missing from research on UD is an interdisciplinary, critical humanities approach that examines the epistemic force of UD as what feminist science studies scholar Karen Barad calls a "material-discursive phenomenon."[87] Such an approach has been impossible because of the lack of a comprehensive historical account of UD's formation within design research disciplines and professional design practices. To shift the focus of research and commentary in the prevailing literature, I approach Universal Design as an epistemic community comprised of university and non-profit

[86] Imrie 2003; Rob Imrie, "The interrelationships between building regulations and architects' practices," *Papers* in Rob Imrie and Emma Street (eds), *'The codification and regulation of architects' practices'* (London: King's College, 2007).
[87] *Material-discursive* is a term I borrow from feminist science studies scholars, Karen Barad and Donna Haraway, to indicate the way that materialities—in this case the built environment—produce meaning and theory. See Barad (2007) for a discussion of the "material-discursive" concept, which she develops in conversation with Donna Haraway. See Karen Barad, *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning* (Durham: Duke University Press, 2007).

research centers, researchers from a number of disciplines, and designers applying knowledge to design.

Universal Design and Disability Studies

To assess the significance of UD's epistemological frame, it is important to first understand its role as an object of knowledge within the humanistic fields of critical disability studies, feminist disability studies, and feminist and disability architectural and geographic theories. Feminist geographer Isabel Dyck notes that "conceptualizing the environment has been crucial to the politics of disability research in delineating issues of access, a crucial dimension of a socio-spatial model of disability."[88] However, within certain feminist and disability theories, *environment* is under-theorized as an empty container for human interaction or taken for granted as necessarily separate from the body or designerly agency. [89] While disability studies has engaged extensively with geographies of access and "cultural locations of disability,"[90] disability theories of built environments have not often invited collaborations with architectural theory or practice. Given the role of space and architecture in both feminist and disability theorizing, I argue that feminist disability studies requires a more nuanced theory of UD based on the relations between bodies and environments.

UD gestures toward the creative possibilities that intentional inclusive design practices can generate. This has made the concept attractive to disability studies, for

[88] Isabel Dyck, "Geographies of Disability: Reflecting on New Body Knowledges," in Vera Chouinard, Edward Hall, and Robert Wilton (eds), *Toward Enabling Geographies: 'Disabled' Bodies and Minds in Society and Space* (Burlington: Ashgate, 2010), 254.
[89] As in Rob Imrie, "Disability, Embodiment, and the Meaning of Home," in Vera Chouinard, Edward Hall, and Robert Wilton (eds), *Toward Enabling Geographies: 'Disabled' Bodies and Minds in Society and Space* (Burlington: Ashgate, 2010).
[90] David Mitchell and Sharon Snyder, *Cultural Locations of Disability* (Chicago: University of Chicago Press, 2006).

which UD is often synonymous with good or inclusive design. Disability theorists have used Universal Design to substantiate the *social model of disability*, according to which the built environment grants privilege to certain bodies and excludes others by producing barriers that construct disability.[91] For instance, feminist disability philosopher Susan Wendell contrasts UD to the medical model under which disability is pathology to be cured or eliminated.[92] Likewise, disability philosopher Anita Silver agrees with Wendell about the need for universal access, invoking UD to mean environments that "welcom[e] rather than def[y]" disabled bodies.[93] She argues that exclusion results from disability not being recognized as a majority experience of spatial inhabitation.[94]

Other disability theorists make political claims about UD being the desired outcome of disability rights activism. For these theorists, UD is a broad and equitable political intervention into the built environment. These theories of the body and the built environment reflect anthropologist Edward Hall's notion of architectural and urban space as a "hidden dimension" of society that articulates values and produces social relations.[95] For instance, Lennard Davis describes UD as a "template for social and political designs," a response to the fantasy of embodied normalcy.[96] If, as UD advocates claim, the built environment can be made universally accessible by design, then the exclusion of people with disabilities from social and built worlds is a *construction* of those worlds rather than predetermined by the biological lack or excess of disabled bodies. Likewise, the existence of UD can prove that disability is a material manifestation of exclusions

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[91] Michael Oliver, *The Politics of Disablement*: *A Sociological Approach* (St. Martin's Press, 1990).
[92] Wendell 1996, 55.
[93] Silvers, Anita. 1998. "Formal Justice," in Anita Silvers, David Wasserman, and Mary Mahowald (eds), *Disability, Difference, and Discrimination,* (Oxford: Rowman and Littlefield Publishers), 129.
[94] Silvers 1998, 74-75.
[95] Edward Hall, *The Hidden Dimension* (Anchor Books, 1966).
[96] Davis, Lennard, *Bending Over Backwards: Disability, Dismodernism and Other Difficult Positions*. 1st edition. (New York: NYU Press), 31.

resulting from the imperceptibility of the concerns of people whose bodies deviate from norms of health and wellness. Thus, disability studies' stake in UD is not only the production of accessible environments, but also the evidence it provides for the social model of disability.

Geographies of access

A rich literature in feminist geography focuses on gendered construction of the public and private realms, namely the architectural implications of home life, work, and urban space for women and children.[97] However, disability geographers have more directly taken up geographies of access to the built environment.[98] Rather than focusing on the formal and physical elements of space, materialist disability geographers have recently shifted to focusing on embodied, lived experiences of built environments.[99] They have argued—quite strongly—that the focus on physical environments as the key to accessibility makes access an issue of technical specification and does not take into account the structural conditions producing the need for access.[100]

Disability geography tends to focus on users rather than designers in order to avoid rendering people with disabilities as "passive victims of insensitive design."[101] However, in an effort to re-conceptualize spatial and social constructivist theories on the

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[97] Denise Scott Brown, "Room at the Top?: Sexism and the Star System in Architecture," in Iain Borden, Barbara Penner, and Jane Rendell (eds), *Gender Space Architecture: An Interdisciplinary Introduction* (London: Routledge, 2000); Rose 1993; Leslie Kanes Weisman, "Redesigning Architectural Education," in Joan Rothschild (ed), *Design and Feminism: Re-visioning Spaces, Places, and Everyday Things,* (Camden: Rutgers UP, 1992).
[98] Vera Chouinard, Edward Hall, and Robert Wilton, eds. *Toward Enabling Geographies: 'Disabled' Bodies and Minds in Society and Space* (Burlington: Ashgate, 2010); Brendan Gleeson, *Geographies of Disability* (London: Routledge, 1999).
[99] Imrie 2010.
[100] Imrie 2010; Gleeson 1999.
[101] Imrie 2010, 35.

materiality of the body, some disability geographers[102] have separated the materiality of the body from the materiality of the environment, characterizing the latter to be static and the former more dynamic.[103] However, in arguing against a focus on the physical environment, disability geographers have separated *environment* and architectural design from their *material-discursive*, representational, embodied, and epistemic qualities. They have also ignored the work that UD does to propose design interventions that go beyond technical requirements.

Instead, this dissertation takes the position that a feminist disability theory of UD requires attention to how physical environments produce material effects, such as access or misfit, through their interactions with embodiment. The notion that there is a physical environment that pre-exists embodied experience fails to acknowledge the reliance of design processes on bodies and inhabitants. Treating built environments as static objects also makes it more difficult to detect the values about bodies that circulate within architectural practices. Following recent work in feminist new materialism, I understand built environments and design processes as emerging from the interfaces between designers, spatial inhabitants, and materiality.[104] The dissertation historicizes these interfaces, showing the mutual emergence and sedimentation of disability, space and knowledge about bodies.

Interdependence and collective access

[102] Here I am mostly referring to so-called *second wave disability geographers*, who focus their work on embodied experiences of space. See Chouinard, Hall, and Wilton 2011.
[103] Imrie 2002, 64.
[104] Barad 2007, 158.

Understanding UD as an *epistemic community*[105] requires a theory of interdependence and collective access that takes into account not only the beneficiaries of access, but also the network of agents that make it possible. Interdependence is a critical feminist disability concept explored through the contexts of care, person-environment relations, and critiques of autonomy under liberal democracy.[106] Feminist disability theory shows that the lack of access to built environments is often about stigmatizing dependencies. Disability, aging, and femininity all characterize dependence in the liberal model, which ignores the fundamental interdependence of all bodies for sustenance, community, and care.[107] Recent disability justice work from activists like Mia Mingus on the notion of "collective access" has advocated for bottom-up practices prioritizing multiple forms of access rather than dismissing access as a resource-intensive strategy necessitating compromises and trade-offs.[108]

Collective access also recalls the work of feminist materialist architects, who designed built environments to challenge inaccessibility through the politics of interdependence. Dolores Hayden, famously asking, "What would a non-sexist city be like?," imagined the re-appropriation of suburban homes to fit the needs of non-traditional families living in collective housing.[109] She showed that suburban neighborhoods built for nuclear families could be divided up into duplexes, co-housing,

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[105] Epistemic community is a concept in science studies, specifically the sociology of scientific knowledge, that understands communities to be the primary epistemic agents. See Knorr-Cetina (1999).
[106] Rosemarie Garland-Thomson, "Disability and Representation." *PMLA* 120.2 (March 2005): 522-527; Nancy Eiseland. *The Disabled God: Toward a Liberatory Theology of Disability* (Nashville: Abington Press, 1994); Eva Kittay, *The Subject of Care: Feminist Perspectives on Dependency* (Lanham, MD: Rowman & Littlefield, 2002); Martha Albertson Fineman, *The Autonomy Myth: A Theory of Dependency* (New York: New Press, 2005).
[107] Wendell 1996, 145-148.
[108] Mia Mingus, "Changing the Framework: Disability Justice," *RESIST Newsletter* November/December (2010).
[109] Dolores Hayden, "What Would a Non-Sexist City Be Like? Speculations on Housing, Urban Design and Human Work," in Iain Borden, Barbara Penner, and Jane Rendell (eds), *Gender Space Architecture: An Interdisciplinary Introduction* (London: Routledge, 2000)

daycare space, and community green space, allowing single people, parents, and children to build community in spaces originally intended for white, middle class families. She tied this work to an anti-capitalist critique of consumer culture, unpaid domestic labor, and the spatial divisions between "the household and the market economy."[110] Redesigning space and critiquing existing built structures was a strategy of addressing broader economic structures that depended upon the suburban household to exist.

Rather than focusing solely on the physical environment or embodied experiences of space, Hayden's work shows why a theory of access must center body-environment entanglements. Her analysis of the construction of suburban space, for example, is not about marginalized people as "passive victims of insensitive design."[111] Instead, it is about how feminists have targeted the culture of suburban home life to simultaneously address capitalism and patriarchy through attention to unpaid labor, lack of access to safe housing, the need for healthy and green spaces, and the unique concerns of non-traditional familial arrangements.

A new materialist approach[112] focusing on UD as a material-discursive phenomenon can build upon this foundational feminist architectural scholarship by focusing not only on capitalism or the interdependence of people, but also the

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[110] Hayden 2000, 270.
[111] Imrie 2010, 35.
[112] New materialism refers to the turn toward embracing materialism or realism as alternatives to constructivism within feminist and non-feminist theoretical fields. New materialists are usually influenced by Gilles Deleuze and Felix Guattari, cybernetics and systems theories, and philosophies of science who have re-evaluated matters of ontology and agency by taking materiality seriously. While the insistence on materiality is not new in feminist critique, feminist new materialists are often responding to post-structuralism's insistence on the primacy of language as the system organizing reality. See Barad 2007; Diana Coole and Samantha Frost (eds), *New Materialisms: Ontology, Agency, and Politics* (Durham: Duke University Press, 2010); Elizabeth Grosz (ed), *Becomings: Explorations in Time, Memory, and Futures* (Ithaca: Cornell University Press, 1999); Manuel Delanda, *A New Philosophy of Society: Assemblage Theory and Social Complexity* (New York: Continuum, 2006); Rosi Braidotti, *Nomadic Subjects* (New York: Columbia University Press, 1994); Stacy Alaimo and Susan Hekman (eds), *Material Feminisms* (Bloomington: Indiana University Press, 2008).

interdependence of bodies, environments, and scientific knowledge. Moreover, such an approach brings into view the unique role of built environments in producing material relationships. In what follows, I develop the critical concept of the *normate template* for design to describe status quo material arrangements of exclusion from the built environment.

The normate template: a feminist disability design concept

Throughout the dissertation, I examine UD's ideological, epistemological, and methodological practices by applying lenses from feminist and disability studies. Two concepts from critical disability studies—the normate and the misfit—guide my discussion. Feminist disability theorist Rosemarie Garland-Thomson coins the term, "normate" to indicate the non-stigmatized figure of the average-sized, able-bodied, white, upper middle class, heterosexual, male body—a body that is deemed so "normal" in society that it has become the standard against which society measures difference.[113] The normate is an imagined figure, but forms a template for society and is often assumed to be the typical person (or in the case of design, the likely end-user). The seeming neutrality of the normate hides the way that using it as a figure of reference has created a built environment not designed for a diversity of bodies in mind.[114]

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[113] Rosemarie Garland-Thomson. *Extraordinary Bodies: Figuring Physical Disability in American Culture and Literature*. New York: Columbia University Press, 1996, 8.
[114] I use *normate* rather than a term such as *normative body* to distinguish figures occupying a standard and ideal space from the statistical concept of *norm* or the term *normative*, which ascribes a regulatory quality of returning things to a so-called *normal state*. I also use *normate* throughout the dissertation to distinguish figures characterized or perceived as *normal* from both the statistical calculation of averages and the prescriptive quality of *normatizing*. When I do use *normative,* I am referring to a prescriptive or polemical function of norms. Likewise, when I refer to *norms* (throughout the dissertation but especially in Chapter 3), I am referring to the 19th century statistical and anthropometric concept of norms and averages and the related cultural idealization of the position of the norm. This provides more precise language for exploring and complicating the *philosophy of the norm* (from the history and philosophy of science), particularly in

As a foil to the normate, Garland-Thomson has recently theorized the "misfit," a condition of embodiment rendered non-normate by its exclusion from the built and social environments.[115] Misfitting marks the failure of the *normate template* to accommodate human diversity. Garland-Thomson writes,

> Like the dominant subject positions such as male, white, or heterosexual, fitting is a comfortable and unremarkable majority experience of material anonymity, an unmarked subject position that most of us occupy at some points in life and that often goes unnoticed. When we fit harmoniously and properly into the world, we forget the truth of contingency because the world sustains us. When we experience misfitting and recognize that disjuncture for its political potential, we expose the relational component and the fragility of fitting. Any of us can fit here today and misfit there tomorrow.[116]

I am interested in this relationship between the *normate* and the *misfit* because it is a conceptual scheme that takes more common binary notions, such as the 19th century medical categories of *normal* and *pathological*, and gives them context within the built environment. *Normates* are impossible social constructs, yet the intended presence of these figures is built into the physical environment. *Misfit* is a material construct and a nearly universal experience that demands accountability by the built environment. Both are temporally contingent and part of a regime of intelligibility. In this regime, the *normate* shifts out of view but is ever-present as a taken-for-granted position while the *misfit* repeatedly becomes apparent through its non-compliance with the existing designed forms. Tracing the history of how *misfits* are included or omitted from categories such as user or spatial inhabitant, as well as knowledge production defining

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chapters 1 and 3. This is not to suggest that the *normate* is not polemical or prescriptive, but rather to parse out the figure from the practices of judgment and normalization surrounding it and create more precise language for discussing the *normativizing* aspects of design and space.

[115] Rosemarie Garland-Thomson, "Misfits: A Feminist Materialist Disability Concept," *Hypatia* 26.3 (2011): 591-609.

[116] Garland-Thomson 2011, 11.

these categories, allows the dissertation to also show how UD addresses *misfit* through epistemological and methodological interventions.

Throughout the dissertation, I develop the notion of a *normate template* for design as an *epistemic regime* or *regime of intelligibility*.[117] The normate template is both an epistemic object (that is, an historically produced and reinforced object of knowledge) and an object of UD's epistemological criticism. *Template* is a design concept describing the application historical form, style, method, or precedent to a design problem. In the case of the body, architects and other designers often use actual templates—predetermined, standardized normate bodies—to determine the spatial needs of users. Templates are material-discursive phenomena. Likewise, the *normate template* is an epistemic regime with an ontologizing function. It not only fits built environments to *normate* bodies, but also performs epistemological work in defining the ways that users and bodies in general can be studied, measured, and applied to design.

Built environments are not simply social constructs, but become *material-discursive* phenomena, articulating meaning through the language of materiality. This meaning also produces social relations—or what Hall characterizes as the "hidden dimension" of architecture.[118] The related notion of *parti* in architectural theory indicates the way that buildings make material arguments using layout, style, or theme.[119] Inaccessible environments often have an unintentional *parti*, such as the exclusion of minority embodiments. For instance, the design of a courthouse with steps leading to its

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[117] As I explain later in the section on methodology and historical epistemology, these are concepts from the history and philosophy of science that allow me to trace the way that meaning and concepts circulate around a particular organizing object or term. The concepts of *epistemic* (having to do with knowledge) and *intelligibility* (the way in which knowledge becomes legible and thinkable) are crucial to my analysis.
[118] Hall 1966.
[119] Patrik Schumacher, *The Autopoesis of Architecture, Volume II: A New Agenda for Architecture* (Sussex: John Wiley & Sons, 2012), 52.

entrance may make an argument about the transcendence of law above the people. Interior grand staircases leading the public into courtrooms and judges chambers can communicate the democratic openness of arenas of legal decision-making. However, the presence of stairs argues for a particular understanding of citizenship—one defined by the ability to climb steps—and results in an implied but potent exclusion of people with mobility disabilities from the symbolic and physical aspects of courtroom space.

In 1977, when disability rights activists staged sit-ins across the country to demand the enforcement of Section 504 of the Federal Rehabilitation Act, they occupied and refused to leave accessible spaces until the law was put into effect.[120] By occupying inaccessible spaces, these activists performed material-symbolic gestures using their bodies in space as arguments against the *parti* of these buildings. The misfit between bodies and steps symbolized the segregation of disability from public life and the need for disability civil rights. This spatial-symbolic activism communicated spatial exclusion in a way that courtroom proceedings, congressional testimony, and other discursive modes alone could not do.

The *normate template* is a critical concept that allows disability scholars to understand both *parti* and embodiment as material arrangements that make arguments about what kinds of bodies should occupy space. The existence and persistence of the normate template demonstrate that built environments are not merely containers for human interaction, but actively contribute to the sedimentation of social arrangements, such as disability exclusion. To understand the way that the *normate template* articulates

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[120] For a comprehensive historical archive of these sit-ins, see National Public Radio (2002), "A Look Back at 'Section 504', available at: < http://www.npr.org/programs/wesun/features/2002/504/>.

the values, ideologies, and epistemic practices of design, I now turn to further theorizing the notion of *value-explicit design*.

Value-explicit design: what built environments do and say

Like feminist and disability approaches to access, Universal Design is what environmental design theorists call a *value-explicit design theory*.[121] It critiques the false universality of inaccessible environments and offers solutions based on ideologies of inclusion and equitable use. Supposedly value-neutral environments are not universally usable, but simply value-implicit. While the design of all built environments keeps certain spatial inhabitants in mind, some designers understand these inhabitants to be generic or average humans. Others more explicitly define strategies of inclusion for minority bodies.

According to UD, while built environments demonstrate the values of designers, they also communicate (as material-discursive phenomena) *parti*s. While *parti* is a more traditional architectural concept, a value-based understanding of this notion mirrors contemporary architectural phenomenologist Juhani Palassma's claim that architecture is a "communication from the body of the architect directly to the body of the person who encounters the work."[122] UD views built environments' *partis* as what post-humanist and new materialist theorists call *agentive,* producing meaning through their material

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[121] Value-explicit design is a term used to describe environmental interventions with a specific ideological goal in mind. See Gary Moore, Paul Tuttle, & Sandra Howell, *Environmental Design Research Directions* (Westport: Praeger, 1985). I further develop this theory here using feminist philosophies of value and knowledge.
[122] Juhani Palassma, *Eyes of the Skin: Architecture and the Senses* (Chichester: John Wiley & Sons, 2005), 46.

effects.[123] For example, buildings with over-stimulating lights or confusing layouts rarely if ever identify themselves as positioned against people with sensory aversions or cognitive impairments, but become so through their design features. Value-explicit designs, like accessible restrooms with transgender-inclusive signs, houses built at the scale of people of short stature, and accessible kitchens with countertops that adjust to different heights, can focus on either specific types of embodiment or a range of embodiments.

Like feminist standpoint and situated knowledge theories, the crux of value-explicit design is that there is no neutral position or "view from nowhere" that is untouched by materiality, context, and identity.[124] While standpoint epistemology focuses on the social location of knowers, the role of architectural space as context or milieu is largely under-theorized. One exception is feminist epistemologist Lorraine Code's work on the situatedness of "geographical-ecological-material [epistemic] locations."[125] Another is the feminist disability concept of "sitpoint theory," which marks the epistemic and spatial position of sitting (i.e. in a wheelchair, as opposed to standing) as generative of knowledge.[126] Value-explicit design builds upon these epistemologies by understanding design itself as an epistemic practice producing and utilizing situated knowledge.[127]

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[123] See for example the theories of agency of Karen Barad (2007); Bruno Latour, *Reassembling the Social: An Introduction to Actor-Network-Theory* (Oxford: Oxford University Press, 2007); and Vicky Kirby, *Vibrant Matter: A Political Ecology of Things* (Durham: Duke University Press, 2010).
[124] Donna Haraway, "Situated Knowledges," in *Simians, Cyborgs, and Women* (New York: Routledge, 1991).
[125] Lorraine Code. *Ecological Thinking: The Politics of Epistemic Location* (New York: Oxford University Press, 2006), viii.
[126] Garland-Thomson 2002; Nancy Mairs, *Waist-High in the World: A Life Among the Nondisabled*, (Boston: Beacon Press, 1997).
[127] In other words, rather than foregrounding situated knowledge, as feminist epistemologists have done, value-explicit design focuses on making the commitments of different forms of knowledge more

Whether explicit or implicit, built environments always reference and imagine bodies and spatial inhabitants. Architecture, like scientific epistemologies, has throughout its history either claimed ignorance of the body or adopted a universal template of the harmonic, geometric, and proportional body.[128] However, both the presumed body and the marginalized body are always implicitly present, structurally built into or excluded from design *partis*. Value-explicit design exposes the reliance of architecture on bodies, demonstrating that bodies and environments "are conjoined in their (mutual) production, meaning, and transformation."[129] Design methodologies that address specific values, such as eco-sustainability, disability access, economic affordability, or gender equality, highlight the interactions between assumed bodies and design outcomes.

The common position of feminist and disability theories of access is that value-neutral built environments mask the dominance of perceived majority identities. Leslie Kanes Weisman, a feminist architectural theorist and UD educator, exemplifies this position in her "Women's Environmental Rights: A Manifesto," declaring:

> The built environment is largely the creation of white, masculine subjectivity. **It is neither value-free nor inclusively human**. Feminism implies that we fully recognize this environmental inadequacy and proceed to think and act out of that recognition […] These are feminist concerns which have critical dimensions that are both societal and spatial. They will require feminist activism as well as architectural expertise to insure a solution.[130]

The feminist focus on "white, masculine subjectivity" and the disability focus on able-bodied designers creating inaccessible environments demonstrate how designers'

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intelligible and explicit within design practice. Thus, my argument here is less about situatedness in terms of the identitarian and embodied perception of the world as it is about developing a theory of how to identify and critique forms of expert designer knowledge that have otherwise characterized as neutral.

[128] Lance Hosey, "Hidden Lines: Gender, Race, and the Body in *Graphic Standards*," *Journal of Architectural Education* 55.2 (2006): 101-112; Imrie 2003.

[129] Imrie 2003, 64.

[130] Leslie Kanes Weisman, "Women's Environmental Rights: A Manifesto," in Iain Borden, Barbara Penner, and Jane Rendell (eds), *Gender Space Architecture: An Interdisciplinary Introduction* (London: Routledge, 1981/2000), 5, emphasis added

embodiments, status, values, and experiences can be made explicit for constructive critique. In feminist and disability theories identifying value-explicit design, such as those of Weisman, Hayden, and barrier-free design, if designers occupy positions deemed normal and neutral, then built environments will reflect the projection of their bodily experience onto that of the assumed spatial user.[131] Likewise, when built environments fail to consider, consult, or include marginalized bodies *by design*, the resulting inaccessibility presents material proof of the injustice of a world crafted by knowers and designers who do not keep accessibility in mind.[132] Value-explicit design theories thus operate in a similar fashion to feminist standpoint theories in the way that they address design as an epistemic practice.

What designers know: the normate template and epistemologies of ignorance

UD frames itself as a response to what disability theorist Tobin Siebers calls the "ideology of ability," or the societal "preference for able-bodiedness" that defines disability as abnormal.[133] The theory of value-explicit design makes a crucial distinction between design that feigns neutrality but is intended for specific users, and design that identifies its intended users. An additional distinction is necessary between the idealized normate user of space and the real, fleshy misfitting bodies that are left out of this

[131] Also see Imrie (2003) on architects' conceptions of and treatments of users. The position that designers do not account for people with disabilities is often put forth in the UD literature without the citation of any data. While this may appear to construct a strawperson argument, it is also a foundational assumption of the practice of accessibility. As I clarified above, I am not endorsing this position as a truth claim, but I am interested in exploring what kind of epistemic position such a claim is.
[132] As a point of clarification, my dissertation is not concerned with making judgments about individual architects and their ableism, but rather identifying the frameworks that different theories of design create for identifying values and ideologies. This is precisely why I do not conduct the kind of design evaluation that is more typical of the design literature. What I am concerned with, however, is creating a framework in which to discuss how design is a knowledge-driven practice, the ideological content of which can be understood through an epistemological and methodological lens as much as or even more so than through a framework that considers specific design examples and evaluates them for the extent of their inclusion.
[133] Tobin Siebers, *Disability Theory* (Ann Arbor: University of Michigan Press, 2008), 8.

idealization. The *normate template* produces the illusion of what Imrie characterizes as disembodied environments that "deny the presence or possibility of bodily impairment."[134] However, marginalized and minority embodiments still exist in space and experience misfit.[135] The *normate template* is thus the ideological system that produces inaccessibilities and misfits by feigning ignorance of specific embodiments. In UD's theory of value-explicit design, the exclusion of misfitting bodies from built environments is not due to their non-existence, but to claims of ignorance about them. The foundational claim that "the more designers know about users, the better they can design"[136] defines a relation between the intelligibility of specific types of users and inclusion in built environments.

Further theorizing the *normate template* requires attention to the rhetorical framings of designers that retroactively excuse the material exclusion of misfitting from the cohort of ideal spatial inhabitants. In *The Question of Access* (2011), Tanya Titchkosky explores how the lack of knowledge about disability became an excuse for misfit when she requested the design of an accessible classroom at her university. Discussing the way that university managers and bureaucrats deployed ignorance in order to avoid spending resources on accessibility, she notes,

> The apparent and obvious ease of a statement like 'things just weren't built with people with disabilities in mind' is a way to make inaccessibility sensible under contemporary conditions. This ordinary 'truth claim' is a type of say-able thing in relation to disability. […] [T]he say-able is where cultural understandings reside.[137]

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[134] Imrie 2010, 40.
[135] Garland-Thomson 2011.
[136] John Salmen, "U.S. Accessibility Codes and Standards: Challenges for Universal Design," in Wolfgang Preiser and Korydon Smith (eds), *Universal Design Handbook* (McGraw-Hill, 2011), 6.1.
[137] Tanya Titchkosky, *The Question of Access* (Toronto: University of Toronto Press, 2011), 74.

Keeping types of people "in mind" is an epistemic position that is often unintelligible within the framework of architectural design processes.[138] However, designers produce misfit when they claim ignorance about spatial inhabitants. Designers and bureaucrats exemplify this by claiming, "You can't accommodate everybody. You've got to draw the line somewhere."[139] These acts of line drawing constitute what Barad calls "agential cuts," or the epistemic and material process through which "bodies differentially materialize as particular patterns of the world as a result of the specific cuts and reconfigurings that are enacted."[140] Although architects design buildings with some bodies in mind, the delineation of normate bodies as spatial inhabitants and misfits as "justifiably excludable" solidifies normate privilege.[141]

Garland-Thomson's notion that environmental fit makes able-bodied people less aware of their own embodied privilege ("we forget the truth of contingency because the world sustains us") echoes moral philosopher Charles Mills' argument that the system of racism makes white people less likely to acknowledge and understand privilege.[142] When normate architects or lawmakers claim that there are too many disabilities to keep in mind, or that they do not have the requisite information to design for minority embodiments, this is not only a lack of available information but also a practice in what critical race and feminist epistemologists call the "epistemology of ignorance."[143] According to this these theorists,

> ignorance is not the result of a benign gap in our knowledge, but deliberate choices to pursue certain kinds of knowledge while ignoring others. We must

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[138] Imrie 2002, 55.
[139] Titchkosky 2011, 31.
[140] Barad 2007, 176
[141] Titchkosky 2011, 78
[142] Charles Mills, *The Racial Contract* (Ithaca: Cornell UP, 1997), 97.
[143] Mills 1997; Nancy Tuana and Shannon Sullivan, eds. *Race and Epistemologies of Ignorance* (Albany: State University of New York Press, 2007).

> therefore concern ourselves with our choices of knowledge production and who we take ourselves to be accountable to through these choices.[144]

As opposed to feminist epistemologies of the construction of situated knowledge, epistemologies of ignorance show the particularized agendas and power relations of (what appears to be) the absence of knowledge. A design theory focusing on the absence of the body in architecture as an implicit design value highlights the ways that knowledge and ideology are always present in built environments, even when they present themselves as neutral. The point is to affirm the normate template as a produced form of ignorance rather than a natural or permissible form of exclusion.

Epistemic activism is a response to epistemologies of ignorance and has a long history within efforts for inclusive design. Misfits, like people with disabilities, have contested the massive structural injustices of value-implicit environments at both symbolic and functional levels. As architect Ray Lifchez[145] wrote in his groundbreaking *Rethinking Architecture: Design Students and Physically Disabled People* (1987),

> Building forms reflect how a society feels about itself and the world it inhabits […] Valuable resources are given over to what is cherished—education, religion, commerce, family life, recreation—and tolerable symbols mask what is intolerable—illness, deviance, poverty, disability, old age. Although architects do not create these social categories, they play a key role in providing the physical framework in which the socially acceptable is celebrated and the unacceptable is confined and contained. Thus when any group that has been physically segregated or excluded protests its second-class status, its members are in effect challenging how architects practice their profession.[146]

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[144] Heidi Grasswick, "Introduction: Feminist Epistemology and the Philosophy of Science in the Twenty-First Century," in Heidi Grasswick (ed), *Feminist Epistemology and the Philosophy of Science* (Middlebury: Springer, 2011), xvii

[145] UD has developed approaches that challenge the designer's epistemic authority and foster collaborations between users and designers (Kawauchi 2009, 76-78). Social justice approaches to UD privilege the "user/expert" and "representative users" in the design process (Fletcher in Kawauchi 2009, v; Story 2011, 4.11-12).

[146] Raymond Lifchez, *Rethinking Architecture: Design Students and Physically Disabled People* (Berkeley: University of California Press, 1987), 1.

Privileging the embodied user experience of misfit is one way of addressing epistemologies of ignorance and conceptualizing alternatives beyond them. Value-explicit design can challenge the relationship between the knowing designer and the spatial inhabitant as an object of design practice.

Participatory design methodologies developed by feminist and disability-focused designers offer a way of using designerly knowledge to critique the normate template's epistemology of ignorance. Lifchez famously trained students at the University of California-Berkley School of Architecture by bringing people with disabilities into the design studio. In doing so, he centered misfit embodiment and made design students accountable to the needs of others beside themselves. He also decentered the designer as the authoritative knower or expert, training students to take on partnership roles with their intended clients and to value their authority and expertise about the experience of the built environment.

While participants in the process noted the difficulties that students had with shifting expertise to clients with disabilities,[147] Lifchez's methods worked to make disability intelligible to design students. Other design educators have focused on training new generations of architectural students in UD methodologies and research through work like the Universal Design Education Project[148] and user-centered service learning.[149] This work productively engages with epistemologies of ignorance by providing alternatives to value-neutral design education and methodologies. However, value-explicit design approaches do not necessarily guarantee a critical consciousness

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[147] Wendy Sarkissian, "How the Students Saw It," in Raymond Lifchez, *Rethinking Architecture: Design Students and Physically Disabled People* (Berkeley: University of California Press, 1987), 142.
[148] Polly Welch, "What Is Universal Design?," in Polly Welch (ed), *Strategies for Teaching Universal Design* (Boston: Adaptive Environments Center and MIG Communications, 1995).
[149] Leslie Kanes Weisman, Personal communication (phone). March 27, 2012.

about the complexities of personal knowledge, testimony, and experience.[150] The dissertation addresses some of these questions by charting the historical progression of how users and disability became legible to designers as factors for inclusion, showing how disability shifts in and out of view[151] according to factors related to design epistemology and shifts in scientific thinking. I argue that understanding the emergence of the normate template as value-implicit design, and interventions against that template as forms of epistemological activism, requires a new feminist disability methodological approach to the history of UD.

Methodology

This dissertation began as an inquiry into how architects think about and know the bodies of users and intended spatial inhabitants. The question of how UD implements broad accessibility, manages to do so by design, and also benefits non-disabled populations is a question of how and what Universal Design can know about users. This question ("What Can Universal Design Know?") is at the heart of the dissertation, and places Universal Design within the critical traditions of disability theory, feminist and historical epistemology, and design history and theory.

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[150] Wendell 1996, 73; Joan Scott, "The Evidence of Experience," *Critical Inquiry* 17.4 (1991): 773-797; Imrie and Hall 2001, 17.

[151] I use this language as part of my broader use of epistemic *regimes of intelligibility* as framings for how knowledge and things become perceivable and knowable. There is, of course, a longer history of the use of vision as a metaphor for knowing that is related to histories of scientific observation. See Lorraine Daston and Peter Galison, *Objectivity,* (New York: Zone Books, 2007). However, as Georgina Kleege has argued in *Sight Unseen* (New Haven: Yale University Press, 1999), the association of vision with knowledge is part of the culture of disability discrimination, as well. For a discussion of Kleege's philosophy vis-à-vis standpoint epistemology, see Susannah B. Mintz, "Invisible Disability: *Georgina* Kleege's Sight Unseen," in Kim Q. Hall (ed), *Feminist Disability Studies* (Bloomington: Indiana University Press, 2011), 74. I use the language of *intelligibility* and *vision* not to privilege visual observation, but to show the historical construction of how such visual observation has made some ways of being seem possible and created ignorance around others.

The question of what Universal Design can know references feminist epistemologist, Lorraine Code's, query in her 1991 book, *What Can She Know?* This question, in turn, is a reference to Immanuel Kant's question, "What can I know?," in his *Critique of Pure Reason*.[152] The subtext of these queries is whether disinterested, objective knowing is possible. Code responds to the positivism of the philosophical sub-discipline of analytic epistemology by situating every aspect of the question, "What Can I Know?" By asking, "What Can She Know?," she forcefully argues that the situatedness of the knower in time, space, identity, and systems of oppression has everything to do with the knowledge produced or known. In later work, Code explicitly theorizes the role of environments (both built and natural) as contexts for situated knowledge.[153]

This dissertation proceeds from the question, "What Can Universal Design Know?" By asking what Universal Design (as an epistemic community) can know, I have been able to focus on a specific set of epistemological questions in UD research. I have done so by situating—historically, spatially, and materially—the very notions of Universal Design and scientific knowledge. Throughout the dissertation, I adopt the view promoted by feminist and historical epistemologies that communities as well as individuals are epistemic agents.[154]

In its earlier conceptualization, the dissertation project began with a focus on the present, intending to describe and analyze existing UD architectural research practices. However, it soon became clear that my object of investigation was slippery, unstable and historically contingent. The built environment includes not only architecture, but also

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[152] Lorraine Code, *What Can She Know: Feminist Theory and the Construction of Knowledge* (Ithaca: Cornell University Press, 1991), epilogue.
[153] Code 2006.
[154] Such as in the work of Knorr-Cetina (1999) and Helen Longino, *Science as Social Knowledge* (Trenton: Princeton University Press, 1990).

industrial design, assistive technology, rehabilitation engineering, urban planning, and a number of other disciplines and scales. Interviews with major UD researchers and practitioners in the pre-prospectus stage led me to frame my investigation around UD's knowledge practices, rather than focusing on more common questions of disability access law or the efficacy of particular designs.

At the time that the project was being formulated, the details of the major research projects in which I was interested had not yet been published. I conducted several trips to talk to researchers at Rehabilitation Engineering Research Centers (RERC) and other UD research centers across the country in order to gain a better sense of their work. During these trips, I was directed to a dozen peripheral actors, including rehabilitation clinicians, urban planners, designers, curators, and product testers, each of whom had varying degrees of involvement in the history of Universal Design. These interviews were my first opportunity to become acquainted with work in fields related to Universal Design, and also to understand its reliance on the interdependence of multiple disciplines.

Several events occurred in the last year of my research that shifted the project's methodology. The first is that several key practitioners and researchers published major research projects and theoretical texts on UD in 2011 and 2012.[155] Serendipitously, these texts answered and predicted the epistemological analysis that the dissertation conducts, often in much greater detail than provided by interviews conducted prior to these publications. As a result, better evidence of UD's historical and epistemological ties to other research frameworks was available for analysis.

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[155] Jon Sanford, *Universal Design as a Rehabilitation Strategy* (New York: Springer, 2012); Steinfeld and Maisel 2012; Edward Steinfeld, Victor Paquet, Clive D'Souza, Caroline Joseph, & Jordana Maisel. *Final Report: Anthropometry of Wheeled Mobility Project*. Report of the Center for Inclusive Design and Environmental Access for the U.S. Access Board, 2010.

The second set of events occurred through a series of encounters that provided me access to a major unprocessed archive of UD materials kept by Katherine Ott, a disability material culture historian and curator at the National Museum of American History. Through introductions from Ott and Rosemarie Garland-Thomson, I was able to visit the private home and collection of Joy Weeber, a disability activist and the surviving partner of Ronald Mace, who coined the term, "Universal Design," and was a key agent in its development.

These collections contained material and textual evidence that contradicted many of widely circulating claims about the history of Universal Design. This transformed my project into one that is much more grounded in *historical epistemology*. Whereas my qualitative research initially set out to survey the sources of UD's evidence base, the discovery of the phenomenon of evidence-based design as a project rigorously pushed forth through UD research eliminated the need for this step, helping me to focus on UD's historical and epistemological development, and its relationships to various design and research disciplines. Thus, my qualitative research was more helpful in the formulation of my research methodology and questions, while the archival sources I sought as a result of these interviews shaped the historical narrative I present here.[156]

The above account situates my approach and use of evidence within a broader network of knowledge circulation around Universal Design — one that includes exchanges between myself, my primary sources of research (designers, researchers, and research reports and manuscripts), other historians and theorists of UD, key players in the phenomenon, and figures at the margins who offered unexpected and otherwise

[156] Because of this, I have only cited interviews in the dissertation that have directly provided historical data, rather than the other interviews in which I was focusing on UD in a more contemporary setting and asking questions about its approach and philosophy.

unavailable perspectives into where UD has been and where it is going. The diversity of sources also revealed, through triangulation, the contradictions and inconsistencies in foundational narratives about UD history. At this point, I made a choice to study the historical conditions that made possible UD's emergence as a framework, approach, and method for broad inclusion by design. The future of this project may include, as I had originally hoped, a more qualitative engagement with UD at the level of ethnographic study of everyday design and research practices. The dissertation, however, proceeds through a set of methods taken from the history and philosophy of science, feminist epistemology, and design studies to understand the epistemic conditions of possibility for Universal Design. I will now turn to describing how my project has taken on and adapted these methods.

Proper objects

> …the problem arises of knowing whether the unity of a discourse is based not so much on the permanence and uniqueness of an object as on the space in which various objects emerge and are continuously transformed -Michel Foucault 1972[157]

> I began writing this book by trying to consider the materiality of the body only to find that the thought of materiality invariably moved me into other domains. I tried to discipline myself to stay on the subject, but found that I could not fix bodies as simple objects of thought. Not only did bodies tend to indicate a world beyond themselves, but this movement beyond their own boundaries, a movement or boundary itself appeared to be quite central to what bodies "are." I kept losing track of the subject. I proved resistant to discipline. Inevitably, I began to consider that perhaps this resistance to fixing the subject was essential to the matter at hand
> -Judith Butler 1993[158]

Universal Design is an unstable term that evolved over the period spanning roughly 1968 through the present. It existed as a fragmented concept slightly before this

[157] Michel Foucault, *The Archaeology of Knowledge & The Discourse on Language.* (New York: Vintage Books, 1972/2002), 32.
[158] Judith Butler, *Bodies that Matter: On the Discursive Limits of 'Sex.'* (New York: Routledge, 1993), ix.

time, and grew to include a community of practice that includes designers and design practice, researchers, and accessibility advocates. Between the 1990 passage of the ADA and the 1997 publication of the "Seven Principles of Universal Design,"[159] the usage of the term *Universal Design* proliferated. Sometimes, this proliferation contributed to the development of theory around the concept, and sometimes it merely created confusion because it was applied to practices, such as *barrier-free design* and *assistive technology*, that it explicitly reject[160]s or supplants.

To make matters more complicated, a number of practices and theories exist in excess of what is officially designated as Universal Design by its community of practice. As I show in Chapter 2, at the same time that certain professional and discursive practices have eroded its meaning, Universal Design is also experiencing a multiplicity of forward-thinking attempts to theorize a proper method and design philosophy. This creates a moving target for both historical research and epistemological analysis. The proliferation of meanings raises methodological problems for writing a history or philosophical analysis of Universal Design that follows an unstable object over the course of several decades. At the same time, this proliferation allowed me to consider the influence of these other approaches on what UD has come to be.

Access to archives—some official, institutional and highly ordered, and others personal, disordered, and brimming with ephemera that resists a straightforward narrative, brought this methodological problem into view. It was not merely that historicizing UD revealed a proliferation of discourses with different allegiances to the

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[159] I discuss the history of this document in Chapter 2.
[160] Steinfeld and Maisel 2012, 68; Kawauchi 2009, 118.

concept, but that the structure (or lack thereof) of the archive made the appearance of certain kinds of evidence possible.

As Michel Foucault writes in his methodological text, *The Archaeology of Knowledge* (1972),

> The archive is the first law of what can be said, the system that governs the appearance of statements as unique events. But the archive is also that which determines that all these things said do not accumulate endlessly in an amorphous mass, nor are they inscribed in an unbroken linearity, nor do they disappear at the mercy of chance external accidents; but they are grouped together in distinct figures composed together in accordance with specific regularities.[161]

Two of the archives I visited were highly ordered and processed, viewable only in special reading rooms, and structured in linear historical progression. The first of these involved a number of collections on the design of assistive technologies, such as computers and prosthetic legs, held by the Archives Center at the National Museum of American History. The second formal archive was the official Ronald Mace collection at North Carolina State University, where Mace taught and directed a UD research center. It primarily contained drawings and documents from Mace's ADA consultancy and design firm, Barrier Free Environments. There were no "amorphous mass[es]" to be found in either collection, and although NC State was missing a few folders of design drawings, the absence of these materials was only perceivable because of the structure of the processed archive.

Although this dissertation focuses on a concept that offers itself as an alternative to assistive technology or legal design standards, the official archives and their systems of organization barely differentiated between the two. This type of organization shifted into view the lasting relationships between UD and the approaches it is designed to supplant. I

[161] Foucault 1972, 129.

found myself slipping increasingly into parsing out the differences between UD and barrier-free design by mapping the terrain established by medical approaches to disability and the ADA's legal technical guidance. UD kept slipping away as I delved deeper into the histories and theories of the individual-based technologies and approaches that UD rejected. Like the body in Judith Butler's account above, the greater my efforts to limit the scope of inquiry around UD, the more it refused containment.

My investigation came full circle with the remainder of the archives that I visited, which consisted of unmarked and unorganized boxes in Katherine Ott's office and a pile of boxes and ephemera under the stairs of the late Mace's home, where Joy Weeber now lives. The former collection was layered with peripheral material objects and texts about assistive technologies and barrier-free design. It also contained the remnants of Ott's own attempts in the late 1990s to establish a Smithsonian archive devoted to Mace.

The collection at Mace's home consisted of dusty boxes that had not been opened in the 13 years since his death. Among childhood photo albums, disability rights movement t-shirts, correspondence with disability rights movement leaders, and business cards, I also found Mace's senior architecture thesis, annotations of disability access law technical guidance, court transcripts, his personal collection of design theory books, and a number of other items that allowed me to understand the relationship between Universal Design and the evidence-based practices it promotes. I was also able to be present in a home that included many early UD structures and technologies, and still bore traces of Mace himself, including an artisan urn of his remains in the form of a tower with a wheelchair ramp winding around the side. These unstructured archives provided access to the most unexpected evidence, detailing the material and epistemological trajectories that Universal Design has taken.

Historical epistemology

Methods from the history and philosophy of science, in particular *historical epistemology*, provide a way of giving an historical account of Universal Design as a changing idea with multiple trajectories and conditions of possibility.[162] Historical epistemology takes seriously the shifting epistemic frames that make an object or phenomenon intelligible over time, revealing the material-discursive regimes of knowledge through which Universal Design can occupy multiple meanings and still remain perceptible. Studying *conditions of possibility* also allows for a close analysis of the ways in which phenomena like user-centered and evidence-based design have co-evolved with Universal Design, not with one precipitating the others, but through a multidiscplinary exchange of ideas and theory building over an historical period.

Historical epistemology is an established critical methodology in the history and philosophy of science that builds upon the work of French epistemologists, such as Michel Foucault, Georges Canguilhem, and Gaston Bachelard.[163] This methodology has been taken up in the histories of medicine and science and demonstrates that knowledge is situated not only within the knower, but also in time and space. Historical epistemologies commonly present histories of *epistemic concepts* (such as objectivity or probability), *epistemic things* (such as laboratory apparatuses), or the long-term

[162] Conditions of possibility are historical forces, distinct from conditions of validity, that make possible the long-term trajectories of scientific development. See Arnold Davidson, *The Emergence of Sexuality: Historical Epistemology and the Formation of Concepts* (Cambridge: Harvard UP, 2004), xii.
[163] For a history of historical epistemology, see Hans-Jorge Rheinberger, *On Historicizing Epistemology: An Essay* (Stanford: Stanford University Press, 2010).

developments in a scientific practice.[164] The dissertation historicizes epistemic concepts (i.e. the body as evidence), epistemic things (i.e. designed objects and spaces), and long-term developments in particular knowledge production practices (i.e. practices of measuring and knowing bodies as evidence).

Historical epistemology is a kind of archaeological investigation, the goal of which, according to Foucault, is to "write a history of discursive objects that does not plunge them into the common depth of a primal soil, but deploys the nexus of regularities that govern their dispersion."[165] In my analysis, users, and the concept of the disabled user, are *epistemic objects* that become intelligible to designers through shifts in the theories and approaches of the design professions. The bodies of users are *epistemic agents* testifying to the status of the built environment as an agent of inclusion or exclusion. Built environments produced as a result have causal and material connections to the historical, cultural, and ideological milieus in which they emerge. Historical epistemology does not seek to identify single foundational moments in the birth of ideas. Instead, like new materialism, it counts these milieus and the material phenomena themselves as actors in the ever-sedimenting process of creating meaning around Universal Design.

The built environment materializes through knowledge practices, highlighting the usefulness of material-discursive concepts presented by historical epistemology. Bachelard's notion of *phenomenotechnique*[166] and Barad's concepts of *onto-epistemology*

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[164] See Uljana Feest and Thomas Turm, "What (Good) is Historical Epistemology? Editors' Introduction," *Erkenntis* 75.3 (2011), 288. These are the three categories receiving the most attention in historical epistemology. My dissertation uses all three of them.
[165] Foucault 1972, 48.
[166] Hans-Jorge Rheinberger, "Gaston Bachelard and the Notion of 'Phenomenotechnique'," *Perspectives on Science*, 13.3 (Fall 2005): 313-328.

and *apparatus*[167] explain the fundamental interdependence between objects of knowledge, standards of knowledge, and how they are known. Both Bachelard and Barad understand that the material arrangements of apparatuses of measuring and knowing are technologies that reconfigure the phenomena themselves. That is, the lenses through which objects of knowledge became intelligible alter both those objects and their knowers, narrowing the distinction between knowing subjects and known objects. In UD, the built environment is not only an apparatus measuring the fit or misfit of bodies and environments; it also produces or prevents the participation of certain bodies. At the same time, Universal Design is an onto-epistemological concept that alters the ways in which social and epistemic agents, such as users, designers, and researchers, keep disability *in mind*.

Historicizing the knowledge underlying accessible spaces historically situates sciences that have been received rare attention in the history of science due to their applied and proprietary content. My historical epistemology shows that sciences like human factors research, rehabilitation engineering, applied physiology, and environmental psychology are conditions of possibility for user-centered and inclusive environments. I argue that these fields carry differential meaning for the articulation of disability access within and beyond built environments.

While histories of laboratory sciences and medicine have employed historical epistemology as a method, its application to design history has been less prevalent. Like the iterative design process itself, historical epistemology returns to conditions of possibility for material phenomena in order to craft material-discursive concepts. Michelle Murphy's (2001) feminist account of the processes of knowledge production

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[167] Barad 2007, 148.

surrounding air conditioning systems, building systems management, and the architecture of high-rise office buildings is a rare and excellent example of the use of historical epistemology in a feminist, disability, and Science & Technology Studies (STS) project that focuses on the built environment.[168] Concerned with the history of the phenomenon of *sick building syndrome*, Murphy uses Michel Foucault's concept of the *regime of perceptibility* to demonstrate how scientific uncertainty around the causes of the syndrome enabled epistemological and political activism for environmental justice. An historical epistemology of a design philosophy such as UD can make intelligible the types of knowledge production that unique to design thinking and provide a method for understanding the application of research in the design process.

I use the concepts of *epistemic frame* and *regime of intelligibility* (rather than *regime of perceptibility*) because the dissertation is concerned with the framing and emergence of legible knowledge within structures or milieus that span a number of historical periods.[169] Thomas Kuhn's notion of *paradigm*, Foucault's *episteme* and archaeological method, Ludwig Fleck's concept of *thought collectives*, and other configurations operate similarly as tools of historical epistemology, marking and describing the way that objects of knowledge shift in and out of view and are "production[s] of a habit of perception."[170] This methodology is appropriate for the dissertation because it considers not only how UD participates in scientific discourses, but also how the applied sciences responsible for user-centered and evidence-based

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[168] Michelle Murphy, *Sick Building Syndrome and the Problem of Uncertainty: Environmental Politics, Technoscience, and Women Workers*. 1st ed. (Durham: Duke University Press Books, 2006).
[169] That is, as I noted in an above footnote, my concern is legibility and the processes by which epistemic objects and processes become thinkable, intelligible, and farmable, rather than the process by which they become perceptible and observable (as in the sense of visual scientific observation). My historical epistemological concern is the emergence of concepts rather than just the appearance of phenomena.
[170] Rheinberger 2010, 30.

design become scientific or epistemological through the efforts of UD researchers and theorists, and gain epistemological persuasiveness by endorsing disability as a necessary category of inclusion.

According to Foucault, new epistemic regimes (*dispositifs*) do not replace but rather "supplant" or "superimpose" themselves upon previous regimes, creating space for the intelligibility of new objects and practices that were previously imperceptible.[171] The historical epistemology of scientific ideas does not "procee[d] by linear deduction, but rather by concentric circles…"[172] The concentric circles mapped by historical epistemology make legible the thresholds that knowledge claims must cross to be understood as valid within a particular epistemic frame. Foucault defines four such thresholds of becoming. The *threshold of positivity* encompasses the initial "moment…at which a single system for the formation of statements [or truth claims] is put into operation."[173] The *threshold of epistemologization* is crossed when this system becomes coherent and defines the standards of the validity of truth claims, providing a way of verifying knowledge.[174] The *threshold of scientificity* is crossed when it is able to make scientific "propositions" and "obeys a number of formal criteria,"[175] including those criteria that are rooted in scientific ideology and techno-scientific rationality.[176] In other words, scientificity belongs to epistemic regimes that look and feel like what is

[171] Michel Foucault, *The History of Sexuality v. 1: An Introduction* (New York: Vintage Books, 1978) 106.
[172] Foucault 1972, 114.
[173] Foucault 1972, 186.
[174] Foucault 1972, 186-187.
[175] Foucault 1972, 187.
[176] Foucault 1972, 185; Georges Canguilhem, *Ideology and Rationality in the History of the Life Sciences* (Cambridge: MIT Press, 1988), 29.

historically regarded as scientific. Finally, the *threshold of formalization* represents the movement into becoming a proper discipline with truth claims that are proper to it.[177]

As Foucault notes, these thresholds do not have any necessary order, nor do they define causal relations. They simply help identify the status of different epistemic claims as they form historically. Some discourses, for example, make claims to scientificity without epistemologization, or exist completely without a formalized disciplinary framework. Many sciences supporting the built environment exist "below the threshold of scientificity" and would not pass as objective or verifiable within a paradigm of scientific rationality.[178] For example, UD research on user preferences or the size of user bodies may not use standards of rigor or statistical significance prescribed by scientific disciplines, but designers may make claims about the inclusion of this research in design as providing scientific verification of the value of their designs.

Epistemic thresholds differentiate between scientific truth claims and conditions of possibility for validity, intelligibility, and coherence. They also put these concepts into historical perspective within a more general epistemic framing. Throughout the dissertation, I will consider the ways in which Universal Design, having crossed the threshold of positivity, participates in knowledge practices that primarily encounter the thresholds of epistemologization and scientificity, and in some cases, are pushed into formalization through their involvement with UD research.

Besides identifying how concepts of knowledge and evidence have come to count as part of UD, historical epistemology provides methods for addressing the proliferation of meaning around the term and concept, even when it contains multiple discernible

[177] Foucault 1972, 187.
[178] Foucault 1972, 178.

meanings in different historical periods. Foucault's archaeological notion of the *field of stabilization* points to the "repeatable materiality" and "temporal viscosity"[179] of the repetition of concepts and statements that creates meaning through sedimentation.[180] Like Barad's concepts of *onto-epistemology* and *material-discursive* and Bachelard's *phenomenotechnique*, the field of stabilization reveals not only the meanings that emerge through the "reinscription and transcription" of utterances,[181] but how meanings become material. In the case of Universal Design, a concept that is not only spoken but also enacted through actual built forms, historical epistemology can shift into view the material effects of the phenomenon even when its meanings are fragmented and dispersed. This makes it possible to refer to UD as an object of inquiry and material approach to world-building while also recognizing that its precise meaning shifts depending on the speaker and historical period.

Transforming historical epistemology

While historical epistemology is a method with broad applicability to feminist and disability studies projects, it emerges within a philosophical tradition that is more concerned with traditional scientific histories in the fields of physics, biology, and chemistry. The historical epistemologies of medicine and scientific knowledge conducted by Georges Canguilhem, Ludwig Fleck, Michel Foucault, Arnold Davidson, and Hans-Jorge Rheinberger demonstrate the contingency of scientific and medical categories, and provide approaches to the critical study of scientific knowledge that could be very useful

[179] Foucault 1972, 175.
[180] Foucault 1972, 102.
[181] Foucault 1972, 103

to disability studies and feminist theory.[182] However, a more contemporary and critical feminist disability analytic would also contribute to the development of historical epistemology as a method by focusing on social justice categories of inclusion, exclusion, and interdependence.

Many existing historical and epistemological concepts in feminist and disability theory are already doing the work of historical epistemology, albeit with a more situated focus. For instance, the historical models tracing the trajectory of social, medical, and moral understandings of disability are implicitly a kind of historical epistemology.[183] By integrating feminist and disability theory to transform historical epistemology, the dissertation makes legible the fruitful connections between these methodological and theoretical frames.

Disability history as historical epistemology

Model	Definition of disability	Historical period	Legitimate evidence
Moral	Disability as moral fault	Unidentified past time when religion was a dominant epistemology testifying to the supernatural basis of nature	Religious and cosmological texts
Medical	Disability as diagnosable	Late 18th-century - early 20th century;	Scientific and medical evidence

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[182] See Ludwig Fleck, *Genesis and Development of a Scientific Fact* (Chicago: University of Chicago Press, 1981); Ian Hacking, *The Emergence of Probability* (Cambridge: Cambridge University Press, 2006); Michel Foucault, *The Birth of the Clinic* (New York: Vintage Book, 1994); Davidson (2004); and Canguilhem (1988).

[183] Henri Jacques-Stiker, whose *A History of Disability* (Ann Arbor: University of Michigan Press, 1982/ 2000) persuasively frames this narrative, operates within a French historical and philosophical tradition and applies many of the same concepts and approaches as Foucault's archaeological work and other historical epistemologies.

	pathology	epistemologies of scientific rationality	
Social	Disability as environmental condition	Mid-20th century – present; sociological and materialist epistemologies	Sociology, anthropology, literature, humanities

One of the foundations of disability studies has been the *models framework* in which disability ontology is understood through the *moral*, *medical*, and *social models*. While the scholarly characterization of these models emerged from movement politics and anti-capitalist critique,[184] they have evolved into a kind of historical epistemology explaining that shifting understandings of what disability *is* have to do with parallel shifts in what counts as knowledge *about* disability.[185] Within disability history and theory, in the time of the moral model, disability is understood as moral fault according to religious and cosmological evidence, whereas in the time period of the medical model, disability is understood as pathology according to scientific and medical evidence. The social model accompanies disability studies as an academic field with its origins in medical anthropology and sociology, and humanistic studies of disability, which emphasize social and cultural knowledge about the phenomenon of disability.

The way that disability studies uses the *models framework* is a product of the social model and becomes a primary way of proving its validity. Disability theorists like Tom Shakespeare have very strongly argued against the usefulness of the social model of disability because of its approach to knowledge, the body and materiality in disability

[184] Oliver (1990).

[185] The influence of historical epistemology is apparent in Stiker's history of disability, which comes out of the French history of medicine tradition and claims to fill gaps in knowledge left by Foucault and Canguilhem.

politics.[186] It is also important to recognize the epistemological limitations of the models framework. As I show throughout the dissertation, manifestations of the moral, medical, and social models persist in multiple historical periods and blur the boundaries not only between the periods typically ascribed to these models but also the concepts they represent. Thus, as Chapter 3 explains, moral concepts of nature are not *replaced* by but actually *underlie* some medical and scientific representations of disability. Likewise, as I show in Chapter 2, the social model is not bereft of the epistemological commitments of the medical model, but in many ways relies on these commitments for the social and built environments to become intelligible as producers of something called disability.

Critical approaches to science from the philosophy of science, feminist science studies, and disability studies have problematized scientific knowledge and notions of objectivity. Scholars whose work runs parallel to disability theory have addressed concerns about the body, science, and ideologies of cure through historical epistemology.[187] Thus, critiques of social construction, positivist science, objectivity, and normalization do not "belong" to any of these scholarly fields alone. Particularly because historical epistemology has often been concerned with issues at the core of disability studies—the normal and the pathological, processes of subjection, bioethics, histories of medical diagnosis and cure, and the changing relationship between space and the body—bringing it to bear on the history of UD contributes to disability studies by making clear the methodological underpinnings of existing histories and theories.

Feminist science studies and disability historical epistemology

[186] Tom Shakespeare, *Disability Rights and Wrongs* (New York: Routledge, 2006).
[187] For instance, Foucault, Fleck, Canguilhem, and others cited above.

The social model of disability has often adopted what feminist science studies scholar, Elizabeth Wilson, refers to as an “oppositional relationship” to scientific knowledge, no doubt because of the way such knowledge has historically been deployed to cure, eliminate, or rehabilitate disability.[188] This opposition echoes feminist science studies critiques of medicalization, scientific abuses of women’s bodies in biomedical testing, and limited healthcare and reproductive rights. These critiques have been crucial to efforts to reclaim knowledge about the body from scientific and medical experts.[189] However, an historical epistemology informed by feminist science studies can provide disability studies’ models framework a way of maintaining critical distance from scientific objectivity while also taking research seriously as a site for intervention.

***Discovery and justification*.** Historical epistemology allows evaluation of critical concepts in the philosophy of science and STS that have been central to feminist epistemology. The first of these is the logical positivist distinction between what philosophers of science refer to as the *context of discovery* (the historical process of scientific discovery) and the *context of justification* (the methods of scientific research).[190] Historical epistemologists, like Thomas Kuhn, and feminist epistemologists, like Helen Longino, have rejected this distinction between the external and internal

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[188] Elizabeth Wilson, *Neural Geographies: Feminism and the Microstructure of Cognition* (New York: Routledge, 1998) 200.

[189] In this way, the social model and the women’s health movement share epistemic tendencies to critique biomedical authority and assert the standpoint of embodied knowers whose bodies are subjected to medical expertise.

[190] This distinction, commonly discussed in 20th century epistemology and the philosophy of science, was first made by Hans Reichenbach and was further explored through sociologies of science. For a discussion of its influence on historical epistemology, see Paul Hoyningen-Huene, “Context of Discovery versus Context of Justification and Thomas Kuhn,” in J. Schickore and E. Stenle (eds), *Revisiting Discovery and Justification* (Netherlands: Springer, 2006): 119-131.

contexts of scientific research.[191] In the traditional explanation of this distinction, scientific knowledge is constructed at the level of discovery and research design, where researcher positionalities and biases are situated and where the ideological values of epistemological systems play out. This is true even if the internal formal and logical procedures of knowledge production follow strict rules governing validity.

Collapsing the distinction between the contexts of discovery and justification promotes an understanding of knowledge production that keeps in mind the subjective processes underlying claims to objectivity. Doing this historically makes apparent regimes of intelligibility that are less perceptible in a given scientific or epistemic era. Including critical disability and feminist concepts of normate and misfit in feminist epistemology contributes to existing critiques of objectivity and neutrality. For the dissertation's purposes, the context of discovery also helps explain the creative elements of design itself as a knowledge production practice, even when it applies certain formal or informal kinds of evidence and logic in a UD context.

Science and ideology. The second related concept from the critical study of science that a feminist disability historical epistemology helps qualify is the role of ideology in knowledge production. Feminist epistemologists have debated ideology in terms of the androcentric bias of certain styles of logical thought or as apparent in the claims of positivist epistemologies to be universal views from nowhere.[192] These critiques recall Georges Canguilhem's analysis of ideology in the life sciences:

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[191] See Thomas Kuhn, *The Structure of Scientific Revolutions* (Chicago: University of Chicago Press, 1962/1970/1996); Longino (1990).

[192] For a genealogy of feminist epistemological thought on this issue, see Iris van der Tuin (2009). "'Jumping Generations': On Second- and Third-wave Feminist Epistemology," *Australian Feminist Studies*: 24.59.

> Ideology is an epistemological concept with a polemical function, applied to systems of representation that express themselves in the languages of politics, ethics, religion, and metaphysics.[193]

The notion of an "epistemological concept with a polemical function" defies the view-from-nowhere by showing the non-neutrality and normative force of epistemic concepts. This notion is crucial for a framework that can explore UD's value-explicit, political, and ethical implications rather than telling a more linear history or focusing on evaluating examples of design.

Disability studies critiques the ideologies of cure and elimination apparent in scientific and medical epistemologies in ways that are similar to or depend upon historical epistemological work.[194] Not only does ideological critique draw attention to the possible biases existing in scientific research, but in the context of historical epistemology, it makes intelligible the way that systems of knowledge that have not crossed the threshold of scientificity, including politics, ethics, religion, and metaphysics, contain epistemological content that can be revealed through the study of ideology. My dissertation finds that elaborating upon UD's epistemological content shows the relationship of its design philosophy to other theories of inclusion in the built environment.

Some ideological critiques of science have thrown out the baby with the bathwater in the sense of understanding ideology and historical contingency as epistemic disqualifiers. These kinds of critiques can also discourage study of the transformative work of shifting epistemologies. Feminist STS offers ways of maintaining ideological critique while also taking epistemology seriously. Feminist new materialism in particular

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[193] Canguilhem 1988, 29.
[194] As in Stiker's (2000) history of disability or Garland-Thomson (2002).

brings together work on feminist epistemology, STS, and political theory to understand the active role that dynamic materialities—such as the built environment in its iterative stages of becoming—play in how society understands and acts upon phenomena like gender, disability, and race.

Many new materialist feminists are critical of the focus of post-structuralist theories of knowledge and language, seeking instead to bring considerations of ontology and matter back into debates about the social construction of material phenomena. For example, Karen Barad argues that the neglect of ontology has been due to a focus on language over matter.[195] Her concept of *onto-epistemology* demonstrates that knowledge is not something constructed through language about a pre-existing reality, but fundamentally a part of the actual sedimentation of the material world.[196]

For Barad, theories of social and material construction must understand the performativity of both objects of knowledge and ways of knowing them. Research is not a practice of objective, disinterested viewing from a distance, but rather an intervention and "direct material engagement with the world."[197] This means that even when a phenomenon like disability is a social construct, it becomes so through the ways that knowledge circulates to create it. Drawing upon Niels Bohr's quantum physics, Barad demonstrates that "concepts are defined by the circumstances required for their measurement. That is, theoretical concepts are not ideational in character; they are specific physical arrangements."[198] Recalling Donna Haraway, Barad argues that the design and apparatuses of research are "specific material-discursive practices" that occur

[195] Barad 2007, 41.
[196] Barad 2007, 185.
[197] Barad 2007, 49.
[198] Barad 2007, 109.

in particular historical and spatial contexts.[199] This description echoes the historical epistemologist Hans-Jorge Rheinberger's focus on epistemic material things, rather than on the more traditional epistemic relation between observation and objects of study.[200]

Barad's feminist new materialism can work in tandem with existing disability theories and historical epistemology as a method to produce new tools for approaching the onto-epistemological implications of UD research. While Barad is critical of epistemological critiques of science that rely upon the construction of phenomena through language, she offers an onto-epistemological model of disability that is not rooted in the medical model. She argues that the misfit of the body with the environment is an apparatus of the measure of ableism in society, making disability both a way of knowing and being.[201] This conceptualization echoes disability sociologist, Tanya Titchkosky's, reminder that accessibility "is an interpretive relation between bodies."[202] This dissertation argues that UD's new materialist philosophy understands body-environment relations as evidence of ableism, inaccessibility, and misfit and draws upon scientific methods of measuring bodies to intervene into epistemic design practices.

Understanding UD research as a material and epistemic intervention requires a new materialist historical epistemology of disability. It is impossible to discuss the critical concept of *disability* put forth in disability studies without understanding its historical material-discursive construction through misfitting environments and epistemic practices that shape design and the law. Nevertheless, discussions of epistemology within disability studies (such as sit-point theories and standpoint epistemologies) are often

[199] Barad 2007, 146.
[200] Rheinberger 2005, 707; Feest & Sturm 2010, 292.
[201] Barad 2007, 158.
[202] Titchkosky 2011, 3.

limited to either granting validity to sources of evidence outside of empirical research, or rejecting the validity of scientific knowledge production.[203]

These epistemologies provide tools for arguing for the comparative value of personal experience as knowledge in the face of medical or diagnostic regimes. Perspective-based epistemologies are not, however, designed to address epistemological issues of validity, objectivity, research design, sampling, or historical epistemology that are raised by scientific research practices in human factors and rehabilitation research.[204] While these epistemologies provide a parallel source of epistemic validity to individual and marginalized knowledge, they are not methods of exposing the ideologies or constructions within scientific research itself. They answer the question of what counts as knowledge, but are not meant to tell us how to evaluate the ideological work of notions of *evidence*, *validity,* or *objectivity*. They also do not tell us what to make of UD's research agenda, given its simultaneous status as proof of the space of the social model. In order to devote critical attention to UD's scientific practices, a separate set of tools is necessary.

This dissertation asks how particular research practices can intervene in the broader history of science to change the production of meaning and environments. *User-centered design* research that occurs around UD intervenes in military and civilian knowledge production underlying the *normate template*. The research practices of disability anthropometry intervene in systems of knowledge, such as statistics, that have dominated medicine, eugenics, and positivist conceptions of objectivity more generally. They do this through what feminist science studies scholar Deboleena Roy calls "asking

[203] Sitpoint theory is an epistemology that takes up feminist and Marxist standpoint epistemologies to argue for the privileged status of knowing from the perspective of disability. See Mairs (1996) and Garland-Thomson (2005).
[204] These disciplines are defined and explored in Chapters 1-2.

different questions,"[205] and also by adopting different material practices of research and apparatus design, sample selection, and data analysis. This, in turn, produces a disjuncture in the epistemic regime of measurement, rendering multiple sources of evidence—including the lived experience of misfit in the built environment—legible to researchers and designers. Understanding UD research as this type of intervention is a project of historical epistemology informed by new materialism.

Intervening theoretically: Universal Design as an epistemic practice

Universal Design is a phenomenon in which design is inseparable from cultures and practices of scientific research on a range of human bodies. While the demand for this knowledge production coincides with the rise of the U.S. disability rights movement in the 1960s and '70s, shifting epistemic frames and methodological reformulations of research within the design research professions are also both a driving force and product of the conditions of UD's emergence with design, and should be considered in UD's history. Rather than taking UD for granted as a stable or ahistorical concept, or arguing that UD's research practices are determined by social, political, and historical forces, the dissertation considers several epistemic shifts through which UD co-emerges with applied research fields. UD research responds to three overlapping epistemic frames, or ways of knowing users, that are prevalent in design: design thinking, evidence-based design, and the normate template.

[205] That is, adopting different problematics, epistemologies, and research questions while using the same research methodologies. Deboleena Roy (2008). "Asking Different Questions: Feminist Practices for the Natural Sciences," *Hypatia* 23.4: 134-157.

Design thinking and logical styles

The first epistemic frame to which Universal Design research responds is a design epistemology that privileges the intuition and problem-solving work of individual architects as the most valuable knowledge for design.[206] This frame explains the processes producing architectural *partis.* Within design practice, the practice of *research* refers not to the results of controlled experiments, but to the designer's production of drawings, studies, and models to explore aesthetic and functional possibilities for a design. Whereas scientific research often describes an existing state of things, design is research a process that, as design methodologist Bryan Lawson argues, projects potential futures by solving problems within the status quo.[207]

The temporal aspects of the iterative design process are especially important to the study of *design methodology*.[208] For instance, designers may attempt to solve the problem of overcrowding by producing different iterations of a lobby until one solution best addresses the problem. However, while intuition and experience guide designers through problem-solving processes, they do not ensure attention to considerations of bodies or experiences beyond that of the designer.

Whereas the critical humanities may not commonly include authorial intent in analyses of creative work, the designer's intentionality is a crucial unit of analysis for design methodology and architectural criticism. The iterative design process creates what Nigel Cross has called "designerly ways of knowing."[209] Such knowing emerges when

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[206] Elizabeth Depoy and Stephen Gilson, "Disability Design and Branding: Rethinking Disability within the 21st Century," *Disability Studies Quarterly* 30.2 (2010).
[207] Bryan Lawson, *How Designers Think, Third Edition: The Design Process Demystified*. 4th ed. (Burlington: Routledge Architectural Press, 1997), 113.
[208] Bryan Lawson, *What Designers Know* (Burlington: Routledge Architectural Press, 2004), ix.
[209] Nigel Cross, "Designerly Ways of Knowing: design discipline versus design science," *Design Issues*, 17.3 (2001): 49-55.

designers identify problems, consult clients, work through possible solutions, and finally build something.[210]

Design epistemology differs from scientific epistemologies at the level of logical argument and the formal status of truth claims arising from the design process. Designers use a unique form of logical thinking that is neither deductive nor inductive, but abductive[211] and pragmatic. Abduction theorizes what is possible, rather than what something is or must be.[212] According to Cross, because abductive reasoning is not formally logical, however, the status of knowledge often remains unclear or gives the impression that intuitive design knowledge is not grounded in prior experience or best practices.[213]

The status of research in design is epistemologically distinct from typical scientific research. Design research includes processes of exploring potential futures, such as producing sketches, technical drawings, renderings, models and prototypes. Visual and three-dimensional representations of a design operate much like a scientific hypothesis, allowing designs to be tested and evaluated[214] to create knowledge around best practices.[215] The presentation of these representations to a client shows that a designer has done research to explore the possibilities for a design, and the visual element has the status of proof or evidence that it the design will be successful. This emphasis on visual and material evidence, I show throughout the dissertation, and especially in Chapter 3, is one of the ways that knowledge becomes institutionalized within design.

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[210] Lawson 2004, 100-104.
[211] Nigel Cross, *Design Thinking: Understanding How Designers Think and Work* (Gordonsville, VA: Berg), 26-28.
[212] Cross 2011, 27.
[213] Cross 2011, 10.
[214] John Zeisel, *Inquiry by Design: Environment/Behavior/Neuroscience in Architecture, Interiors, Landscape, and Planning*. Revised. (New York: W. W. Norton & Co., 2006), 23.
[215] Lawson 2004, 2-3.

Designers and scholars studying design also sometimes adopt social scientific and qualitative research methods. Some designers do proprietary research or studies specific to a particular project and in consultation with clients. Another type of research, called Post-Occupancy Evaluation, assesses whether a design was successful by conducting ethnographic research on inhabitants. Participatory design research and Post-Occupancy Evaluation are two forms of design research that produce knowledge about the value of certain types of design.[216] Both types of research involve clients and users in the design process as sources of knowledge—either before or after the design is complete—to evaluate the efficacy of the current stage of design.[217]

The knowledge produced through these evaluations is situated and non-generalizable. Such knowledge applies to the particular design project being conducted, and may inform a designer's future projects, but is not intended to make general truth claims. Likewise, design thinking is not about finding single truths marking the best possible design solution, but, rather, designating, through abduction, the "domain of acceptable responses," or a range of possible and workable solutions, which can then be tested through design research.[218] Iterative design allows for testing of multiple solutions, and makes design a creative and open-ended process with methodological value produced through this kind of openness.[219] While this research is not positivistic or systematic in

[216] Zeisel 2006, 50, 59.
[217] As John Zeisel, environmental design researcher, explains, the phenomenon of hiring a researcher is a recent phenomenon. Vernacular architecture almost always involved users in the design process, but today, designers can involve users by engaging in participatory research or evaluations of use after buildings are finished (POE) (Zeisel 2006, 49).
[218] Zeisel 2006, 27.
[219] Design methodologists have developed a number of ways of studying such open-ended creative design processes. Lawson (2004) provides a concise overview of potential controlled experiments and interview-based methods for understanding how designers apply knowledge in the design process (4-5). This dissertation takes a more historical approach, considering the disciplinary and design formations that have made possible the phenomenon of evidence-based practice in Universal Design.

the scientific sense, it is nevertheless contains positivities and epistemologies defining the types of knowledge that are most applicable to design.[220]

Lawson notes, however, that the norms of representation and research in intuitive design processes do not reveal many aspects of relevant information to designers, particularly around user needs. Drawing helps test aspects of design related to aesthetics, appearance, and form, but not necessarily usability. According to Lawson,

> The drawing offers a reasonably accurate and reliable model of appearance but not necessarily of performance. Architects could thus design quite new forms of housing never previously constructed once new technology enabled the high-rise block. What they could not necessarily see from their drawings were the social problems which were to appear so obvious years later when these buildings were in use.[221]

Thus, intuitive design thinking guides designers through problem-solving processes, but does not necessarily introduce considerations of bodies, experiences, or other knowledge beyond that of the designer.

Proponents of accessible architecture, whether supporting barrier-free or UD, have been critical of intuitive design thinking because, they argue, if an able-bodied designer investigates solutions intuitively, they may only design for other users with similar embodiments.[222] The disability rights slogan, "nothing about us without us," reflects a critique of the implicit bias of the "ideology of ability," as well as construction of

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[220] Historically, the critique of intuitive design thinking in architecture has accompanied epistemic claims about the necessity of scientific thinking as a corrective. On the role of critiques of intuition in modernist and scientific architectures of the 1960s, see Alexander Tzonis and Lianne Lefaivre, "The Mechanical vs. Divine Body: The rise of modern design theory in Europe," *Journal of Architectural Education* (September 1975). As I explain later, many of UD's key proponents were professionalized within this milieu and extended the critique of intuitive design to a rejection of the normate template.

[221] Lawson 1997, 25.

[222] Edward Steinfeld (2011), a UD proponent of evidence-based design, clarified to me in an interview that intuitive design thinking, the typical source of evidence about the body, does not require the rigorous application of knowledge or theories from other perspectives, thus limiting the perspective to the one that is most available (that of the designer themselves). Also see Steinfeld and Maisel (2012, 153) on the theory of evidence-based design.

epistemologies of ignorance around what Garland-Thomson calls "forgetting the truth of contingency because the world sustains us."[223] If these arguments are true, they mean that much of intuitive design can only achieve minimal measures of body-environment fit.

Thus, critiques of intuitive design are also critiques of the situated epistemic positionality of designers. Design researcher Lucy Kimbell, in her recent critique of scholarship on design methodology, reveals that "for all the claims about being user-centered, [design thinking] still emphasiz[es] the designer as the main agent within design."[224] Although some theorists have emphasized design as a human-centered endeavor, information gleaned about users by designers may not include the nuance or rigor of social scientific approaches to, for example, ethnographic data.[225] As I show in Chapter 3, the creation of evidence bases for design is often informal rather than systematic. Also, there are not established guidelines for determining the validity of design as research, and there is little incentive to pursue a high degree of rigor given the limited application of a particular research project. For UD, however, the stakes of identifying and formalizing effective design knowledge are not only epistemological, but also ethical, because such knowledge defines the accessibility of design.

Evidence-based design

The perception that intuitive design thinking produces less user-centered design has precipitated another framing of knowledge within design practice: *evidence-based design*. In the history of architecture, critiques of intuitive design have often accompanied appeals to apply scientific knowledge as a corrective to the "spontaneous and deprived

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[223] Garland-Thomson 2011, 11.
[224] Lucy Kimbell, "Rethinking Design Thinking: Part I," *Design & Culture* 3.3 (November 2011), 289.
[225] Kimbell 2011, 294-295.

conscious ordering" of typical architectural practice.[226] However, contemporary evidence-based design also exists as a method of "knowledge translation" between designers and users.[227] To explain the crucial role of this concept in UD, it is necessary to understand the academic field from which it emerged and the epistemic practices to which this field responds.[228]

Environmental design research, a field co-emerging alongside user-centered design in late 1960s, promotes the intentional design of spaces and products based on data collected by sociologists, anthropologists, historians, and human factors researchers. It differs from design thinking because it occurs using methods that have crossed thresholds of epistemologization, scientificity, and formalization. As a multidisciplinary field, however, environmental design research continues to negotiate its location at these thresholds. While the focus of environmental design research has often been user satisfaction or body-environment interactions, environmental design research outside of UD does not often focus on users with disabilities, thus prompting Universal Design advocates to produce more inclusive research.[229]

The key epistemological concept emerging from environmental design research is *evidence-based design.* Like evidence-based medicine, evidence-based design promotes the application of knowledge to design practices as an alternative to intuitive design thinking.[230] Practitioners intend scientific research about bodies and human behavior to

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[226] Tzonis & Lafaivre (1975, 4) trace this position as far back as the 17th century. See above footnote about how this type of claim is part of the legacy of modernist architecture.
[227] Steinfeld and Maisel 2012, 89.
[228] I explain the history of this field and its relation to UD in Chapter 2.
[229] This is further explored in Chapter 2. For the latest developments in evidence-based design in UD, see *The State of the Science in Universal Design Research: Emerging Research and Developments*, ed. Jordana Maisel. Bentham Publishers, 2010.
[230] Keith Diaz Moore and Lyn Geboy, "The Question of Evidence: Current Worldviews in Environmental Design Research and Practice." *Architectural Research Quarterly* 14.2 (2010): 105-114.

provide knowledge about diverse embodied experiences that are unavailable to the intuition of the designer, particularly in projects in which the stakes of knowing the user are particularly high. Whereas design thinking is abductive, evidence-based design formalizes both deductive and inductive logic as part of the design process, making these available as epistemological resources through the concept of *evidence*. With evidence-based practice, designers can apply inductive logic and scientific knowledge to design problems and also produce knowledge about prevalent design problems through deduction about practical situations.

The notion of an *evidence base* assumes that the outcomes of research are somewhat stable, minimally contested, and applicable to design. These assumptions echo many of the fundamental assumptions of philosophies of scientific objectivity, namely that knowledge should be generalizable between controlled settings and real world applications. Because evidence-based design emerges from an evidence-based medicine context, it often addresses evidence about human bodies and applies this evidence to design for healthcare, disability, and aging.

As I show in Chapter 2, UD advocates with expertise in rehabilitation medicine, gerontology, human factors research, and environmental psychology have driven UD in the direction of evidence-based practice because of their familiarity with medical evidence. However, this work does not merely operate within a medical model of disability. Rather, UD's involvement in evidence-based design transforms medical and scientific research and adopts more nuanced ways of knowing the body.

The normate template

Finally, UD research responds to an epistemic frame, often appearing as a graphic representation, that I call the *normate template*. The normate template is institutionalized within U.S. architecture and industrial design through stock figures in design handbooks representing average-sized and shaped bodies.[231] Rather than accounting for diverse body types, sizes, and abilities, the normate template privileges a small group of individuals in mainstream design, giving these individuals the appearance of normalcy or universality due to their fit in the environment. The resulting built environment is precisely what the social model of disability criticizes—a world built without considering all ranges of ability.

The UD critique of the normate template originates in social movement efforts toward desegregation during the civil rights era. Disability, feminist, and anti-racist movements in the 1960s and '70s shared a common demand for access to de-segregated spaces as necessary for social justice. At the same time, the emergence of the environmental design research field liberalized architectural research and made the inclusion of diverse users more possible. The notion of *flexibility*, central to UD's strategy for broad inclusion, pervades alternatives to the normate template.

Responding to these three frames—intuitive design thinking, evidence-based design, and the normate template—constitutes the basis of UD research activity. As it strives to provide evidence-based justifications for design, UD develops its own epistemic frame. Throughout its development since the late 1960s, the UD frame has shifted in and out of view in the design profession, both attempting to challenge the basis of existing design norms and to maintain legitimacy and legibility within them by establishing itself as a science.

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[231] Henry Dreyfuss, *The Measure of Man* (New York: Watson-Guptill, 1960), 5.

Dissertation overview

In what follows, I craft an historical epistemology of Universal Design as an epistemic community and set of knowledge production practices. Chapter 1 makes an original contribution to the study of user-centered design by historicizing the scientific construction of the *user. User* is a category that indicates the potential inhabitant of designs and spaces. I argue that this category emerges from a regime of intelligibility produced by two overlapping contexts of scientific research: 1. studies of *human factors and ergonomics* in the U.S. military and 2. research on the body in *rehabilitation medicine and engineering*. These scientific milieus are conditions of possibility for the late 20th century practice of *user-centered design*, often synonymous with ergonomics and rehabilitation and very much existing within the same epistemic community of researchers and designers.

The user-centered design milieu not only defines the *user* as a particular type of body, but also outlines its relations to industrial, work, and home environments. This milieu also uses the body as evidence for introducing considerations of users into design and engineering. As a result, it becomes possible to design for specific users or a more broad conception of *the user*. However, the problems of targeted or collective design highlighted in my above discussion of the ADA are still relevant to user-centered design. The purpose of the chapter is to show how the epistemic practices that make broadly accessible design possible emerge from the 19th and 20th century practices that also produce limited and targeted accommodations. One of the consequences of this historical inheritance is that key UD concepts, such as *flexibility* and *usability,* have foundations in practices of military and industrial engineering or rehabilitation medicine, the purposes of which are at odds with disability inclusion.

In Chapter 2, I produce the first scholarly history of UD that considers not only the events through which the practice emerges, but also the broader scientific histories of UD theories. I continue Chapter 1's narrative by examining how the *human factors* and *rehabilitation* regimes interface with the architectural discourses of *functionalism* and *usability* in the early 20th century. I show that the resulting conception of *barrier-free design* both rejects the disability neutrality of earlier epistemic milieus and professional systems of norms, and also borrows heavily from their conceptions of the *user*.

The history of Universal Design, I demonstrate, both carries and qualifies threads of all of these earlier practices. As a result, UD's approach to design is much more epistemologically and politically complex than ahistorical treatments of the concept have understood. In tracing the more recent history of UD, I show that parts of the concept emerged long before the term ever appeared in print. Whereas the previous chapter discusses the way that the *user* becomes a source of evidence, this chapter shows how the application of evidence to design trickles through professional milieus and brings together multidisciplinary epistemic communities. I argue that the meaning of UD shifted as its epistemic agents negotiated how to differentiate it from the milieus from which it emerged.

Chapter 3 breaks new ground in disability histories and theories of measurement by focusing on the long-term trajectory of the practice of *anthropometry,* or the measurement of bodies. The chapter operates as a palimpsest of the previous two, broadly covering the same historical ground but through a lens that focuses on UD's interventions in architectural representation and the history of mathematics. Anthropometry, established in the early 19th century as an instrument of criminology and eugenics, has become a key strategy for UD proponents attempting to make the built environment accessible to a range of bodily sizes and functions. I examine this historical paradox by asking how UD research departs from the historical epistemological and methodological practices of anthropometry, and addresses the broader scientific epistemologies and practices, such as the discipline of statistics, that the practice of anthropometry has enabled.

To show the significance of my argument within the history of architecture, I illustrate UD anthropometry's interventions into the visual representation of the classical body as evidence of an underlying nature or geometric harmony, as well as into the use of the body to visualize statistical data since the emergence of 19th century statistics. I argue that UD intervenes both the graphic representations of the body and the processes of producing evidence about the body to produce situated knowledge about disabled bodies for broad accessibility.

Finally, in the Conclusion, I summarize the dissertation's key contributions to three fields: critical disability studies, feminist science studies, and design studies. Then, I briefly outline areas of study made possible by my historical epistemology of UD. These include: expanding the concept of bodies as evidence to include cognitive, psychological, and phenomenological aspects of evidence-based design; comparing the historical epistemologies of UD and disability access laws; exploring UD's philosophy of standardization and its relationship to producing new institutional arrangements for the enforcement of accessibility; the politics of marketization and added value discourses surrounding UD; and the critical study of international UD efforts, particularly in the majority world.

Chapter 1: The *User* as an Epistemic Object

Introduction

This chapter focuses on the scientific construction of the *user.* The *user* is a figure that becomes intelligible as a necessary design consideration through 19th and 20th century military, medical, and industrial research culminating in *user-centered design*. In most cases, it is a general, anonymous, and seemingly-neutral unit. In its *normate* iterations, the *user* is typically a unit about which knowledge is generated and for whom design occurs. It is also a category that undergirds the notions of *functionality* and *usability*, an active agent whose embodiment and behavior toward designed objects and spaces designers believe to be predictable and researchable. The *user's* intelligibility makes possible the practice of using *bodies as evidence* for contemporary design. However, the *user* also often contributes to the *normate template* for design, glossing over the differences between users.

The history of the concept complicates the distinction between particular or universal understandings of *user*. The same epistemic and rhetorical practices that produce Universal Design claims about *broad accessibility* (design that supposedly takes into account "all people, disabled or not")[232] can easily slip into the general category of the neutral, featureless user as a sufficient consideration of human variation. To parse out the ways that the user either comes to represent a general universal category or a unit representing a range of variation, it is necessary to understand the history of how the concept emerges through efforts to know and quantify human needs vis-à-vis the built environment.

[232] Mace 1985, 1.

Based on this historical and epistemological understanding of the concept of *user*, I argue that the late 20th century practice of *user-centered design* emerges from specific disciplinary and epistemic arrangements that make bodies available as evidence for design and engineering. Likewise, I show that a host of concepts and practices that later become key components of UD emerge through the historical delineation of specific user populations. These include the concepts of *flexibility*, *usability*, *person-environment relations*, and *evidence-based design*.

The User as a Unit for Universal Design

The Seven Principles of UD, which I introduced in the Introduction, focus on the figure of the *user* and the notions of *use* and *usability*.[233] Four out of the seven principles explicitly deploy these terms, while the others assume them. The term "all users" frequently appears to indicate the intended beneficiary of UD. Other descriptions of UD, including Mace's 1985 definition, use the term *people* or *subjects.*[234] These terms do not denote neutral categories, but emerge from specific epistemic regimes defining users as units of design and making particular types of knowledge about users and their bodies intelligible, measurable, and observable.

This chapter focuses on a broad set of questions: Who is the *user*? Through what historical, scientific, and embodied entanglements do designers claim to know it? How does the user overlap or divert from the figures of the soldier, the citizen, the disabled

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[233] Center for Universal Design 1997; Steinfeld and Maisel 2012, xiii, 30-31; Mueller in Kawauchi 2009, 35.

[234] This is especially the case in critiques of mainstream or status quo design approaches. For instance, Ruth Hall Lusher, one of Mace's collaborators positioned UD against legal accessibility standards by arguing that "Design standards do not explain what kinds of people will use the product and how they will use the product, so it is difficult for designers to imagine how they will actually be used" (Lusher in Kawauchi 2009, 140). Another UD proponent, Polly Welch, criticizes non-disability-focused user-centered design, noting that "there is a question of who the user is. Most of the time, it is the majority of users" (Welch in Kawauchi 2009, 114).

person, the consumer, and the housewife? From what epistemic paradigms does design draw the notion of the user as a basic unit of design practice?

Human-centered design, a contemporary practice championed by industrial and interaction designers such as Donald Norman and the design firm, IDEO,[235] promotes the notion of keeping the user in mind—and even privileging it—in the design process. The *user* has become a key concept in the design of human-computer interfaces, whereas in architectural design the focus is often on the *spatial inhabitant*. Because UD combines architecture and industrial design and (as I show in Chapter 2) emphasizes the *user* often in opposition to norms of design practice, I use historicize the figure of the *user* as it encompasses both the technological user and the spatial inhabitant.

The prevalence of UD in industrial and product design, which focus on single-user technologies, has led some critics to highlight to these disciplines' reliance on a conception of the user-as-consumer. As Rob Imrie and Peter Hall argue,

> Universal Design is characterized by a particular conception of the user as a consumer or customer of design products […] The customer analogy is, however, problematical because it does little to challenge or change the design professionals and their position as knowledge experts […] Users are seen as consumers of a service, and only active in its production through market-based testing or exercises similar to those carried out by large private corporations prior to the development of its latest product.[236]

Imrie and Hall highlight the reliance of some user-centered and accessible design approaches on marketing accessibility to users. Such marketing and consumer testing practices certainly have their own unexamined politics. However, from an historical

[235] Donald Norman's work spans the depths of what is considered user-centered and human-centered design, including his work on product design (such as *The Design of Everyday Things* [New York: Basic Books, 2002]) and his earlier work on technology interfaces (such as *User Centered System Design: New Perspectives on Human-Computer Interaction* [Boca Raton: CRC Press, 1986]). Norman's influence may account for the prevalence of the figure of the *user* in industrial design and architecture, beyond the field of human-technology interaction design, where the user is always central. I further explicate the role of the user in industrial and architectural design in Chapters 2 and 3

[236] Imrie and Hall 2001, 17.

epistemological perspective, we must also ask through what industrial, social, military, and design histories the *user* became not only an intended recipient of designed objects and spaces, but also intelligible as a unit of design practice.

In this chapter, I am concerned with the historical conditions of possibility for Universal Design and user-centeredness. I show that broad accessibility is not simply a question of well-intentioned inclusivity, *good design*, or universal human rights. As design historian Stephen Hayward has noted, the discourse of "good design" quickly disintegrates into vague claims about "common sense," "intuition," and majority "good taste."[237] Likewise, what counts as *good design* is subject to historical shifts in the emphasis of design.[238] For example, indications of *good design* range from the notion that "Good design is largely a matter of common sense" in the 1930s to an emphasis on quality construction in the 1940s and eventually a focus on consumer usability and style in the 1980s.[239]

Universal Design, too, participates in the discourse of *good design,* with proponents claiming that UD produces common sense solutions that are both usable and beautiful. However, as Stanton Jones notes, UD "started out as a search for a new definition on [sic] what good design is. However, it still cannot distinguish itself from 'accessibility,' 'design for the lifespan,' 'design for people with disabilities,' and so forth." [240] Thus, the conflation of UD with good design makes it more difficult to parse out the historical and conceptual specificity of its claims from other alternatives. In order to understand how

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[237] Stephen Hayward, "'Good Design is Largely a Matter of Common Sense': Questioning the Meaning and Ownership of a Twentieth-Century Orthodoxy," *Journal of Design History* 11.3 (1998): 217-233.
[238] Hayward 1998, 223.
[239] Hayward 1998, 223.
[240] Jones in Kawauchi 2009, 118. Also see Mace 1985, 152; Welch 1995; Beth Tauke, "Universal Design = Good Design" podcast (Buffalo: Center for Inclusive Design and Environmental Access, 2010); Selwyn Goldsmith, "The Bottom-Up Methodology of Universal Design," in Wolfgang Preiser and Elaine Ostroff (eds), *Universal Design Handbook: 1st Edition* (McGraw-Hill: 2001), l; Kawauchi 2009, 110-111.

UD contributes a notion of user-centered design that goes beyond the vague characterization of *good design*, I differentiate between broad accessibility as a concept denoting the inclusion of diverse differences and *good design* as a framing that designers use to subjectively characterize a worthwhile type of design.

Although the terms *user-centered design* and the related and often synonymous *human-centered design* have achieved more critical reception since the 1980s, the paradigm that these terms describe is much older, with historical origins in scientific disciplines seeking to know users and their bodies. I begin by explaining the relevance of the *user* as an epistemic unit to design and specifically architecture via the concept of *evidence-based design*. Then, I turn to a history of military *human factors* research and its role in shaping user-centered design. Finally, I trace the history of 20th century rehabilitation, mapping its treatment of the *user* and the body as inputs into design intended to normalize or accommodate disability. Throughout the chapter, I show how the concept of the *user* slips between the individual and the collectivity alongside shifts in understandings of the body, the consumer, the worker, the soldier, the citizen, and systems of military and industrial labor. All of these factors influence and are renegotiated by the work of the *user* as an epistemic object. They also, as I show in Chapter 2, become the disciplinary foundations of evidence-based practices of accessible and Universal Design.

Theorizing the user

To locate the user in design, we must begin with the question of the body. Bodies are epistemic objects that shift in and out of view for designers working at multiple scales. While smaller-scale designs, such as individual products, technologies, and furniture, tend to focus more closely on bodily specificity, architecture and urban planning focus on population-level concerns. However, the embodied user persists across scales. While industrial, architecture, and urban design are different professions, their treatment of the *user* as a unit that interacts with built environments relies upon the same theoretical and evidential base.

My historical epistemology of user-centered design complicates UD's theory of value-explicit design articulated in the Introduction by showing that the *user* is a key unit of designers' value-commitments. Architecture, like scientific epistemologies, often feigns neutrality in relation to the body.[241] But the presumed body and the user are always built into designed objects and buildings, even when they are not acknowledged as such. As new materialist feminist philosopher Elizabeth Grosz writes,

> [A]rchitecture is a discipline, not unlike medicine, that does not need to bring the body back to itself because it's already there, albeit shrouded in latency or virtuality. Bodies are absent in architecture but they remain architecture's unspoken condition…Bodies are there in a way that architects don't want or can't afford to recognize. But the body is there in an incontrovertible way. The point is to affirm that it's there, and to find the right kind of terms and values by which to make it profitable for architecture to think its own investments in corporeality.[242]

Part of the task of making it "profitable for architecture to think about its own investments in corporeality" is to expose the neutrality and universality of the intended user of architectural space. *Value-explicit design*[243] exposes the reliance of architecture on embodied users, demonstrating that bodies and environments "are conjoined in their (mutual) production, meaning, and transformation."[244] Every space, door handle, doorway, window, shelf, chair, stairway, and ramp in the built environment is designed

[241] Hosey 2006; Imrie 2002.
[242] Grosz 2001, 12-14.
[243] Moore et al. 1985.
[244] Imrie 2002, 64

according to a particular understanding of users' size and function. Likewise, presumed users often resemble a projection of a normate rather than disabled user. As I explained in the Introduction, this often occurs through the active construction of epistemologies of ignorance.

The abstraction and neutralization of the body, of course, has existed throughout the history of western architecture. Vitruvius's *10 Books on Architecture* established harmonic geometries of the body, derived through cosmological theories of human bodily proportion, as the basis of beautiful architectural design.[245] In Chapter 3, I argue that architecture and design institutionalize available statistical data about average bodily sizes and functions within the built environment through references to Vitruvius. In this chapter, however, I am concerned with how the *user* shapes a regime of intelligibility for human bodies that actively produces knowledge about normate bodies in some iterations, but that also makes possible more contemporary efforts toward Universal Design.

Bodies as evidence, or why knowledge matters for design

As I discussed in the Introduction, users become intelligible as bodies in design through a phenomenon called *evidence-based design*. Evidence-based design parallels and builds on the concept of *evidence-based medicine*, which emerged a decade earlier in the 1980s.[246] Both of these phenomena focus on the application of the best available scientific knowledge to professional practices, like treatment or design. However, medical practice is already entangled with particular basic and clinical research agendas and has a conception of the necessity and validity of scientific evidence. Design, as I

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[245] Vitruvius, *Ten Books on Architecture (de Architectura)*, trans. Ingrid Rowland and Thomas Howe. (Cambridge: Cambridge University Press, 15 BC/2001).
[246] See David Sackett, Evidence-Based Medicine Working Group, "Evidence-based medicine. A new approach to teaching the practice of medicine". *JAMA* 268.17 (November 1992): 2420–5.

explained earlier, instead encompasses a set of practices that are not traditionally rooted in any notion of the scientific method or the need for evidence.

With the exception of user-centered approaches like UD, architectural design methods are overwhelmingly about formal and aesthetic rather than functional factors, excluding a focus on the bodies or people who will most likely inhabit a building or use a design.[247] Universal Design education efforts have arisen to address the ways in which architectural schools train designers as creative professionals who apply experiential knowledge and intuition to the design of buildings, technologies, and products.[248] What counts as knowledge in design is the experiential history of the designer, the technical knowledge of the drafter, and occasionally, the requests of the client.[249] Perhaps most importantly, what makes a notion of *evidence-based design* (as an alternative approach to mainstream design) possible is that few designers are trained as researchers or taught to discern what counts as rigorous evidence. Thus, evidence-based design is somewhat of an unintelligible intervention into design practice because it introduces an epistemological notion of *evidence* into a field that does not have a notion of a need for scientific proof.

This does not mean that design is not already based on implicit knowledge, but that this knowledge is taken for granted as neutral. When objects of knowledge that are often in the domain of medicine and science, such as the body, the user, biological or physiological need, cognition and perception become explicit as variables for design, a major epistemological upheaval occurs because the misfitting body shifts into view and

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[247] This claim, related to the development of modern art, architecture, and design, is further explored in Chapter 2.
[248] For example, Polly Welch, *Strategies for Teaching Universal Design* (Boston: Adaptive Environments, 1995) on the Universal Design Education Project (1993-1994), which took place at 21 architecture schools and design programs across the United States and tested strategies for teaching UD to complement the existing curricular focus on creativity and building systems knowledge.
[249] Cross 2010, 2011; Lawson 2004.

the normate body can no longer be assumed. Disability access, which was mandated by law in U.S. federal buildings in the late 1960s and in all spaces of public accommodation after 1990, produced this kind of upheaval. Demonstrating the anxieties produced by centering misfits in design, architects of new construction protested that the technical guidelines mandating accessible buildings or retrofits would squelch their artistic efforts and reduce them to technical processes.[250]

While evidence-based medicine emerged in the late 1980s as a way of applying knowledge about risk factors for disease to clinical care, the application of scientific evidence to medicine has a much longer history. Likewise, the practice of applying evidence about the body to designing technologies, objects, and spaces goes back much further than any of the literature on evidence-based design has yet acknowledged. Its development is entangled with medical and scientific discourses in the 19th and 20th centuries that prefigure user-centered design and negotiate their own relationships to scientific objectivity and authority.

There was no single moment in which user-centered design took hold or in which Universal Design became possible. Rather, the history of user-centered design can be understood not as a sudden break, but rather a series of ruptures in the prevailing regimes of intelligibility surrounding whether users matter, which users are privileged, and how multiple users become legible to designers.[251] To take hold in design practice, evidence-

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[250] See Kirk Hamilton and David H. Watkins, *Evidence-Based Design for Multiple Building Types* (Wiley, 2009), 14-15. This was also part of the more general backlash against the ADA. See Michelle A. Travis, “Lashing Back at the ADA Backlash: How the Americans With Disabilities Act Benefits Americans Without Disabilities,” *Tennessee Law Review* 76(2009).

[251] This is an archaeological and historical epistemological understanding of the history of user-centered design. Foucault notes that archaeology shows “how a succession of events may in the same order in which it is presented, become an object of discourse, be recorded, described, explained, elaborated into concepts, and provide the opportunity for a theoretical choice” (Michel Foucault, *The Archaeology of Knowledge & The Discourse on Language* [New York: Vintage Books, 1972/2002], 167). He elaborates: “The idea of a

based design has had to not only produce and apply knowledge about bodies, but also to show that something called *evidence* can translate into design practice.

The User and epistemologies of ignorance

As I explained in the Introduction, at the heart of disability access is the idea that design should keep in mind a broad range of bodies and human diversities. This idea of *keeping disability in mind* while designing is an epistemic practice of defining existing gaps in knowledge, and addressing these gaps through the production and application of evidence to design. Feminist work on *epistemologies of ignorance* has mostly focused on race and questions of how racial inequalities are produced through ignorance that is itself a construction of certain research agendas, such as the exclusion of people of color from clinical and pharmaceutical testing.[252] However, this concept also highlights the epistemic value of the categories of *normate* and *misfit*.

The claims of designers to be ignorant or lack adequate evidence of disability are one way of naturalizing the lack of research on the functional needs of people with disabilities in the built environment. These claims also de-historicize the way that scientific research is responsible for institutionalizing the privilege of normate users in the design of built environments. Nevertheless, the late 20th century phenomenon of *evidence-based design* has arisen as a corrective to designer claims of ignorance. With very few exceptions, evidence-based design is always about integrating evidence about users' bodies—the kinds of evidence made legible by evidence-based medicine—and

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single break suddenly, at a given moment, dividing all discursive formations, interrupting them in a single moment and reconstituting them in accordance with the same rules—such an idea cannot be sustained" (Foucault 1972/2002, 175).

[252] Tuana and Sullivan 2007.

about making explicit the types of (already-available) evidence about bodies that shapes the built environment but goes unnoticed.

User-centeredness emerges in response to the perception that architecture and other forms of design do not keep a diversity of users or bodies in mind. As I noted in the Introduction, this perception was especially prevalent in the 1960s and '70s after a federal government survey revealed widespread ignorance of accessibility guidelines among designers.[253] As Jon Lang writes in his seminal *Design for Human Behavior: Architecture and the Behavioral Sciences* (1974),

> This disparity between success and failure illustrates the difficulty that architects have had in predicting the outcome of designs—their impact on people—with any reasonable probability of accuracy. The reasons for this are diverse but have to do basically with the changing nature of the architectural client. As long as architects designed buildings for clients like themselves—that is, people with similar needs, values, and attitudes—relatively few problems arose. The probability of success declines, however, with the growing heterogeneity of client groups and the shifting of needs from those related to physiology and security toward higher-order needs of self-esteem and self-actualization.[254]

Writing within a similar professional milieu that led feminist architects like Weisman and Hayden to critique architects' white, male subjectivity, Lang makes two important points that prefigure Grosz's later new materialist argument about the body in architecture. First, the user of architectural design is typically a virtual rather than real figure. Second, that architects typically presume this figure by using their own bodies as evidence. In contrast, Lang presents the heterogeneity of clients, physiology, and psychological factors like self-esteem and security as proof that the architect alone cannot be the locus of expert knowledge about users.

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[253] National Commission on Architectural Barriers to Rehabilitation of the Handicapped 1967.
[254] Jon Lang, *Design for Human Behavior: architecture and the behavioral sciences*. (Stroudsberg, PA: Dowden, Hutchinson, and Ross, 1974), 3.

In other words, architectural *user-centered design* emerged from the evidence-based design position that if architects position themselves as universal knowers, they will prescribe spatial experiences for users without having an empirical basis of the diversity of users. As a result (according to this theory), architects fail at the epistemic and scientific practice of "predicting the outcome of designs […] with any reasonable probability of accuracy."[255] The epistemic values of prediction, probability, accuracy, and their overarching conception of objectivity, demonstrate that evidence-based and user-centered design construct a binary between *intuition* and *evidence*.

While Lang and others perhaps display excess confidence in evidence about users representing their needs, this kind of evidentiary claim shows the construction of ignorance in architectural design. In the theory of user-centered and evidence-based design, ignorance emerges through the illusion of the architect's non-scientificity, fallibility, and lack of access to valid knowledge. Misfitting, as an epistemic position, is a product of designers' ignorance that results in inaccessible mainstream designs.

Users as an evidence-base

While designers since the late 1960s have been calling for *evidence-based design*, the scholarly literature on evidence-based practice has afforded limited attention to the history or philosophy of the concept of evidence, or to the epistemic politics of claims to know users' bodies. User-centered design is not by itself inclusive, and can either institute the normate as the ideal user or develop approaches that make non-normates the focus of design. The latter strategy includes design efforts that focus exclusively on

[255] Lang 1974, 3.

disability (in the case of assistive technologies), or it can include Universal Design efforts that take into account both normate and non-normate users.

The rules governing how and when particular bodies are considered relevant to design emerge from two specific *technoscientific* fields of user-centric research: military human factors research and rehabilitation. I refer to these fields as technoscientific because they are not only concerned with producing knowledge, but also with applying it to the engineering and design of spaces, assistive technologies, consumer products, transportation, and clothing. Focusing on these particular research milieus demonstrates the entanglement of discourses of military efficiency, labor productivity, body-environment fit, medicine, and health in *user-centered design*.

The User and the 'Human Factor'

The field of *human factors and ergonomics* research originates from 19th century biomechanics and U.S. military research on soldiers' bodies after the Civil War.[256] However, human factors did not become an applied science until the early 20th century, when emerging technologies of war and the standardization of uniforms required greater understanding of soldiers' diverse bodily measurements. Though late 19th century military human factors research focused on quantifying the supposed deficiencies of soldiers' bodies, 20th century human factors research shifted to include ergonomics — the science of fitting bodies to machines and environments to facilitate more efficient and streamlined use. This research, in turn, produced the types of civilian ergonomic

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[256] See Benjamin Apthorp Gould,, *Investigations in the Military and Anthropological Statistics of American Soldiers* (New York: Arno Press, 1869/1979). Gould was an astronomer, member of the National Academy of the Sciences, President of the American Association of the Advancement of Science, an associate of the Royal Astronomical Society of London, and an actuary to the U.S. Sanitary Commission. As I explain in greater detail in chapter 3, Gould's 1869 anthropometric studies of soldiers' bodies represent an early and significant link between emerging statistical studies of human bodies in criminology and eugenics with the military use of bodies as evidence for the purpose of maximizing its warfighting capabilities.

technologies, such as adjustable desk chairs and cushioned mouse pads, which are available today for mass consumption.

Human factors research produced the notion of a human *user* of design (the "human factor") as a unit in broader engineered systems, such as military and industry. In these systems, the user represents not only an individual unit, but also a population range of possible soldiers' or workers' bodies. Human factors interventions in the military likewise focus on engineering a system for a range of bodies rather than focusing on the particularities of individual bodies or integrating them into the military system. However, although historically military human factors and ergonomics research made soldiers intelligible to military engineers and designers, this research became embedded in the industrial ideology of optimizing bodies in spaces of military or industrial production and excluding bodies deemed defective or unproductive according to a normate standard of efficiency. Eventually, the *soldier* and the *worker* became the generalized embodied evidence bases and normate templates for a more general category of *users.*

Military human factors research

Within the United States military, prior to the formalization of human factors as a field of research, knowledge about soldiers' bodies was almost exclusively within the expert domain of military medicine.[257] In the 1930s, when technological advancements in aircraft technology required engineers to understand the physiological stresses that would be placed on soldiers' bodies, "the functional specifications for the first pressure-cabin aircraft were written by a flight surgeon."[258] Human factors historians David Meister and

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[257] The exception to this is the work of the astronomer and actuary, Benjamin Gould.
[258] Morley Gray Whillans, *Anthropometry and human engineering,* a symposium on anthropometry, human engineering and related subjects. North Atlantic Treaty Organization Advisory Group for Aeronautical

Valerie Gowan note that military human factors research, particularly between the World Wars, "was primarily medical/physiological," focusing on how emerging aviation technologies, gravity, acceleration, and altitude affected not only the health of human bodies, but also the category of "human performance."[259] Statistical and psychological human factors research emerged as an addendum to medical and physiological knowledge of the body aimed at promoting health or eliminating disease.[260] The population-scale quantification and study of human size and cognition became necessary with the greater number of soldiers and the invention of new aircraft technologies requiring closer-fitting uniforms and materials.[261]

Early 20th century military human factors research in the U.S. catalogued the characteristics of normate soldiers with high performance and presumed high intelligence.[262] These were soldiers deemed most able to fit and manage existing military technologies and physical environments. World War II, however, marked a major shift in military human factors research, as the diversity of both soldiers and weapons of war increased dramatically, requiring military engineers to understand the range of "human capabilities and limitations that had to be accommodated."[263] Rather than statistically

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Research and Development, Aerospace Medical Panel. May 3-4 (Scheveningen, The Netherlands. London: Butterworths Scientific Publications, 1955), 113.

[259] David Meister and Valerie Gawron, "Measurement in Aviation Systems," in John A. Wise, V. David Hopkin, and Daniel J. Garland (eds), *Handbook of Aviation Human Factors* (Boca Raton: CRC Press, 2010), 3-1.

[260] Chapter 3 explains the history of these quantifications within the emergence of statistical principles of norm and average in the 19th and 20th centuries.

[261] See Ruth O'Brien, "An Annotated List of Literature References on Garment Sizes and Body Measurements," U.S. Department of Agriculture, Miscellaneous Publication No. 78. (Washington D.C., 1930), 3. The collection of anthropometric data for uniforms after World War I was one of the first human factors studies conducted by trained scientists using the scientific method (which, in this case, included the eugenicist and statistician, Charles Davenport, among others).

[262] David Meister, *The History of Human Factors and Ergonomics* (Boca Raton: CRC Press, 1999), 148. There is a parallel history of psychological testing and development of psychological tests in the military through human factors research.

[263] Meister 1999, 151.

discerning the ideal soldier, the military shifted to understanding the diversity of soldiers within its own population and fitting technologies and environments to this population. After the shift, the focus of human factors research became producing data about a range of soldiers' bodies (albeit limited to able-bodied, physically fit male bodies that were deemed qualified for duty), rather than studying the ideal military body.[264]

After the World War II, human factors research continued to impact both military and civilian industries. Anthropometric data sets obtained from approximately 100,000 soldiers were published for general civilian application.[265] Military-funded university laboratories continued to conduct human factors research for military efficiency while civilian corporations incorporated human factors into the development of new aviation and other technologies.[266] The military also continued to use human factors research to enhance war-fighting through ergonomic design of cockpits and weapons.[267]

Human factors and scientific management

The military subsidization of the human factors industry after World War II reflects the ties between military production and industrial scientific management. Scientific management and industrial engineering promoted by Frederick Winslow Taylor and Lillian and Frank Gilbreth approached the design of productive and efficient work through the standardization of workers' bodily movements in the assembly line.[268] The *worker*—the basic unit of industrial engineering—would later make possible the *user* and *consumer* as basic units of design.

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[264] This specific claim is further explored in Chapter 3, on military and UD anthropometry and its treatment of bodies as statistical evidence.
[265] Meister 1999, 152-3.
[266] Meister 1999, 154-5.
[267] Wickens and Hollands 2000.
[268] See Frederick Winslow Taylor, *The Principles of Scientific Management* (New York: Norton, 1967).

Taylorism, an approach characterized by the scientific management of bodies to control the outcomes of labor, appealed to military leaders who valued the chain of command and the need for order.[269] Although for Taylor the physiological aspects of the body, such as elements of "energy and fatigue," were not important factors in productivity,[270] concurrent developments in applied physiology and biomechanics at the turn of the century made possible the study of the body as a productive and efficient machine.[271]

While Taylorist scientific management is distinct from European ergonomists studying "the science of work" because of the latter's concern with physiology,[272] Taylor's disciples, the Gilbreths, emphasized human factors research in the U.S. as "an important corrective to Taylor's limited interest in the social consequences of scientific management."[273] Like 19th century anthropometrists and criminologists measuring human bodies through the use of photography,[274] the Gilbreths adopted photographic time motion studies of human bodies to promote the efficiency of work.[275]

As historian Anson Rabinbach argues, World War I had made military human factors a necessary extension of scientific management, showing that "the application of

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[269] See Charles R. Shrader, *History of Operations Research in the United States*, Volume 2: 1961-1973, (Washington, D.C.: Government Printing Office, 2008). Shrader notes that many of Taylor's early powerful disciplines were military men, who "introduced the scientific management system in the Army arsenals" (Shrader 2008, 12). Scientific management in the military would later translate into the field of operations research (OR).

[270] As Rabinbach notes, "Taylor's goal was the maximization of output—productivity—irrespective of the physiological cost to the worker. As an engineer, he considered the body as a 'machine,' which either operated efficiently or it did not. He did not consider, as the physiologists concerned with the 'human motor,' how energy and fatigue might be optimally calculated for long-term use, rather than productivity, *per se*." See Anson Rabinbach, *The Human Motor: Energy, Fatigue, and the Origins of Modernity* (Berkeley: University of California Press, 1990), 117.

[271] Rabinbach 1990, 122.

[272] Rabinbach 1990 242-243.

[273] Rabinbach 1990, 276.

[274] Alan Sekula, "The Body and the Archive," *October* 39 (1986).

[275] Elspeth Brown, "The Prosthetics of Management," in Katherine Ott, David Serlin, and Stephen Mihm (eds). *Artificial Parts, Practical Lives (*New York: NYU Press, 2002), 254.

insights and techniques developed in the peacetime laboratory [was relevant to] to the exigencies of combat, especially in the vocational rehabilitation and retraining of the wounded."[276] Still, human factors research within the scientific management paradigm aspired toward maximizing bodily efficiency and usefulness through the environment, originating the idea of the environment as an enabler or disabler of certain bodily functions. The efficiency of bodies and soldiers-as-workers was a key concern of military ergonomics as well, because better body-machine or body-environment fit could eliminate errors in war-fighting that produce casualties.[277]

Military and industrial human factors researchers produced methodologies with cross-applicability between military and industrial contexts, recognizing that ergonomics had added value for the civilian population beyond its military applications. For example, military ergonomics and anthropometric studies influenced the civilian industrial design of workplace products, such as office chairs, door handles, and desks.[278] The Gilbreths' motion studies of human performance and energy use—which eventually had a range of uses for rehabilitative medicine, furniture design, home economics, and disability access—also drove their consulting work with the military.[279]

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[276] Rabinbach 1990, 269.
[277] For example, much of the focus of military human factors research is the elimination of accidents and improvement of safety in war-fighting technologies.
[278] The industrial designer, Henry Dreyfuss, promoted the use of military human factors to designers as a way of pursuing user-centered design. His texts, such as *The Measure of Man* (New York: Watson-Guptill, 1960) and *The Measure of Man and Woman*: *Human Factors in Design* (Wiley, 2001) followed earlier uses of military human factors data to introduce ergonomics into industrial design. Although Dreyfuss and his firm, Henry Dreyfuss Associates, updated this data with other information from the general population over the several decades, the industrial design use of human factors research still remains overwhelmingly focused on normate bodies.
[279] Michael C. Wood, *Frank and Lillian Gilbreth: Critical Evaluations in Business and Management, Volume 1*. New York: Routledge, 2003), 128; Jane Lancaste, *Making Time: Lillian Moller Gilbreth, A Life Beyond 'Cheaper by the Dozen.'* (Lebanon, NH: University Press of New England, 2004), 315.

The cross-application of military and industrial research is not unique to the Gilbreths. Business historian Charles Shrader argues that the U.S. military application of scientific methods and knowledge from industrial sectors is historically co-extensive with the existence of the military itself, but became more concentrated in the mid-19th century.[280] The contemporary military-industrial complex not only relies upon defense contracts with major corporations, but also on several decades of applying industrial management principles to achieve military efficiency. The military has thus come to subsidize scientific management research, with human factors and ergonomics largely developing to support the efficiency of work and defense preparation in the post-World War II era.[281]

The military expansion of human factors research defined the stakes of acquiring and applying knowledge about a range of diverse human bodies. Such research was not simply a resource to apply selectively; it was embedded in the very fabric of military efforts to engineer body-environment relationships according to scientific management principles. Based on the historical record, it is often difficult to discern the boundary between military and civilian industrial uses and applications of human factors research. As Morley Gray Whillans, the superintendent of the Canadian Defense Research Medical Laboratories, wrote in a (1995) report to the North Atlantic Treaty Organization (NATO):

> From the reports and design handbooks we have been receiving from the United States, it is clear that the Americans are demonstrating what appears to be a most satisfactory collaboration between aircraft design engineers and the scientists concerned with human factors. Such collaboration is also evident in the United

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[280] Shrader 2008, 7.
[281] Shrader 2008, 8.

> Kingdom. This we envy, for it appears to be much more than a consultation arrangement.[282]

Whillans' comment that the military-human factors connection is "much more than a consultation arrangement" gestures toward the interconnectivity of emerging military and human factors knowledge. Neither was simply in service of the other. According to Meister and Gawron, in the 1950s and 1960s "all engineering companies that bided [sic] on the development of military aircraft had to increase their staffs to include [human factors] specialists" at the same time that the Air Force expanded internal human factors research.[283] In this way, human factors knowledge about bodies, which enabled the fit of military spaces and technologies like aircraft to soldiers, became a necessary condition for all expansions in military research and development.

Human factors and evidence-based design

In military human factors engineering, the body serves as valuable and necessary evidence driving internal military research, as well as the research and development of industries subsidized through military financing and contracts. The early 20th century military use of human factors science produced over a century of applied, evidence-based, and user-centered collaborations between designers and researchers. While human factors research initially was most important to Air Force design, in the mid-late 20th century it expanded into all branches of the U.S. military. Robert Proctor and Trisha Van Zandt explain:

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[282] Whillans, NATO 1955, 113. British military commanding officer of the Institute of Aviation Medicine, W.K. Stewart, wrote to NATO in 1955 about "adapting the airplane to the pilot," noting the development of "pilot error" studies and demonstrating the influence of industrial scientific management research in the British armed forces, as well.
[283] Meister & Gowan 2010, 3-1 − 3-2.

> The U.S. military incorporates human factors analyses into the design and evaluation of all military systems. All branches of the military have human factors research programs. These programs are administered by the Air Force Office of Scientific Research, the Office of Naval Research, the Army Research Institute, and Army Engineering Laboratories. Additionally, the military branches have special programs to ensure that human factors principles are incorporated into the development of weapons and other military systems and equipment. For the Army, the development program is MANPRINT (Manpower and Personnel Integration); for the Air Force, it is IMPACTS (Integrated Manpower, Personnel and Comprehensive Training and Safety); for the Navy, it is HARDMAN (Hardware/Manpower Integration).[284]

These collaborations have meant that the application of evidence about human bodies is folded into every aspect of military design, and that knowledge production about bodies in the emerging human factors research fields has been heavily subsidized by the U.S. military. Not surprisingly, the military human factors operations aggressively titled MANPRINT, IMPACTS, and HARDMAN overcompensate for the perception that human factors may soften the blow of military might through their focus on users' bodies and psychological health, demonstrating that such research still occurs within a militaristic culture and framework for knowledge production.

Militarism notwithstanding, the military investment in human factors research illuminates the principle of user-centeredness by design. Throughout the 20th century, military human factors and ergonomics have, by necessity, employed the notion of flexible design for a range of bodies—albeit a limited, normate range. In doing so, they have made the efficacy of user-centered design more intelligible. Indeed, as human factors and ergonomics developed after World War II, this work became synonymous with user-centered design. The application of human factors research in the fields of rehabilitation medicine and engineering, industrial design, human-computer interaction,

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[284] Robert Procter and Trisha Van Zandt, *Human Factors in Simple and Complex Systems* (Boca Raton: CRC Press, 1993), 12-13

office ergonomics, and even emotional ergonomics[285] demonstrates the extent to which the "human factor," typified by the use of bodies as evidence for design, has impacted industry in the 20th century.

Thus, user-centeredness emerges from an intelligible conception of the *user* and the *human factor* that emerged through the demands of military and industry. The UD principle of "flexibility," reflecting the military's approach to design for diverse bodies, has become both an inclusive design practice and a strategy of late capitalist marketing to a range of consumers.[286] Since the late 1960s, however, human factors research has also been put into conversation with a number of physical and psychological research disciplines, adding complexity to the understanding of the *human* and the *user*.[287]

The System as the Fundamental Construct

Through its ties to military research and scientific management, human factors maintained an allegiance to design for human systems, rather than for individual users, "as the fundamental construct."[288] This expanded human factors research beyond military applications. For instance, the cybernetic tendency of human factors research—the focus on studying the interconnections of humans, technologies, and environments within the broader military system—has allowed design at multiple scales using the same principles, making principles of user-centered computer networking and human-computer interaction potentially applicable to the design of human group interactions with built environments. The cross-applicability of human factors across scales, to include both

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[285] Norman, Donald, *Emotional Design: Why We Love (or Hate Everyday) Things* (New York: Basic Books, 2005).
[286] Imrie 2012.
[287] JD Brewer and HM Hsiang, "The 'ergonomics paradigm': foundations, challenges and future directions," *Theoretical Issues in Ergonomics Science*. 3.3(2002): 285-305(21).
[288] Meister 1999, 89.

individuals and collectivities, has been foundational to UD as a method, particularly in its ways of addressing broad accessibility. However, human factors engineers have recognized that the increasing complexity of human-environment interfaces also changes the way that users and human factors data are understood scientifically.[289]

In the design of the built environment, human factors research has been introduced at multiple scales. The first is at the level of design for a range of individual users, such as in the application of anthropometric data to the design of single user spaces or products such as cockpits and uniforms.[290] The second is at the level of building systems design, including the use of human factors research and cybernetics principles in the engineering of air conditioning systems, spatial circulation pathways, and programmatic components of buildings.[291] These approaches reveal how the application of human factors in the built environment reflects industrial notions of efficiency and bodies as units within broader systems.

The belief that efficiency can be achieved through safety, comfort, and usability is foundational to human factors and ergonomics. For example, John Burgess, a human factors expert in human-machine interfaces and an environmental psychologist working for the Army Corps of Engineers, has written a comprehensive guide (*Human Factors in the Built Environment* [1981]) that explains methods of achieving "human efficiency, safety, comfort, morale, and general usability associated with interior-design features of

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[289] Mark Wise, David Abbott, John Wise, and Suzanne Wise, "Underpinnings of System Evaluation," in Wise, Abbott, Wise, & Wise (eds), *Handbook of Aviation Human Factors* (Boca Raton: CRC Press, 2009).
[290] Further elaborated in Chapter 3.
[291] See Michelle Murphy's *Sick Building Syndrome* (2006) for a history of the application of systems theory to the design of high-rise office buildings to control the circulation of bodies and environmental agents, such as air, allergens, and toxic chemicals.

built facilities"[292] through the application of human factors research. Safety, usability, and comfort become intelligible as design goals when they are tied to tangible and measurable outcomes in terms of the efficiency and performance of the human body. The application of human factors to the built environment is thus ideologically and practically linked to scientific management principles and a notion of the user.

Understanding built environments as systems of human relationships, Burgess touts the systems approach to design as one that "emphasizes interrelationships rather than concentrating on simple isolated problems."[293] This means that rather than simply focusing on "Building-Construction Systems," or the systems of efficiency within a building that include HVAC, stairs, hallways, water, and electricity,[294] the human factors systems approach focuses on "Building-User Systems," or the production and maintenance of person-environment relations and interfaces that are efficient and usable.[295]

Burgess argues that although this approach is complex and often requires data inputs from experts, such as "human-factors and industrial engineers, social scientists, [and] civil engineers," it reduces costs through "enhanced efficiency" and "the intrinsic value of the building is enhanced through greater usability and flexibility."[296] The claim that human factors design improves the efficiency, usability, and flexibility of a building prefigures UD's later claim that good, user-centered, disability-inclusive design has enhanced added value and usability for all users, including non-disabled users.

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[292] John H. Burgess, *Human Factors in the Built Environment* (Newtonville: Environmental Design & Research Center, 1981), v.
[293] Burgess 1981, 95.
[294] Burgess 1981, 96
[295] Burgess 1981, 100.
[296] Burgess 1981, 105.

Likewise, the human factors concepts of *usability* and *flexibility*, though not necessarily focused on inclusive design, eventually become key components of UD as a method.[297] As I explained earlier in the chapter, these concepts are central to at least four of the seven Principles of UD. Additionally, flexibility underlies the notions of *broad accessibility* and *added value*, as it prescribes a method for addressing multiple users, either within single designs or through multiple available design modalities.

In continuing the military tradition of applying human factors research to user-centered and evidence-based design, Burgess characterizes the absence of user-centered spaces as a problem of ignorance, or the lack of data about users. Echoing Grosz and Lang, he writes,

> [T]he architect [...] attempts to obtain as much information as possible about projected uses and operational requirements of the interior building spaces. Otherwise lacking this information, and the wherewithal to obtain it, he is forced to rely on his internal resources and creative intuition. Without a thorough understanding of the characteristics and performance requirements of the people who will occupy the building, what is likely to go wrong in its operation, how it must be maintained and be maintainable, etc., such cogent pragmatic areas might be given less attention than the adequate attention that decor, building style, aesthetic appeal, etc. get [sic].[298]

Here, again, evidence becomes an antidote to "internal resources and creative intuition," demonstrating the crucial link between the framing of human factors as such an antidote and user-centered questions.

For Burgess and other human factors proponents of evidence-based design, the tension between the application of useful data about users and the aesthetic considerations of architects produces a need for additional research that can make the

[297] See Chapter 2 on discussion of the "Seven Principles of Universal Design."
[298] Burgess 1981, 1.

user intelligible to designers. This belief, apparent in a number of design research projects, echoes an understanding of the *body* and the *user* as units of evidence that can be placed into systems to facilitate efficiency and equilibrium. The belief in bodies as evidence for user-centered design later becomes central to Universal Design as a knowledge production practice.[299] To make UD possible, however, the notion of the disabled body as a worthy or likely user of built spaces had to become intelligible through several other research paradigms.

Human factors and ergonomics research operates as a kind of governmentality, organizing the efficiency and management of bodies by creating links between military and industrial methods and practices. Paradoxically, it also operates through notions of usability and flexibility that go beyond standardizing bodies to also fit environments to users. However, although human factors research promotes user-centeredness with the *potential* to make accessibility a human necessity, disabled bodies are never imagined to qualify as military and industrial bodies. The process by which disabled bodies come to be constructed as potential users occurs through the complex milieu of rehabilitative medicine and engineering, which emerges within a late 19th and early 20th century military context to return soldiers, physically or emotionally injured during war, back into the workforce. However, while human factors focused on making the military system work more efficiently, rehabilitation would target individual users and making their bodies better suited to work within the industrial system.

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[299] See Chapter 2 on UD's role in evidence-based design.

The Rehabilitation Paradigm

> "How differently, for example, does a society view disability that results from war injury or industrial accident as opposed to disability that results from congenital deformity, acquired illness, or even self-mutilation? Part of this delineation relies on the perceived difference between disability induced by modern technology or warfare and hereditary disability, attitudes toward which were influenced by antiquated notions of a 'monstrous birth' even as late as the 1950s. In the former, disability is material proof of one's service to the military, to the modern state, to industrial capitalism: these help preserve patriotic values and respectable citizenship. In the latter, disability is a material stigma that marks one's rejection from competent service to society."[300]
>
> -David Serlin, 2004

> "Catastrophe can be the object of repair; we rebuild after an earthquake. To these 'soldiers, husbands, and fathers of families' who left part of themselves behind in combat, the others owe a debt. Culpability and moral obligation are linked with the idea of a catastrophe: we can and must repair, re-establish, restore, in other words, efface, expiate, redeem. The wound can be closed in a scar. The war, like employment itself, can destroy and diminish, but restoration, incorporation, insertion are necessary and possible. A new will is born: to reintegrate. Everyone knows that the basic ideas here are of the integral, intact, complete, at the same time as recovering possession of a former place, a prior situation, property of the past. When speaking of the war-wounded, we are also speaking of rehabilitation. And inversely, speaking of rehabilitation envisages disability as a lack to be filled, almost a lack to be overcome."[301]
>
> - Henri-Jacques Stiker, 1997

This section charts the development of what I refer to as the *rehabilitation paradigm,* an epistemic regime that began to emerge in the late 19th century but entered full force after World War I when weapons of war created new types of disabled bodies.[302] The rehabilitation paradigm is a regime of intelligibility responsible for making disabled bodies, as receivers of rehabilitative services, legible as *users* of technologies and built environments. Rehabilitation understands the user as a dependent recipient of care who must be made an independent worker and citizen. It serves as a

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[300] David Serlin, *Replaceable You: Engineering the Body in Postwar America* (Chicago: University of Chicago Press, 2004), 35.
[301] Stiker 1997, 124.
[302] Anna Carden-Coyne, *Reconstructing the Body: Classicism, Modernism, and the First World War* (Oxford: Oxford University Press), 70.

civilian counterpart to human factors research as a field studying the body and its relationship to environments. However, whereas human factors research quickly became about adapting the environment to the body, mainstream rehabilitation has a longer history of adapting bodies to fit existing environments.[303]

This section does not attempt a comprehensive history of rehabilitation medicine. My focus is the emergence of rehabilitation as an epistemic regime through which disabled bodies become legible users of the built environment. Although rehabilitation emerges from military and medical regimes of knowledge that seek to restore bodies to a state of normalcy, the rehabilitation paradigm is a necessary step between military human factors research and later UD work that includes both disabled and able-bodied people within the category of *user*.

By making disabled bodies legible to designers through medical and physiological research, the rehabilitation paradigm introduced the idea of human variation produced by environmental forces, such as war. In this way, the paradigm discloses the historical specificity of the appearance of certain types of disabled bodies—as Serlin puts it, "disability that results from war injury or industrial accident as opposed to disability that results from congenital" effects.[304] While rehabilitation also contributed to harmful moral and medical model perceptions of disability as a state of *lack* to overcome, it also functioned as an epistemic regime producing ongoing shifts within precursors to UD, such as barrier-free design and assistive technology.[305] Rehabilitation also made possible

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[303] When rehabilitation later allies with UD, it also begins to focus on built environment strategies. However, in these strategies, the built environment becomes a prosthetic that increases the capacities of bodies rather than accommodating them. See Sanford 2012.

[304] Serlin 2004, 35.

[305] My argument complicates the reductive account of the medical model in disability studies, which conflates the treatment of the body and elimination of difference as central to medicine. Rehabilitation, I demonstrate, is a complex social and scientific force that is foundational to social model approaches that

other tendencies that eventually become central to UD, including the view of the body as part of an environmental milieu and the practice of evidence-based design through interdisciplinary teams of researchers, designers, and users.[306]

Space, material structures, and design interventions are fundamental aspects of the rehabilitation paradigm. As historian Ana Carden-Coyne has written, rehabilitation after World War I was crucial to the broader discourse of socio-spatial reconstruction:

> Originally a political term, 'reconstruction' encompassed the rebuilding of cities and economies and the reorganization of society, including repatriation and welfare provisions […] Linked to reconstruction were the terms 'rebuilding', 'restoration', and 'rehabilitation', signifying material progress, physical fortification, and the rebirth of a lost world. These expressions evoked the hopes for recovery in the aftermath of war.[307]

The association between rehabilitation and reconstruction is not accidental. As parts of the larger project of postwar progress, both medical rehabilitation and societal reconstruction operated as interventions on bodies and nations. Just as civilian infrastructure, roads, buildings, and economies could be rebuilt to exceed the previous capacities of the nation, the body could be a site for rebuilding and engineering, a material object of design intervention. It is not surprising, then, that both architects and industrial designers took up the work of developing prosthetic limbs, in addition to their existing work on tools, furniture, and buildings, after World War II.[308]

In his history of disability, Henri-Jacques Stiker differentiates between 19th century medical *cure*, and the addition of the concept of *rehabilitation* in the 20th

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make environments fit disabled bodies. However, as I demonstrate in this section and the next chapter, rehabilitation does not do this without interfacing with a number of other milieus to produce a more complex notion of the *user.*

[306] Further discussed in Chapter 2.

[307] Carden-Coyne 2009, 22.

[308] See for example the artificial legs designed by Henry Dreyfuss and Charles and Ray Eames.

century.[309] Stiker writes that rehabilitation "is a notion different from cure. Cure is a removal and relates to health. Rehabilitation is situated in the social sphere and constitutes replacement for a deficit."[310] In Stiker's narrative, rehabilitation does not eclipse cure entirely, but maintains elements of the devaluation of abnormalcy while seeking the normalization, rather than elimination, of disabled bodies from society.[311] Rehabilitation sometimes even exceeds normalization, turning toward *optimization* and the development of capacities beyond those of typical bodies.[312] Stiker argues that the establishment of institutional settings devoted to rehabilitation "shows the predominance of a social framework over a medical framework, although the one shapes the condition of the disabled no less than the other."[313] Although the shift to "recovery and assistance" under the rehabilitation paradigm is preferable to the "exclusion and surveillance" of the 19th century medical model, the logic of the medical model and its use of medical knowledge to diagnose disability as a condition of disqualification persists within rehabilitation.[314]

Stiker's distinctions importantly demonstrate the way that notions of disability as a lack to be filled or overcome persist in social understandings of the disabled user, even when removed from the medical context of cure. As the rehabilitation paradigm becomes institutionalized and professionalized in the early 20th century, Stiker notes that it facilitates a kind of "*demedicalization* that is only possible through the intermediary of

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309 Stiker 1997, 115.
310 Stiker 1997, 124.
311 This is also a key distinction made by Nikolas Rose in *The Politics of Life Itself: Biomedicine, Power, and Subjectivity in the Twenty-First Century* (Princeton: Princeton University Press, 2006).
312 Rose 2006.
313 Stiker 1997, 114.
314 Stiker 1997, 114.

rehabilitation and reintegration."[315] Rehabilitation is thus a complex paradigm that in some ways originates the idea of a *social model of disability* at the same time that it relies upon medical knowledge to perform social interventions for purposes that are not directly medical.[316] Later, we will see that Universal Design similarly relies upon scientific knowledge about disabled bodies because it emerges within an academic milieu that heavily features rehabilitation, albeit several steps removed from the rehabilitative paradigm of the late 19th and early 20th centuries.[317]

Rehabilitation and epistemic authority

Rehabilitation is an epistemic practice insofar as it employs knowledge about bodies, intelligible through certain understandings of disability and the "normal" state of the body, to design spaces and assistive technologies. Rehabilitation also reflects more general epistemic shifts in the history of science and technology. For example, developments in prosthetic technologies, particularly prosthetic limbs as "normalization devices" in the 19th century, required this type of scientific knowledge about movement and matter to be combined with what could be known about human bodies.[318] Stiker explains that the 19th century witnessed an upsurge in the design of "normalization devices" developed through the application of knowledge about bodies derived from research in musculature and physiology. The latter research translated knowledge of fleshy bodies into the mechanics of artificial limbs and other prosthetics.[319]

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[315] Stiker 1997, 145.
[316] The person-environment theory of disability is also central to Occupational Therapy and as, such, has had a great deal of influence on UD. See Sanford 2012.
[317] Further discussed in Chapters 2-3.
[318] For detailed histories of the relationship between scientific knowledge and prosthetics, particularly in the context of social and national cultures, see Katherine Ott, Stephen Mihm, and David Serlin, *Artificial Parts, Practical Lives: Modern Histories of Prosthetics* (New York: NYU Press, 2008).
[319] Stiker 1997, 115, 221.

The characterization of assistive devices as machines demonstrates the way that technologies of the body predated but were transformed into instruments of rehabilitation. Nineteenth century prosthetics emerged through a strange relationship with mechanical notions of the body that predate rehabilitation and medicalization. Within this conception of the body, amputation was not pathology, but rather an individual mechanical failure of the body or need for supplementation. Mechanical characterizations of prosthetics relied on epistemic claims about authority and mechanical skill. For instance, in 1851, the U.S. Orthopedic Institute claimed to be "fully prepared to *invent and adapt* machinery to *every* variety of *deformity*," demonstrating an understanding of prosthetics as functional and mechanical extensions of the body.[320] Prosthetics and artificial limbs were not simply medical cures, but technologies of rehabilitation and restoration intended to transform the architecture of the body.

Pushing back against the notion of the body-as-machine, mid-19th century inventors of prosthetics also differentiated mechanics from fleshy bodies. In the post Civil War Era, disabled inventors' established epistemic authority over the body and prosthetics by claiming experiential and technical (mechanical and engineering) knowledge outside of the realm of medicine. For example, Douglas Bly, a disabled veteran of the Civil War, explained in an 1862 advertisement for prosthetic legs that "by frequent dissections, Dr. Bly has succeeded in embodying the principles of the natural leg in an artificial one."[321] Bly claimed that his prosthetic "takes NATURE as its guide," and

[320] See Pamphlet circa 1851 from US Orthopedic Institute for the Application of Improved Anatomical Machinery to the treatment of every variety of deformity. "Artificial Limbs," Warshaw Collection, National Museum of American History, Smithsonian Institution.
[321] Douglas Bly, M.D. "A New and Important Invention by Douglas Bly," (Rochester, Press of Curtis, Butts, and Co., Union and Advertiser Office, 1862). "Artificial Limbs," Warshaw Collection, National Museum of American History, Smithsonian Institution.

that previous legs were "MERELY MECHANICAL, AND NOT ANATOMICAL." The notion of the dissected body as evidence of nature and anatomy, and in opposition to the mechanical, both kept the development of prosthetic limbs in the realm of the physiological and biomechanical and differentiated purely mechanical designs from those that could pass as natural. Bly established his authority to judge the function of the natural, mechanical, and anatomical through his own credentials as a disabled veteran and prosthetics user. Thus, for Bly, the first person, fleshy experience of embodiment allowed him to claim access to knowledge of the supposed *nature* of disabled bodies and question the access of normate inventors to this same knowledge. His epistemic claims distanced the design of prosthetics from mechanical or determinist understandings of bodily function that would dominate Taylorist scientific management at the turn of the century. Thus, even prior to the development of medical practices and discourses specializing in the restoration or rehabilitation of disabled bodies, inventors like Bly invoked their own bodily experiences of disablement as evidence for the effective design of artificial limbs and prosthetics.

Several other disabled inventors made similar claims about accessing knowledge about the natural mechanisms of legs. In his *Illustrated Circular* (circa 1868), the disabled inventor James Foster asserts,

> I claim to be the only PATENTEE and MANUFACTURER in America (perhaps in the world) who wears a full length artificial leg and who was a practical mechanician at the time of amputation, and that no other manufacturer has had the same facilities for experimenting with and improving artificial limbs that I have had, for I served a regular apprenticeship and was a practical mechanic before I lost my limb (which was amputated in February, 1860), and since which time I have had a thorough practical experience with other manufacturers of artificial limbs.[322]

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[322] James Foster, "Illustrated Circular," circa 1868. "Artificial Limbs," Warshaw Collection, National Museum of American History, Smithsonian Institution.

This integration of professional expertise and personal experience into claims about the usefulness and function of prosthetic legs pre-dates the emergence of rehabilitative medicine and human factors research as regimes of knowing the body. As an epistemic claim, personal experience with war and amputation buttressed Foster's professional qualifications as a mechanic by privileging his situated knowledge in the production of rehabilitation technologies. This example shows that technology has important social, epistemic, and political implications beyond its functional or mechanistic characteristics.

First person accounts of the efficacy of prosthetics comprised a significant portion of advertising material for prosthetics, even for inventors who were not themselves disabled. The New York City prosthetics manufacturer, A.A. Marks & Co.[323] used the testimonials of prosthetics users in advertisements beginning in 1867. It published images and personal testimonies about the fit and function of prosthetics from wide sections of the population, including women and poor people. These testimonials attested to the natural appearance and function of prosthetic limbs, which not only included artificial legs, but also arms, fingers, and feet with complex mechanical parts. Unlike the inventors who derived epistemic authority from their own situated embodiments, however, Marks & Co. established the validity of their designs according to the accumulation of anecdotes and testimonials about fit and good design. Overwhelmingly, these testimonials focused on the value of prosthetics for reintegrating amputees into mainstream life, rather than on the complex mechanical and functional details of the prosthetic (as in Bly and Foster). In this way, artificial limbs in the post-Civil War era were as much aesthetic objects and style-facilitating accessories as they were normalization devices.

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[323] A.A. Marks, advertisement booklets circa 1867. "Artificial Limbs," Warshaw Collection, National Museum of American History, Smithsonian Institution.

The design of prosthetics prior to World War I represents an early iteration of the notion of *evidence-based design*. Every inventor and engineer claimed to have superior and privileged knowledge of the body in the design of prosthetic limbs while also making comparative claims about the superiority of mechanical, anatomical, physiological, and lived/experiential evidence.[324] These knowledge claims reflect the emergence of body-as-machine discourses within physiology and biomechanics in the mid-19th century, but also show that assistive technologies are products of embodied experience, and not merely consumer products or medical technologies.

20th century rehabilitation after the World Wars

Rehabilitation emerged as a 20th century program of social and public health and hygiene.[325] Shifting demographics and the introduction of anesthesia and antiseptics enabled people to live longer but increased the demand for rehabilitating injured soldiers.[326] The massive and impersonal destruction of World War I created new types of disabled bodies that survived as veterans with greater need for care and accommodation

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[324] For example, a pamphlet from Union Artificial Limb Company in 1872 discusses the comparative value of knowledge derived from surgical procedures and other scientific knowledge to prosthetics designed without the application of such knowledge. "Artificial Limbs," Warshaw Collection, National Museum of American History, Smithsonian Institution. See also Bly (1862) above, who claims to have conducted dissections on human legs to understand their function, and who claims that mechanical knowledge alone is not enough to design a superior leg.

[325] Although my interest is primarily in the U.S. rehabilitation paradigm, I draw on sources about both European and U.S. rehabilitation culture in this section. I do this to ground my discussion within broader disability histories and theories (such as from Stiker and Carden-Coyne).

[326] Although the use of plants and vapors as anesthetics predates the 19th century, Horace Wells famously used the inhalation of ether for surgical anesthesia in 1847. See Horace Wells, *A History of the Discovery of the Application of Nitrous Oxide Gas, Ether, and Other Vapors to Surgical Operations* (Hartford: J. Gaylord Wells, 1847). Likewise, although some knowledge of germs as a factor in disease spread existed in the early 19th century, the application of antiseptics in surgery can be traced to Joseph Lister's (1867) *Antiseptic Principle of the Practice of Surgery*. Henri Jacques Garrigues brought antiseptic surgery to North America in the late 19th century, particularly through his gynecological practice. See Henri Jacques Garrigues, *Practical Guide in Antiseptic Midwifery in Hospital and Private Practice* (Detroit: G.S. Davis, 1886).

than after the Civil War.[327] Because hundreds of thousands of soldiers[328] now re-entered civilian life, it became increasingly obvious that the built environment did not account for these new bodies.

The design and production of rehabilitative objects and spaces proliferated under the rehabilitation paradigm when injured veterans returning from World Wars I and II required technologies that could adapt them to existing built environments. The design of prosthetic limbs for veterans came to feature emerging industrial and military techno-scientific applications and materials, reflecting the hold of the military-industrial complex over matters of the normal and desirable citizen body.[329] Like the human factors research paradigm, the rehabilitation of soldiers raised the issue of disability as a relationship between body and environment, rather than one of the relationship between the body, diagnosable pathology, and medical cure. However, whereas human factors engineering within the military system during wartime meant to fit environments to bodies to enhance war-fighting capabilities, the postwar rehabilitation paradigm focused on re-integrating injured bodies into the industrial system.

Although my interest is primarily in the types of knowledge circulating within the rehabilitation paradigm, it is important to note that one of the most significant ideas promoted about disability by the rehabilitation paradigm is that non-rehabilitated bodies are dependent and that this dependency can be reduced by normalizing or mainstreaming disabled bodies. This distinguishes rehabilitation from other systems of medical

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[327] Carden-Coyne 2009, 73.
[328] The Union army had about 282,000 soldiers return from war wounded but surviving. The number of wounded but surviving Confederate soldiers is unknown. See Department of Veterans Affairs, Office of Public Affairs, “America’s Wars” factsheet (November 2011). Available at: < www.va.gov/opa/publications/factsheets/fs_americas_wars.pdf>. Accessed 3/11/13.
[329] Serlin 2004, 36-37.

knowledge, exemplified by doctor-patient relationships, in which the focus is curing the individual body rather than reintegrating it back into society. The user within the rehabilitation paradigm is also dependent until the point of re-entering society. As a result, rehabilitative designs must take into account the dependencies and interdependencies of users, rather than assuming an independent, autonomous, and able-bodied user who has choices about technologies and services to use that are made available within a free market. At the same time, the goals of rehabilitation, such as employment, independent living, and social inclusion, are aligned with those of late 20th century social justice efforts for people with disabilities. This complicates the narrative of *social model* proponents that the medical model promotes an individualistic and deterministic view of the body.[330] The philosophy of the rehabilitation paradigm actually contains elements of both the medical and social models.

One problematic element of the medical model that does remain, however, is the association of disability with lack in need of addressing. Carden-Coyne observes that "War exacerbated older beliefs about population problems, but also provided a cache of bodies for professionals to study."[331] Disabled bodies, particular those injured in war, became evidence not only of the war's devastation, but also of dependence on rehabilitation. As such, they were used as proof of the necessity of normalization. Paradoxically, this was a way of valuing the experience of embodiment related to disability in a context that was not entirely governed by medical knowledge, but that nevertheless continued to identify disability with incompleteness and deviation from social and embodied scripts.

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[330] Such as the basic premise of Oliver 1990.
[331] Carden-Coyne 2009, 7.

Rehabilitation became medicalized through the association between restoring the body and rebuilding the nation. The emergence of nationalist discourses after World War II in connection to rehabilitation made the supposed medical restoration of soldiers' bodies a national imperative.[332] For example, Serlin cites a 1945 *Popular Science* article that claims that "War's rehabilitation engineering may well become the *social engineering of the future.*"[333] The association of post-war rehabilitation with social engineering or hygiene is not coincidental, given the alliance between military human factors research and eugenicists, such as Charles Davenport.[334] Rehabilitation defined the contours of who could count as fit for citizenship while maintaining racist attitudes about people of color and people with disabilities as inferior citizen bodies.[335] Serlin notes that the relationship between rehabilitation and engineering science furthered nativist attitudes about the inferiority of non-white bodies, connecting scientific research to the figure of the superior and ideal citizen.[336] The nationalist imperative to rehabilitate soldiers' bodies was thus tied to the eugenic externalities of wartime research.

For Stiker, post-World War II veteran rehabilitation, emerging assistive technologies for people with disabilities, vocational and legal protections, and special education were all part of the same rehabilitation paradigm, governed by the logic of normalization and assimilation.[337] Discourses of "replacement," "re-establishment of the prior situation," and "compensation," for example, emerged through the materialization

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[332] Serlin 2004, 12.
[333] Quoted in Serlin 2004, 12.
[334] This point will be further elaborated in Chapter 3. See Charles Davenport and Albert Love, *Army Anthropology: The Medical Department of the United States Army in the World War* (Washington DC Government Printing Office, 1921).
[335] Jennifer James, "Gwendolyn Brooks, World War II, and the Politics of Rehabilitation," in Kim Q. Hall (ed) *Feminist Disability Studies* (Bloomington: Indiana UP, 2011).
[336] Serlin 2004, 13.
[337] Stiker 1997, 135.

of the rehabilitation paradigm[338] by way of what Stiker calls a "legislative discourse."[339] That is, they were enmeshed with notions of "vocational redeployment" and "normalization based on the perception of the average," both part of the paternalistic "juridical discourse" in which, according to Stiker, "assistance is more significantly related to social control of populations."[340] Social services and rehabilitation discourses, then, converge at two points: the control over populations and the enhancement of life according to understandings of normalcy that are governed by the philosophy of rehabilitation itself.

Rehabilitation and the intelligibility of the independent user

Human factors engineered the military system to adapt to the population of soldiers—a range limited by requirements of able-bodiedness. By contrast, the rehabilitation paradigm made civilian users intelligible as individual producers and consumers whose dependency on state or medical systems could be lessened through industrial employment. Engineering individual user bodies to comply with industry required the rehabilitation paradigm and the technologies supporting it to make individual bodies legible as sources of knowledge. As Serlin writes:

> After World War I, psychiatry and rehabilitation medicine…reorganized nonnormativity as a public health issue rather than a badge of personal shame that must be suffered in private. *Individuals became case studies*…In almost all cases, this entailed teaching the physically or sexually nonnormative to adopt and follow some kind of easily recognizable cultural narrative: how to become whole, or how to become beautiful, or even how to become the right kind of person and achieve the right character.[341]

[338] Stiker 1997, 124-125.
[339] Stiker 1997, 124.
[340] Stiker 1997, 125.
[341] Serlin 2004, 10, my emphasis.

The shift to the individual as both a generalizable case study and a site of rehabilitative intervention relied upon human factors to make bodies intelligible as sources of evidence. It also reverted to pre-medical model notions of the body as proof of moral character and social worth. However, the *moral model of disability* also relied upon assumptions about morality and work ethic, and ties between individualism, consumption, and industry that were still very present in the 20th century.[342]

The rehabilitation paradigm made disabled bodies legible to designers and engineers, but the symbolic and financial value of these bodies was still calculated according to national and industrial priorities. As Serlin notes, bodies that were disabled as a result of military service or wartime factory labor became "material proof of one's service to the military, to the modern state, to industrial capitalism," while people with disabilities that are congenital or non-military disabilities bore the "material stigma that marks one's rejection from competent service to society."[343] Serlin's terms, "material proof" and "material stigma" demonstrate the status of bodies as evidence and material-discursive phenomena within the rehabilitation paradigm.

The rehabilitation paradigm's role in defining national belonging in the postwar era also occurred through a framework of knowledge production and technological development that persists within contemporary assistive technologies and barrier-free access projects. The *normalization* approach to the integration of people with cognitive disabilities into society, popularized by Wolf Wolfensberger in the 1970s, was articulated long before this period through military efforts to rehabilitate war veterans.[344]

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[342] See Oliver 1990, 25-39 and 43-54.
[343] Serlin 2004, 35.
[344] Wolfensberger, Wolf. *The principle of Normalization in human services* (Toronto: National Institute on Mental Retardation, 1972)

Normalization, assimilation, and the elimination of alleged defect[345] reflect particular understandings of the concept of the normal and the figure of the normate that are apparent within and perpetuated throughout the rehabilitation paradigm: the notion that the body to be rehabilitated has experienced a previous state of health and/or equilibrium to which it can return.[346] In the history of rehabilitation, restoration of functionality sometimes coincides with the promotion of the aesthetics of normate bodies (such as the use of classical imagery of ideal bodies),[347] or contrasts with more aesthetic approaches to bodily reconstruction.[348]

To understand how the rehabilitation paradigm frames bodily norms, we must recognize two models of the *norm* that emerged in 19th century medicine. Historian and philosopher of medicine Georges Canguilhem differentiates between *statistical norms* for the collectivity and *norms of health and equilibrium* that are specific to each individual. The first of these conceptions comes from mathematics and statistics, and defines norms

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[345] See Cora Kaplan, "Afterword: Liberalism, Feminism, and Defect," in Helen Deutsch and Felicity Nussbaum (eds), *"Defects": Engendering the Modern Body* (Ann Arbor: University of Michigan 2000), 303-318, for a discussion of the role of normalization and the elimination of defect within liberalism.
[346] This rehabilitative ideology reflects not only medical and moral notions of tragedy and overcoming, but also relates to 19th and early 20th century biological and scientific understandings of inferior organisms as atavistic and likely to retreat back to earlier evolutionary stages. See for example the notion of atavism celebrated by criminologist Cesare Lombroso in *Criminal Man* (Durham: Duke University Press, 1876/2006).
[347] Carden-Coyne 2009, 10.
[348] See Sander Gilman's distinction between aesthetic and reconstructive surgery, for example. Sander Gilman, *Making the Body Beautiful: A Cultural History of Aesthetic Surgery* (Princeton: Princeton University Press, 1999), 8. This distinction is important when considering the long-term history of prosthetics and the distinction between functional prosthetics with moving and hinging elements and more aesthetic prosthetics that promote upright posture or normalize the appearance of worn clothing. Building upon Gilman's argument, Garland-Thomson argues, "feminist disability theory calls into question the separation of reconstructive and cosmetic surgery, recognizing their essentially normalizing function" (Garland-Thomson 2002, 10). My account further develops this discussion of the relation between aesthetics and function in the rehabilitation paradigm, showing that (as I do in the next chapter), reconstructive ideals shape and support the underlying theories of accessible design. This point complicates the association between rehabilitation and the normate template.

according to population averages.[349] This is a positivistic norm that characterizes non-conforming individual cases as deviations. It is this conception of the norm—based on population-level prescriptions—that underlies the disability studies *medical model* or what Garland-Thomson calls the "ideology of cure."[350] Cures regulate and prescribe the normate as the ideal standard and eliminate disability and human variation.

The second conception of the *norm* is that it is an internal state of equilibrium specific to an individual organism or system.[351] According to the individual theory of the norm articulated by Canguilhem based on the work of French physiologist Claude Bernard,[352] an organism has an internal steady state (or vital *normativity*) from which it departs when disease is present. The individualized philosophy of the norm is inconsistent with the polemical *ideology of ability* that views anomaly and diversity as pathological departures from population norms.[353] Rather, at least in theory, within the individualized norm, *rehabilitating* the organism requires restoration to its own previous state of equilibrium, as opposed to a uniform state of health prescribed for the whole population.

The individual concept of norm still retains a *normative* and prescriptive dimension dictating that return to equilibrium is both possible and desirable. For this reason, its relationship to the medical model is more complicated than medical cure. If individual bodies determine and regulate their own internal norms, they cannot be treated as pathological by statistical standards. However, there is still a question of the medical and

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[349] Georges Canguilhem. *The Normal and the Pathological* (New York: Zone Books, 1966/1991), 42, 110-111. The history of this concept of the norm is investigated in much greater detail in Chapter 3 on anthropometry.
[350] Garland-Thomson 2005, 525.
[351] Canguilhem 1991, 122-123.
[352] Canguilhem 1991, 136.
[353] Canguilhem 1991, 137.

scientific authority to judge and diagnose whether or not bodies are maintaining their individual norms. This authority can be derived from more general medical and statistical understandings of embodiment, health, and work. The distinction, then, is between methods of intervention and methods of knowing.

The notion of an individual *user* with particular needs emerges through the conflation of individualized and statistical conceptions of the norm. The *user* is an individual insofar as it is a worker, soldier, or consumer, but the epistemic construction of the *user* occurs according to an evidence base derived from normate populations, such as male soldiers and workers. This is why the rehabilitation paradigm differs from other ways of valuing the internal norms of each individual, such as the disability rights and independent living movements, which maintained the rights of people to refuse medical care or to seek out non-medical approaches to accommodation, such as architectural accommodations.

As disability historian Kim Nielson has argued, the disability rights movement's push for independent living was based on notions of "self-determination, consumer control, and deinstitutionalization."[354] Whereas in human factors, the *system* and the population are the fundamental units of knowledge and intervention, in rehabilitation and independent living, the *individual* user the focus of spatial and material interventions. However, rehabilitation understands the individual in relation to collective standards of normalcy. For instance, prosthetics and other assistive technologies fit the individual to existing collectively inhabited spaces. By contrast, independent living, as part of the drive for accessible design, has sought to transform the built environment so that disabled people can participate in society rather than being segregated in institutions.

[354] Nielson 2012, 163.

Thus, both rehabilitation and human factors in the early 20th century measured the individual's normalcy in relation to the broader normate population. This was largely due to the overlaps in evidence base and research methods. However, the rehabilitation paradigm contained enough of an emphasis on the individual user that it would later work to support individualized norms, independent living, and accessible design. To achieve this, it would have to shift authority away from medical knowledge, and also use established scientific methods to ask questions that would be more useful for independent living. I now turn to explaining how this occurred through a series of transformations within rehabilitation, military, and industry that constructed the agency of the independent user.

Assistive technology: rehabilitation, military, and industry

> "Preventative and curative medicine and surgery have made great advances. The third phase of medicine which takes the patient from the bed to the job—rehabilitation—has been neglected. Comprehensive rehabilitation programs have been established in the armed forces and the veterans administration. The disabled civilian, in a democracy, deserves the same opportunity."[355]
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> -Howard Rusk and Eugene Taylor, 1950

The field of civilian assistive technology emerges from rehabilitation medicine and engineering. Serlin's history of prosthetics in the aftermath of World War II demonstrates that assistive technologies, such as prosthetic limbs, "were medical technologies whose design and development expressed postwar culture's need to reengineer the physical body to accommodate the social mandates of the era"[356] and to manage postwar anxieties with the "damaged male body."[357] Serlin notes the postwar

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[355] Howard Rusk and Eugene Taylor, *New Hope for the Handicapped* (New York: Harper and Brothers, 1949), quoted in Book Reviews, *Journal of Bone and Joint Surgery*, 32.2 (April 1950), 472.
[356] Serlin 2004, 16.
[357] Serlin 2004, 25.

shift from prosthetics made of natural materials to prosthetics produced with inorganic materials and engineered according to cybernetic and biomechanical principles.[358] While industrial materials had been used in the design of prostheses after the Civil War, this particular shift reflected emerging industrial capacities initiating a shift from "prosthetics as objects to prosthetics as science."[359] The introduction of hydraulics into prosthetic legs, for instance, resulted from the application of military and wartime scientific and technological advances.[360]

While post-World War II military-industrial ties extended the legibility of the body as evidence for human factors design and military ergonomics, the development of prosthetics, according to Serlin, "may have been an intentional strategy to link disabled veterans with the cutting edge of new scientific discoveries."[361] The association of disabled bodies with scientific advancement was a de-stigmatizing strategy. In the context of normalizing rehabilitation strategies aligning the body with cultural expectations of performance and masculinity, *prosthetics science* tied rehabilitation with scientific progress and discovery. However, to only read this association as de-stigmatizing shifts the historical connection between the ideology of rehabilitation and the emergence of assistive technologies out of view.

The association of disabled bodies in need of rehabilitation with "cutting edge" technologies was part of the post-World War II strategy of restoring veterans to create a standing reserve of manpower and human resources. This occurred through the

[358] Serlin 2004, 26.
[359] Serlin 2004, 36; 26.
[360] Serlin 2004, 37.
[361] Serlin 2004, 37.

promotion of self-help strategies to disabled individuals in general.[362] As I argue in Chapter 2, it also made rehabilitation available to civilians as consumers and users, laying the groundwork for the prevalent use of assistive technologies to accommodate misfitting bodies under the later barrier-free design paradigm.[363]

Rehabilitating the misfit: beyond male soldiers and normates

The slippage between military and civilian rehabilitation created gendered targets for certain types of assistive technologies. While the post-World War II development of prosthetics in conjunction with the military focused on male bodies, the manufacturing and sale of prosthetics to women and people of color at the turn of the century was not uncommon. For example, the late 19th century prosthetics and wheelchair manufacturer A.A. Marks includes extensive discussions of artificial limbs for elderly people, women, indigenous Americans, and even users from Japan in his *Manual of Artificial Limbs* (1905).[364]

As prosthetics historians Katherine Ott and Steven Mihm have noted, Marks' work was entrenched in the trope of disability as an affliction to be overcome.[365] His illustrations of prosthetics users include morphological (rather than medical) drawings of unusual bodies and limbs displayed next to images of the same bodies after having been "corrected" by prosthetics. Marks depicted artificial limb users as if in portraiture, standing upright, wearing clothing indicating higher socioeconomic status, and hiding

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[362] See for example Edward W. Lowman, *Rehabilitation Monograph VI: Self-Help Devices for the Arthritic* (New York: Institute of Physical Medicine and Rehabilitation, NYU-Bellevue, 1962).
[363] Discussed in Chapter 2.
[364] A.A. Marks, *Manual of Artificial Limbs: Copiously Illustrated* (New York: A.A. Marks, 1905) "Artificial Limbs," Warshaw Collection, National Museum of American History, Smithsonian Institution.
[365] Katherine Ott, "The Sum of its Parts: An Introduction to the Modern History of Prosthetics," in Ott, Mihm, and Serlin, *Artificial Parts, Practical Lives: Modern Histories of Prosthetics* (New York: NYU Press, 2008), 28.

their prosthetics. In these images, people with disabilities pass as affluent by passing as able-bodied.

As in the post-World War II era, civilian use of prosthetics after the Civil War included an emphasis on “Utility” (a close relative of *usability*) and work. Marks depicted prosthetics-wearers, including ladies writing letters or driving carriages and men yielding axes and rowing boats, as participating in mainstream social, cultural, and consumer life.[366] Other images displayed men with prosthetic arms serving drinks or playing cards in spaces that wealthier classes would occupy.[367] Like contemporary advertisements that include images of stereotypical beauty to sell diet products, yogurt, and car insurance, Marks’ illustrations associate normate embodiment through upright citizenship—quite literally—with the use of prosthetic limbs to correct posture and erase the appearance of disability. Women, in these illustrations, appear to have gained happiness and honor through the normalization of their bodies. Another stereotypical image — of a Native American man in a headdress, wearing a prosthetic leg and adorned with feathers—conveys the idea that multiple bodies can use assistive technologies.

Depictions like those in Marks’ illustrations represent early notions of the Universal Design idea of *broad accessibility*—the notion that built environments should correct the exclusion of a range of bodies. Here, the representation of a range of bodies — the young and the elderly, rich people and poor people, white people and people of color, male bodies and female bodies — is part of a marketing strategy to show the broad usefulness of artificial limbs. At the same time, the *Manual of Artificial Limbs* serves to catalogue the prevalence of disability in early 20th century U.S. society. When the

[366] Marks 1905, 226-228.
[367] Marks 1905, 229.

rehabilitation paradigm extends beyond soldiers to civilian bodies, it promotes a broad notion of the user, albeit using limited and problematic representations of race, class, and disability.

Post-World War II introductions of rehabilitation into a civilian assistive technology milieu occurred through connections that the military had already forged with scientific management through the work of Frank and Lillian Gilbreth.[368] Though scientific management under Taylorism had been focused on making bodies into ideal working machines, the Gilbreths focused on integrating disability and rehabilitation into industrial engineering. They wrote their first *Motion Study for the Handicapped* in 1920,[369] concentrating on establishing "methods of least waste" for the disabled veteran.[370] As model scientific managers, their approaches to rehabilitation and work were rooted in evidence-based research and labor practices.[371] They predicted the cross-applicability of their motion studies of veterans to civilian people with disabilities, writing that their findings,

> were similar for all handicapped—soldiers and civilians alike. They apply equally well to the maimed and the blinded. They involve determining the One Best Way to do work and teaching it through the most efficient learning process.[372]

The Gilbreths' dedication to efficiency rendered employability as both a measure of inclusion and a mark of citizenship. The notions of "methods of least waste" and the

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[368] For an historical overview of the Gilbreth's rehabilitation work, see Elspeth Brown (2002), "The Prosthetics of Management," cited above. Brown argues that "There is little evidence that the Gilbreths did much work except the rhetorical with the disabled during Frank's lifetime," arguing instead that it was Lillian Gilbreth who took on more substantive rehabilitation work after Frank Gilbreth passed away in 1924.

[369] Gilbreth, Lillian and Frank Gilbreth. *Motion Study for the Handicapped* (London: Routledge, 1920).

[370] Gilbreth and Gilbreth 1920, xi.

[371] "No definite and permanent advance is made with any kind of work, whether with materials or men, until use is made of measurement. This is especially true of the advancement of the human factor in industry" (Gilbreth and Gilbreth 1920, 68).

[372] Gilbreth and Gilbreth 1920, xiv.

"One Best Way" focused on making bodies into efficient workers to facilitate social belonging but de-emphasized individual norms in favor of standardized collective norms of work and embodiment.

The Gilbreths' work on rehabilitation rooted itself in a disability rights paradigm. They lauded the post-World War I shift to the term "handicapped" from (the Civil War-era term) "crippled," as progress in disability rights.[373] The reason that they celebrated the "handicapped," however, was that disabled people "ha[d] become a recognized part of the industrial community,—welcomed and admired, an element that stands for both progress and maintenance."[374] The value of rehabilitation, then, for industrial scientific managers like the Gilbreths, was located in making disability a resource to efficient capitalist production. Lillian Gilbreth continued work on rehabilitation after her husband's death.[375] In this work, she emphasized the relationship between the rehabilitated body and evidence of fitness for work as a condition of disability rights and equality.

From military men to housewives

Whereas military human factors research and the development of prosthetics within the rehabilitation paradigm focused mostly on male bodies,[376] the rehabilitative logic of work as empowerment extended into studies of gender and home economics that applied methods from human factors research (such as measuring the body), principles of

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[373] Gilbreth and Gilbreth 1920, xv.
[374] Gilbreth and Gilbreth 1920, xv.
[375] See Edna Yost and Lillian Gilbreth, *Normal Lives for the Disabled* (New York: Macmillan Company, 1944), vii. *Normal Lives for the Disabled*, a text that Lillian Gilbreth wrote with Edna Yost after Frank Gilbreth's passing, sets forth a set of rehabilitation techniques to be used not only by individuals with disabilities, but also by their wider social and familial networks, employers, industries, and the broader public. It serves as a kind of self-help text, not unlike the series of *Rehabilitation Monographs* published by the Howard Rusk and the Institute of Physical Medicine and Rehabilitation after World War II.
[376] For more on the history of women in post-war rehabilitation, see Carden Coyne (2009, 11-13).

scientific management (such as efficient labor), and rehabilitation (and its related concepts of returning to normal life) to produce assistive technologies for disabled homemakers. As with the production of prosthetics for the general population, household assistive technologies represented a bridge between rehabilitation engineering and industrial design. Products developed as assistive tools for disabled housewives, such as food processors, became commonplace technologies that were marketed as part of the realization of norms of suburban household life.[377]

The inclusion of disabled housewives in rehabilitation via assistive technology first occurred through medical-rehabilitative knowledge production and representation. Rehabilitation manuals for disabled housewives appeared throughout the mid-century, emphasizing the biomechanical and functional rather than medical aspects of impairment in the suburban home.[378] A *Rehabilitation Monograph* by rehabilitation advocate Howard Rusk, funded by the Handicapped Homemakers Research Fund (1955), encouraged disabled housewives to use assistive technologies to prevent the use of excess energy.[379] Though the manual targeted elderly women and wheelchair users, Rusk constructed female-bodiedness in general as disability, emphasizing female weakness and applying ergonomics and scientific management principles to encourage the reduction of energy expenditure in household labor.

Echoing the foundations of human factors research in biomechanics and 19th century thermodynamics and operating as a paternalistic medical professional, Rusk

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[377] See the work of Marc Harrison, an industrial designer who worked at Cuisinart and taught at the Rhode Island School of Design. See Lynn Catanese. "Thomas Lamb, Marc Harrison, Richard Hollerith and the Origins of Universal Design," *Journal of Design History* 25.2 (2012): 206-217.

[378] Virginia Hart Wheeler, *Rehabilitation Monograph XXVII: Planning Kitchens for Handicapped Homemakers* (New York: Institute of Rehabilitation Medicine, NYU, 1976).

[379] Howard Rusk. *Rehabilitation Monograph VIII: A Manual for Training the Disabled Homemaker* (New York: Institute of Rehabilitation Medicine, NYU, 1955)

stigmatized femininity and disability as co-extensive and legible categories of users requiring normalization devices and rehabilitation.[380] Similar manuals for disabled housewives continued to appear in the 1970s, emphasizing the use of assistive technologies to make disabled homemakers into efficient home economists and laborers.[381] These manuals all demonstrate the complex relations between disability and industry, particularly around concepts of dependence, weakness, and lack of access.

Efforts to maximize the productivity of disabled housewives thus emerged from both the rehabilitation and human factors paradigms, operationalizing the body as an efficient machine that could in turn operate the home according to certain social and economic expectations of homemaking. The slippage between body-as-machine and body-as-source-of-knowledge appears throughout the rehabilitation paradigm, as it put physiological and mechanical knowledge of the body to use in the supposed restoration of health and functionality. Particularly in the case of assistive technologies, the rehabilitation paradigm exemplifies evidence-based design and engineering that use the body as a source of knowledge for the development of assistive tools.

From the user to the consumer

In contrast to approaches like military ergonomics, barrier-free design, and Universal Design that transform environments to fit users' bodies, assistive technologies can be understood as tools that help disabled bodies participate in existing social and built environments.[382] As artifacts of the rehabilitation paradigm, they rely upon the

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[380] See my above elaboration of Anson Rabinbach's work on 19th century thermodynamics, human factors research, and Taylorism.

[381] One such monograph claims that an accessible kitchen "pays for itself in the kind of homemakers it puts back in business" (Wheeler 1976).

[382] Assistive technologies are sometimes referred to as *adaptive* because they adapt the body to norms set by the environment (Kawauchi 2009, 10). This contrasts with the later UD notion of *adaptive environments*

intelligibility of the *individual user* as the target of assistance. Rather than standardizing spaces or making them flexible for use, rehabilitation has historically promoted tools and retrofits to make disability an individualized problem with targeted solutions, rather than a collective problem requiring built environment transformations.

Whereas 19th century prosthetics appealed to consumers seeking acceptance into upright citizenship, assistive technologies created by rehabilitation engineers operated under a 20th century consumer-oriented model, through which medical patients became *user-consumers* with choice about the assistive tools to use for access.[383] Although these technologies target individuals, their design addresses a consumer market comprised of particular types of bodies and users. This explains why, even after the influx of soldiers back into society after World War II, architects continued designing built environments with a normate body in mind while soldiers and workers received rehabilitation through medical care and assistive technologies.

As I explained in the Introduction, the impact of this individualized focus on the emergence of accessibility laws is also evident in the limited protections made available through legal frameworks like the ADA. These frameworks limit accommodations to individual cases in the same way that a doctor prescribes treatment to remedy individual bodies. As a result, major overhauls of the built environment become more difficult because the lack of a notion of collective access renders individual disabled bodies as exceptions to normate embodiment.

(promoted through the work of Elaine Ostroff at the Adaptive Environments Center, which later becomes the Institute for Human Centered Design), which are flexible to the individual norms of users' bodies.

[383] Albert Cook, "Foreward," in David Gray, Louis Quatrano, and Morton Lieberman (eds), *Designing and Using Assistive Technology: the human perspective*, (Paul H. Brookes Publishing Co., 1998), xviii.

Institutionalizing rehabilitation research

Although the U.S. federal government has funded prosthetics and rehabilitation research and development since the establishment of the Veteran's Administration after the Civil War,[384] major sources of rehabilitation research funding have emerged since the 1970s that operate within a particular type of rehabilitation paradigm exemplified by the mid-1960s *Nagi model*.[385] This model emerged from the work of Egyptian sociologist, Saad Nagi, who sought a rehabilitation paradigm that focused on functional, rather than medical-pathological, dimensions of disability.[386]

The Nagi model differentiates between pathology, impairment, functional limitation, and disability to mark scales of abnormality or limitation — at the scale of cells and tissues, anatomy and physiology, activity and performance, and social and physical interaction with the environment.[387] As this model demonstrates, contemporary rehabilitation models are focused on a spectrum of interventions beginning at individual pathologies and ending with body-environment relations. While one end of this spectrum maintains a medical model of disability, the other adopts a more social model that is nevertheless rooted in the idea that bodies can and should be rehabilitated to a certain level of function. Both ends of the spectrum focus on individuals.

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[384] Institute of Medicine (IOM), *Enabling America: Assessing the Role of Rehabilitation Science and Engineering* (Washington D.C.: National Academies Press, 1997), 28. For a timeline of federal rehabilitation funding programs, see page 35.

[385] Saad Nagi, "Some conceptual issues in disability and rehabilitation," in M.B. Sussman (ed), *Sociology and Rehabilitation* (Washington, D.C.: American Sociological Association, 1964).

[386] For a history of the development of the Nagi model, and its subsequent revisions in conversation with U.S. and UK disability civil rights organizations and medical-rehabilitative professionals, see C. Masala and DR Petretto, "Models of Disability." In JH Stone, M Blouin (eds), *International Encyclopedia of Rehabilitation* (2012). Available online: http://cirrie.buffalo.edu/encyclopedia/en/article/135/.

[387] Institute of Medicine (1997). pp. 26.

The notion of *functional limitation* has emerged within rehabilitation discourses to denote a kind of impairment produced by misfitting or ill-performing environments. According to *functional limitation*, two individuals with the same impairment can have differing levels of functionality based on other embodied factors. The social environment, too, can create differential levels of access amongst individuals. These distinctions between pathology and functional limitation become crucial for understanding the way that rehabilitative ideologies continue to exist within contemporary disability access and Universal Design efforts.[388]

The distinctions made within the Nagi model parallel those of the British social model of disability, which differentiates between impairment (as a physiological or biological condition) and disability (as a social condition of an individual's competence and fitness in navigating the environment).[389] However, while extreme versions of the British social model place the causality for disability solely within the built environment and tend to disregard the materiality of the body, the Nagi model defines disability as "a relational concept—a function of the interaction of the person with the social and physical environments."[390] Because of the rehabilitation paradigm's relationship to assistive technologies, its theory of the built environment includes not only built structures, but also the objects that make these structures usable to human bodies.[391] The

[388] While some rehabilitation professionals and the Institute of Medicine have argued that the field has shifted away from the medical model, these arguments are usually prescriptive of academic models rather than descriptive of practice. See IOM 1997, 147: "In the past four decades the prevailing wisdom about the cause of disability has undergone profound change. Previous models of absolute determinism that viewed pathology and disability interchangeably and that excluded consideration of the environment have been replaced by models in which disability is seen to result from the interaction between the characteristics of individuals with potentially disabling conditions and the characteristics of their environment."
[389] Oliver 1990.
[390] IOM 1997, 148.
[391] IOM 1997, 150.

rehabilitation paradigm makes assistive technologies that may otherwise be understood as individualized medical tools legible as features of the broader built environment.

The Nagi model is an evidence-based paradigm rooted in a particular type of positivity. It not only provides a theory of *person-environment relations*, but measures ability and disability numerically according to the degree to which the environment supports the person.[392] As part of the legacy of rehabilitation and human factors, the model measures and values body-environment fit as evidence. Initially, what the Nagi model meant by *environment* was mostly social and psychological rather than spatial.[393] The social environment included family, home, and work life. In the 1960s, the disability rights movement, federal access laws, and changes in the architectural and industrial design professions made the physical environment legible as a factor in body-environment fit and interaction, but this kind of intervention was not a product of the rehabilitation paradigm. Rather, as I demonstrate in Chapter 2, the rehabilitation paradigm grew over time to incorporate considerations of the built environment, including buildings, products, and assistive technologies, through its connections to the disability rights movement and barrier-free design.[394]

Like military human factors, which utilized research techniques ranging from anthropometry to physiology to psychology, rehabilitation science evolved throughout the 20th century into an interdisciplinary field bringing together occupational and physical therapy, speech therapy, orthopedic surgery, prosthetics, and the engineering of assistive technologies.[395] It grew to combine human factors and rehabilitation research with

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[392] IOM 1997, 79.
[393] IOM 1997, 79.
[394] As in the work of Timothy Nugent (discussed in Chapters 2-3).
[395] IOM 1997, 29-30.

engineering, making them part of the broader techno-scientific milieu of *user-centered design*. The interdisciplinarity of the human factors and rehabilitation paradigms was in part fostered by federal funding opportunities for the development of rehabilitation science and technology after 1945[396] and also by the proliferation of organizations devoted to research and professionalization in each of these individual areas.[397]

While military rehabilitation research through the Veterans Administration continued after World War II, civilian rehabilitation research has been supported primarily through the Office of Vocational Rehabilitation (OVR), established in 1954 under the Department of Health, Education, and Welfare.[398] The OVR began funding research centers called Rehabilitation Research Training Centers (RRTC) in 1962 and Rehabilitation Engineering Research Centers (RERC) in 1972.[399] Following the restructuring of federal agencies in 1979, the RRTC and RERC programs came to be funded by a new program - the National Institute on Disability and Rehabilitation Research (NIDRR), under the Department of Education's Office of Special Education and Rehabilitation Services.[400]

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[396] IOM 1997, 32-33.

[397] See IOM 1997, 31. Although the American Electrotherapeutic Association was established in 1890, the American Occupational Therapy Association was not established until the end of World War I. The American Physical Therapy Association, the American Speech-Language-Hearing Association, the American Congress of Rehabilitation Medicine, the American Academy of Orthopaedic Surgery, and the American Academy of Physical Medicine and Rehabilitation were established in the interwar period. Rehabilitation medicine became professionalized as a field after World War II, with the establishment of the Association of Academic Physiatrists and two accreditation boards (the American Board of Physical Medicine and the Residency Review Committee for Physical Medicine and Rehabilitation). In the late 1960s and 1970s, rehabilitative specialties emerged with the International Rehabilitative Medicine Association, the American Academy of Orthotists and Prosthetics, the American Spinal Cord Injury Association, and the Rehabilitation Nursing Foundation. Finally, in 1981, the Rehabilitation Engineering and Assistive Technology Society of North America (RESNA) was established, serving as an umbrella association for rehabilitation clinicians, researchers, and engineers.

[398] IOM 1997, 35.

[399] IOM 1997, 35.

[400] IOM 1997, 35.

The resulting research centers have made possible the development of UD as an evidence-based phenomenon based in rehabilitation science. Research funded by NIDRR and the Veterans Administration, and fostered through the Rehabilitation Engineering and Assistive Technology Society of North America (RESNA), helped establish the field of *rehabilitation engineering* as one specifically focused on the application of knowledge about bodies to the development of assistive and adaptive technologies.[401] Contemporary UD research, as I show in the next chapter, primarily occurs within these institutional arrangements and through interdisciplinary teams of researchers trained in rehabilitation and human factors, but also focuses on environments themselves as technologies that must adapt to the individual norms of bodies.

Conclusion

Rehabilitation has, in the last four decades, adopted a post-medical model theory of person-environment relations[402] that locates causality for disability equally in the individual and the environment.[403] It has done so largely through contact with disability rights movements, UD ideas, and the development of professional research fields studying environmental design, environment and behavior, and person-environment relations.[404] As I explain in the next chapter, the rehabilitation paradigm and its transformations of human factors research have been fundamental to the practice of

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[401] IOM 1997, 34.
[402] By post-medical model, I do not mean that rehabilitation has displaced the medical emphasis on cure, but rather that its understanding of the body as a phenomenon to address through design and engineering goes beyond existing Disability Studies medical models.
[403] Masala and Petretto 2012.
[404] This is further elaborated in Chapter 2.

barrier-free design, a precursor to UD. This has led some UD proponents to advocate the use of UD strategies to improve rehabilitation practice.[405]

However, to understand the scope of UD, it is important to distinguish between *assistive technologies*, which focus on acclimating individual disabled bodies to environments, and more *collective approaches* like UD. Universal Design intervenes in the rehabilitative medicine paradigm as an alternative to individual-based technologies and designs, focusing instead on collectivities and their common exclusions from the built environment. In order for this to happen, however, shifts within the design professions have had to occur to integrate disability, feminist, and anti-racist movement demands for de-segregated spaces into the design of architecture and products.[406]

In this chapter, I have shown that the user is an *epistemic object* or figure[407] that not only appears in multiple scientific milieus, but that also produces points of convergence between them. Through human factors, it has become possible to design for a *range* of users. By transforming the body into a source of evidence, the rehabilitation paradigm has also produced a more complex notion of the individual user and its relation to industrial systems.[408]

In the next chapter, I show that while user-centered design is UD's condition of possibility, UD far exceeds it. UD requires not only a concept of a *user* but a design methodology aimed at keeping *particular users* in mind. While making bodies and

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[405] See Sanford 2012 and the special feature on Universal Design in *The Journal of Rehabilitation*, July/August/September 1993, v. 59, no. 3.
[406] This is further explored in Chapter 3.
[407] What I have done here, then, is to use the category of epistemic object or thing more commonly used in historical epistemology to analyze objects such as laboratory instruments or objects of study, and applied it to the work of broader epistemic frames. The application of historical epistemology to structural and social knowledge is an approach that builds upon Foucauldian archaeology and Ludwig Fleck's notion of *thought collectives*, but also feminist epistemological work on communities as the primary epistemic agents. See the Methodology section in the Introduction.
[408] Foucault 2002, 200.

people legible as units of design, user-centered design does not guarantee a focus on or even inclusion of disability. Likewise, some forms of disability access treat disability access as a special needs issue rather than an issue inherent to all user-centered projects. I argue that despite the intelligibility of the figure of the *user,* the range of users still depends on the availability of evidence and training within the design professions to translate this intelligibility into meaningful usability. This point disputes the orthodoxy among UD proponents that broad accessibility by design is simply a matter of common sense and *good design*.

Chapter 2: Evidence and Function: the Emergence of Universal Design

Introduction

In 1966, a young architecture student, Ronald Mace, completed his architecture degree at North Carolina State University by writing a senior thesis about the need for user-centered architectural design. In it, he wrote,

> Today's culture and society, by reason of increased size and heterogeneity of the population, has produced new problems which are completely unprecedented and for which the architect has no answers whatsoever. In accordance with the law of evolution in the sense of perpetual expansion, accelerating bifurcation, and proliferation in all directions, the architect's working processes must develop simultaneously and proportionally with the development of civilization itself. The working processes of the majority of today's architects are not developing proportionally, leaving the architect stranded, defeasible, or even defunct. One of the major reasons that architects' working processes are not developing is the fact that architects are not studying and designing for the full range of human experience. It is the primary task of architects to respond to human needs, both physical and emotional.[409]

As a survivor of childhood polio and wheelchair user with a lifelong interest in design,[410] Mace's experience of attending North Carolina State University in the 1960s was characterized by day-to-day experiences of architectural barriers.[411] His architectural training reflected the design philosophy and epistemology of the obscure, emerging frameworks of *user-centered* and *person-environment design*. These paradigms emphasized the application of scientific knowledge from rehabilitation, human factors, and (later) environmental psychology to design. In Mace's thesis, the influence of these fields is evident in the way that he stresses design for "the full range of human

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[409] Ronald Mace. *Fifth Year Architecture Thesis*. Spring Semester. (Raleigh: North Carolina State University, 1966). Private collection of Joy Weeber.
[410] As a child, Mace designed soapbox derby cars and model airplanes. Joy Weeber. *Personal communication*. March 18, 2012. Raleigh, NC.
[411] Weeber 2012.

experience," both "physical and emotional," and recognizes the failures of *status quo* architectural methodologies in addressing what military researchers before him called the *human factor*. The research milieus discussed in the previous chapter made these types of claims possible, but in the mid-60s were only beginning to enter the architectural design field.

Two decades later, after becoming one of the foremost experts in barrier-free design in the U.S., Mace would coin the term, "Universal Design," to describe accessible built environments that could keep in mind the "full range of human experience."[412] While Mace was the first to describe the phenomenon using the term, "Universal Design," the idea of design for a broad range of bodies and experiences was circulating among the disability rights movement and advocates of *barrier-free design* even before Mace wrote his senior architecture thesis.

In the last chapter, I explored how a notion of the *user*, as a person using designed and engineered spaces and things, emerged through human factors and rehabilitation research. In this chapter, I trace how the practice of *designing* became a strategy for attending to users' needs. I show how UD emerges from the field of *environmental design research* through a *person-environment* framework stressing the application of human factors and rehabilitation research to design. Tracing claims about the need to make design user-centric, I show that inclusive design relies on *functionality* and *usability*, two related concepts that emerge from evidence-based design. I begin by exploring 19th and 20th century architectural theories of form and function. Then, I explain the turn to *barrier-free design* as an early iteration of inclusive design. I show the relationship between barrier-free design, evidence-based design, and the emerging field

[412] Mace 1985.

of *environmental design research*. Finally, I turn to the history of Universal Design and show how it is shaped by developments in inclusive and evidence-based architectural and industrial design. By the end of the chapter, I show the persistence of all of these milieus in the institutional and professional conditions producing UD's epistemic community.

What is design?

So far in the dissertation, I have answered the question of what design practice is by turning to *design epistemology* (Introduction) and the notion of *evidence-based design* (Chapter 1). In this chapter, I am interested in how the history of architectural and industrial design in the 19th and 20th centuries shapes the notions of *usable* or *functional* design. Human factors and rehabilitation often describe their interventions through the techno-scientific category of *engineering,* rather than the aesthetic or creative act described by *design*. Thus, we have specialists who are human factors and rehabilitation engineers who are trained as researchers and clinicians in these fields. Because these specialists study human performance and are trained in a common evidence base, they are able to foster multidisciplinary collaborations at the same time that their methodological approaches proliferate under different titles.[413]

The design disciplines—architecture, industrial design, landscape architecture, urban design, fashion design, and others—remain a somewhat separate milieu from human factors and rehabilitation. These disciplines participate in creative work with an

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[413] The common evidence base studies *human performance* (Steinfeld and Maisel 2012, 95). Although the fields of industrial design and assistive technology, which are the contemporary extensions of human factors and rehabilitation, share an evidence base, there is what Steinfeld and Maisel describe as a "gulf" between the contemporary manifestations of their practices because of the former's emphasis on aestheticizing technologies and the latter's emphasis on functionality (Steinfeld and Maisel 2012, 307). However, their work often addresses the same technological needs and industrial design often takes assistive technologies and transforms them into broadly usable consumer products. Steinfeld and Maisel cite eyeglasses and closed captioning as examples.

aesthetic focus and train designers to adopt intuitive design thinking and methodologies (as described in the Introduction). However, *user-centered design* and *evidence-based practice* build bridges in the mid-20th century between design and engineering advocating for shared evidence bases, epistemologies, and methodologies of approaching design. In *inclusive design*,[414] both designers and engineers have increasingly adopted functional approaches to designing for users that incorporate aesthetic considerations.[415]

In order to trace the UD notions of *broad accessibility*, *access by design*, and *added value* within the discourses of the design professions, I begin by explaining theories of form and function that underlie 19th and 20th century architecture and industrial design theories in the U.S. and Europe. The professed relationship between form and function in these theories disrupts the binary between design and engineering, showing that design is not simply art, but also a *techno-scientific phenomenon* participating in scientific, nationalist, and industrial discourses.

While modernist architecture in the 20th century approaches design as a kind of functional social engineering, barrier-free design arises out of the claim that the architectural profession fails to address the functional needs of diverse users.[416] Industrial design, however, takes a different trajectory in the 20th century, keeping considerations of human variation alive in order to market products to individual users. Later, Universal Design combines these design disciplines to facilitate broader inclusion through

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[414] Inclusive design is a term that is roughly synonymous with accessible design. Like the latter, it does not specify a specific cohort for whom to seek inclusion, but it does differentiate between mainstream inaccessible designs and more value-explicit approaches.
[415] Mueller 1995.
[416] This is a claim that barrier-free design and user-centered design proponents share. Mace (1966 and 1985) makes similar claims about designers' ignorance of disability and human variation as those that Burgess (1981), Grosz (2001), and Lang (1974) (discussed in Chapter 1) made about the need for including users.

considerations of users while still relying on many of the knowledge bases that made these earlier, more limited approaches possible.

Architectural design and user-centeredness

> "Architecture, after its gross distortions during the last hundred years, must once more be placed at the service of man. It must abandon sterile pomp, must care for the individual and create for his happiness the installations that make up his environment so as to facilitate all his actions. Who could carry out the measures necessary for the special accomplishment of this task if not the architect, who possesses a perfect knowledge of man, who has abandoned designs based on illusory aesthetic considerations, and who, by precisely adapting means to the desired ends, will create an order that bears within its own poetry?"[417]
>
> -Congrès internationaux d'architecture moderne (CIAM) (1933)

In this section, I briefly trace the notions of *function* and *usability* within architectural and industrial design in order to demonstrate two points. First, I want to impress the significance of functionalism and usability as values that transform 20th century practice. Second, I show that functionalism and usability produce a relationship between the design of buildings and products that becomes essential to UD's strategy of environmental change. I am interested in how the user becomes a recipient of functional design.[418] Later in the chapter, I discuss how the failures of modernist functionalism reinforce the normate template and precipitate accessible design as an alternative practice.

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[417] Congrès internationaux d'architecture moderne (CIAM), "Charter of Athens," in Ulrich Conrads (ed), *Programs and Manifestoes on 20th-Century Architecture* (Cambridge: MIT Press, 1933/1975).
[418] I focus in particular on the period between the late 19th and mid-20th centuries because the notion of the user emerges in this period through the sciences of human factors and rehabilitation outlined above.

By design: Functionalism vs. Form

The distinction between *form* and *function* speaks to the difference between design for *usability* (function) and design that upholds principles of *aesthetics and style* (form). This distinction is foundational to the practice of architecture, but becomes formally articulated through the doctrine of *functionalism*. According to the architectural scholar Hyungmin Pai, *functionalism*, along with the assumption of its utility and scientificity, promotes the idea that usable built environments could "solve the complex problems of modern institutions"[419] and (like medicine or rehabilitation) serve as correctives to the ills of modern society.[420] As in military human factors, functionalism has meant to intervene at the scale of systems—institutional arrangements, buildings, and groups of people, rather than at the level of the individual body, as in the rehabilitation paradigm. However, rehabilitation engineering and assistive technologies also employ functionalism to promote individual usability.

Since the mid-19th century, functionalism has been entwined with the logics of scientific management and the rational control of human behavior through environmental determinism. Pai argues that by using machinic metaphors for spatial relations, the mechanical notion of the body could serve as a template for spatial design:

> the physical environment could be transcribed as a social and institutional function. In order to close the gap between body and space, to merge Gilbreth's ideal diagram of the functionalized body and Bentham's utopia of a functionalized space, the metaphor of architecture as a mechanical apparatus or a

[419] Hyungmin Pai, *The Portfolio and the Diagram: Architecture, Discourse, and Modernity in America* (Cambridge: MIT Press, 2006), 109.
[420] Steinfeld and Maisel 2012, 32.

> natural system was constructed. It was through this metaphor that one could visualize and talk about 'the function of the building.'[421]

Functionalism, then, reflected not only the notion of buildings as efficient machines, but also the integration of ideas about the body as a human motor into the design of architectural mechanisms.[422] Optimizing the functionality of architecture and industrial design for the user required conceptualizing both buildings and bodies as machines that could be engineered and streamlined to efficiently achieve societal goals.[423]

Horatio Greenough, the American sculptor and architect, articulated an early version of the doctrine of functionalism in 1852, near the end of the first Industrial Revolution. Greenough defined human use as the "nucleus" of the building as a system of parts operating at different scales:

> Instead of forcing the functions of every sort of building into one general form, adopting an outward shape for the sake of the eye or of association, without reference to the inner distribution, let us begin from the heart as a nucleus and work outward. The most convenient size and arrangement of the rooms that are to constitute the building being fixed, the access of the light that may, of the air that must, be wanted, being provided for, we have the skeleton of our building. Nay, we have all excepting the dress. The connection and order of parts, juxtaposed for convenience, cannot fail to speak of their relation and uses. […] If this anatomic connection and proportion has been attained in ships, in machines, and in spite of false principles, in such buildings as make a departure from it fatal, as in bridges and in scaffolding, why should we fear its immediate use in all construction![424]

Greenough's description of the building system as comprised of "anatomic" parts reflects early 19th century designs of machines with inter-changeable parts to improve industrial

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[421] Pai 2006, 197.
[422] See my discussion of Anson Rabinbach's work in *The Human Motor* in Chapter 1.
[423] See Pai 2006, 164-165. In chapter 3, I elaborate upon an earlier history of the body as a template for architecture when I discuss Vitruvius and his prescription of human dimensions as the basis of the Golden Ratio.
[424] Horatio Greenough, "The Law of Adaptation" (1852), in Carma Gorman (ed), *The Industrial Design Reader* (New York: Allworth Press, 2003), 13.

efficiency. His description also demonstrates that functionalism produced a mechanical conception of the building as a body in the sense of the relationships between its parts.[425]

By contrast, Classical and Renaissance architecture conceived of the body as emblematic of harmonic geometry that should be reflected in beautiful buildings.[426] While both of these representations make the body a model for architecture, the former relies upon the functional aspects of bodily mechanics, while the latter prescribes the body as the basis of architectural form and beauty. In the late 19th and early 20th centuries, the distinction between form and function would become even more pronounced with the emergence of applied arts,[427] the Bauhaus, and modern architecture and industrial design treatises advocating functionality and usability.[428] In some cases, as with modernist architect Louis Sullivan, functionality became a way of defining and driving efforts to produce form.[429]

The notion of usability can be traced as far back as Vitruvius, who emphasized the firmness and utility of built structures, and periodically re-enters architectural discourse.[430] In modernism, usability and functionality work in tandem with the professionalization and advanced theorization of industrial design. The Bauhaus, in particular, focused on both the design of architecture and industrial products as a way of promoting Germany's industrial superiority through the mass production of functional

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[425] In Chapter 3, I discuss another way that the body becomes a template for buildings, derived from Vitruvian proportions re-discovered in the Renaissance.
[426] See the discussion of Vitruvius and the Golden Ratio in chapter 3.
[427] See Candace Wheeler, "Decorative and Applied Art," *Household Art* (New York: Harper & Brothers, 1893), 198-204, in Carma Gorman (ed), *The Industrial Design Reader* (New York: Allworth Press, 1893/2003).
[428] Ulrich Conrads (ed), *Programs and Manifestoes on 20th-Century Architecture* (Cambridge: MIT Press, 1975).
[429] As in the adage, "form follows function" (Steinfeld and Maisel 2012, 31).
[430] Steinfeld and Maisel 2012, 30-31.

forms.[431] Particularly at the turn of the century, this wedding of architecture and industrial design represented the involvement of industry in the economic and infrastructural development of nation building. Later, these ideas would be transplanted into an American context that transformed industrial design into a practice more akin to consumer product design than the design of machine parts or tools useful to industry. Yet, industrial design would retain its theoretical basis in functional design for individual users in ways that would distinguish it from architectural practices for a broader or more general cohort of inhabitants.

The crux of the argument for functionality is a critique of aesthetic considerations. In the early 20th century, the anti-aesthetics argument was often reactionary. Austro-Hungarian architect Adolf Loos, in his 1908 essay, "Ornament and Crime" famously characterized the aesthetic of ornamentation as culturally backwards and unevolved, like the tattoos of criminals and the piercings of "alien cultures."[432] In the U.S., the formalization of streamlining, an aesthetic based on minimizing ornamentation, would similarly produce an aversion to ornamentation in favor of sleek and useful designs. As Christina Cogdell has demonstrated, streamlining was steeped in the eugenic logic of eliminating non-functional elements in order for the whole to function.[433] However, functionalism is not necessarily tied to these values. Its approaches to the *user* and the *body* do their own work in solidifying or breaking down the normate template.

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[431] See Muthesius, Le Corbusier, Mies van der Rohe, and Gropius below.
[432] Adolf Loos, "Ornament and Crime" (1908), in Ulrich Conrads (ed), *Programs and Manifestoes on 20th-Century Architecture* (Cambridge: MIT Press, 1975), 19-24.
[433] Christina Cogdell, *Eugenic Design: Streamlining America in the 1930s* (Philadelphia: University of Pennsylvania Press, 2010).

Standardization and the Organism: Building Systems and the Body as Template

In 1910, Frank Lloyd Wright wrote of "Organic Architecture" that could merge functional elements, such as furniture, light, and ventilation, into the very design of the building.[434] Such a building would be an "organic-entity" showcasing "the higher ideal of unity as a more intimate working out of the expression of one's life in one's environment. One great thing instead of a quarreling collection of so many little things."[435] Designing a building as an organic-entity would require the forethought of the architect designing a system of interfaces with the building's users. It would create a new aesthetics emphasizing the functionality and harmony of building systems rather than the decorative arts. These systems included users as a fundamental unit of design.

Wright's functional understanding of building systems is an historical precursor to the notion of producing a certain outcome *by design* but follows the doctrine of functionalism articulated by Greenough and others. Like the UD concept of accessibility by design, Wright's emphasis on functionality by design invests power in the role of the architect to create a supportive system for users and their bodies—from the shape of the chairs to the quality of light. Functional buildings would not only interface with users, but also serve as intermediaries between the user and the outside natural environment—an approach for which Wright would become famous.

Other modernists, emerging from the English and German Arts and Crafts traditions promoting industrialized production of art and design, debated the functionality of standardized design. These debates characterized an early 20th century merging of

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[434] Frank Lloyd Wright, "Young architecture" (1931), in Ulrich Conrads (ed), *Programs and Manifestoes on 20th-Century Architecture* (Cambridge: MIT Press, 1975), 25.
[435] Ibid.

theories of architecture and industrial design, disciplines that would experience significant overlaps and divergences over the course of the next century. The debates also marked a functionalist view of architecture that understood built structures to be designed and fabricated objects, like furniture and clothing at a larger scale.[436]

German architect and diplomat Hermann Muthesius outlined universal principles of design in 1914 for the first exhibition of the Deutscher Werkbund, the forerunner of the Bauhaus. Muthesius posited that "Standardization […] will alone make possible the development of a universally valid, unfailing good taste."[437] Universalized taste, based on functional standardization, was intended to promote Germany modernism internationally. Henry van de Velde, a Belgian painter and architect credited as an originator of Art Nouveu, had in 1897 proposed the mass production of rational and functional furniture and other products, claiming that "a man's worth can be measured by the number of people who have derived use and benefit from his life's work."[438] By 1914, however, van de Velde protested Muthesius's impulse for standardization, arguing that it would destroy the creativity of art and design.[439]

This debate, a critical moment in the history of modernist design and architecture, focused on the standardization of methods of designing rather than the standardization of outcomes for the user. Nevertheless, it relied upon a normate and standard user who would benefit from the new design methods. The philosophy of standardization in design and aesthetics prefigures mid-to late-20th century developments in accessible architecture

[436] This idea later becomes important in UD as it emphasizes buildings as technologies that can be made user-centered through attention to better technological arrangements.
[437] Hermann Muthesius, "Aims of the Werkbund" and "Werkbund Theses and Antitheses" (1911), in Ulrich Conrads (ed), *Programs and Manifestoes on 20th-Century Architecture* (Cambridge: MIT Press, 1975), 28.
[438] See Henry van de Velde, "A Chapter on the Design and Construction of Modern Furniture," Pan (Berlin), v. III (1897): 260-64, in Carma Gorman (ed), *Industrial Design Reader* (New York: Allworth Press, 2003).
[439] Van de Velde in Conrads 1975, 29-30.

focusing on function—namely legal access codes and the establishment of principles for inclusive design.[440] These demonstrate the influence of modernism, entwined with the laws and values of the modern state, on progressive and value-explicit design frameworks.

By arguing for universal principles of design, Muthesius made apparent an ongoing modernist fascination with standardization that would appear later in the work of Bauhaus architects, Le Corbusier,[441] Ludwig Mies van der Rohe,[442] and Walter Gropius.[443] Le Corbusier in particular posited that:

> A standard is necessary for order in human effort.
> A standard is established on sure bases, not capriciously but with the surety of something intentional and of a logic controlled by analysis and experiment.
> All men have the same organism, the same functions.
> All men have the same needs.[444]

The standardization of the body, the person, and the user, thus follow the standardization of functionality in modern architecture. They retain the view of the normate as the basis of embodied and functional needs. As historian Ana Carden-Coyne has noted, the images of the body circulating in modernism reinforce classical ideals of bodily integrity and sameness in order to promote post-war industry and reconstruction.[445]

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[440] See my discussion of the ADA in the Introduction and later in this chapter.

[441] See Le Corbusier, "Towards a new architecture: guiding principles" (1920), in Ulrich Conrads (ed) *Programs and Manifestoes on 20th-Century Architecture* (Cambridge: MIT Press, 1975), 59-62.

[442] "Architecture is the will of the age conceived in spatial terms." See Ludwig Mies van der Rohe, "Working Theses" (1927) in Ulrich Conrads (ed), *Programs and Manifestoes on 20th-Century Architecture* (Cambridge: MIT Press, 1975), 74-75. Although van der Rohe was opposed to formalism and architectural doctrine, his work naturalized the hidden dimensions of architecture, particularly the seeming neutrality of modernist buildings that nevertheless were constructed according to particular industrial economic and cultural principles.

[443] See Walter Gropius, "Principles of Bauhaus production" (1926), in Ulrich Conrads (ed), *Programs and Manifestoes on 20th-Century Architecture* (Cambridge: MIT Press, 1975), 95-97.

[444] Le Corbusier, "Eyes Which Do Not See: Automobiles" (1923), in Carma Gorman (ed), *The Industrial Design Reader* (New York: Allworth Press), 107.

[445] Carden-Coyne 2009, 52-53.

Because the Bauhaus, like the Deutscher Werkbund from which it emerged, focused on the industrial aspects of architectural design, it also included a heavy emphasis on industrial and product design through which it could promote the standardization of body-machine interactions articulated through similar systems-based principles as those that govern the design of buildings as systems for human interaction. Lillian Gilbreth's notions of "functionalization," "standardization," and the "One Best Way" established a decade earlier through her work on industrial psychology, are particularly evident in Le Corbusier's emphases on the control of the body through logic and uniformity. [446] As I discuss later, the mass production of products according to standardization survives today in UD, though the focus on standardizing the body shifts dramatically to include a more inclusive range of bodily functions and dimensions.

Not surprisingly, modernist attention to the particularities of users emerged in the 1930s within the sphere of industrial design for (what was perceived to be) the particular needs of women as home consumers. Belle Kogan, the Russian-born, U.S. American industrial designer, argued that industrial design must keep pace with the demands of the public. In the designer, she located epistemic authority to know consumer needs and adopt a "broad conception of consumer[s'] desire."[447] Kogan believed in mass production according to user-centered principles, calling for designers to "know who the ultimate consumer is likely to be" in order to produce designs that are "practical from the standpoint of their utilitarian appeal to the public."[448] Though never defining what is

[446] See Pai 2002, 165. Pai discusses the impact of standardization and functionalization on the architectural diagram

[447] See Marcy Babbit (1935), "As a Woman Sees Design: An Interview with Belle Kogan," *Modern Plastics*, 13(4): 138, in Carma Gorman(ed), *The Industrial Design Reader* (New York: Allworth Press, 2003).

[448] Babbit 1935, 139.

meant by the public, Kogan was operating within an early 20th century industrial design milieu that relied upon human factors, time motion studies, and scientific management to produce a conception of the average and most frequently occurring consumer as housewife and homemaker.

Even when the identity of the user is not directly in question, standardization has accompanied the language of universal methods, principles, and outcomes of design. Following Muthesius and the later Bauhaus architects, British architect Buckminster Fuller developed the notion of "universal architecture."[449] He outlined architecture as a tool of human survival in times of war, necessarily providing "spatial control" against assaults on the body from natural phenomena, such as earthquakes and tornados, as well as internal spatial phenomena, such as nerve shock and labor-related fatigue.[450] Also following the tradition of industrial-minded designers, Fuller maintained that "*Science + Art + Industry = Universal Architecture,"* a formulation that squarely placed the relationship between *evidence* and *design* within the context of industrial efficiency and production.[451] Ideologically and methodologically, this calculation mapped onto scientific management approaches to design for users and bodies that were researched by Taylor, the Gilbreths, and military human factors researchers. Although "Universal Architecture" bears no resemblance to contemporary Universal Design, the formulation of a connection among science, art, and industry is essential to both and shows the longer trajectory of negotiations of evidence, aesthetics, and usability.

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[449] See Buckminster Fuller, "Universal architecture" (1932), in Ulrich Conrads (ed), *Programs and Manifestoes on 20th-Century Architecture* (Cambridge: MIT Press, 1975), 128-136.
[450] Fuller in Conrads 1975, 129.
[451] Fuller in Conrads 1975, 131.

Fuller's attention to buildings as systems that protect people from war is one exception to the modernist inattention to the range of human variation, and demonstrates the way in which war and disability make bodies and human physical and psychological requirements intelligible to designers. His work contrasts with Le Corbusier's insistence that buildings and cities be designed "exclusively on human proportions,"[452] reflected in his normate Modulor figure and its aesthetic and proportional reference to the Vitruvian Man.[453] Nevertheless, neither of these exceptions makes the bodies of users intelligible in the way that rehabilitation and human factors are able to do. When modernist architects do introduce some notion of human users in space, they do so on the basis of standardization, assuming that all bodies benefit equally from good design.

For example, in 1933, the Congrès internationaux d'architecture moderne (CIAM) brought attention to the dangers to human health posed by pollution in cities, and argued that the time spent by city dwellers in "mechanical vehicles" would eventually impair their ability to walk.[454] While making human health legible to designers at the scale of urban planning, CIAM did not have a critical consciousness about other factors creating barriers to walking—such as mobility-related disabilities incurred from war or streets designed without walkable surfaces. Thus, while CIAM focused on the large-scale effects of urban planning on environmental health, it did so with a normate conception of human needs.

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[452] See CIAM (1933), "Charter of Athens," in Conrads 1975, 138-139.
[453] This is further elaborated in great detail in Chapter 3.
[454] CIAM 1933, 140.

After World War II, modernists continued to insist upon the standardization of form.[455] However, multiple alternatives to rigid and universal functionality began to appear that promoted organic, non-rationalized, and open forms of architecture.[456] In 1958, Friedensreich Hundertwasser, a Viennese painter and architect, delivered a critique of modernism that exemplified claims made by critics of the normate template throughout the mid 20th century:

> A cage construction or utilitarian construction is a building that remains alien to all three categories of people that have to do with it!
> 1. The architect has no relationship to the building. Even if he is the greatest architectural genius he cannot foresee what kind of person is going to live in it. The so-called human measurement in architecture is a criminal deception. Particularly when this measurement has emerged as an average value from a public opinion poll.
> 2. The bricklayer has no relationship to the building. If, for example, he wants to build a wall just a little differently in accordance with his personal ideas, if he has any, he loses his job. And anyhow he really doesn't care, because he isn't going to live in the building.
> 3. The occupant has no relationship to the building. Because he hasn't built it but has merely moved in. His human needs, his human space are certain to be quite different. And this remains a fact even if the architect and bricklayer try to build exactly according to the instructions of the occupant and employer.[457]

These claims - that the architect is alienated from the user, that the statistical user is a fiction, that the worker (in this case, the bricklayer) is alienated from the labor of design due to the professionalization of architecture, and that the spatial occupant's "human needs" are unmet by existing designs—underlie all critiques of the normate template and mirror claims about the construction of ignorance around the *user* made in both user-

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[455] See Henry van de Velde, "Forms" (1949), in Ulrich Conrads (ed), *Programs and Manifestoes on 20th-Century Architecture* (Cambridge: MIT Press, 1975), 152-153; Konrad Wachsman, "Seven Theses" (1957), in Ulrich Conrads (ed), *Programs and Manifestoes on 20th-Century Architecture* (Cambridge: MIT Press, 1975), 156.
[456] See Friedensreich Hundertwasser, "Mould Manifesto against rationalism in architecture" (1958), in Ulrich Conrads (ed), *Programs and Manifestoes on 20th-Century Architecture* (Cambridge: MIT Press, 1975), 157-160; William Katavolos, "Organics" (1960), in Ulrich Conrads (ed), *Programs and Manifestoes on 20th-Century Architecture* (Cambridge: MIT Press, 1975), 163-164.
[457] Hundertwasser in Conrads 1975, 158.

centered and barrier-free design.[458] They convey a sense that the architect has too much epistemic and designerly authority, and overlooks the occupant-user's human factor.

From one perspective, modernism had the best of intentions. It assumed that architects had full knowledge of human experience from which to design environments that would make their inhabitants universally happy and healthy. This agenda is not one that is itself problematic, except when it uses the normate template to define universal human experience. From a more historical perspective, inclusive and accessible design emerged as a response to the *failure* of modernist architecture to meaningfully understand the needs of human users and their bodies. As disability geographer Rob Imrie has argued, CIAM's vision of user-centered architecture was one "producing functional living spaces derived from standard measures relating to human biological and psychological needs,"[459] a practice that is foundational to the normate template for contemporary architecture.

The quotation from CIAM at the beginning of this section, which describes a humanistic architecture focusing on individual needs through well-designed environments, demonstrates the relationship between architects' presumed epistemic authority, the constructed *user,* and standards of *functionality.* malleability of modernist principles for user-centered design. The limitations of functionality for a narrow, normate conception of the user become clearer as we examine how the normate template finally entered architectural design via functionalism, human factors, and rehabilitation.

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[458] See Mace (1966, 1985), Burgess (1981), Grosz (2001), and Lang (1974).
[459] Imrie 2007, 9.

Whose Body is the Architectural User?: The Average Man and Woman

In 1942, sexologist Robert Dickinson commissioned sculptor Abram Belskie to create two sculptures, which he called Norma and Normman.[460] They were, quite literally, materialized normates. Norma and Normman were also forms of data visualization whose dimensions exemplified the average size of humans whose bodies had been measured by human factors specialists, anthropometrists, and eugenicists in the early 20th century. However, in these sculptures, the presentation of normate bodies had as much to do with representing data as it did with institutionalizing an idealized body in a material-discursive form.

Historian Anna Creadick suggests that Norma and Normman were

> most startlingly reminiscent of the bodies and faces constructed by the totalitarian propaganda of Nazi Germany and Stalinist Russia. The Aryan look and eugenicist overtones of Norm and Norma were not aberrations, but signs of a midcentury obsession. Their boldly European features, their alabaster whiteness, their youthful, able bodies reveal what 'normality' has been designed to include and exclude.[461]

While Norma and Normman clearly represented eugenic ideals, they also mimicked other figures of the idealized body, including the Leonardo Da Vinci's Vitruvian Man and Le Corbusier's Modulor. Norma and Normman also reflected the postwar tendency to define and regulate acceptable bodies through rehabilitation, gymnastics, and beauty competitions.[462] The ideal user, in this moment, reflected social ideas about the ideal

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[460] Anna Creadick, *Perfectly Average: The Pursuit of Normality in Postwar America* (Boston: University of Massachusetts Press, 2010), 15.
[461] Creadick 2010, 15.
[462] See Carden-Coyne (2009) for an account of how classical aesthetics of the body manifested themselves in post-World War I rehabilitation culture through the promotion of regimes of human performance, including rehabilitation, gymnastics, and beauty competitions. Creadick (2010) and Serlin (2004) provide accounts of how these activities continued after World War II.

person and citizen even while it was constrained by limited sets of data about who the ideal person or citizen may be.

In a post-World War II moment in which the average person, man, woman, body, and user became intelligible to U.S. society through military human factors research, rehabilitation medicine, and social science surveys,[463] the industrial designer Henry Dreyfuss inaugurated a paradigm of user-centered design using the same type of data enabling the production of military uniforms, eugenic baby competitions, and the Norma and Normman statues.[464] Dreyfuss, who had been a theater designer for Norman Bel Geddes,[465] was perhaps the most important U.S. industrial designer of the 20th century. His firm designed ubiquitous products like the Hoover vacuum cleaner, the Honeywell thermostat, and the John Deere tractor.[466]

Dreyfuss was responsible for propelling human factors research into user-centered design, making users a key concern of the design of consumer products and technologies.[467] The resulting *Designing for People* (1955) became one of the first texts

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[463] Sarah Igo, *The Averaged American: Surveys, Citizens, and the Making of a Mass Public* (Cambridge: Harvard UP, 2007).

[464] Dreyfuss is most notable for the design of Hoover vacuum cleaners, John Deere tractors, and the tabletop telephone. He was also responsible for the design of artificial legs, not surprising given his involvement in military and human factors design (Serlin 2002, 68).

[465] In her history of industrial design and eugenics, Christina Cogdell's *Eugenic Design: Streamlining America in the 1930s* (Philadelphia: University of Pennsylvania, 2010) shows that Geddes, a theatrical and industrial designer who developed the aesthetics of streamlining, was influenced by Loos and Le Corbusier, and sought to manifest the philosophy of eugenics in his own work (3). I am more interested in establishing an historical account of the emergence of professional and epistemological concepts than I am in making aesthetic judgments about modernism and the aesthetics of aerodynamics. However, Dreyfuss's relationship with Geddes is an important part of this history.

[466] For more on Dreyfuss's history and biography, see Henry Dreyfuss, *Designing for People* (New York: Allworth Press, 1955/2003) and Russell Flinchum, *Henry Dreyfuss, Industrial Designer: The Man in the Brown Suit* (New York: Rizzoli, 1997).

[467] I discuss Dreyfuss' influence on the industrial and architectural design professions in Chapter 3. Dreyfuss' figures followed more classical depictions of the body that dominated architectural manuals and were some of the only sources of data about human bodies available to designers in the U.S. in the 20th century. While other sources were available, and while part of the work of accessible design has been to diversify these figures and images, Henry Dreyfuss Associates was a leader in the introduction of human

to bring accessible information about the body to an audience of industrial designers and architects. Later, in *The Measure of Man* (1959) and *The Measure of Man and Woman* (1967), Dreyfuss recalls the process of coming to crafting a text that would make people intelligible to designers as worthwhile considerations. Going beyond the vague notion of function, Dreyfuss was concerned with elements like human dimensions, tolerance of light, noise, smell, and air pressure, and environmental health conditions such as air quality. These were all categories of evidence emerging from military and industrial human factors, and the related fields of occupational health and safety. They also reflected the concerns of modernists like Buckminster Fuller with design to prevent the impact of harsh environmental conditions on the body.

Henry Dreyfuss Associates, a powerhouse of U.S. industrial design, revolutionized the application of human factors-driven, evidence-based design by civilian industrial designers. Creating this influence required the firm to negotiate what kinds of evidence to apply to design and where to get it. The first problem was to establish that data could be useful to the design of better industrial products and architectural spaces. Recalling the history of collecting this data, Dreyfuss describes how military human factors helped to establish the evidence base for design:

> The problem was that [Henry Dreyfuss Associates] had no single body of knowledge that we could turn to for all the odd facts we might need. Here and there we found a book or an article with some data we could use. Often this was no more than a statistical footnote or a chart on a back page. We bought these publications when we could—though many were old, out of print and probably inaccurate—borrowed the ones we couldn't buy and scribbled the data on index cards.
>
> Over the years, our pile of books, pamphlets, clippings, and dog-eared index cards grew higher and more jumbled. When World War II came, the pile grew even faster. The armed forces and their suppliers undertook some very ambitious

factors research into the design profession and published volumes that translated statistical data into a format that would make the body intelligible to designers.

> human engineering and published their findings. But still no one assembled these data into a single package that a designer could refer to and spend days wading through his library and files. [468]

Dreyfuss formalized design for human factors by constructing an archive piecing together various data sets and assuming a degree of generalization between them. The casual collection of data from out-of-print materials, footnotes, and random statistics indicates one of the key tendencies of the *normate* the: the generalization of some statistical bodies to all fleshy bodies.

Prior to the standardization of a "single body of knowledge" for user-centered industrial design, there was no archive of such data available, let alone a discernible epistemological standard for industrial designers seeking to apply evidence about bodies to design. As I discussed in the last chapter, even within the military, each branch gathered its own data according to specific engineering needs, and civilian research was often proprietary rather than intended for general use. It was finally after World War II that Dreyfuss had the idea of collecting and representing data about human function and size to designers by using graphic depictions of the body itself. The first of these, which Dreyfuss called "average man Joe," was followed by a female figure, "Josephine."[469] Like Norma and Normman, Joe and Josephine represented average, idealized figures for use in design.[470]

As normate figures, Joe and Josephine provided an evidence base for built environments built according to the normate template. *Designing for People* (1955) and *The Measure of Man* (1960) reflected a post-World War II and Cold War period in which

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[468] Henry Dreyfuss, *The Measure of Man and Woman: Human Factors in Design* (John Wiley & Sons: 1967/2001), 4.
[469] Dreyfuss 1967, 4.
[470] As I discuss further below, Dreyfuss later denied that Joe and Josephine were meant to be average figures, but this was their reception among designers.

human factors and scientific management had spilled over into the design of civilian work, aeronautics, and other industries (as described in Chapter 2). Dreyfuss' work ensured that the application of scientific knowledge to user-centered design would become part of what industrial designers counted as *good design*.

Most importantly, Dreyfuss' work made the user legible as a measurement of the success or failure of functional product design. This is evident in his firm's creed:

> We bear in mind that the object being worked on is going to be ridden in, sat upon, looked at, talked into, activated, operated, or in some other way used by people.
> When the point of contact between the product and the people becomes a point of friction, then the industrial designer has failed.
> On the other hand, if people are made safer, more efficient, more comfortable—or just plain happier—by contact with the product, then the designer has succeeded.[471]

Henry Dreyfuss Associates' creed initiates a shift away from the body as evidence of the *human factor* or the body as a problem in need of rehabilitation toward the body as an instrument of measurement and unit of consumption. Through this shift, measurements taken by specialists or applied by designers could be understood through the body, but the body was not the only object of knowledge.

Rather, the body-environment interaction became a litmus test of the success or failure of design as a social and material practice. As social attention to the diversities of the *human factor* emerged in the 1960s, the question became more than just *the body*, understood as both the flesh of individuals and the embodiment of the nation. Instead, the growing social and pluralist recognition of a diversity of *bodies* made the normate template inadequate for designers accounting for non-normate consumers. However, while Dreyfuss's work infused industrial design, its entrance into architectural design was

[471] Dreyfuss 1967, 3.

delayed by nearly 30 years.[472] For this evidence and user-centered design to become intelligible to architects, two developments in the architectural profession had to occur: environmental design research and barrier-free design.

Environmental Design Research and the Emergence of Evidence-based User-centered Design

> "…traditional concepts of *architectural theory* are inadequate for the design tasks that architects face. It will be argued that architecture needs a theoretical base comparable to that of the social sciences if the issues that need discussion are to be considered with any rationality or if the research necessary for the progress of the profession is to be carried out."[473]
>
> -Jon Lang, 1974

Environmental design research and the related notion of *evidence-based design* are two key elements of user-centered design in the late 20th century. Although I have attempted to demonstrate above that these notions of *design research*, *user-centered design*, and *evidence-based design* have a much longer history, the field of *environmental design research* names and formalizes these phenomena, promoting functionality and usability in parallel to prevailing trends within architectural design. Likewise, the mid-20th century epistemic community of environmental design research eventually maps onto that of Universal Design, with consequences for the way that users become intelligible through the application of evidence.

Like the epistemic communities surrounding human factors and rehabilitation, the environmental design research milieu includes multidisciplinary researchers and professional organizations. This milieu includes not only designers, human factors

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[472] As I discuss in Chapter 3, the anthropometric images available to architects from the 1940s through the 1980s did not use Henry Dreyfuss Associates' data or drawings, but rather more classical depictions of the body by Ernest Irving Freese. However, Dreyfuss's work influenced the field of industrial design to integrate human factors and ergonomics considerations.

[473] Jon Lang, *Design for Human Behavior: architecture and the behavioral sciences* (Stroudsberg, PA: Dowden, Hutchinson, and Ross, 1974), viii.

researchers, and rehabilitation specialists, but also environmental psychologists, anthropologists, sociologists, and humanistic scholars. As a result, this milieu crafts a notion of *human-centered design*, roughly synonymous with user-centeredness but with a more complex understanding of the user's cognition, preferences, and personality.

History of the field

The multidisciplinary scholarly field of *environmental design research* (often alternately referred to as the study of environment-behavior, environmental psychology, environmental design research, human-centered design, evidence-based design, or person-environment relations) studies the relationships between people, their bodies and minds, and built environments.[474] While body-environment relationships constitute the field's most prevalent object of study, research about targeted user groups, the behavioral aspects of design, or the Post-Occupancy-Evaluation of specific types of environments is common. The field represents a point of convergence for design that is *value-explicit* and *user-oriented* at multiple scales.[475] Environmental design research also studies and responds to changing demographics and shifting "economic and political context[s]" that require designers to take account of different potential users.[476]

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[474] Although these fields are in some ways discrete, I will refer to them collectively as "environmental design research," naming them individually when appropriate to differentiate them historically or functionally (Moore, Tuttle, & Howell 1985, ix). *Environmental design research* names the broader field of academic study, which is distinct from architectural research and often architectural training. Although environmental design research is meant to provide evidence that aids in environmental design, it is to design practice what medical anthropology is to the study of medicine, a field with its own formalized methodologies and epistemologies, professional organizations, and research agendas that exists somewhat separately from professional practices. The field is only intelligible as part of design practice to those designers who have adopted an evidence-based orientation. Many of the UD Principles authors, including Mace, Sanford, Steinfeld, and Jones, were trained or professionalized in the person-environment framework, environmental psychology, and human factors. This made environmental design research the milieu from which their user-centered philosophies emerged and it also set them apart from the mainstream of architects and designers.

[475] Moore, Tuttle, & Howell 1985, xvii, 21.

[476] Moore, Tuttle, & Howell 1985, xvi.

Environmental design research occurs within an epistemic community that became particularly strong in the 1960s in response to a liberalizing social environment.[477] While the study of the built environment in psychology, sociology, and anthropology preceded it, the multidisciplinary field of environmental design research formed around professional organizations, most notably the Environmental Design Research Association (EDRA), in the late 1960s. These organizations brought together designers, human factors and rehabilitation specialists, and scholars trained in the social sciences and humanities to formulate new epistemologies and methodologies of spatial research specifically geared toward expanding the evidence-base of user-centered design.[478]

Through its multidisciplinarity and ties to progressive social movements, environmental design research was founded on the premise that "science is not value-free," and that research must therefore be "oriented to all levels of human experience…at all scales of the everyday physical environment."[479] In their history of the early foundations of the field, Gary Moore, Paul Tuttle, and Sandra Howell argue that environmental design research is fundamentally about "respect for environmental justice and a call for the redress of injustices in the form of inaccessibility, exclusion, or unequal distribution of economic resources and amenities," reflecting a clear connection to social protest movement ideologies around access to space and the importance of desegregation.[480] However, while recognizing the prevalence of the normate template in design ("Much of the environment is designed for only one segment of the population in

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[477] Moore, Tuttle & Howell 1985, xvi-xvii.
[478] Gary Moore and Reginald Gollege, *Environmental knowing: theories, research, and methods* (Stroudsberg, PA: Dowden, Hutchinson, & Ross, 1976).
[479] Moore, Tuttle, & Howell 1985, xvii.
[480] Moore, Tuttle, & Howell 1985, xvii-xviii.

one stage of the life cycle- middle income, middle age, white Anglo-Saxon")[481], and whereas some environmental design research is concerned with disability, the field is somewhat anomalous within user-centered design research more generally, which often conceives of the "user" as the normate.

Nevertheless, the philosophy of environmental design research, with its emphasis on evidence-based practices, serves as a vector for disability interventions in design research. One such intervention is that evidence-based practices provide an alternative to aesthetic and formal critiques of designs by making social and human factors intelligible and subject to observation and study.[482] Environmental design researchers emphasizing participatory research and evaluation demonstrate the value-explicit methodology of lessening the gulf between designers and users.[483] Through its connections to social and behavioral science methodologies, environmental design research has produced evidence bases that focus on previously understudied users. These include not only normate user groups, but also groups conceived of as special populations: "elderly people, people with disabilities, hospital patients, office workers, low income families, pedestrians, and museum visitors."[484] However, as UD theorists Polly Welch and Stanton Jones have noted,

> The taxonomy that has evolved over time for identifying user groups has hardly been systematic and often labels groups of people by their shared experience as occupants of a building or place type. The literature tends to convey homogenous, typical users whose environmental behaviors and needs are generic to the group being described and seldom address the implications of other facets of identity. The literature is an important resource for understanding one facet of identity but

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[481] Moore, Tuttle, & Howell 1985, xxi.
[482] Moore, Tuttle, & Howell 1985, xxiii.
[483] Moore, Tuttle, & Howell 1985, xxiii.
[484] Polly Welch and Stanton Jones "Universal Design: An Opportunity for Critical Discourse in Design Education," in Jon Christophersen (ed), *Universal Design: 17 Ways of Thinking and Teaching* (Husbanken: Council of Europe, 2002), 195.

> it is only partially informative unless it is complemented by input from real users with real, complex identities and needs.[485]

Thus, the central epistemological issue of environmental design research is how it defines units of users for inclusion or exclusion. The problem of generalization from specific studies to broader populations is relevant to all human sciences. However, in the case of environmental design research, this problem highlights the ideological strength of the normate template in promoting a homogenous view of users within so-called special needs groups even while these groups are differentiated from a more general normate user. Ultimately, this is a problem of translation and intelligibility that later accessible design movements contest.

EDRA and Universal Design

In 1968, while social protest movements erupted all over the world, Congress passed the Architectural Barriers Act, requiring all federal buildings to comply with accessibility mandates crafted by the American National Standards Institute.[486] In the same year, the Environmental Design Research Association (EDRA) was founded to bring together researchers whose work could inform evidence-based design, "portending linkages between research-driven evidence and environmental design."[487] Although evidence-based design and engineering existed long before EDRA, the organization formalized such research as an institutionalized academic milieu, established networks between designers and researchers debating epistemologies and methodologies, and made

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[485] Welch and Jones 2002, 195.
[486] ANSI A117.1-1961.
[487] Moore and Geboy, 2010, 105.

it possible to think about functional and usable architecture beyond the intuitive tendencies of the designer.[488]

EDRA helped form certain alliances that eventually made UD part of the milieus of user-centered and evidence-based design. In addition promoting evidence-based design, many of UD's early proponents and key researchers were and continue to be involved with EDRA.[489] These proponents were not only participants at the EDRA meetings, but editors of publications and key figures in the organization.[490] Rather than claiming a causal connection between this early work and UD's current research practices, however, it is more useful to understand EDRA's formation and encouragement of environmental design research with a user focus as a condition of possibility for a more socially engaged and broadly accessible design research practice.

Prior to the late 1960s, research in architectural design and buildings engineering focused on cybernetic systems-based understandings of architecture and human-environment relations.[491] Research on built environments from the human and social sciences had not, however, been formally introduced into architectural design. In EDRA's third annual meeting in 1973, architects, cognitive scientists, neuroscientists, computer programmers, urban planners, and other professionals interested in person-environment relations convened to create a shared evidence base for user-centered design. They displayed broad interest in design for social and political purposes.

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[488] Moore et al. 1985.
[489] Mueller 2011, Mullick 2011; Sanford 2012; Steinfeld 2011.
[490] Wolfgang Preiser, "Preface," in Wolfgang Preiser (ed), *Environmental Design Research, v. 2: Symposia and Workshops*. Fourth International EDRA conference (Stroudsberg, PA: Dowden, Hutchinson, & Ross, Inc., 1973); Edward Steinfeld, "Action Research in Man-Environment Relations," in Wolfgang Preiser (ed), *Environmental Design Research, v. 2: Symposia and Workshops*. Fourth International EDRA conference (Stroudsberg, PA: Dowden, Hutchinson, & Ross, Inc., 1973).
[491] Clovis Heimsath, *Behavioral Architecture: toward an accountable design process* (McGraw-Hill, 1977). This is part of the legacy of human factors research. See Chapter 1.

The conference was a pivotal moment in the convergence of user-centered, evidence-based, and social justice approaches to designing for people. Charles Burnette, an architect and design researcher, spoke of a shift in design research from those that were created by industrial and military human factors to studies that were "inherently more humanistic and relevant to the broader concerns of environmental design."[492] Whereas previous environmental design research was based on engineering or economic maximization, designers were now looking to psychology, linguistics, communication, and art to learn about user needs.

The meeting also introduced several key UD figures into the professional network of environmental design research and evidence-based design, including Edward Steinfeld[493] and Wolfgang Preiser,[494] two of the most prolific writers on the topic. Eventually, through the EDRA that Steinfeld, Preiser, Mace, and many of the UD Principles authors that UD came to be professionalized within the epistemic community of design researchers promoting a particular brand of user-centered, evidence-based

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[492] Charles H. Burnette, "Design Languages As Design Methods," in Wolfgang Preiser (ed), *Environmental Design Research, v. 2: Symposia and Workshops*. Fourth International EDRA conference (Stroudsberg, PA: Dowden, Hutchinson, & Ross, Inc., 1973), 309.

[493] Steinfeld, who began a career with the National Bureau of Standards before becoming an environmental design researcher assessing barrier-free design for the U.S. Department of Housing and Urban Development (Steinfeld 2011) conducted the research underlying the ANSI standards for accessible housing (Steinfeld et al. 1979). At the 1973 EDRA conference, Steinfeld initiated an important epistemological discussion on the significance of user input in design. He led a workshop on design processes as sites of research to understand user input and to improve environmental responsiveness to users (Steinfeld 1973).

[494] Preiser, an expert in user-centered design and Post-Occupancy Evaluation, is currently professor emeritus of Architecture at the University of Cincinnati and a prolific user-centered design researcher. He received his Ph.D. in the late 1970s in Man-Environment relations from Penn State University, after he had already received an architecture degree. Most commonly known in the UD world as having compiled the Universal Design Handbook (Preiser & Ostroff 2001), Preiser edited two volumes of proceedings from the 4th international EDRA conference as a graduate student in 1973. In his preface to the volumes, he notes the following shifts in environmental design research frameworks at that time: "incorporation of changing societal and political conditions," "shifts in basic theoretical orientations," "the acceptance of cultural heterogeneity," and "the recognition of man's [sic] biological functioning and limitations as information processing systems" (Preiser 1973).

design that could focus on disability. It was also within this institutional and professional space that networks of experts emerged to apply evidence bases from human factors and rehabilitation, as well as environmental psychology, ethnography, and Post-Occupancy Evaluation, to UD. Its emergence from this epistemic community explains why UD's framing and practice have always been in terms of evidence-based, user-centered design. However, to address how environmental design research came to include disability, we must first understand how evidence-based design contributes to the emergence of barrier-free design, retrofit, and legal accessibility standards.

The Barrier-Free Design Paradigm

Barrier-free design emerged in the 1950s from within the rehabilitation paradigm, but later became a focus of social movement and environmental design research work. Whereas rehabilitation initially made interventions on the body through assistive technologies, barrier-free design focused on environmental interventions that could support the reintegration of disabled people into society. However, later barrier-free design work contributed to transforming the norms and practices of rehabilitation by adopting person-environment models, such as the Nagi model.

The logic of barrier-free, as in the *formal equality* model of the ADA, is that removing obstacles to participation facilitates meaningful access.[495] As I mentioned before, this approach often limits itself to individual, piecemeal gestures rather than to

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[495] Barrier-removal refers to the material exclusion of wheelchair users from spaces where barriers, such as stairs, prevent their participation. It also refers to spatial barriers underlying all segregations and could include barriers such as "Whites Only" signs in racially segregated spaces. However, what makes barrier-free part of the formal equality model (as I explained in the Introduction) is that it assumes that removing barriers facilitates meaningful use of spaces, whereas other approaches such as UD seek to actively enable meaningful use through design. For instance, a barrier-removal approach may be to build a ramp at the back entrance of a building. While this would technically allow a wheelchair user and many other types of bodies to enter the building, the placement of the ramp may be stigmatizing or discourage use. UD considers not only how to remove barriers, but also build new designs that avoid these disadvantages.

broader structural changes. Nevertheless, although barrier-free design strategies often focus on retrofitting rather than accessibility by design, these strategies are one of UD's conditions of possibility and promoted the intelligibility of disabled users in architectural and industrial design.

Barrier-free design, like user-centered design, is rooted in evidence-based human factors and rehabilitation practices. In the late 1950s, a number of studies at the University of Illinois Urbana-Champaign produced data that would later serve as the basis of state and federal accessibility standards for barrier removal. Timothy Nugent, a rehabilitation specialist and war veteran, spearheaded these studies in the late 1950s. In 1959, Nugent received federal and private funding to conduct Project A-117, investigating architectural barriers through research on wheelchair users at his university. Using human factors research methods, Nugent conducted rehabilitation studies of spatial usage by disabled students using wheelchairs.[496] He was able to do so because after World War II, the University of Illinois and the cities of Urbana and Champaign were designed to be highly accessible to disabled soldiers returning from war. Ramps and accessible buses, dormitories, and classrooms with adequate clearance for a wheelchair were the norm rather than the exception. As a result, the area drew civilian students with disabilities, as well.

The results of Nugent's data were incorporated into the American National Standards Association (ANSI A117.1) guidelines that defined the first state and federal accessibility standards and were meant to "be incorporated in any type of building

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[496] Timothy Nugent, "Design of Buildings to Permit Their Use by the Physically Handicapped," *New Building Research* (Fall 1961).

regardless of the basic architectural concept."[497] Although Nugent was a rehabilitation specialist, he intended his studies to serve as evidence for a different kind of audience: designers and builders. Recognizing that rehabilitation and assistive technologies alone would not be able to address the structural barriers to participation in society by people with disabilities, Nugent wrote,

> Professionals in the field of rehabilitation […] are finding it very difficult to project clients into normal situations of education, recreation, and employment because of architectural barriers. Therefore, the problems inherent in the design of buildings and facilities quickly take on the role of "villain" and might even tend to reverse some of the social and economic gains now evident in constructive rehabilitation. Solution of these problems is not within the realm of professional rehabilitation workers, but must be accomplished by those to whom this paper is being presented: the architects, engineers, designers, builders, manufacturers, and in all probability, the legislators, with encouragement and guidance from those professionally engaged in rehabilitation.[498]

By centralizing the role of designers in rehabilitative practice, Nugent expressed an early version of the idea of *accessibility by design*. He did this by articulating an idea at the heart of barrier removal: that built environments have transformative power over the material conditions that affect people and their bodies. *Barrier-free design* understands the built environment to be an arena of power in which the primary agents are builders, designers, and the legislators setting standards for design professionals to follow.

Nugent's study also articulated earlier versions of the two other UD ideas: *added value* and *broad accessibility*. *Added value* is the idea that accessible design benefits not only disabled people but also non-disabled people in a range of varying embodiments and social locations. Nugent justified barrier-free design by claiming, "All standards which will be recommended to benefit the permanently physically handicapped will be of

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[497] Nugent 1961, 59

[498] Nugent 1961, 53.

benefit to everyone."[499] Whereas Universal Design would later cite the usability of the curb cut by wheelchair users, stroller pushers, and roller skaters as an example of the idea of added value, Nugent cited ramps and accessible shower stalls and other features of the Urbana-Champaign built environment as benefitting all students, disabled and non-disabled.[500]

Nugent's work became part of a larger push for rehabilitation research supporting barrier-free design in the 1960s. As explained earlier, grants from the Department of Education enabled the establishment of Rehabilitation Engineering Research Centers (RERCs) and Rehabilitation Research Training Centers (RRTCs) throughout the country. The primary work of these centers would be rehabilitation research supporting assistive technology and barrier-free design in individual technologies, buildings, and transportation, among other areas.

Barrier-free Industrial Design

Barrier-free design, although most notably exemplified in architectural and urban design elements, such as curb cuts, benefitted from the involvement of industrial designers with experience designing objects at the scale of individual users. Through the involvement of industrial designers, barrier-free design was able to integrate the individualized focus of assistive technologies with interventions into architectural spaces. As a result, contemporary inclusive and Universal Design rely heavily on the accumulation of multiple industrial design products, such as doors, handles, elevators, faucets, and light fixtures.

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[499] Nugent 1961, 59.
[500] Nugent 1961, 59.

Several industrial designers who later became involved in UD's epistemic community were influential in the development of barrier-free product design. For example, Rolfe Faste, a product designer and mechanical engineer who also worked on the development of the ANSI guidelines, went on to become an expert in human-centered design and design thinking.[501] Faste understood design as both a techno-scientific activity and a creative one, arguing that engineering and industrial design must contain a human element rather than assuming that designers have objective distance from users.[502]

In 1979, Faste served as a testing facilities designer for a group of studies conducted by Edward Steinfeld, an architect and gerontologist who later became a key UD researcher.[503] Through Faste's involvement, Steinfeld's study pushed barrier-free design, and the legal standards it produced, toward the idea of designing for the "lower limits of performance"—an industrial design concept emerging from the human factors and scientific management study of "human performance."[504] "Lower limits of performance" was also an understanding of the category of *functional limitation* that had emerged through the influence of Dreyfuss's data on industrial design and through the introduction of the Nagi model into rehabilitation.[505]

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[501] Rolf Faste, "The Human Challenge in Engineering Design," *International Journal of Engineering Education* 17.4-5 (2001), 327-331.
[502] Faste 2001, 329.
[503] Edward Steinfeld, Steven Shroeder, and Marilyn Bishop, *Access to the Built Environment: a review of the literature* (Washington D.C.: U.S. Department of Housing and Urban Development Office of Policy and Development Research, 1979a) (hereafter Steinfeld, Shroeder, & Bishop 1979a); Edward Steinfeld, Steven Shroeder, and Marilyn Bishop. *Accessible buildings for people with walking and reaching limitations* (Washington D.C.: U.S. Department of Housing and Urban Development Office of Policy and Development Research, 1979b) (hereafter Steinfeld, Shroeder, & Bishop 1979b).
[504] Steinfeld, Shroeder, & Bishop 1979a, 9.
[505] As I explained above, Dreyfuss's influence included design for the range that included lower performance as a necessary condition of usability. That is, if the weakest and strongest, tallest and shortest people can use a design or space, then it is presumably accessible to everyone within that range.

"Lower limits of performance" defines both an individual's functional limitations and helps quantify the range of performance in a population. As Steinfeld (1979) claimed,

> If the lower limits can be satisfied by design recommendations based on this research, those people with better abilities will also be accommodated, unless there are conflicts between the needs of more able-bodied people and those with severe disabilities.[506]

Designing for the "lower limits of performance" takes the notion of *user-centered design* one step further to include a notion of the range of possible abilities. In doing so, it also produces the UD notion of *added value*, according to which accessible designs that are usable by the most disabled people also benefit non-disabled people.

Another industrial designer who was crucial to the development of barrier-free design was Richard Hollerith. Hollerith was an industrial design consultant who, along with Faste, Nugent, and Steinfeld (described above), worked on the ANSI A117.1 guidelines.[507] Hollerith also worked as an account manager for Henry Dreyfuss Associates from 1956-1966, a period of time spanning the firm's publications of *Designing for People*, *The Measure of Man*, and *The Measure of Man and Woman*. In the late 1970s, he presided over the Industrial Design Society of America (IDSA) during a period in which the design professions were becoming increasingly liberalized and industrial design was incorporating considerations of users with disabilities.[508]

Like other barrier-free design advocates, Hollerith understood the built environment to be the primary cause of disabling conditions. Reflecting social model and rehabilitative notions of body-environment relations and functional limitation, Hollerith

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[506] Steinfeld, Shroeder, & Bishop 1979a, 9.
[507] Catanese 2012, 1.
[508] Industrial Design Society of America, "Richard Hollerith," Available at: http://idsa.org/richard-hollerith.

(1981) argued, "It is the interface between the user and the product where a disability turns into a handicap through the user's inability to use the product—and because of design."[509] *Interface*, a term used to describe the human use of technologies like computers, here recognizes the interactivity of human users with products—a recognition central to Dreyfuss's work on extending human factors to industrial design in the mid-20th century. It is also a crucial concept in ergonomics, the field of civilian human factors. Thus, Hollerith was making rehabilitative notions of disability intelligible through human factors concepts received via industrial design.

To address accessibility, Hollerith approached barrier-free design as an epistemic practice of keeping disability *in mind.* As he wrote, "Design with disabilities in mind is not a matter of designing for some mysterious incomprehensible group. It is design for all of us."[510] The construction of an "all" comprised of particular types of people who benefit from accessible design is a key part of barrier-free design ideology and of the later UD notion of added value. Articulating a pre-UD version of the idea of added value, Hollerith also claimed that accessible designs that are usable by non-disabled people,

> would generate highly innovative design solutions for many of the mundane products in our daily lives. Its major advantage would be in marketing wherein there would no longer be a handicapped market which is always too small to be addressed, except by legislation which has happened relative to architectural barriers, or small specialists who essentially provide adaptation techniques.[511]

This claim that addressing market conditions would go beyond the limitations of access legislation would later become the crux of how UD differentiates itself from barrier-free

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[509] Hollerith (1981), quoted in Catanese 2012, 1.
[510] Hollerith (1981), quoted in Catanese 2012, 1.
[511] Hollerith (1981), quoted in Catanese 2012, 1.

design.[512] What Hollerith shows here is that the framing of UD as an extra-legal alternative is not a product of its underlying design philosophy necessarily being in opposition to other forms of accessible design, but rather a result of its connections to industrial designers focused on inclusivity as a marketable feature.

The industrial designer most significantly involved in barrier-free industrial design is James Mueller, who entered accessibility practices through his work on workplace ergonomic environments in the 1970s.[513] Mueller began working with Ron Mace in the 1980s through Mace's firm, Barrier-Free Design, and published a number of works in the 1990s defining the scope of UD and barrier-free design.[514] Focusing on disability as a functional relationship produced by disenabling technologies, Mueller argued as early as 1977 against industrial designs that stigmatize disability by requiring specialized solutions, as opposed to those designed for a broader user group in mind.[515] Reflecting the overlapping approaches between user-centered design and modernist functionalism, Mueller was also influential in introducing consumer testing and ergonomics into barrier-free design practice, emphasizing design for functional limitations over aesthetic considerations.[516]

As discussed earlier, industrial design is a practice that is intimately tied to both rehabilitation and human factors. Barrier-free approaches to architecture and industrial

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[512] See Imrie 2012 on how this reliance on marketing technologies is an unexamined part of UD's epistemic community.
[513] James Mueller, *Designing for Functional Limitations,* George Washington University Rehabilitation Research and Training Center (Washington D.C.: The Job Development Laboratory, 1979); Mueller, S. Yuspeh and J. Mallick. *Comprehensive Vocational Rehabilitation for Severely Disabled Persons* (Washington, D.C.: George Washington University Medical Center, Job Development Laboratory, 1975).
[514] Mueller 1995; James Mueller, "Toward Universal Design: an ongoing project on the ergonomics of disability," *American Rehabilitation* (Summer 1990).
[515] James Mueller, Editorial. *Industrial design* 24.3 (May/June 1977).
[516] Mueller 2011.

design often rely upon technical product solutions that make these practices more similar to rehabilitation engineering and assistive technologies than to more mainstream types of design. As Imrie and Hall have noted, adaptive technologies and designs at the scale of the individual, like the medical model of disability, necessitate technical solutions to disability as a supposed problem to be fixed or altered.[517] This is a paradox of scale—industrial design and assistive technologies focus on the body and accessibility more than architectural practice, which occurs at a broader scale. At the same time, the individual focus sometimes trades off with collective responsibility for access.[518] To understand how buildings, as multi-user designs, incorporate user-centered approaches and become disability inclusive, it is necessary to understand how the epistemic concept of *Universal Design*, and the epistemic community producing it, finally emerged through the historical and epistemological trajectories I have explained so far in the chapter.

Universal Design: origin stories

> "Like a bean sprout that emerges only after its root is deep and strong, universal design has its beginnings in demographic, legislative, economic, and social changes among older adults and people with disabilities throughout the 20th century."[519]
> - Molly Story, Jim Mueller, and Ron Mace, 1998

By this point, it should be clear that the ideologies underlying Universal Design theory and practice have long-term historical trajectories. However, it is still necessary to examine how UD tells the story of its own emergence and to contextualize this within the narrative presented here. To date, no comprehensive history of the concept or emergence of UD exists, except those histories written by actors directly involved in the

[517] Imrie and Hall 2001, 45.
[518] See my discussion of Satz's concept of fragmentation in the Introduction.
[519] Story, Mueller, and Mace 1998, 6.

movement.[520] These histories, which repeat the same basic events, do not approach UD through scholarly historiography, archival research, or oral histories. Some of them identify UD's relationship to the aging population, modernist architecture, barrier-free design, human factors research, and rehabilitation, but these citations are mostly conceptual rather than historical.[521]

While my narrative largely coincides with these histories, it also seeks to correct some of the claims made about UD history more generally. An historical epistemology of UD both problematizes this simplistic historical understanding of UD's emergence and shifts the ongoing influence of certain epistemological frameworks into perception. It rejects arguing that UD has its foundations in any single phenomenon, instead demonstrating that UD emerges through a broader milieu of user-centered design that includes what Story, Mueller, and Mace cite as multiple "demographic, legislative, economic, and social changes," as well as shifts in design professions.

The emergence of the term, Universal Design

The most common historical account of Universal Design is that it emerged from the disability rights movement, was named by Ronald Mace in 1985 in an article in *Designer's West Magazine*, and then became formalized through the "Seven Principles of

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[520] Most of the historical data available in published accounts on UD either repeats the same basic facts, such as the date of key publications, or focuses on questions of UD philosophy rather than history. For instance, Japanese UD proponent Yoshikikio Kawauchi's (2009) *Universal Design: A Reconsideration of Barrier Free* collects interviews from UD experts between 1998 and 2000 in order to clarify the shifting meanings of UD and explain them to a Japanese audience. Kawauchi's book is not concerned with an historical epistemology of UD or even a chronology of events, but rather in capturing some of the different perspectives that each proponent brought to UD's development. Some UD histories resemble historical epistemology but do not actually undertake any historical exploration. For instance, Ostroff (2011) notes the foundations of UD in the disability rights movement, barrier-free design, and the population of aging baby boomers but does not devote more than a few paragraphs to these histories (Ostroff 2011, 1.4-1.5). My historical epistemology in Chapters 1 and 2 is meant to build upon this narrative and shift the focus from the formation of approaches to design to the emergence of the concepts of *user* and *design*.

[521] Steinfeld and Maisel 2012, 31-32; Story, Mueller, & Mace 1998; Story 2011.

Universal Design," written by a group of experts at North Carolina State University's Center for Universal Design between 1995 and 1997.[522] Some UD proponents have noted, in their various historical notes, that a version of the idea of UD existed long before 1985, and that Mace himself had been formulating the idea since the 1970s.[523] By other accounts, the term was simply one of many used to describe emerging accessible design practices.[524] As I suggested in Chapter 1 and earlier in this chapter, some version of the UD ideas of *broad accessibility*, *accessibility by design*, and *added value* has existed through the work of functionalist modern architects, rehabilitation, barrier-free design, human factors and ergonomics, and the work of researchers like Nugent, Mace, and Steinfeld far before 1985.[525] The exact date of the idea's emergence is less important than what its emergence reveals about UD's conditions of possibility.

Universal Design is a slippery term applied to mean, in some cases, the barrier-free, rehabilitative, and legal accessibility approaches to design that it means to replace.[526] In other cases, UD is reduced to an inclusive design philosophy, shifting out of perception the epistemological work it does to create broadly accessible design. The interdisciplinary citations of UD as a design philosophy often reduce it to a chiefly architectural phenomenon with broader potential cross-applications,[527] but in doing so

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[522] Center for Universal Design 1997.
[523] Kawauchi 2009, 6-7; Steinfeld 2011.
[524] Mueller 2011.
[525] Steinfeld, in a 2012 interview, reported that Mace had articulated the idea of UD to him in 1978 at a conference, and that the terminology came much later.
[526] As Steinfeld and Maisel (2012) note, "Problems with understanding the difference between [UD] and its precursors are still evident . Even some designers and rehabilitation professionals still view [UD] as a new buzzword for accessible design or assistive technology" (68). Stanton Jones agrees, noting that the differences between UD, barrier-free, and inclusive design often become "blurred" in the literature on accessibility (Jones in Kawauchi 2009, 118). Kawauchi (2009) notes that in the early 1990s, the use of the term "expand[ed] rapidly" and that this expansion often "chang[ed] the nature of the concept itself" (vii).
[527] Such as the citations within disability studies from Wendell, Silvers, and Davis that I discussed in the Introduction.

ignore the disciplinary conditions of its emergence and the nuanced theories of body-environment relations that it makes possible.

Debates over the terminology of accessible design characterize most of the substantive discussions about the scope of UD. This section outlines the professional and institutional discourses surrounding UD, and shows how these discourses produce slippery meanings because they operate within the overlapping human factors, rehabilitation, and environmental design research milieus that already borrow concepts and methodologies from one another. In the resulting confusion, *Universal Design* takes on meanings that it means to replace or reject.[528] Although the epistemic regimes I have outlined are UD's conditions of possibility, I argue that UD is not synonymous with any of these approaches, but rather takes an approach that weaves them through one another to produce new possibilities for design.

Debating *Universal* and *Design*

UD proponents Steinfeld and Maisel have argued that the word "universal" in UD should "be understood as it is used in terms like 'universal suffrage' or 'universal healthcare'."[529] This makes sense given that UD emerges from a barrier-free design milieu overlapping with disability rights, anti-racist, and feminist demands for spatial desegregation. While the academic branches of these same social movements (disability studies, feminist studies, and critical race studies) are highly uncomfortable with the idea of the *universal*, its usage here is different from the prescriptive universal created by ideal normate bodies. At the same time, every terminological debate about UD focuses on debating the meaning and scope of *universal* or rejecting it altogether.

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[528] Steinfeld and Maisel 2012, 68; Kawauchi 2009, 118.
[529] Steinfeld and Maisel 2012, 30.

Universal and its meanings qualify what counts as inclusive *design.* UD theorists Welch and Jones note that an "emergent definition of universal design [is] 'good design'."[530] This definition appeals to the idea that UD is "merely a matter of common sense."[531] While the marketing appeal of such a claim is obvious, defining UD as good design provides no meaningful conceptual or historical way to distinguish it from terms such as barrier-free design or even from mainstream inaccessible design. In modernist architecture, human factors, or rehabilitation, good design is often synonymous with the normate template. In alternatives to the normate template, good design could be design that is very functional for specific bodies (as in assistive technologies) or ineffective user-centered design that functions mediocrely for all bodies. The characterization of *good design* can apply equally to any design framework, including those that have nothing to do with disability access at all. It is therefore necessary to establish more precise language in order to parse out these differences.

UD as extra-legal intervention

As UD Principles author Elaine Ostroff has argued, in marketing discourses UD has become a "trendy acronym for compliance with the Americans with Disabilities Act" and other barrier-free approaches.[532] For this reason, UD proponents often contrast the practice with ADA design, as I have done in the Introduction. For instance, Welch and Jones write,

> universal design is a value that establishes a quality of relationship between people and designed environments or physical objects, based on an inclusive definition of users and the potential of the built environment to empower and enable users. It is related to, by virtue of history, *but not synonymous with,* the

[530] Welch and Jones 2002, 191.
[531] Hayward 1998.
[532] Ostroff 2011, 1.6.

> disability-focused terms *accessible design, barrier free design* and *adaptable design* or, in the United States, design that complies with the requirements of the American with Disabilities Act.[533]

This definition makes an important distinction between the common conceptual basis of UD and barrier-free in facilitating person-environment relations, but retains UD's emphasis that its practices are different from ADA compliance. Similarly, Story, Mueller, and Mace (1998) argue that the foundations of barrier-free design are in "the legal, economic, and social power of a concept that addressed the common needs of people with and without disabilities," but that the implementation of barrier-free accessibility shows that individual accommodations are often ineffective or too specialized to meet the needs of a broad user group.[534]

Historically, there have been significant areas of overlap between the epistemic communities promoting *barrier-free design* and UD.[535] However, UD proponents often differentiate their practices by defining *barrier-free design* as a narrow or limited approach that is necessary but insufficient for achieving an accessible built environment. As Valerie Fletcher explains,

> barrier-free/accessible design is an important commitment to equal opportunity but a narrow concept about special solutions for a portion of the population with functional limitations related to disability and/or aging. Universal Design is […] a way of thinking about the power of design to facilitate everyone's experience and well-being.[536]

Thus, UD explicitly frames barrier-free design's focus on "special solutions for a portion of the population with functional limitations" as producing rather than preventing

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533 Welch and Jones 2002, 192-193

534 Story, Mueller, and Mace 1998, 10.

535 Although Mace was an early promoter of UD, most of his career was spent as a barrier-free design consultant through his firm, Barrier Free Design, which also employed several figures who would later become UD experts. During this time, he wrote the first state access guidelines for North Carolina (Mace 1974) and worked on retrofitting public buildings and museums in the Raleigh-Durham area, as well as in Washington D.C. (Weeber 2012).

536 Fletcher in Kawauchi 2009, v. Also see Mace 1985.

segregation.[537] This language also reflects a dismissal of rehabilitative concepts (such as *functional limitation*), even while the very concept of *broad accessibility* depends upon it.

Although the limitations of the ADA's targeted approach are clear based on the loopholes of the law and subsequent court interpretations, the distinction between specialized, individual, targeted accommodations and broad, collective, and *universal* accessibility often becomes confusing and muddled in debates over UD as an alternative to the ADA or *barrier-free design.* Like the disability rights and independent living movements, UD aims to de-stigmatize disability, include people with disabilities in public and private built environments, and expand the definition of what counts as a environmental misfit. However, its efforts to avoid the particularized accessibility strategies associated with barrier-free design also risk emphasizing a neutral, universal user (or group of users designated as *all)*. By emphasizing a non-specified collectivity, UD distances itself from the particularities within and between categories of disability.

Welch and Jones exemplify this point when they argue that UD is associated with disability access because it emerged from the disability rights movement,[538] but then cite Mace's insistence, in 1998, that UD's "focus is not specifically on people with disabilities, but all people."[539] This claim demonstrates the tension between the notions of *broad accessibility* and *added value*. While the first understands disability as a universal condition of environmental misfit that built environments must address, the second posits that there are indeed many people in the world who are not disabled at all, but should still benefit from UD. The latter of these characterizations, especially when used in marketing discourses, gives the impression that disability justice is not enough on its own terms to

[537] Kawauchi 2009, 26-27.
[538] Welch and Jones 2002, 192-193.
[539] Cited in Welch and Jones 2002, 192-193.

warrant accessible design. It also implies that the association of UD with disability rights is just a circumstance of UD's history rather than an important focus of its method.

The UD emphasis on *broad accessibility* sometimes still only reflects the scope of how existing evidence defines users. For instance, Steinfeld and Maisel (2012) define UD as design that "benefits everyone, or, at least, a large majority."[540] While this new cohort of beneficiaries may include more individuals than presumed disabled people (usually wheelchair users) and "benefit a broader population than conventional [accessibility] practices,"[541] human factors research also attempted to address the "large majority," but failed to recognize that its normate standards for human performance prevented this from occurring. These framings show the difficulties of framing broad inclusion without slipping into some of the approaches that UD means to reject or replace.

Alternatives to *Universal*

Some UD theorists have critiqued the notion of *universal* as it relates to the international context of UD,[542] while others have argued that UD displays a kind of utopian thinking about universality that is both theoretically and ethically risky and productive.[543] Because the term is so fraught with unintended implications, proponents have debated using other terminology. In doing so, they have also debated the scope of what inclusive design should do and what kinds of users it should include.

Design for All is a popular term within the particular legal and design profession contexts of European countries that have prioritized disability access.[544] This term is

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540 Steinfeld and Maisel 2012, 23.
541 Steinfeld and Maisel 2012, 29.
542 Sandhu 2011.
543 Steinfeld & Tauke 2002, 181.
544 European Institute for Design and Disability, "Stockholm Declaration" (2004). Available at: <http://ec.europa.eu/information_society/activities/einclusion/policy/accessibility/dfa/index_en.htm?

roughly synonymous with UD, and replaces *Universal* with *All* in order to avoid invoking value-neutral universality. However, the term still carries constructs a notion of *all* that can be problematic for the reasons outlined above.

Other terms, such as Design for Aging and Design for the Lifespan, emerge from gerontology and narrow the scope of *all* to designs that account for aging.[545] These approaches specifically reference gerontological and rehabilitative medicine frameworks for designing a world that keeps all ages in mind. However, they do not necessarily include a broader disability justice goal, nor do they keep in mind categories of race, class, and gender misfit that some versions of UD include.

For instance, some feminist designers have allied themselves with UD education as a way of achieving broad social justice goals and the inclusion of gender issues in the design process.[546] Universal Design advocates have also taken on projects at historically black colleges and universities to address the way that the built environment has produced racial segregation, and to provide methodologies for understanding the mutuality of multiple forms of segregation.[547] These efforts are not properly included in Design for Aging or the Lifespan.

Another concept, called *visitability*,[548] has been promoted as a limited version of UD in the context of home accessibility, an area left uncovered by the ADA. The Atlanta-based organization *Concrete Change* promotes visitability as both a market-based

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[545] Lusher in Kawauchi 2009, 140; Center for Universal Design, *Housing for the Life Span of All People* (Raleigh: North Carolina State University, 2000). Accessible online at < http://design-dev.ncsu.edu/openjournal/index.php/redlab/article/view/101>.
[546] For instance, Leslie Kanes Weisman.
[547] SUNY Buffalo IDEA Center, "Bridging the Gap," Available at: http://www.ap.buffalo.edu/idea/projects/index.asp#gap.
[548] See < http://concretechange.org>. See also Steinfeld and Maisel 2012, 229; Jordana Maisel, "The Evolution of Universal Design in Housing in the United States: Toward Visitability and Pattern Books," in Wolfgang Preiser and Korydon Smith (eds), *Universal Design Handbook: 2nd edition* (McGraw-Hill, 2009), 25.3; Kawauchi 2009, 112.

strategy and one that can be incorporated into local access codes. Visitable homes are those that have zero-slope entrances without stairs, doorways wide enough to accommodate a wheelchair, and accessible bathrooms. While homeowners can adopt UD solutions to make their homes more visitable, visitability often focuses on mobility impairments rather than the broader set of accessibility concerns raised by UD.

Alternative language to describe UD has proliferated within accessible design in order to avoid the uncomfortable association of UD with one-size-fits-all approaches to every form of difference. Demonstrating the confusions that arise from the proliferation of these terminologies, Linda Nussbaumer, an interior designer and inclusive design advocate, writes,

> Some books and organizations use the term 'universal design' whereas others use the term 'inclusive design.' There are similarities and differences between these terms. Most often, the universal design term is used in the United States and inclusive design in Europe, Canada, and other countries. However, even in the United States, organizations and conferences have used inclusive design and some have used both terms in the same discussion.[549]

Nussbaumer is correct that the terms *Universal Design* and *inclusive design* are often used interchangeably, but by conflating within her own definition of UD, she fails to provide any meaningful way to discuss the comparative philosophy and scope of these approaches. For example, Titles II and III of the Americans With Disabilities Act, which concern the built environment, provide minimal standards for inclusive and accessible design. Their standards are not, however, as extensive as the kinds of practices that UD makes possible.

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[549] Linda Nussbaumer, *Evidence-Based Design for Interior Designers* (Berg/Fairchild Publications, 2012), xii.

While *inclusive design* represents the least contested of all of the alternatives to *Universal Design*, its precise requirements, values, and commitments are still vague.[550] Like *good design,* the term *inclusive design* could mean any number of things depending on what a designer determines is important to include. The scope of UD is thus much larger and more complex than these terms reflect. While UD is a type of inclusive design, not every type of inclusive design aims for the three UD components of *broad accessibility*, *access by design*, and *added value*.

It is more useful to consider *inclusive* or *accessible design* to be the broader milieu in which UD is one strategy among many. At the same time, it is necessary to understand that UD as an historically situated practice made possible through evidence-based, user-centered design practices prioritizing disability access. This understanding, as I have presented it here, allows us to unpack the conceptual, epistemological, methodological, and political values underlying UD in a way that simply characterizing it as extra-legal, market-based, or more marketable cannot do.

The Seven Principles of Universal Design

When the ADA was passed in 1990, the only definition of UD in existence was Mace's 1985 article. Design magazines, conferences, and a number of other sources began to use UD synonymously with ADA mandates, although the two are markedly different approaches.[551] In industrial design, especially, the term took on a life of its own,

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[550] Polly Welch advocates for the use of the term *inclusive design* rather than *Universal Design* in order to better fulfill the objectives of user-centeredness. According to Welch, "Inclusive design makes us think of who the subjects are. Universal does not clarify the subjects" (Welch in Kawauchi 2009, 117). *Inclusive design* is also the preferred term for accessible design in the UK (Sandhu 2011, 44.3).

[551] There are too many examples of this to cite here, but I came to this conclusion after reviewing a decade of magazine articles on UD as an approach to housing retrofits, as well as archival documents on UD conferences and design competitions held between 1990 and 1998.

with multiple conferences and other events being held in the early-mid 1990s to explore what UD could mean for the profession.[552] The lack of consensus on UD's scope and methodology not only precipitated some of the terminological debates I discussed above, but also created a need to clarify UD's purpose through an expert and evidence-based framework.[553] In the tradition of formulating design manifestos and principles, in 1995, Mace assembled a team of his colleagues—many of whom had been working closely with him since earlier in his career—at the North Carolina State University Center for Universal Design to formalize UD by naming a set of desirable traits and methods.

When the Seven Principles of Universal Design were finally released in 1997, they were the most developed set of statements or rules concerning what UD should or could be.[554] Today, the Principles also continue to be cited extensively in the fields into which UD has expanded, such as education and technology. However, these citations take for granted the historical and epistemic specificity of how the Principles emerged. One of the major objectives of my historical epistemological framework is to show that the Principles are not ahistorical guidance for achieving UD, nor are they de facto unproblematic methods for achieving inclusive design. Rather, they arise from specific historical and disciplinary formations that must be excavated and analyzed in order to understand the long-term history of UD's emergence.

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[552] Most notably, the Pratt Institute held a conference on Universal Design in May 1992 and released a publication about it. See Robert Anders and Daniel Fechtner, *Design Primers: Universal Design* (New York: Pratt Institute, 1992).

[553] Although UD positions itself against technical standards, as UD Principles author Molly Story notes, the emergence of the Seven Principles is part of a broader history of work on access standardization by the other authors (Molly Story, "The Principles of Universal Design," in Wolfgang Preiser and Korydon Smith, *Universal Design Handbook: 2nd edition* [McGraw-Hill, 2011], 4.3). Although the Principles are more akin to creative guidelines than technical specifications, they follow in the trajectory of both modernist design principles and manifestos and several decades of best practices guidelines for accessible design.

[554] Center for Universal Design 1997.

The practice of setting principles for design is entwined with the history of architecture itself. From Vitruvius' *De Architectura* to the design manifestos of 20th century modernist architects like Le Corbusier and Buckminster Fuller, design principles present ideals for architectural practice and clarify the aesthetic and social agendas that architecture is meant to achieve.[555] However, exploring the underlying content and commitments of design principles also reveals broader institutional and scientific histories that explain how certain choices are made regarding what principles to elevate and what methodologies to pursue.

To understand the institutional history of the UD Principles, we must first understand how UD came to be a phenomenon that is practiced and developed within research institutions. As I have hinted previously, the institutional support for UD research came from government-funded rehabilitation research centers. The Department of Education's Office of Special Education and Rehabilitative Services established the National Institute on Disability and Rehabilitation Research (NIDRR) in 1978.[556] NIDRR's mission is to

> generate new knowledge and promote its effective use to improve the abilities of people with disabilities to perform activities of their choice in the community, and also to expand society's capacity to provide full opportunities and accommodations for its citizens with disabilities.[557]

NIDRR is a major funder for research on disability and assistive technology, rehabilitation, barrier-free design, and Universal Design and has direct connections with

[555] Conrads 1975.
[556] Office of Special Education and Rehabilitative Services, "About NIDRR," Available at: http://www2.ed.gov/about/offices/list/osers/nidrr/about.html
[557] Ibid.

federal agencies responsible for implementing accessibility guidelines.[558] It has not only funded UD research projects, but is also responsible for funding the subsequent research of many of the UD Principles authors, who are expanding UD beyond architecture to include web design and human-technology interfaces (such as Apple iPhones).[559]

The remainder of NIDRR's research operates within frameworks that both make UD possible and that UD critiques as inadequate: assistive technology, rehabilitation, and barrier-free design. Nevertheless, many UD proponents have been trained in the disciplinary epistemologies and methodologies of these approaches. These disciplinary backgrounds, coupled with participation in the epistemic communities of environmental design research, human factors, and rehabilitation, and propelled forward through the availability of NIDRR funding, has made UD intelligible as an evidence-based, user-centered design phenomenon, as opposed to a design or political movement.

While NIDRR emerged to promote research-based interventions into special education and rehabilitation, its shifting foci reflect the way that the emergence of UD also created shifts within rehabilitation and assistive technology paradigms to encourage a focus on fitting environments to bodies rather than bodies to environments. These shifts are also evident in the work of UD practitioners, like Mace, Mueller, Steinfeld, and others, who participated in both barrier-free and Universal Design.

Mace, as an architect experiencing and concerned with user-centered design, entered the field of barrier-free consulting in the mid-1970s, establishing a firm called

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[558] NIDRR has a system in place to collaborate with the Architecture and Transportation Compliance Board (Kawauchi 2009, 11).

[559] See for example, the Wireless RERC at the Georgia Institute of Technology, led by James Mueller and Mike Jones, or the RERC on Information Technology Access at the University of Wisconsin-Madison, led by Greg Vanderheiden.

Barrier Free Environments, Inc. (BFE) in North Carolina in 1974.[560] He was widely considered an expert in the field of accessible design, and because he had been involved with writing the technical specifications for ANSI A117.1, BFE provided guidance on emerging disability rights laws to state governments and businesses.[561] BFE also prepared reports on accessibility for the National Academy of the Sciences, the U.S. Department of Health, Education, and Welfare, the Architectural and Transportation Compliance Board, the Department of Housing and Urban Development.[562] After the passage of the ADA in 1990, BFE provided guidance to architects and planners on implementing the ADAAG.[563] At this point, BFE also collaborated with John Salmen at Universal Designers and Consultants on producing a newsletter that would differentiate major developments in UD and ADA design, and also promote UD to designers as a way of enforcing the ADA.[564]

The BFE's activities focused on legal compliance with disability civil rights laws. In contrast, the emerging idea of Universal Design created the possibility of extra-legal and knowledge-based interventions. In 1989, Mace, then a faculty member in architecture at North Carolina State University (NCSU), established the Center for Accessible Housing (CAH) in the School of Design, funded by NIDRR as a Rehabilitation Research

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[560] Barrier-Free Environments 1991, "Capsule History of the Firm," Ronald L. Mace Collection, North Carolina State University archives.

[561] Barrier-Free Environments, Pamphlet produced by for North Carolina Department of Insurance on state laws for PWD, circa mid-1970s. Universal Design collection, National Museum of American History, Division of Medicine and Science.

[562] Barrier-Free Environments. 1976. "Mobile Homes: alternate housing for the handicapped," Pamphlet produced for HUD Office of Policy Development and Research. Universal Design collection, National Museum of American History, Division of Medicine and Science.

[563] Correspondence from Lucy Harber to Catherine Shaw of the American Institute of Architects Professional Development Department. 1991. Ronald Mace Collection, North Carolina State University.

[564] Barrier-Free Environments, 1991. "Strategic Plan," Ronald Mace Collection, North Carolina State University; Correspondence from Ron Mace to John Salmen, 1991. Ronald Mace Collection, North Carolina State University.

and Training Center (RRTC).[565] The CAH continued work along the lines of BFE, but focused on research applying human factors and rehabilitation methods to product testing.[566] The CAH also included a serious design education component, creating opportunities for training undergraduate and graduate NCSU design students in accessible and inclusive design.[567] The multidisciplinary CAH brought together a number of experts who would continue to be important to the development of UD, including Bettye-Rose Connell of Atlanta Veterans Affairs, Elaine Ostroff of Adaptive Environments in Boston, MA, and CAH staff, Mike Jones, Ron Mace, Jim Mueller, Jan Reagan, and Leslie Young.[568]

The CAH became the Center for Universal Design (CUD) in 1994, funded by a NIDRR Rehabilitation Engineering Research Center (RERC) grant,[569] a NIDRR Research and Development grant for Studies in Universal Design, and a number of federal grants related to ADA assistance.[570] The CUD allied itself with a number of other research centers, such as Adaptive Technologies in Boston, MA (now the Institute for Human Centered Design [IHCD]) and the SUNY Buffalo Center for Inclusive Design and Environmental Access (IDEA Center), which currently holds the RERC on Universal Design and the Built Environment.[571] The CUD performed a number of services, including evaluations, design development and testing, workshops for designers and

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[565] Center for Universal Design, circa late 1990s. "CUD Show and Tell," Private collection of Joy Weeber.
[566] Center for Affordable Housing, 1993. "Center for Affordable Housing Thermostat Project," Private collection of Joy Weeber. Center for Affordable Housing, 1995. "CAH Management Meeting Minutes," Private collection of Joy Weeber.
[567] NCSU School of Design News, circa 1989. Private collection of Joy Weeber.
[568] Center for Affordable Housing, 1995. "CAH Meeting Minutes," Private collection of Joy Weeber.
[569] Ibid
[570] Ibid
[571] Ibid

builders, education, housing policy consulting, and outreach.[572] These services represented multiple knowledge-based interventions through education, evaluation, and research.

Finally, in 1995 Mace convened a number of his colleagues who had been involved in the CAH and CUD and were experts in accessible architecture and industrial design to write the Seven Principles. Recalling this period, Story, Mueller, and Mace write,

> The Center's staff then convened a working group of architects, product designers, engineers, and environmental design researchers to assemble a set of principles of universal design that would encapsulate the existing knowledge base. These principles would apply to all design disciplines and all people. The principles could be applied to evaluate existing designs, guide the design process, and educate designers and consumers about the characteristics of more usable products and environments.[573]

The emphasis in this narrative on experts, a knowledge base, and the application of the Principles to "all design disciplines and all people," as well as the use of the Principles in evaluation, design, and knowledge dissemination, demonstrates the extent to which UD is, within its foundational narratives, an evidence-based design phenomenon.

The authors of the Principles were all trained in evidence-based disciplines or specializations. They were:

- Bettye Rose Connell, a rehabilitation specialist and gerontologist,
- Mike Jones, a rehabilitation specialist,
- Ronald Mace, an architect and barrier-free design consultant,
- Jim Mueller, an industrial designer and workplace design specialist,
- Abir Mullick, an industrial designer,
- Elaine Ostroff, an education specialist with a background in special education,
- Jon Sanford, an architect with a background in environmental psychology,
- Edward Steinfeld, an architect and gerontologist,
- Molly Story, an industrial designer and product engineer, and

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[572] Ibid

[573] Story, Mueller, and Mace 1998, 32.

- Greg Vanderheiden, a rehabilitation engineer and assistive technology expert

Absent from this group were several experts who had worked extensively with Mace in developing inclusive design approaches.[574] What is apparent from the list, however, is the concentration of authorship in professionals trained in fields responsible for user-centered design, functionalism, and evidence-based design.

The cohort of experts defined UD as "the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaption or specialized design."[575] This definition retained Mace's recognition of the ties between products and environments, as well as a notion of a broad user group, but added an additional notion that design must already account for this group.

The resulting Seven Principles of Universal Design were written to provide guidance for how to achieve broad and inclusive design. They are:

1. Equitable use
2. Flexibility in use
3. Simple and intuitive use
4. Perceptible information
5. Tolerance for error
6. Low physical effort
7. Size and space for approach and use

As I explained in Chapter 1, four of the seven Principles specifically refer to *use,* while the rest imply enhanced *functionality* or *usability.* Of the seven Principles, equitable use and flexibility are the most value-based, and fit with the concepts of *broad accessibility* and *added value*. The remaining Principles are geared toward particular design

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[574] For example, Ruth Hall Lusher and John Salmen, both of whom were involved in BFE and worked with Mace on accessibility projects.
[575] Center for Universal Design 1997.

disciplines — particularly product and industrial design — and do not necessarily serve as general philosophical principles.[576]

None of the Principles, or definitions of UD, mention disability, even while the focus of most UD work is disability access and many of the Principles authors were trained in disability-focused disciplines or helped to write *barrier-free* legal guidelines. Instead, the Principles define a theory of person-environment relations and explain the exclusion of misfitting embodiment from the built environment according to functional and value-based criteria. Crucially, the Principles also create a demand for evidence as a design tool. Flexible design obliges designers to account for a range of user body sizes and functions. To understand the range of possible variations, designers can rely upon anthropometric data about bodily movement, reach, or size.[577] Standards for easy usability may require an understanding of cognition and human-technology interfaces.[578] Building the necessity of evidence into the principles shows the professional and disciplinary commitments of the authors, most of whom were university researchers in evidence-based fields such as ergonomics and human factors research, gerontology, and rehabilitative medicine.

Since 1997, many alternatives to the Seven Principles have been proposed by the original authors and others doing work in this area. Edward Steinfeld, one of the original authors of the Principles, has proposed a set of measurable outcomes and goals for UD, but not necessarily a theory of social justice or a design philosophy.[579] Steinfeld and his collaborators at the Center for Inclusive Design and Environmental Access (SUNY-

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[576] Steinfeld and Maisel 2012, 88.
[577] This is the subject of Chapter 3.
[578] Such as data from environmental and behavioral psychology and environmental design research.
[579] Steinfeld and Maisel 2012, 90.

Buffalo) have formulated a set of evidence-based principles for Universal Design that make clear the knowledge-based inputs necessary for achieving broad accessibility. These are:

1. Body fit
2. Comfort
3. Awareness
4. Understanding
5. Wellness
6. Social integration
7. Personalization
8. Cultural appropriateness[580]

These new principles respond to existing criticisms of the 1997 Seven Principles, which allegedly focused more on product design, were not easily translatable into other languages, lacked “clarity of purpose,” did not provide “metrics or standards” for evaluating success, and did not have “a body of evidence tied to the Principles.”[581] Steinfeld’s evidence-based principles are meant to create “[t]erminology related to established domains of knowledge,”[582] crossing UD into the threshold of epistemologization.

The notion that the Principles must have measurable outcomes and a reliable evidence base is a techno-rationalistic solution made possible by existing knowledge frameworks. Particularly in the case of Steinfeld’s eight new principles, the terminology makes explicit the influence of specific fields of study and privileges evidence bases from rehabilitative medicine (“social integration” and “wellness”), ergonomics (“body fit” and “comfort”), environmental psychology (“awareness” and “understanding”), and person-

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[580] Steinfeld and Maisel 2012.
[581] Steinfeld and Maisel 2012, 88.
[582] Steinfeld and Maisel 2012, 88..

environment relations ("personalization" as an alternative to flexibility and "cultural appropriateness").

The very existence of UD Principles is a form of epistemic politics. The impulse to standardize UD and create guidelines for practice reflects its proponents' involvement in the creation of technical guidelines for disability access laws, such as the ADA. It is also a form of technical rationality seeking the standardization of a framework that otherwise implies open-ended design creativity.

Other iterations of the Principles call for market-based interventions, focusing on commodifying accessibility rather than promoting equity,[583] or on reforms to the health care system that would make UD viable as a rehabilitation strategy.[584] Various iterations of the UD idea exist internationally in Europe, India, and Japan, as well,[585] resulting in the proliferation of categories and approaches with asymptotic relationships, never fully mapping onto one another but existing as similar discourses in different cultural and legal contexts.

The Seven Principles are not ahistorical or consistent, but rather subject to interdisciplinary debates producing the ongoing development of a field of thought around UD. These developments have everything to do with epistemic framings in the disciplines and approaches that are represented at the table of UD theory-building in particular historical moments. When the Seven Principles as defined synonymous with Universal Design, without recognition of their history and contested status, however, this

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[583] Gail Finkel and Yhetta Gold. "Actualizing Universal Design," *Journal of Leisurability*. 26.1 (1999); Kawauchi 2009, 83; Imrie 2012, 878; Steinfeld and Maisel 2012, 70-71; Molly Story and James Mueller, "Universal Design of Products," in Wolfgang Preiser and Korydon Smith, *Universal Design Handbook: 2nd edition* (McGraw-Hill, 2011), 32.10.
[584] Sanford 2012.
[585] Kawauchi 2009; Abir Mullick, Shiksha Agarwal, Ashok Kumar, and Pushplata Swarnkar. "Public Bathroom for Universal Access: An Article." *The Trellis* 2.7 (2011): 117-126.

gives the impression that the Principles authors merely uncovered general principles that had been there all along. This is also true of critiques of UD, which focus on the limitations of the Seven Principles rather than the more general design philosophy.[586] Instead, my historical epistemology of UD traces how these principles emerge from specific disciplinary contexts and have their own histories long before UD emerges as an approach to the built environment. This focus is not merely a different way of framing UD, but shows its epistemological, methodological, and ideological relationships to the disciplines and approaches that it rejects but that made its emergence possible.

UD and the Disability Rights Movement

One of the orthodoxies of UD histories is that the phenomenon emerged from the disability rights movement. As I explained in the Introduction, UD has ideological links to social protest movements that emphasize space as a litmus test of broader inclusions in society.[587] Welch and Jones cite UD's philosophy of desegregation to link it historically with efforts by marginalized people, such as people with disabilities "to challenge spatial practices that either unduly segregated them or ignored their existence altogether."[588] Rejecting the notion of separate-but-equal (which it uses to characterize the barrier-free approach) is key to this framing, and UD histories include the U.S. Supreme Court decisions, *Plessy v. Fergusen* and *Brown v. Board* in their historical timelines of UD's emergence.[589]

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[586] Sandhu 2011.
[587] "The physical environment has been an element central to equal protection" (Robert Francis, "The Development of Federal Accessibility Law," *Journal of Rehabilitation* Jan-March [1983]).
[588] Welch and Jones 2002, 193
[589] Story, Mueller, and Mace 1998.

Story, Mueller, and Mace, in their 1998 history of UD, relate civil rights movement ideologies to the development of barrier-free legislation in the 1970s-1990s.[590] They note that efforts to reduce physical barriers in society were especially charged in the 1950s, as disabled veterans organizations pushed for national standards for buildings.[591] This led to the establishment of the first American National Standards Institute (ANSI) standards (A 117.1) for accessible buildings in 1961[592] and the establishment of the Architectural Barriers Act in 1968. Likewise, UD also has historical connections to the barrier-free legal design guidelines established as a result of movement demands.

What is meant by UD emerging from the disability rights movement, then, is that it takes ideas and standards of broad inclusion from 1970s civil rights movements for disability, race, and gender equity, and at least theoretically uses this to formulate an understanding of how the physical environment can create barriers to access for any body. The ideology of barrier-free design, emerging from the disability rights movement and also from post-World War II rehabilitation efforts for veterans, infused these efforts. However, UD clearly rejects *barrier-free design* as too limited while lauding the social movement efforts that precipitated it.

In terms of framing UD's history, equating UD with civil rights legislation limits our understanding of it to top-down efforts, rather than showing the work that UD has done within professional cultures. UD proponents, such as Ron Mace, the Principles authors, and many of the other professionals and policymakers involved with the phenomenon were not involved in the disability rights movement in the sense of doing community organizing, direct action, and sit-ins. Rather crucially, they were concerned with

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[590] Story, Mueller, and Mace 1998.
[591] Story, Mueller, and Mace 1998, 7.
[592] Story, Mueller, and Mace 1998, 7.

changing the way that architects are trained and think about users, and understood this type of intervention to be more direct than laws specifying particular technical solutions or enabling marginalized people to sue for retrofits.[593] Thus, while the activist spirit of the disability rights movement may have informed accessible design in general, UD's adoption of different epistemological and methodological frameworks to transform the design professions also produces a different set of ideological commitments. This is not to imply that the disability rights movement did not influence UD, but rather to argue that the movement did not by itself cause Universal Design, nor did it have access to the kinds of professional and epistemological developments that made UD possible.

While UD has developed to perform epistemological and ideological interventions within the design professions, the basis of these interventions is as much a product of genealogies of professional, epistemic activism as it is of activist demands for legal protections. To the extent that UD promotes itself as an alternative to the ADA and technical standards, it is also an ideological relative of market-based and extra-legal solutions that rely upon social change amongst designers, builders, fabricators, and producers to transform the built environment.[594] As I explain in the Conclusion, these are important ideological aspects of UD to keep in mind in any analysis of its politics.

As Mace's honor's thesis reflects, UD's approach to desegregation emerges through a need for user-centered design, articulated through the notion of person-environment misfit that emerges from the environmental design research field.[595]

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[593] This is evident in the work of UD proponents who were also environmental design research advocates (such as Mace and Steinfeld), as well as in the work of Elaine Ostroff, Valerie Fletcher, and Leslie Kanes Weisman in promoting UD education in design schools (explained later in the chapter). See also Ostroff 2011, 1.9.

[594] See Imrie (2012) for the ideological implications of discourses of marketization and the "commodification of access" in UD (878).

[595] Mace 1966.

Steinfeld and Tauke clarify the relationship between these ideologies for the design professions:

> Universal Design, in fact, emerged through a cultural critique. The need to design environments to be accessible to and usable by people with disabilities was viewed by second generation proponents including some, like Ron Mace and Ruth Hall Lusher in the United States, who were both trained as architects and had disabilities themselves, as a symptom of a broad failure of society to incorporate disability into its consciousness. Their argument was that if disability is perceived as a "normal" part of life – something that could happen to any of us – then the material world would be designed to accommodate it without the need for a political movement or professional specialty. Accessibility and usability, they argued, should be a goal of design right from the start. Every designer should be able to design an environment that will benefit everyone, not just temporarily able-bodied people.[596]

This integration of disability as a critical concept of "cultural critique" into architectural labor does not only reflect social movement ideologies of equity. Rather, it shows the influence of human factors and rehabilitation research in making users intelligible and addressable through design. As I now turn to arguing, understanding UD's conceptual apparatus beyond the influence of civil rights movements is necessary to make the influence of these research milieus perceptible. UD is a key piece of an historical puzzle linking together a number of research disciplines with design practices and the emergence of legal standards for accessibility.

Split approaches to UD intervention

This chapter has shown UD's connections to *functionalist architecture* and *barrier-free design* approaches, as well as its ties to *environmental design research* and *person-environment design* frameworks that build upon *rehabilitative* and *human factors* models. The phenomenon known as UD today overlaps with but significantly departs from all of these milieus. As it develops past the 1990s, UD splits into two distinct but

[596] Steinfeld & Tauke 2002, 166.

complementary approaches: evidence-based and techno-rational UD funded by NIDRR and social justice approaches to architectural education and policy emerging from non-profit, non-governmental, and activist designers affiliated with UD.

Techno-rational approaches

The techno-rational approach is a direct product of the scientific histories I traced in Chapter 1, as well as the institutional histories I have outlined in this chapter. In the U.S., NIDRR funding places UD research, design, and technology development within a rehabilitation and human factors framework while bringing together architecture and industrial design as tools for evidence-based design. The techno-rational approach to UD not only carries out empirical research on bodies, but also has a proclivity for establishing standards and review boards to make UD an official scientific and design discourse.[597]

As I noted earlier, the UD Principles were drafted at the RERC on Universal Design and the Built Environment, then at the North Carolina Center for Universal Design. Since then, most of the UD Principles authors, including Ron Mace, Edward Steinfeld, Mike Jones, Jon Sanford, Jim Mueller, Greg Vanderheiden, and Abir Mullick, have directed other RERCs on UD or specific topics, such as transportation, aging, and technology. Because only one RERC exists that is explicitly centered on Universal Design and the Built Environment,[598] UD advocates have pursued research through other RERCs on the workplace, user-technology interfaces, and transportation.[599] The mandate

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[597] Moore & Geboy 2010, in their literature review of environmental design research, characterize UD accessibility research as part of a techno-rational approach that uses data to produce specific guidelines. Although UD itself is more open-ended, many key UD figures were involved in researching and drafting ANSI A117, and the recent development of consensus standards by the Global Universal Design Commission (discussed later) is also arguably a techno-rational approach.
[598] The RERC for Universal Design and the Built Environment is housed at the SUNY-Buffalo Center for Inclusive Design and Environmental Access.
[599] Such as the Wireless RERC at Georgia Tech.

of these other RERCs is not to achieve the scope of broad accessibility, but to contribute to it through specific forms of research. Because UD proponents work as researchers in these RERCs they have taken on a rehabilitation engineering work, focusing on developing assistive technologies, products, and research that can accumulate to address gaps produced by more limited approaches to access. Thus, UD's epistemic community uses RERCs, as well as methodologies from human factors and rehabilitation research, to accumulate a knowledge base that can add up to more broadly inclusive approaches.

Social justice approaches

Another, non-subsidized approach to UD is characterized by humanistic and social justice perspectives and strategies deployed at institutional or non-institutional sites. These approaches focus on design education, phenomenological and experiential approaches to UD, making connections between U.S. and international inclusive design advocates, and social and environmental sustainability. The Institute for Human-Centered Design (IHCD), formerly Adaptive Environments, is a non-profit organization doing UD and inclusive design work and focusing on creating cultural shifts within the design profession.

The IHCD is still an advocate of evidence-based approaches to UD,[600] and has been at the forefront of certain aspects of UD research, such as museum design, that focus on human and "user-expert" experiences and inclusion.[601] They have also been

[600] Adaptive Environments collaborated with the Center for Universal Design on evidence-based approaches to UD, including: Adaptive Environments, *Universal Design: Housing for a Lifetime - Workbook on Universal and Adaptable Design* (Boston: Adaptive Environments, 1998), National Museum of American History, Division of Medicine and Science, Smithsonian Institution; Adaptive Environments and Center for Universal Design. *Universal Design '95 Reference Book*. Division of Medicine and Science, Smithsonian Institution; and the *UD Education Project* (Raleigh: Center for Universal Design, 1995).
[601] Beth Ziebarth, Personal Communication, Washington, D.C.: National Museum of American History, February 2011; Eliza Kaye. Personal communication. August 2, 2010. Boston, Massachusetts; Elaine

active in compiling a database of UD best practices as knowledge that can inform designers via the application of design precedent and knowledge about specific cases.[602] These *best practice approaches* harness epistemic practices that are more traditional to design, rather than the quantitative data-centered approaches of evidence-based design research in the RERCs. For instance, the IHCD runs an in-house design firm, client-centered design research, more general research focused on creating *best practices* for UD, and runs programming for educating designers about accessibility.

The key figures in the social justice approach to UD are women, though they work with people of all genders in their firms and projects. Elaine Ostroff's entrance into UD and barrier-free environments world within a similar milieu as many of the other UD Principles authors. Her book, *Humanizing Environments* (1978), borrowed from the person-environment and rehabilitation frameworks to talk about the human factors notions of environmental fit and misfit in educational spaces for students with intellectual disabilities.[603]

Ostroff was responsible for introducing several other women into the UD world. These include Valerie Fletcher, the IHCD's current Executive Director, and Leslie Kanes Weisman, a feminist architectural theorist and design educator. Weisman worked with Ostroff on the *Universal Design Education Project*, integrating her feminist design

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Ostroff and Daniel Iacofano, *Teaching Design for All People: the state of the art* (Boston: Adaptive Environments, 1982), National Museum of American History, Division of Medicine and Science, Smithsonian Institution.

[602] See Institute for Human Centered Design, "UD Resources," Available at: http://humancentereddesign.org/all-resources.

[603] Elaine Ostroff. *Humanizing Environments: A primer* (Cambridge: The Word Guild and Massachusetts Department of Mental Health), National Museum of American History, Division of Medicine and Science, Smithsonian Institution.

pedagogy to the UD classroom and promoting UD in affordable housing for single mothers.[604]

Though these are not the only figures involved in the two approaches, one cannot help but notice that the two approaches to UD are divided along gender lines. Proponents of the scientific, technical-rationalistic approach are mostly men trained in scientific and technical fields in the Cold War era. Proponents of the social justice, educational, and phenomenological approach, instead, consist of women educators and designers. These divisions likely reflect the gendered division of education in science and engineering or education and architecture in the particular generation of designers and researchers through which UD became formalized.

Conclusion

As the scientific and social justice approaches to UD move beyond its initial foundations, it will be necessary to further explore and theorize the epistemic implications of these approaches. Both dispute and disrupt the normate template, contesting prevailing norms of architectural practice and showing that design depends on knowledge production about users that can become a site for intervention. In the next chapter, I turn to showing that the very mathematical practices through which bodies become connected to nature and through which positivist statistical practices emerge are historical precursors to UD.

[604] Weisman 2012.

Chapter 3: Evidence-Based Design: Anthropometry and the Normate Template

Introduction

In *The Measure of Man and Woman* (1967), American industrial designer Henry Dreyfuss recalls sitting in his firm's office adding numbers to a human figure posted to the wall. His firm, Henry Dreyfuss Associates, had been commissioned by the U.S. Army to design the interior of a tank. Dreyfuss describes the scene in this way:

> We had tacked a huge, life-size drawing of the tank driver's compartment on the wall. The driver's figure had been indicated with a thick black pencil line and we had been jotting odds and ends of dimensional data on him as we dug the data out of our files. Surrounded by arcs and rectangles, we looked something like one of the famous dimensional studies of Leonardo. Suddenly it dawned on us that the drawing on the wall was more than a study of the tank driver's compartment: without being aware of it, we had been putting together a dimensional chart of the average adult American male.[605]

Fitting a tank driver's compartment to the human user had demanded that Dreyfuss and his team have knowledge of the likely tank driver's dimensions. They had filed away data on human size somewhat haphazardly, deeming it significant to the design process but not (until this moment) requiring it to be systematic.

Whose bodies did this data represent? That of the "average adult American male." What kind of intelligible body emerged from this act of figure drawing? One that approximated "one of the famous dimensional studies of Leonardo," such as the Vitruvian Man. What purpose did this data serve? While for Dreyfuss, it aided in the design of the tank driver's compartment, the resulting figure would come to shape a key contemporary manifestation of the normate template: the *anthropometric figure* serving as evidence of the normate user for designers.

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[605] Dreyfuss 1967, 4.

Fleshy human bodies are the basis of the *normate template*, and but also the material evidence that challenges and disrupts it. This chapter produces an historical epistemology of one of the ways that UD disrupts the normate template. I focus on the epistemic concept of the *body as evidence* by conducting a long-term history of practices of measuring and quantifying human bodies, particularly anthropometry, which plays a key role in contemporary Universal Design research. In doing so, I trace both the history of anthropometric data and of the visual conventions of anthropometric images.

The term *anthropometry* describes practices of body measurement developed in the 19th century. While some histories of human factors research and architectural design have noted anthropometry's role in making human bodies intelligible to engineers and designers,[606] most histories of anthropometry focus on its role in criminology, eugenics, and physical anthropology. The dominant narrative about anthropometry in critical disability studies and the histories of science and mathematics focuses on these negative, reductive, and normalizing applications of anthropometry.[607] By crafting histories of key figures in eugenics or historicizing epistemic objects like the bell curve, this scholarship has complicated the supposed objectivity of anthropometric measurement. At the same time, these accounts do not offer a way of making sense of contemporary uses of anthropometry for disability inclusion in the late 20th and early 21st centuries.

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[606] Meister 1999, 148.

[607] Such as in: Lennard Davis, "Constructing Normalcy: The Bell Curve, The Novel, and the Invention of the Disabled Body in the Nineteenth Century," in Lennard Davis (ed), *Disability Studies Reader* (New York: Routledge, 2010), 4-5; Garland-Thomson 2002, 10; Jacqueline Urla and Alan C. Swedlund, "The Anthropometry of Barbie: Unsettling Ideals of the Feminine Body in Popular Culture," in Jennifer Terry and Jacqueline Urla (eds), *Deviant Bodies: Critical Perspectives on Difference in Science and Popular Culture* (Bloomington: Indiana University Press, 1995), 277-313; Daniel Kevles, *In the Name of Eugenics: Genetics and the Uses of Human Heredity* (Berkley: University of California Press, 1985), chapters 1-3; Stephen Jay Gould, *The Mismeasure of Man*. (New York: W.W. Norton & Company, 1981), 108, 116, and 171.

The prevailing literature on anthropometry focuses on epistemological and ontological questions offered by what can be broadly considered the *philosophy of the norm*.[608] Disability studies and history of science accounts assume the normalizing and polemical function of anthropometry. My original contribution to this literature is to resist an historically essentialist reading of anthropometry by showing that *measurement* in contemporary UD research is not a way of valorizing average bodies or preventing considerations of difference. Rather, the strategic application of measurement has made 20th century barrier-free and Universal Design possible. This is a perspective that is only legible when viewed through the lens of the long-term history of anthropometric methodologies and epistemologies.

Tracing shifts in anthropometry from the early 19th century to the present, I not only consider the historical ontology[609] of what anthropometry *is* but also the historical epistemology of how it challenges the very idea of objective, scientific knowledge. My analysis focuses on three central questions:

1. How do anthropometric practices produce regimes of knowledge and intelligibility, construct normate and misfit embodiment, and establish epistemological and scientific techniques of quantification?
2. What impact does anthropometry have on landscapes of idealized bodies and built environments?
3. What are the ethical implications of UD's use of anthropometry, given its history as a science associated with 19th century eugenics, criminology, and physical anthropology?

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[608] The *philosophy of the norm* in French epistemology is attributed to the historical epistemological works of Georges Canguilhem (1991, 1998), Michel Foucault (1994), and Pierre Macharey, "Towards a Natural History of Norms," in Timothy Armstrong (ed), *Michel Foucault: Philosopher* (Routledge: New York, 1992), 176-191.

[609] *Historical ontology* is Ian Hacking's term for a concept roughly similar to *historical epistemology*. However, while my use of *historical epistemology* is mostly methodological, Hacking's concept is best used to describe the historicity of things themselves. See Ian Hacking, *Historical Ontology* (Cambridge: Harvard University Press, 2002).

To address these questions, I analyze shifts in scientific thought and epistemic concepts, developments in the history and philosophy of the mathematical disciplines of geometry and statistics, and the slippery relationships between technology and science that produce Universal Design. As with the rest of the dissertation, my aim is to show that addressing epistemological questions about issues otherwise only treated ontologically or historically opens up space for new critical questions about bodies, disability, and knowledge.

In what follows, I construct an historical epistemology of UD's paradoxical use of anthropometry through a palimpsest of the narratives I constructed in Chapters 1 and 2. Although I visit some of the same historical periods, figures, and scientific practices, I focus on following the thread of one particular practice and connect it to additional historical, architectural, and epistemic phenomena. The narrative I construct is only possible after an understanding of UD's relationship to user-centered and evidence-based design, as well as its historical and institutional ties to rehabilitation and human factors. In this chapter, I argue that contemporary UD research produces historical, epistemological, and methodological shifts that are only intelligible when understood within the long-term history of anthropometry.

Historical epistemology

The prevailing historical narrative in disability studies is that disability was once treated as a condition of moral fault, then became medicalized, and finally was understood (through social protest movements) as a social construct.[610] I complicate this narrative by arguing that the medical model, often presented as a positivistic approach to the body that grants epistemic value to biomedicine, does not replace the moral model of

[610] Oliver 1990; Wendell 1996.

bodily defect as a departure from nature. Rather, ideas about the underlying desirable nature of normate bodies persist in regimes of quantification, even when these regimes intend to eclipse or replace classical notions of the body as a source of harmonic proportionality. Likewise, medical and moral conceptions of the body persist in social models of disability. The shift to the social model of disability, as I argued in Chapter 1, carries epistemological frameworks from medical, military, and industrial sciences.

Rather than constructing a teleological history of anthropometry, I understand the history of ideas about the body, measurement, and difference as a regime of intelligibility, perceptibility, and ignorance.[611] To establish this dissertation's historical epistemology of anthropometry, I locate it at various points within three overlapping systems of intelligibility: the normate template, 19th century practices of scientific measurement, and 20th century user-centered design.

First, I return to the question of the body in architecture. Whereas in the last chapter, I focused on the emerging notion of the user's body in relation to the functionality of built environments, here I begin with the proportional and geometrical architectural body of classical architecture. This body persists for centuries and renders possible, intelligible, and desirable the contemporary *normate template* for design. The normate template coincides with epistemic shifts in scientific and mathematical disciplines like astronomy, geometry, or statistics that seemingly have seemingly little to do with the body or design. Accordingly, the rules according to which bodies shift in and out of view in this regime are governed by epistemological standards of evidence at different moments in history, making it a question of *historical epistemology*.

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[611] I borrow this framing from Michelle Murphy (2006), who in turn creates it from Foucauldian *dispositif* or the "grid of intelligibility."

The second regime of intelligibility in which I locate anthropometry encompasses 19th-21st century practices of measuring and statistically quantifying bodies. Critics of sociobiology and scientific racism have characterized many of these practices, such as phrenology, biometry, early physical anthropology, eugenics, and craniology, as pseudoscientific.[612] However, the same techniques underlying scientific racism and eugenics are those that produce the discipline of statistics and define its rules using comparisons between normate and non-normate bodies. These practices all converge in anthropometry.

I argue that anthropometry is not a pseudoscience, but in fact, the basis of the discipline of statistics and the association of measurement with epistemic validity, generalizability, authority, and expertise. Thus, rather than dismissing anthropometry as failing to meet the standards of scientific validity (and therefore taking such standards and the notion of objectivity for granted), I show that standards for statistical objectivity emerge from anthropometric practices produced in specific historical contexts, making quantification a situated research practice. Then, I use this framework to evaluate the status of contemporary statistical anthropometric research in UD.

The third regime of intelligibility encompasses 20th and 21st century practices of user-centered design and human factors engineering, which are explained in Chapter 1. It is within this context that disability anthropometry is used according to functional need, and eventually becomes a justification for the access of Universal Design to the domain of science. I periodically return to this history in this chapter in order to point out the epistemological traces and interventions carried in disability anthropometry.

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[612] S Gould 1981; Kevles 1985; Cowan 1972.

Temporally, the 19th century does not alone contain anthropometric techniques, tools, or systems of representation; these have (less intelligible) histories both before and after that time. However, it is in the 19th century that the regime of intelligibility articulating a normate template and the emerging regimes of human ordering via eugenics, quantification, and measurement meet and reinforce one another to produce positivist epistemologies and methodologies.[613] As I demonstrate, the convergence of these regimes produces new sources of evidence and new standards of validity that grant a privileged epistemic status to many of our contemporary notions of statistical norms, averages, and standard deviations. They also conflate the average with the natural or desirable.

The notions of *nature*, *cosmos*, and *harmony* that 19th century epistemological standards endorse—through anthropometry—persist from earlier geometric and mechanistic understandings of the body that date back to classical philosophy and architecture, particularly Aristotle's Golden Mean and Vitruvius's description of the human body. By taking an expansive view of these 19th century practices, my historical epistemology of anthropometry traces the relationships between *statistics*, *norm*, *average*, and *standard deviation* as they shift into 20th century practices of *rehabilitation*, *user-centered design*, and eventually, *barrier-free* and *Universal Design*. This history also shows how Universal Design departs from or makes interventions within regimes of knowledge that produce environmental misfit.

In what follows, I consider each regime of intelligibility by showing what sources and methodologies for the production of valid evidence support and become legible in

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[613] Positivism is a philosophy of science based on the epistemic validity of observation, statistics, and logic. Its 19th century roots, I show later in the chapter, are actually in the initial practice of anthropometry.

these regimes, and how the representation of bodies as evidence shapes their ontological status. In asking these questions, I also uncover these regimes' reliance on the visual representation of bodies as evidence, showing how these visualizations articulate broader values and norms around normate and misfit.

The *normate template*

As I explained in the Introduction, the normate is an imagined figure. However, the idea of the normate as both a real fleshy body and an ideal type underlie the ideological system of the *normate template* in architecture. The historical linkage of ideal, proportional bodies to beautiful architecture underlies the later conflation of statistically average bodies with the norm as an ideal. This section considers the history of geometric and graphic representation of the *harmonic*, *proportional*, and *beautiful* body in architecture as evidence or indication of an underlying *nature*. The characterization of disabled or misfitting bodies as unnatural or anomalous emerges from the positioning of the normate as a template for beautiful buildings. I argue that the binary between normate and misfit as *types* is thus a pre-determined idea of the human derived from classical geometry, aesthetics, and cosmology and precedes empirical or statistical notions of the user.

Vitruvius: the body as representative of an underlying nature

Though mathematicians and architects have long debated the exact proportions of buildings like the Parthenon, some architectural geometries and proportionalities appear repeatedly in the history architecture.[614] Common to Egyptian, Greek, Roman, Gothic,

[614] Proportionality was crucial to the Renaissance revival of classical architectural styles. See Rudolph Wittkover, *Architectural Principles in the Age of Humanism* (New York: W.W. Norton & Company, 1971).

Renaissance and Islamic architecture, for instance, are the equilateral and isosceles triangles.[615] The mathematician and architect Richard Padovan has chronicled the history of proportion in architecture as beginning long before the ancient Greeks, but becoming canonized through the concepts of several important ancient Greek figures. These include Pythagoras' triangle, Euclid's documentation of the Golden Ratio, Aristotle's Golden Mean, and Plato's theory of proportion (in which "two things, called the *extremes,* are united by a third, the *mean").*[616] Harmonic proportion underlies the normate by serving as a foundational normative architectural *parti.* As architectural historians Andreas Tzonis and Liane Lefaivre (1975) argue,

> Sacred harmony [is] an ultimate warrant, a quasi-deductive logic of inference, a classificatory foundation for the justification of design decisions and authority backings to validate them, and a concentration of the reparatory of design decisions around proportion, size, and shape.[617]

Thus, references to the body in classical architecture produced and justified the material-discursive basis of the normate template, granting validity to design decisions by appealing to an underlying connection to nature and mathematics. The appearance of harmonic geometries in plants, seashells, and other natural objects led to what Tzonis calls the "divine model" of architecture and geometry, or the belief that fundamental geometries and harmonic proportions underlie the structure of the universe.[618] For classical architects and mathematicians, nature could be observed in these materialities and their underlying truths would echo across multiple scales.[619]

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[615] Richard Padovan, *Proportion: Science, Philosophy, Architecture* (New York: Taylor & Francis, 2002), 82.
[616] Padovan 2002, 106.
[617] Tzonis and Lefaivre 1975, 5.
[618] Padovan 2002, 305-306; Alexander Tzonis, *Towards a Non-Oppressive Architecture* (Cambridge: MIT Press, 1972), 20, 27.
[619] This focus on observation as proof would later be crucial to positivism and statistics as a discipline born from the observation of bodily types.

In his *Ten Books on Architecture* (*De architectura),* the Roman military architect Vitruvius (80-15 B.C.) laid out principles of proportion for buildings based on the human body.[620] *De architectura* is the only work on architecture to survive from early antiquity, making an authoritative text on architecture until the 18th century.[621] At this point, epistemic shifts in science discredited the book as a source of knowledge about the body, and it was instead regarded as a text about the architecture of classical antiquity.[622] My analysis here is less concerned with *De architectura's* authority for architects, however, than it is with its epistemological understanding of nature and the body reflected in Vitruvius's conception of architecture.

Unlike contemporary user-centered design, Vitruvius was not concerned with the fit of buildings to bodies but rather a standard of beauty reflecting the assumed proportions of the human body (in turn, as a reflection of nature).[623] The symmetrical and proportional relationship between parts of the body and components of a building was especially important to Vitruvius. In Book I, Chapter II, he used the body as geometric evidence, writing, "...in the human body there is a kind of symmetrical harmony between forearm, foot, palm, finger, and other small parts; and so it is with perfect buildings."[624]

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[620] According to art historian and critic, William Wetmore Story, Vitruvius's notion of proportionality comes from Polycletus, who brought together classical and Egyptian ideas about proportionality, including the work of Pythagoras and Plato. Vitruvius's account, according to Story, is "confused" and full of inaccuracies. See William Wetmore Story, *Proportions of the Human Figure, according to the canon, for practical use* (London: Chapman and Hall, 1864), 21-23).

[621] According to Indra McEwen, Vitruvius's text was also the authoritative reference for architects during the Renaissance. See Indra McEwen, *Vitruvius: Writing the Body of Architecture* (Cambridge: MIT Press, 2002), 1-2.

[622] McEwen attributes this shift to positivism (McEwen 2002, 2).

[623] As McEwen has demonstrated, Vitruvius, in writing "the body of architecture" (*corpus architecturae*) was writing at the scale of the worlds of architecture and Roman civilization, not the human body. His construction of the human body as a prescription for architecture was closely entwined with the project of Roman imperialism and military expansion (McEwen 2002, 303). As I discuss later, this theme of architectural conceptions of the body that are constructed and disseminated through military design or colonialism repeats itself at the turn of the 20th century.

[624] Vitruvius 15 B.C./2001, 14.

In Book III, dedicated to describing the temples of the gods, Vitruvius further elaborated that symmetry relies on proportions that are established by nature, meaning that both the body and architecture reflect an external reality in physical form. To establish the relationship between symmetry and proportion, he wrote,

> Without symmetry and proportion there can be no principles in the design of any temple; that is, if there is no precise relation between its members, as in the case of those of a well shaped man. For the human body is so designed by nature that the face from the chin to the top of the forehead and the lowest roots of the hair, is a tenth of the whole height; the open hand from the wrist to the tip of the middle finger is just the same; the head from the chin to the crown is an eighth, and with the neck and shoulder from the top of the breast to the lowest roots of the hair is a sixth; from the middle of the breast to the summit of the crown is a fourth...The length of the foot is one sixth of the height of the body; of the forearm, one fourth; and the breadth of the breast is also one fourth. The other members, too, have their own symmetrical proportions, and it is by employing them that the famous painters and sculptors of antiquity attained to great and endless renown.[625]

The body in this account becomes a standard and instrument of the measurement. Its measurements became evidence of an underlying nature and thus affirm the Golden Ratio's mathematical principles of proportionality as positive truth. Using the body to reveal a natural system of proportionality is an epistemic practice that associates geometry itself with nature and beauty.

For Vitruvius, graphing the body in space was key to establishing the universal validity of geometric principles of proportion:

> [In] the human body the central point is naturally the navel...And just as the human body yields a circular outline, so too a square figure may be found from it. For if we measure the distance from the soles of the feet to the top of the head, and then apply that measure to the outstretched arms, the breadth will be found to be the same as the height, as in the case of plane surfaces which are perfectly square.[626]

[625] Vitruvius 15 B.C./2001, 72.
[626] Vitruvius 2001, 73.

In the Renaissance, this description of the body within a square and a circle eventually became the basis of the iconography of proportional, ideal, and healthy bodies within both architecture and medicine.[627] Although the proportions that Vitruvius described were later found to be geometrically impossible,[628] the image produced by this description of proportions established a dominant convention of depicting the body in architecture: a figure with limbs extended into geometric space. Later graphic depictions of Leonardo da Vinci's "Vitruvian Man" (1490) and the body within architecture would continue to use this image of the body in a circular or square space as a way of indicating the ideal user of space even when these images are not concerned with proportionality.

De architectura does not identify Vitruvius' sources of evidence about the proportions of the body, nor is it apparent whether he is writing about ideal bodies or physical ones. However, his references to the ancient Greeks mean that the geometrical principles of proportion that Vitruvius finds in the body pre-date *De architectura* by several hundred years. William Wetmore Story attributes these ideas about proportionality to the ancient Greek sculptor, Polycletus, about whom Vitruvius was one of the only surviving references.[629] Polycletus' notion of proportionality in turn brings together classical (Pythagorean) and Egyptian systems of proportionality that, according to Story, have likely influences in the religions and cosmologies of each civilization.

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[627] Relatedly, metaphorical uses of architecture to describe the body rely on a similar relationship between nature or cosmos and material manifestations of harmonic geometries. See the Belgian anatomist, Andreas Vesalius (1544), *De Humani Corporis Fabrica,* trans. Daniel Harrison and Malcolm Hast, available at: <http://vesalius.northwestern.edu>. In Chapter One, Vesalius uses several architectural metaphors to describe the body. He argues that the Divine design of the body serves as its "foundation," while bones operate as "fortifications" and "walls and beams."

[628] McEwen 2002, 2.

[629] Story 1864, 21.

The Vitruvian imperative: the normative normate

An epistemological question that emerges from these principles of proportion is about the standardization of supposedly natural bodily measurements. Padovan asks whether "[the Vitruvian scale] is intended as an accurate account of actual human proportions, *derived from* average measurements, or rather as a convenient way of illustrating a mathematical scheme by *imposing it upon* the body."[630] If it is the latter, which Padovan finds likely, the Vitruvian imperative for architecture to reflect the supposedly natural proportions of a normate body is no more than a way of justifying the treatment of such proportions as mathematically perfect, rather than finding fixed proportions in nature. In other words, for Vitruvius, the body seems to provide confirmation bias for a presumed unobservable nature. Neither Vitruvius nor Polycletus conducted studies of human bodies, nor would there be a concept of the statistical norm until the 19th century.[631]

The Vitruvian notion of *nature*, evidenced by the human body, reflects a cosmological understanding of the world and the heavens.[632] The geometric and cosmological understanding of nature, derived from Aristotle,[633] is one in which heavenly bodies move through space, creating certain geometric relationships. The notion that the *human body* is a microcosmic representation of nature follows from the notion of *astrological bodies*, such as planets and stars, reflecting the harmony and symmetry of the cosmos. Thus, the Vitruvian architectural body reflects a conception of nature based

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630 Padovan 2002, 164.
631 Ian Hacking, *The Taming of Chance* (Cambridge: Cambridge University Press, 1990), 180-188.
632 Vitruvius, Book IX; Tzonis 1972, 20, 27. This point becomes crucial to my later exploration of the role of mechanics and astronomy in 19th century anthropometry.
633 Henry Guerlac, "Copernicus and Aristotle's Gosmos," *Journal of the History of Ideas*. 29.1(1968): 109 113.

on the geometrical patterns of the universe. Vitruvius renders these patterns as aesthetic and epistemic, making the body's connection to nature evidence of its beautiful proportion and symmetry.

The Vitruvian Man as data visualization

The Renaissance revival of architecture as an aesthetic (rather than functional) discipline with a renewed interest in Vitruvius carried these epistemological associations of the body with nature and nature with the cosmos. Geographer Denis Cosgrove has shown that the mutual revival of Vitruvius' architectural work and Ptolemy's cosmographic texts created new ways of representing space visually.[634] These visualizations had to reconcile classical geometry with new empirical sciences, which eventually meant that the scientific content of Vitruvius's writings would be abandoned while the visual depictions of the body would remain. Later, I reveal that it is 19th century astronomers who bring these visual conventions to the *statistical* study of the body through their application of *astronomical* sciences to the visualization of data about statistical probabilities.

The Vitruvian Man begins a tradition of graphic depictions of the body as a user of architecture. As I explained in the two previous chapters, these kinds of depictions are related to the regimes of user-centered design and evidence-based design. Da Vinci's graphic rendering of the Vitruvian Man makes the normate template possible by grounding it in the *material-discursive* object of an image that not only conveys meaning, but also prescribes an ideal body. For architecture, the Vitruvian Man shapes the

[634] Dennis Cosgrove, "Ptolemy and Vitruvius: Spatial Representation in the Sixteenth-Century Texts and Commentaries," in Antoine Picon and Alesandra Ponte (eds), *Architecture and the Sciences: Exchanging Metaphors* (Princeton: Princeton Architectural Press, 2003), 22-24.

conventions of *orthographic drawing*, or the technical drawing of architectural space (and also containing the root “ortho,” which means to correct or normalize[635]). The Vitruvian Man is both normate and *normative*, prescribing a kind of corrective body as the basis of architectural graphics. It also becomes a ubiquitous symbol of medicine, another normalization practice, and later, part of the iconography of Dreyfuss’s average user.[636]

Technical orthographic drawings are images that translate directly into plans for buildings. They render three dimensional and material objects in two dimensions. Orthographic drawings depict features of a building, such as walls, windows, and doors, or (in the late 20th century) the dimensions of human bodies in space. Commonly, these drawings display geometric space with measurements that provide builders the requisite information to translate the idea of a building into a material reality. Thus, orthographic drawings are not only part of architectural argumentation and logic, but also part of the material-discursive force of architectural design.

Today, the drafting conventions used for orthographic drawing are standardized in the *Architectural Graphic Standards*, which remains the standard orthographic language between drawn and computer-based images in the U.S. The *Graphic Standards’* ubiquity has led the architect, Phillip Johnson, to declare it to be “one of the clearest reflections of

[635] The origins of the word, “normal,” lie in Greek geometries. As Hacking explains, the Latin meaning of “ortho-“ underlies the slippage in the contemporary usage of normal from describing a state of things and prescribing or correcting to the point of ideal states (as in normative judgments or normalizing practices) (Hacking 1990, 162-3). Orthographic drawings also normalize space, rendering it via intelligible geometric graphics.
[636] See my discussion in Chapter 2 of the industrial designer Henry Dreyfuss and his anthropometric images.

conventional [architectural] methodology."[637] As such, the text serves as a kind of social history of the treatment of the body and inhabitants of space by architects.

Each edition of the *Architectural Graphic Standards* reflects changes in the profession's understanding of bodies and space over time. For example, in the Forward to the 1981 edition, William Dudley Hunt, Jr., the architecture editor for John Wiley & Sons, writes that every subsequent edition of the text has incorporated "important current and future concerns," among which are value-explicit agendas for energy conservation, "design for the handicapped," and changing systems of knowledge concerning the body and spatial measurements.[638] Anthropometric images of human bodies in design manuals follow the conventions of the Vitruvian Man, displaying a geometric body extended into space. What differentiates the contemporary images, however, is the heavy use of statistical data to provide an empirical basis for the normate bodies represented.

Although (as I explained in Chapter 2 and at the beginning of this chapter) these figures emerge through via the work of Henry Dreyfuss Associates, it was not until the late 1980s that they made their way into the *Architectural Graphic Standards* to provide designers actual statistical data about a range of spatial users. In the interim, however, several figures that looked like the Vitruvian Man and purported to present statistical data about human bodies were made available.

Before looking at the images themselves, we must follow the trajectory of how the *anthropometric figure* for contemporary user-centered design came to exist. How did

[637] Johnson, in Hosey 2001, 101.

[638] William Hunt, "Forward," in Charles Ramsey and Harold Sleeper (eds), *Architectural Graphic Standards,* 7th edition (Hoboken: John Wiley & Sons, 1981). For further work on the social history of architecture, as expressed through the *Architectural Graphic Standards,* see George Johnston, *Drafting Culture: a social history of* Architectural Graphic Standards (Cambridge: MIT Press, 2008).

statistical data come to accompany these images? As it turns out, the emergence of statistical laws concerning the concepts of norm, average, and standard deviation—laws defining normates and misfits—emerged through the same scientific practice that would later make human bodies intelligible to designers. The anthropometric figure emerges from the overlaps between geometrical and statistical conceptions of the body, establishing the normate template and also creating the conditions for challenging it.

Measuring the normate in 19th century science and mathematics

In order to understand the significance of shifts in the representation of the body in architecture, we must understand a split occurring in the 19th century with the emergence of techniques of bodily quantification. Even while they did not always correspond to scientific norms of the time, these practices of measurement and representation used science as a means of self-justification and aided in the emergence of phenomena such as eugenics and statistics. Using statistics rather than geometry, 19th century positivists critiqued the proportionality of the Vitruvian Man while arguing for the epistemic validity of statistical models of the body.[639] Crucially, these critiques demonstrate the persistence of normate figures representing mathematical data, even while shifts occur in mathematical epistemologies. To illustrate the persistence of moral model ideas about nature and the cosmos in 19th century regimes of measurement, I begin by considering the practice of phrenology and then turn to anthropometry.

Phrenology

[639] McEwen 2002 1-2

Phrenology is a practice of reading an individual's underlying moral nature and competencies through bumps on the head. Although considered pseudoscience, phrenology reflects many of the assumptions and practices of positivist biometrics and anthropometrics that emerge in the 19th century. In this sense, anthropometry and phrenology are of the same milieu, understanding the body as a map revealing a person's character and behavior. I include phrenology here as part of my historical epistemology of anthropometry because it bridges understandings of the body as evidence founded upon nature and morality with those based on measurement, typology, and statistical norm.

Phrenological practices of the 19th century bear traces of much earlier ideas about morality, deviance, and nature. According to Alan Sekula, phrenology emerges from late 18th and early 19th century attempts at "systematizing physiognomy," when "Johann Caspar Lavater argued that the 'original language of Nature, written on the face of Man' could be deciphered by a rigorous physiognomic science."[640] Sekula calls the epistemic practices surrounding phrenology "an everyday nonspecialist empiricism with increasingly authoritative attempts to medicalize the study of the mind," noting that it led to the eventual development of other biometric practices, such as brain dissection and craniology that adopted a similar "materialist science of the self."[641] Thus, phrenology becomes crucial to the development of the material practice of the body as evidence of an underlying nature or causal mechanism.

The principles of phrenology reflect a deterministic understanding of the body and its relationship to the mind or the soul. As in Vitruvius' geometric conception of the

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[640] Sekula 1986, 11
[641] Sekula 1986, 11-12

body, cranial bumps provided supposed evidence of phenomena that were not otherwise observable through scientific observation, such as a person's strengths and deficiencies. Phrenology's objects of measurement were human skulls —both those of white European people and those of racial and ethnic groups that phrenologists deemed inferior. The practice was also heavily implicated in constructing the moral and embodied alterity of people with sensory and cognitive disabilities in 19th century Europe.[642] We can read the layering of racism and ableism not only in phrenology's practice of identifying typologies of people, but also in its mapping of nature and morality onto embodiment. This is an epistemological tendency that repeats itself in anthropometry, but the foundations of which are already present in Vitruvius.[643]

To a contemporary reader, phrenological readings may appear to be more akin to an astrological horoscope than a scientific text. Readings included both a written analysis of the skull and visual representations of the head as a map detailing the corresponding qualities of the individual. Phrenology claimed scientificity through taxonomic ordering and the use of body parts as landmarks for meaning.[644] Because phrenology was a "comparative, taxonomic discipline," according to Sekula, it "sought to encompass an entire range of human diversity."[645] While phrenology prefigured the statistical concept

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642 Pieter Verstraete, "The Taming of Disability: Phrenology and Bio-Power on the Road to the Destruction of Otherness in France (1800-60)," *History of Education* 34.2 (2005): 119-134.

643 I am avoiding directly arguing against the moral model of disability here because while it is often cited in disability histories as a model against which the medical model positions itself, it is often unclear exactly what historical period coincides with the moral model. The moral model of disability usually refers to a vague pre-19th century period in which disability is regarded with superstition prior to the emergence of the medical model. Sometimes, the moral model is associated with the supposedly superstitious practices of non-Western cultures. I want to avoid participating in these associations because they both treat the moral condemnation of disability as a thing of the past and associate non-Western cultures with pre-scientific conceptions of the body. Instead, I trace the connection between the body and nature as a way of understanding the endorsement of normate bodies in the histories of architecture and science.

644 As I discuss later, the use of embodied landmarks becomes key to the methodology of eugenic anthropometry.

645 Sekula 1986, 12.

of *range,* phrenologists ascribed desirable or undesirable qualities to certain types of human diversity.

Phrenologists made moral claims by explaining the body as an apparatus or technology for knowing the soul. The mind-body connection was central to their claims, and many phrenologists used it to argue that phrenology was a science[646] grounded in materiality. The phrenological map rendered the cranium as an apparatus for accessing and observing the realities of the soul (as determined by the body). By using the body as evidence that can be read in order to verify an underlying nature, phrenology participated in the epistemic practice of using observation to verify and make empirical claims about these relationships. At the same time, phrenologists denied other, more acceptable scientific and materialist practices of observing the body as epistemically invalid. Demonstrating this practice, phrenologist George Combe (1847) wrote,

> Phrenology is a system of Philosophy of the Human Mind, and is founded on facts ascertainable by consciousness and observation. It is a principle of Physiology which cannot be disputed, that dissection alone can give us no information concerning the functions of the bodily organs; no anatomist, by dissecting the optic nerve, could predicate that its function is to minister to vision; or, by dissecting the tongue, could discover that it is the organ of taste. Metaphysicians having confined themselves chiefly to reflection on consciousness, could not discover the organs of the mind; and anatomists, having merely discovered the brain, could not discover the functions of that organ, and hence the comparative ignorance which has hitherto prevailed…[647]

Combe's description shows how the concept of an underlying mechanism without observed proof makes itself apparent. The principle of correspondence and correlation established for phrenology that mental characteristics were proportional or relative to

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[646] See George Combe, "Observations of Combe 'On the Constitution of Man,' Principally in reference to Phrenology and its Merits as a Science" (London: Simpkin, Marshall, and Company, 1847). "Phrenology," Warshaw Collection, National Museum of American History, Smithsonian Institution.
[647] Combe 1847, 1-2.

physical characteristics.[648] As in Vitruvius, the physical body made the metaphysical accessible to observation.

Because the truth to which it aspired was beyond direct observation, however, phrenology was distinct from 19th century positivism. As O.S. Fowler, leading phrenologist and publisher of the *American Phrenological Journal,* wrote in an 1849 treatise on phrenology and physiology,

> All truth bears upon its front unmistakeable evidence of its divine origin, in its philosophical consistency, fitness, and beauty, whereas all untruth is grossly and palpably deformed. All truth, also, harmonizes with all other truth, and conflicts with all error, so that to ascertain what is true and detect what is false, is perfectly easy. Apply this test, intellectual reader to one after another of the doctrines, as presented in this science.[649]

For phrenology then, the ancient and classical notions of fitness and beauty were tantamount to truth, and their epistemic validity was established by spiritual doctrines about the body as evidence of divine will. The association of fitness and beauty with truth, and untruth and deformity with misfit, demonstrate the mapping of moral values onto embodied difference.

The numerical scales used in phrenology measured qualitative faculties rather than the body as an object in itself. They did not refer to any usage of instruments of standardized measurement.[650] As such, they were un-generalizable and did not refer to

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[648] Fowler 1849, 35.
[649] Fowler 1849, 42.
[650] According to Grimes, "Most phrenologists use numerical figures, to express the size of the organs; and, if correctly done, it is undoubtedly the best way. Some adopt 9 1/2 as a medium number, and then, of course, 20 stands for the highest and 1 for the lowest degree of development. I prefer to adopt 5 as a medium number, and, therefore, 9 stands for the highest, and 1 for the lowest degree of development. If a head were perfectly formed, and all the organs equally developed, every organ should be numbered 5; and as there are 39 organs, the sum of all their numbers would be 5 times 39, or 195. We cannot number any more above medium than we do below, for no organ can be large without being so at the expense of others. If an organ is marked 6, some other must be marked 4; and whatever be the form or size of the head, the sum of all numbers must be 195, or the examination is incorrect…Simple and undeniable as this rule is, it has hitherto been either unknown, or totally disregarded by all practical phrenologians. It is common to see a chart in which nearly all the organs are marked higher than the medium number; a practice, which,

population averages, as would later be the case in statistics and anthropometry. They did, however, carry a notion of deficiency based on relative averages and individualized norms. According to Grimes (1845), phrenological readings referred to

> the *relative* size of organs in the same individual, without reference to other persons. Two men may have their organs numbered precisely alike, and yet one head may be a third larger than the other; one may be a man of extraordinary talent and energy, while the other is far below mediocrity, on account of the small size of his head.[651]

Phrenologists were confident in the status of their practice as a science founded upon observation and perception, but rejected the ability of more mainstream biomedical and scientific practices to access the realities or mechanisms of the mind/body connection. Nevertheless, phrenological knowledge undergirded claims about the value and desirability of bodies that would later become objects of statistical quantification.[652] Phrenological racism and the use of phrenological methods to predict the propensity for criminality reflected the tendency of early 19th century statisticians to favor correlational understandings of the quantified body and human behavior.[653] Thus, the notion of the body as evidence of underlying deficiency or cause of bad behavior existed even before the formal regime of quantification established by anthropometry.

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however complimentary it may seem to the subject, is perfectly absurd, and renders the chart worse than useless." See Stanley Grimes, *Etherology, or the Philosophy of Mesmerism* (New York: Saxton and Miles, 1845). "Phrenology," Warshaw Collection, National Museum of American History, Smithsonian Institution, 11.

[651] Grimes 1845, 12.

[652] Prior to the emergence of a statistical concept of norm or average and before the standardization of bodily measurements for anthropometry, phrenologists made limited statistical claims rooted in an arithmetical mean. Fowler (1852) writes, ""I. The Size of the Brain, other conditions being equal, is found to be the measure of the *aggregate* amount of the mental power; and the relative size of several *organs* of an individual, indicates the proportional strength and energy of his corresponding *faculties*." See O.S. Fowler, *Synopsis of Phrenology; and the Phrenological Developments Together with the Character and Talents* (New York: Fowlers and Wells, 1852). "Phrenology," Warshaw Collection, National Museum of American History, Smithsonian Institution.

[653] Sekula 1986, 12.

Anthropometry

Anthropometry emerged to map and measure the body, much like phrenology, but without aspiring to know divine truth or nature. Instead, anthropometry was foundational to the history of modern *statistics*, in particular the formation of the concepts of *statistical norm*, *average, standard deviation,* and *normal distribution*, as well as to uses of measurement to predict human behavior, such as criminality. *Eugenics*, in particular, benefitted from the development of statistics and criminology through anthropometry, while anthropometric studies by physical anthropologists in colonial locations contributed to scientific racism.[654]

Sociologist of science, Steven Epstein (2009), has noted the paradox that many marginalized groups in the 20th century have demanded inclusion in scientific research that less than a century prior was used to segregate or eliminate these same populations.[655] A similar paradox operates in UD's use of anthropometry, the historical practice of which has been at odds with the goals of broad inclusion and social justice. Co-produced with 19th century positivism and eugenics, anthropometry has been used to provide evidence of the supposed excess or deficiency of bodies that deviated from the statistical average. This raises the question of what it means for anthropometric evidence about bodies to also be used for disability inclusion.

As I noted earlier, the prevailing treatment of anthropometry in disability studies and the history of science occurs in histories of eugenics, criminology, and scientific

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[654] See, for example, the work of criminologists Alphonse Bertillon, Auguste Comte, and Cesare Lombroso. Kavita Phillip also notes the significance of anthropometry for British criminology and racism in colonial India. See Kavita Phillip, *Civilizing Natures: Race, Resources, and Modernity in Colonial South India* (Camden: Rutgers University Press, 2004), 126-127.
[655] Steven Epstein, *Inclusion: The Politics of Difference in Medical Research* (Chicago: University Of Chicago Press, 2009).

racism. Rather than dismissing UD's use of anthropometry as complicit with eugenics or positivism, I argue that it is more productive to complicate anthropometry's shifting histories and examine how the practice becomes a key site for what I characterize as *epistemological activism* that challenges the normate template.

Early anthropometry and the emergence of statistics

Anthropometry emerged alongside 19th century statistics and the philosophy of science known as *positivism*, which insists upon the link between observation and epistemic validity.[656] In the late 18th century, the word *statistics* referred to the collection of data about the populace by sovereign states, rather than to the mathematical calculation of probabilities, as came to be understood in the mid-19th century.[657] At this point, the practice of *social statistics* emerged through the efforts of criminologists, who used the measurement of the body as evidence of an underlying deviant nature or propensity for criminality.[658] Emerging social and state statisticians sought evidence of mathematical *correlation* as a corrective the perceived weaknesses of "strictly mechanistic theories of causality," which could not predict the probabilities of events or behaviors.[659]

The resulting systems of biological determinism established by criminologist Alphonse Bertillon and eugenicist Francis Galton in the late 19th century sought to locate criminal types in highly organized systems of documentation and measurement. Despite their characterizations as scientific, these systems were quite like the racial hierarchies

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[656] In some iterations, positivism relies upon quantification and statistics, and anthropometry is foundational to this. In other iterations, such as the work of Auguste Comte, positivity has more to do with the rules and laws governing particular phenomena. See Auguste Comte, *A General View of Positivism*. Trans. J.H. Bridges (London: Routledge, 1844/1908). Also see Emile Durkheim and criminologists such as Alphonse Bertillon, for whom statistical knowledge could help predict human behavior, especially in the case of deviance or suicide.
[657] Sekula 1988, 20.
[658] Sekula 1988, 18.
[659] Sekula 1988, 20.

promoted by phrenologists.[660] This has led some historians to characterize anthropometric methods as pseudoscience when they were, in fact, complexly entangled with the emergence of 19th century positivism, statistics, and the epistemic status of quantification—epistemic concepts that survive today in all evidence-based disciplines.

Norms, *averages*, and statistical measurements are not abstract ahistorical concepts, but rather *material-discursive* epistemic objects derived from data about real, living bodies. In no case is this point more evident than in the use of anthropometrics to apply the bell curve to human populations, produce statistical laws, and naturalize the existence of normate bodies according to these laws. In 1835, the Belgian mathematician and astronomer Adolph Quetelet discovered that data on Scottish soldiers' chest sizes revealed the distribution of bodies along a *Gaussian curve*, or what is now referred to as a *normal distribution curve* or *bell curve*.[661] Quetelet, like many of the anthropometrists who followed him, was trained as an astronomer and applied the mathematical laws governing the probable geometric locations of planets to the distribution of human bodies.[662]

By applying an astronomical model to human bodies, Quetelet also "transformed the mean into a real quantity," a materiality measuring a preexisting nature rather than simply a projection of probabilities.[663] Thus, he not only created a model for charting the likelihoods of bodily sizes via anthropometry, but also a bell curve with the epistemic

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[660] S Gould 1981, 25. Also see previous section on phrenology.
[661] Adolphe Quetelet, *Sur l'homme et le développement de ses facultés, ou Essai de physique sociale* (Paris: Bachelier, 1835)
[662] Hacking 1990, 107.
[663] Hacking explains, that Quetelet "transformed the theory of measuring unknown physical quantities, with a definite probable error, into the theory of measuring ideal or abstract properties of a population. Because these could be subjected to the same formal techniques they became real quantities. This is a crucial step in the taming of chance. It began to turn statistical laws that were merely descriptive of large-scale regularities into laws of nature and society that dealt in underlying truths and causes" (Hacking 1990, 107-108).

status of reflecting real rather than ideational bodies. This would serve to naturalize the status of the normate rather than complicating the likelihood of its existence.

From this emerged Quetelet's treatise on "the average man" (*l'homme moyen*), a concept superimposing statistical verification of likelihood onto existing understandings of harmonic, proportional, and desirable bodies.[664] The "average man" thus provided quantitative verification of a normate human form that had existed for centuries in the figure of the Vitruvian Man and Aristotle's Golden Mean, translating the prescriptive and normative geometries of the cosmos, nature, and the normate body into a new system of statistical rules.[665] Thus, the bell curve became not simply a means of data visualization, but a material-discursive arrangement arguing for the reality of the (false) normate.

Quetelet became what philosopher of science Ian Hacking calls "the greatest regularity salesman of the nineteenth century,"[666] applying his theory of the normal distribution of bodies to early military human factors research, namely measurements of over 20,000 soldiers taken in the U.S. Civil War.[667] These measurements were analyzed by another astronomer-turned-statistician, Benjamin Apthorp Gould, who worked as an actuary for the U.S. Sanitary Commission and published military anthropometrics after the Civil War.[668] While Quetelet insisted on the reality of the "average man," Gould approached the normal distribution with caution. He argued that statistical samples must be sufficiently large and representative of the population before making calculations of

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664 Sekula notes that Quetelet also used astronomic metaphors to discuss the "average man," defining "the social norm as 'a center of gravity,' and the average man as 'the type of all which is beautiful—of all which is good'" (Sekula 1988, 21).
665 Steven Epstein, "Beyond the Standard Human?" in Martha Lampland and Susan Leigh Star (eds), *Standards and Their Stories: How Quantifying, Classifying, and Formalizing Practices Shape Everyday Life* (Ithaca: Cornel University Press, 2009), 38.
666 Hacking 1990, 105.
667 Hacking 1990, 100.
668 B Gould 1869.

averages.[669] This position reflected the functional needs of military human factors research and endorsed the idea of proportionate sampling as a way of enabling statistical generalizations and inferences.[670]

As I explained in Chapter 1, military human factors research sought to optimize the fit of military instruments and uniforms to soldiers' bodies, and did not thus find it useful to adopt a notion of the "average man" for very long.[671] However, the military was also instrumental in one particular aspect of anthropometry: the establishment of the "military position," or upright military posture, as the ideal posture for the measurement of bodies. In accordance with its place in verifying and providing evidence for the continuation of the normate template, the study of anthropometric averages arose from Quetelet's analysis of Scottish soldiers and later came to require military embodiment as a condition of measurement.

Upright military posture, which requires a subject to stand with the feet together, makes the standardization of linear measurements with calipers and rulers more precise.[672] However, the historical usage of this method excluded all bodies that could not stand or that had atypical bodily landmarks.[673] Thus, upright measurement was not simply a neutral method for achieving standardized results, but also part of the normate template's historical production of measurement practices.

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[669] B Gould 1869, 151.

[670] As I show later in the chapter, UD anthropometry actually rejects proportionate sampling in favor of oversampling for underrepresented statistical minorities at the extremes of the bell curve.

[671] The military did turn to statistical measurements to establish other thresholds of value, however. For example, the use of psychological and IQ testing in the U.S. army to determine the ideal soldier and to differentiate racially between groups of soldiers (Kevles 1985, 82).

[672] Harris Wilder, *A laboratory manual of anthropometry* (Philadelphia: Blackiston's Sons & Co., 1920), 151.

[673] As I discussed in Chapter 1, upright posture also reflected 19th and early 20th century class associations between standing posture, class position, and upright citizenship. For instance, in A.A. Marks' prosthetics catalogues, amputees represented as standing upright wearing artificial legs were often dressed in gentlemanly attire, while "before" images displayed them as disheveled or in underwear.

A key methodological problem in anthropometry is the location of embodied landmarks for measurement, such as the tip of the elbow or the heel of the foot. Standard landmarks and linear measurements were especially necessary in the 19th century, when the anthropometric instruments were primarily analog calipers and rulers. These apparatuses of measurement biased anthropometric data toward primarily able-bodied people. Physical anthropologist Ales Hrdlicka, an influential methodologist and practitioner of anthropometry, argued for the disqualification of any bodies with a “pathological condition” or with “defective constitution,” which he defined as having syphilis, giantism, dwarfism, microcephaly, arthritis, or other conditions affecting posture, size, and gait.[674] Thus, foundational to the methodological practices of 19th and early 20th century anthropometry, and owing much to the involvement of militaries in collecting anthropometric data, many forms of diverse embodiment were automatically excluded from representation in a normal population sample. This was a condition produced as much through the material culture and instruments of anthropometrics as it was through explicit standards of sampling.

Not surprisingly, the exception to the exclusion of non-normate embodiment was to be found in the anthropometry of eugenicists, which emphasized the study of difference in order to establish hierarchies of superior embodiment. Francis Galton, a key figure in the development of modern statistics, worked to make quantitative measurement the standard of epistemic validity while also fashioning measurement as a tool for eugenics.[675] Like Quetelet, Galton was interested in applying statistics to human

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[674] Ales Hrdlicka, *Anthropometry* (Philadelphia: Wistar Institute of Anatomy and Biology, 1920), 46.
[675] S Gould 1981, 75; Kevles 1985, 13.

populations.[676] However, while Quetelet focused on the *average* man, Galton was concerned with *normal distributions* and the *range* of deviations from the mean[677] as tools to explain race and heredity.

Galton's primary concern was the epistemic status of the concept of *range*. As a material-discursive arrangement, the range (and the notion of standard deviation upon which it relies) produces spheres of acceptable embodiment but also defines deviation from the norm. The range is paradoxical, both including multiple possible embodiments beyond the (unreal, ideational) average, but also quantifying deviation from the average. Galton's fixation on *deviation* underscored his use of statistics and anthropometry for eugenics. For instance, his use of anthropometry to measure intelligence through race and inheritance laid the groundwork for the use of craniometry for racial differentiation.[678] In these studies, Galton valued the upper ranges of intelligence rather than the average body.

Stephen J. Gould, in *The Mismeasure of Man*, thus attributes the biological determinism of 19th century sciences to their reduction of human bodies, anatomical features, and intelligence to measurements.[679] Similarly, more recent controversies over the ethics of applying the bell curve to intelligence take issue with the epistemological certainty and predictive capacities of standard deviations.[680] Although Galton valued ranges of deviation over the study of the average, the mean still served as a guidepost for his measurements of deviant bodies. Thus, his philosophy of *range* was one that centered the norm. With the *average man* occupying the place of normalcy in Galton's eugenic

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676 Cowan 1972, 514.
677 Hacking 1990, 183-184.
678 S Gould 1981, 76; George Stocking, *Bones, Bodies, Behavior* (Madison: University of Wisconsin Press, 1988), 5; Wilder 1920, 1.
679 S Gould 1981, 25.
680 See, for example, the controversy over Richard Hernstein and Charles Murray's 1994 book, *The Bell Curve: Intelligence and Class Structure in American Life.* Free Press.

ideology, he advanced the idea of statistical *correlation*.[681] Because correlation, as I explained above, was presented as an alternative to mechanistic causality, it allowed Galton and other eugenicists to insist upon the validity of claims about the correspondence of certain morphological traits and factors such as intelligence without having to consider issues of causality.[682] Thus, while the concepts of *correlation*, *norm*, and *average* appear neutral as purely mathematical ideas, their articulation through early anthropometry was the basis of polemical and normative judgments about normal and pathological bodies. For anthropometry to be used for eugenics and colonialism, it had to be understood as unmediated statistical data about bodies as evidence of natural ideal types, rather than as a snapshot of a portion of a population in one historical moment and in one environmental context.

Interestingly, in some accounts, Galton's emphasis on statistical correlation used faulty mathematics and, like classical cosmological approaches to the body, relied upon "constructing mechanical analogues, and […] geometry and intuition."[683] Thus, while these new statistical concepts were unique to the 19th century, they reflected classical, value-laden, and geometric ideas about the body, proportionality, and mechanistic causality that brought the notion of *nature* in line with the idea of the *norm*.

Not all uses of anthropometric measurement and data were explicitly eugenic. The anthropometry of soldiers, school children, prisoners, and indigenous people were all part of societal compilations of statistical evidence to define ideal types and averages within

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[681] Stigler 1989; Cowan 1972, 509.
[682] This is especially evident in the work of Galton's student, Karl Pearson, who founded the world's first academic statistics department and edited the journal, *Biometrika*, which was devoted to the development of theories of statistics and biometrics. Pearson was also responsible for the statistical concept of *correlation coefficient*. See Eileen Magnello, "Karl Pearson and the Origins of Modern Statistics: An Elastician becomes a Statistician," *The Rutherford Journal* (1996).
[683] Kevles 1985, 27.

these categories.[684] However, as histories of normalization have demonstrated, anthropometrics in the late 19th century fulfilled a normalizing function, streamlining the bodies of people within particular spatial coordinates and institutions—schools, clubs, prisons, and reservations—and attempting to find statistical trends within these populations.[685]

Having established its connection to the discipline of statistics, anthropometry moved on to becoming formalized within existing research disciplines. In the late 19th century, the historical actors and experts conducting anthropometric studies were often eugenicists trained in fields such as physical anthropology. In the U.S. and Europe, international committees emerged to standardize statistical concepts, as well as anthropometric tools and methods.[686] As in criminology, the measurement of bodily norms, averages, and standard deviations also provided European physical anthropologists the means to categorize the bodies of colonized people and establishing hierarchies of racial dominance.[687]

In the late 19th and early 20th centuries, some physical anthropologists attempted to distance themselves from eugenic anthropometry.[688] However, both eugenicists and

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684 Edward Mussey Hartwell, "A Preliminary Report on Anthropometry in the United States," Publications of the American Statistical Association. 3.24 (1894): 555-557.
685 Hartwell 1893, 557.
686 Hartwell 1893, 557 (such as the International Statistical Institute and the American Statistical Association).
687 S.S. Adebisi "Medical Impacts of Anthropometric Records." *Annals of African Medicine* 7.1 (2008), 42 47; Phillip 2004, 99; Claude Blanckaert, "On the Origins of French Ethnology," in George Stocking (ed), *Bones, Bodies, Behavior*, ed. George W. Stocking Jr. (Madison: University of Wisconsin Press, 1988), 49.
688 In Ales Hrdlicka's personal copy of Charles Davenport's *Anthropometry and Anthroscopy* (NY: Cold Spring Harbor, 1927)—a copy signed to Hrdlicka from Davenport—Hrdlicka asks in a note to himself, "Why do men, even otherwise good men, write on things they do not know!" (found in the Smithsonian Institution Anthropology Library). This sentiment is consistent with Hrdlicka's consistent attempts in the early 20th century to differentiate physical anthropology from the measurements taken for military and eugenics (Hrdlicka 1920). Also see Hrdlicka (1920, 7) on the split of anthropometry into physical anthropology on the one hand and criminological, military, medical, dental, sports, and eugenic applications on the other.

physical anthropologists provided technical and methodological expertise to military anthropometry studies, the work of which remained to study the comparative body capacities of different races as part of post-World War II human factors research.[689] The American eugenicist Charles Davenport aided in the production of one of the largest anthropometric datasets of soldiers in World War I.[690] Teams of physical anthropologists from Harvard and elsewhere aided military researchers to create new types of measurement with functional usage for the military.[691]

The normate template in 20th century architecture

At this point, we must shift back to architecture to understand the connection between 19th century anthropometry and contemporary built environments—a connection fundamental to the practices of user-centered and evidence-based design discussed in Chapters 1 and 2. As I discussed previously, the Vitruvian Man was based on the harmonic proportions of the body noted by the Roman architect, Vitruvius, to be the foundation of beautiful design.[692] In the 19th century, the work of measurement practices like phrenology and anthropometry also helped establish norms, morphologies, and typologies of architectural style and function.[693] These categories were in turn used to

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689 See for example, H. T., Hertzberg, G. S. Daniels and E. Churchill, "Anthropometry of flying personnel - 1950," WADC Technical Report 52-321 (Wright Air Development Center, Wright-Patterson Air Force Base, 1953).

690 Charles Davenport and Albert Love, *Army Anthropology: The Medical Department of the United States Army in the World War* (Washington D.C.: Government Printing Office, 1921).

691 Hertzberg, Daniels, and Churchill 1953, 1.

692 Vitruvius, *De Architectura*. 15 B.C.

693 Georges Teyssot, "Norm and Type: Variations on a Theme," in Antoine Picon and Alesandra Ponte (eds), *Architecture and the Sciences: Exchanging Metaphors* (Princeton: Princeton Architectural Press, 2003), 156.

characterize, quantify, and control the sanitary conditions of buildings, bringing together quantification and hygiene as in contemporaneous human eugenics.[694]

Anthropometric images for architectural design

In the early 20th century, the normate body, as a *norm*, *typology*, and *morphology*, re-entered architectural templates. Ernst Neufert, an early Bauhaus architect, published *Architects Data* in 1936, representing a normate body in the graphic tradition of the Vitruvian Man.[695] Another 20th century figure, Le Corbusier's Modulor,[696] referenced the geometric foundations of the Vitruvian Man, showing a normate human figure with both numerical dimensions and a diagram of the Golden Ratio, depicted via shaded rectangles. Like the Vitruvian man, Modulor appears to have male-bodied proportions and extends a limb to demonstrate the body's relationship to geometric space. Le Corbusier also intended Modulor to be a universal template for all architecture.

In U.S. architecture, the *Architectural Graphic Standards*, a text that standardized templates and patterns for design based on industry rules of thumb for architects, institutionalized the normate template. In 1941, the *Graphic Standards* adopted a set of drawings called the "Geometry of the Human Figure" by Ernest Irving Freese (1934),[697] publishing these drawings as the "Dimensions of the Human Figure" in 1941.[698] Like the Vitruvian Man and his normate relatives, Freese's drawings displayed generic male

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[694] Teyssot 2003, 160.
[695] Ernst Neufert, *Architect's Data* (Blackwell Publishers, 1936/2012).
[696] Le Corbusier. *The Modulor: A Harmonious Measure to the Human Scale, Universally Applicable to Architecture and Mechanics* (Basel & Boston: Birkhäuser, 1954/2004).
[697] Ernest Irving Freese. "The Geometry of the Human Figure," *American Architect and Architecture* (July 1934): 57-60.
[698] Charles Ramsey and Harold Sleeper, *Architectural Graphic Standards* (3rd ed.) (New York: John Wiley & Sons, 1941). This was the third edition of the text, with the first having been published in 1932. Thus, the first two editions did not have any figures of the human body, but beginning with the third, Freese's images were included for almost 40 years.

bodies with both geometric and measurement data. However, while Freese's figures included dimensions, no specific studies or sources for these were cited. As some architectural historians have noted, the indicated dimensions do not match any anthropometric evidence available at the time.[699] The images simply look like anthropometric figures, in the tradition of 19th century criminological, anthropological, or eugenic anthropometrics. This complicates the epistemological status of the figures, which derive as much authority from their relationship to architectural precedent and the history of dimensional figures than from their use of (false) statistics.

The figures also privilege normate embodiment as the likely user of space, providing additional details only to demonstrate difference. For instance, in one of the figures, a male-bodied figure, seen from profile, extends an arm into space. Next to his body appears a disembodied high-heeled shoe, with measurements indicated to be several inches smaller than the man's foot. Meant to represent female dimensions, the curious omission of the body marks the assumptions made by the normate template about the statistical probability of non-normate users as well as the relevance of diverse embodiment to design. The foot is not merely a functional size marker but the active construction of ignorance around the dimensions of female embodiment. Likewise, the universalization of the abstract male normate figure to all human bodies constructs other forms of ignorance, particularly around the representation of disability and race.[700] Given the problematic history of anthropometry as a scientific practice of measuring and ordering bodies signifying difference as deviance, however, it is also

[699] Pai 2002, 348.
[700] See Hosey (2006) for an extensive discussion of the problematic representation of race and gender in these images.

important to consider the layering of normate privilege with access to representations characterized as neutral or beneficial, as in design templates.

If the ordering of the *Graphic Standards* is any indication, Freese's images were not considered significant enough to showcase within the orthographic manual. For almost 40 years, the figures only appeared in the appendix of the *Graphic Standards* between the entries for "Abbreviations" and "Modulor Coordination." In the process, post-World War II architectural development in the U.S. was designed according to a standardized but non-existent user, leading feminists and disability rights advocates to call for more inclusive public and private architecture.

Anthropometric images and industrial design

Throughout the mid-late 20th century, Henry Dreyfuss Associates compiled and published anthropometric human figures that served as authoritative information about bodies for 20th century industrial designers. The data for these figures came from military human factors and rehabilitation research conducted from the late 19th to mid-20th centuries.[701] The images and tables were prepared by Niels Diffrient and Alvin Tilley, industrial designers and human factors specialists working for Henry Dreyfuss Associates in the early 1970s.[702]

It was during the civil rights movement-era that that Dreyfuss began to distance his work from the "average man Joe." This was for reasons that were both functional and political. Joe and Josephine were, by the time that *The Measure of Man and Woman* was published in 1967, no longer adequate representations of the diversity of intelligible users. For several reasons, Dreyfuss and his firm quickly realized the drawbacks of

[701] See Chapter 1, on military human factors research and the rehabilitation paradigm.
[702] Niels Diffrient, Alvin Tilley, and Joan Bardagjy. *Humanscale* (Cambridge: MIT Press, 1974).

representing idealized figures to designers. The first was that post-World War II human factors research proliferated and made new data available much more quickly than new editions of *The Measure of Man* could be published.[703] The second more ideological problem was that the drawings were misused. As Dreyfuss wrote in *The Measure of Man and Woman,*

> the published drawings included the dimensions of the small, average and large men, but only the average man was drawn. We found that people referred to the charts as "Dreyfuss' average man," which indicated that many people had misunderstood the diagrams and probably misused them. A good design must 'fit' not only the theoretical average, but his large and small brothers. We had thought this was obvious in the charts, but we seemed to be wrong.[704]

According to Dreyfuss, although the actual bodies depicted were those of the average, the firm had meant the statistical data included with these bodies—data indicating a range of size—to be the basis of designer application. It is impossible to know if Dreyfuss and Alvin Tilley, his illustrator, meant for Joe and Josephine to truly represent a range of human diversity or if they were merely saying so in the late 1960s to reflect shifts in social ideologies regarding difference and inclusion. It is possible that other designers had conflated Joe and Josephine with the eugenics figures, Norma or Normman, or that Dreyfuss had come to understand Joe and Josephine to be inadequate representations of human need. Either way, the shift in Dreyfuss's thinking reflects a related liberalization within the design professions, which were beginning to include attention to human variation through the milieu of environmental design research and barrier-free design.

Although Henry Dreyfuss Associates' data and images were available to industrial designers for the 40 years that Freese's images appeared in the *Graphic Standards*, they did not replace Freese's figures until the post-civil rights movement era.

[703] Dreyfuss 1967, 4.
[704] Dreyfuss 1967, 4.

In the interim, several independent books were published containing anthropometric data for designers.[705] However, the *Graphic Standards* did not keep up with these developments until social movements, environmental design research, user-centered design, and barrier-free design had been in effect for several decades.

A shift occurred in the early 1980s that was an outcome, rather than the cause, of the greater intelligibility of human diversity for architects. In 1981, the seventh edition of the *Architectural Graphic Standards* finally adopted Diffrient and Tilley's anthropometric charts, which were much more expansive than Freese's.[706] These were the first truly anthropometric images in the *Graphic Standards* in that they included actual data, but were nevertheless based on statistics in circulation for decades in various forms.[707] This also placed the emergence of these images within the milieu of evidence-based architectural design. Whereas Freese's images had been hidden in an appendix, Diffrient and Tilley's anthropometric figures were featured at the very beginning of the text, taking up multiple pages. The new images depicted male and female bodies sitting, standing, and working. There were also images of a figure in a wheelchair alongside the dimensions of wheelchair clearance information for doors and landings.

The replacement of Freese's images with Diffrient and Tilley's occurred as a result of the *regime of intelligibility* of *evidence-based* and *user-centered design*. This regime demanded the inclusion of statistically verified data rather than the anecdotal numbers associated with Freese's figures. It also occurred after two decades of disability

[705] For instance, Selwyn Goldsmith. *Designing for the Disabled: The New Paradigm* (New York: Routledge Architectural Press, 1963); John Croney, *Anthropometrics for Designers* (New York: Van Nostrand Reinhold, 1971); and later, Stephen Pheasant, *Anthropometry, Ergonomics, and Design* (Bristol, PA: Taylor & Francis, 1986/1988).
[706] Ramsey and Sleeper 1981.
[707] By the 1980s, Henry Dreyfuss Associates had acquired anthropometric data from the general population. However, earlier figures relied on military human factors data from World Wars I and II (Dreyfuss 1967, 5).

rights activism culminating in the Federal Rehabilitation Act of 1973, the first federal legislation requiring the accessibility of federal buildings to people with disabilities.[708] In particular, the changes to the *Graphic Standards* were made possible by epistemic shifts in design research, particularly the reconfiguration of anthropometry as a science for studying diverse disability embodiments. Diffrient and Tilley's anthropometric images still carried the epistemological and representational problems of earlier images, however, in that they showed singular typologies of bodies (male, female, and disabled) rather than diversity within these categories. As a result, new anthropometric studies became necessary that could quantify differences within populations of environmental misfits.

Challenging the normate template: the new disability anthropometry

Disability anthropometry is a recent epistemic and methodological challenge to the normate template and to the limitations of anthropometry as a scientific practice. Rather than using the body to measure an underlying nature or to predict behavior, disability anthropometry has focused on proving the statistical variation of a range of disabled bodies. By showing that the normate, constituted through exclusionary anthropometric data, is a socially and historically specific figure that is not generalizable to the whole population, disability anthropometry undermines its seeming neutrality and objectivity.

Central to the UD research strategy is establishing a regime of perceptibility whereby knowledge production makes excluded bodies apparent to designers while also shifting the meaning and methods of research. The history of disability anthropometry demonstrates the constant negotiation of *locality* and *generalizability*, the epistemological

[708] Federal Rehabilitation Act of 1973 (Pub.L. 93-112, 87 Stat. 355).

questions of whether particular samples can represent whole populations and become the basis of national standards. This history also reflects the shifting intelligibility of disabled people, from the focus on wheelchair users to the eventual study of multiple mobilities and ways of reaching and moving within space.

Anthropometry and rehabilitation

As I discussed in Chapter 1, the first disability anthropometry studies in the U.S. were conducted from Timothy Nugent, a rehabilitation expert at the University of Illinois-Champaign-Urbana, in the late 1950s. At this time, Nugent had studied wheelchair clearances and the physiological effects of ramp use on the bodies of disabled university undergraduates living in the midwestern U.S., many of whom were soldiers.[709] Nugent's research integrated human factors with barrier-free design by measuring the interactions between bodies and the environment. He measured wheelchair clearances, turning radiuses, and vertical and horizontal reach for 73 wheelchair-using students with a range of neurological, muscular, and other physical disabilities.

Nugent's instruments of measurement, in addition to the calipers and tape measures characterizing anthropometrics, were also environmental. For example, Nugent measured exertion using a ramp adjustable to "32 positions, lengths or pitches, or combinations of length or pitch."[710] He also used the ramp to conduct timed motion studies in varying weather conditions. As a rehabilitation specialist, he was interested in proving the eligibility of disabled people for work, and so adopted the same kinds of motion studies

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[709] Nugent 1961; Selwyn Goldsmith *Universal Design: A Manual of Practical Guidance for Architects* (New York: Routledge Architectural Press, 2000), 9.
[710] Nugent 1961, 54.

that scientific management specialists like Frederick Winslow Taylor and Frank and Lillian Gilbreth used to measure worker efficiency in the early 20th century.

These experimental conditions provided data about the difficulty or ease of wheelchair use by University of Illinois students with access to a rehabilitation program and accustomed to an accessible and accommodating campus environment. Their experiences and capacities did not reflect those of students attending or barred from inaccessible public universities in the 1950s, like Ronald Mace. Nevertheless, the specificity of University of Chicago students' bodies became a seedbed for national standards. The result of Nugent's study was ANSI A117.1, the first attempt at producing standards for wheelchair clearances that could be applied across architectural spaces.[711]

Disability anthropometry and barrier-free design

In 1963, just a few years before Mace wrote his senior architectural thesis on person-environment relations and the environmental design research field began to incorporate human factors research, the British architect, Selwyn Goldsmith published *Designing for the Disabled*[712] (1963) as a model for incorporating anthropometric data about people with disabilities into design as a corrective to existing data sets. In it, he reflects on the impact of Nugent's studies, arguing "the disabled people whose characteristics and capabilities had helped inform the design prescriptions were translated into the world beyond the University of Illinois."[713] Goldsmith built upon Nugent's work by providing more measurements and systematizing them within the context of a larger text about the importance of considering disability in design.

[711] ANSI 117; Selwyn Goldsmith, *Designing for the Disabled: The New Paradigm*. New York: Routledge Architectural Press, 1963); Steinfeld 2011.
[712] Goldsmith 1963.
[713] Goldsmith 2000, 16.

In *Designing for the Disabled* (1976), however, Goldsmith used dimensional data from Dreyfuss's (1960) *The Measure of Man*, simply placing the standing figures in wheelchairs, rather than accounting for the particular sizes and reach ranges of people with a variety of reasons for using assistive technologies for mobility.[714] As a result, the anthropometric images had many of the same omissions as military data sets that had excluded people with height or strength-related disabilites. As Dreyfuss updated his data, however, Goldsmith adjusted his figures to include a broadened range and considerations of difference within the population of wheelchair users.[715]

In the early 1970s, Edward Steinfeld, an architecture and gerontology graduate student at the University of Michigan who would become one of the primary advocates of evidence-based design and an author of the UD Principles, received a grant from the U.S. Department of Housing and Urban Development to conduct a study on 60 wheelchair users that became the basis of the federal government's technical accessibility standards for housing.[716] Steinfeld had served on the ANSI committee, working with Ron Mace and other experts to write the language of the first federal access guidelines. Through this work, he saw that there was a gap in knowledge regarding the empirical collection of data to justify accessibility standards.[717]

Though not trained as an anthropometrist, Steinfeld's training as a gerontologist had exposed him to emerging rehabilitation models of person-environment relations and also to human factors research, which had infused civilian rehabilitation engineering.[718] In a groundbreaking literature review often cited in the literature on barrier-free

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[714] Goldsmith 2000, 22.
[715] Goldsmith 2000, 22-24.
[716] Steinfeld, Shroeder, and Bishop 1979b; Steinfeld 2011.
[717] Steinfeld 2011.
[718] Steinfeld 2011.

environments, Steinfeld and his researchers synthesized rehabilitation theory with architecture, environmental psychology, and anthropology to produce a new approach to designing accessible built environments grounded in social rather than medical models of disability.[719]

Based on this literature review, Steinfeld formulated a new anthropometric study. The resulting research, published in 1979, challenged the normate template by studying mostly elderly female wheelchair users—a group excluded from Nugent and Goldsmith's studies. This research became the basis of the 1980 revisions ANSI A117.1, and in 1986 helped establish the first federal accessibility standards for public housing.[720] The study also influenced the development of evidence-based design itself, and is often cited in the literature as exemplary of this approach to design.[721]

Steinfeld framed this study as an evidence-based design intervention, arguing that although a "major goal" of ANSI 117.1 was "the use of technical criteria generated from reliable empirical research," existing barrier-free environment recommendations either lack data, "have an anecdotal source, or rely on a limited or ambiguous data base."[722] The justification for an evidence-based approach was its utility for developing consensus standards and also for making explicit, through data, "who was being included or excluded from access or use of buildings" in these standards.[723] Thus, Steinfeld defined the status of statistical data according to its ability to testify to the epistemic justifications for disability inclusion and exclusion.

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[719] Steinfeld, Shroeder, and Bishop 1979b.
[720] Blanck, et al. 2010, 10.
[721] Moore & Geboy 2010.
[722] Steinfeld, Shroeder, and Bishop 1979b, 3.
[723] Steinfeld, Shroeder, and Bishop 1979b, 3.

Recognizing the non-generalizability and locality of data produced using disabled young people and soldiers to whole populations, Steinfeld's sample included people with a range of functional capacities, including mostly elderly women with low upper body strength to reflect the demographics of elderly people living in various forms of housing.[724] The logic of measuring this population, for accessibility, was that unlike people who have been actively involved in rehabilitation programs, this population would likely "exhibit generally lower strength and stamina, reduced agility, smaller stature and a greater familiarity with kitchen work" than if the sample had included younger men (as in Nugent's studies).[725] Designing for decreased strength and agility, in this logic, accounts for a broader range of people than designing for stronger or younger bodies. The resulting research was used for the 1980 ANSI guidelines and was the first version of these guidelines to include standards for accessible kitchens in single and multi-family housing units.[726]

Although the researchers indicated that the inclusion of the "kitchen work"[727] criteria was meant to eliminate bias related to lower levels of skill related to the study's test procedures, this criteria demonstrates continuity with broader rehabilitation projects, such as the rehabilitation guides for housewives published by Howard Rusk that I discussed in Chapter 1. As mentioned before, these guides reflected a view of all female bodies as fundamentally weak but with the potential to become productive in the home through the promotion of "energy-saving" behaviors and tools consistent with the scientific management of factory worker's bodies. In Steinfeld's case, however, the

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[724] Steinfeld, Shroeder, and Bishop 1979b, 9.
[725] Steinfeld, Shroeder, and Bishop 1979b, 9.
[726] Bruce Bassler (ed), *Architectural Graphic Standards* (Student Edition – 11th edition) (Hoboken: John Wiley & Sons, 2008), 13.82.
[727] Steinfeld, Shroeder, and Bishop 1979b, 9.

emphasis was on identifying prevalent functional limitations within the population of elderly disabled women, using surveys and interviews to understand their spatial needs related to reach and mobility.[728] Steinfeld still relied upon some existing human factors research, however, citing the work of Niels Diffrient on the 2.5-97.5 percentiles of adult eye levels, for example.[729] Nevertheless, this range went far beyond the typical 25-75 percentile measurements presented in general population anthropometrics for architectural design and fashion, setting the stage for Steinfeld to conduct further research on extreme population outliers.

The result of Steinfeld's study was the development of this figure, "The Enabler," which follows in the graphic tradition of the Vitruvian Man, Modulor, and other figures to denote an architectural body, but also makes the specificities of embodiment explicit. Reflecting a *functional limitation* view of disability emerging from *rehabilitation* and *person-environment relations* models, the Enabler challenges designers to take into account disabilities beyond mobility, including sensory impairment, size and weight, coordination, balance, stamina, and other factors.[730] While The Enabler does not provide any specific data, it uses a familiar graphic convention while serving as a checklist for inclusive design. As such, it also sets an agenda for evidence-based barrier-free design research, asking designers to use information about each node to adequately produce human-centered design.

[728] Steinfeld, Shroeder, and Bishop 1979b, 3.
[729] Steinfeld, Shroeder, and Bishop 1979b, 23.
[730] See my discussion of the Nagi model in Chapter 1. Both the Nagi model and the Enabler take into account the way that built environments disable bodies. The Enabler shifts the consideration of disabilities and functional limitations away from an exclusive focus on mobility toward sensory and other disabilities. However, both models identify disability as a state of lack. While rehabilitation addresses the association of disability with deficit through interventions into the body-environment relation, the Enabler and later barrier-free and UD approaches focus on providing evidence of the body for interventions into the environment. This point shows the complexity of even a socio-spatial model of disability, in which a deficit-based understanding of the body can still undergird changes to the structure of society.

Recent developments in disability anthropometry

In the years leading up to the 1990 passage of the ADA, a number of states adopted ANSI A117.1, while federal retrofits and new construction, such as the national capitol building and monuments and federally funded universities and museums,[731] also occurred according to these standards. ANSI A117.1 became the basis of the Uniform Federal Accessibility Standard (UFAS), and later the ADA Accessibility Guidelines for Buildings and Facilities (ADAAG). At the same time, the passage of the ADA relied in part on the availability of statistics from the Congressional Budget Office on the prevalence of disabled people in society.[732] As the text of the ADA shows, the willingness of lawmakers to guarantee access relied upon the ability of advocates to prove that there were a sufficient number of disabled people in the U.S. to constitute a civil rights category and that changes to the built and social environments would thus be able to benefit a large number of people.[733] The use of anthropometric data to define accessibility standards grows out of a similar epistemic valuation of statistical data proving that ranges of embodiment exist for whom the built environment does not account.

Steinfeld's initial mobility anthropometry data was not updated until the 2000s. At this time, Steinfeld and a new team of researchers at the Rehabilitation Engineering Research Center (RERC) on Universal Design and Built Environment at SUNY-Buffalo's Center for Inclusive Design and Environmental Access (IDEA) undertook a

[731] For instance, many components of the city of Washington D.C. have been retrofitted or constructed to reflect the ANSI standards. This includes the Smithsonian Institution museums, many of which have incorporated Universal Design principles into the design of buildings and exhibits. I plan to write a chapter on this topic when I expand the dissertation into a book.
[732] 42 U.S.C. § 1201 (a)(1): "The Congress finds that—some 43,000,000 Americans have one or more physical or mental disabilities, and that this number is increasing as the population as a whole is growing older."
[733] Ibid.

decade-long study with a much larger sample size, different targets and objectives of study, new tools of measurement, and improved research methods.[734] The final version, published in 2010, included 500 users of wheeled mobility devices, including manual and power wheelchairs and scooters.[735] It is to date the largest study of the anthropometry of wheeled mobility devices.

The IDEA Center's anthropometry research operates through an evidence-based design paradigm emphasizing the scientificity of UD research within rehabilitation and human factors paradigms. They have held *State of the Science* conferences on Universal Design, and used their placement within a rehabilitation engineering and human factors network to justify their research as scientific to grant agencies.[736] In the course of this research, they have also had to negotiate between the competing demands of scientific rigor and the need to produce functional data that can be intelligible to designers.

Epistemic shifts

Like 19th century positivists who used quantitative data to argue for the epistemic validity of their knowledge production, the IDEA Center researchers adopted the view that making available increasing amounts of information on the range of embodiments using wheeled mobility devices would provide solid evidence against the intuition of architects. However, the use of anthropometry by UD researchers is not simply a replication of 19th century statistical methods or epistemologies, nor does it have much in common with the practices of anthropometry adopted by eugenicists or military researchers. Instead, UD anthropometry has made major interventions in the practices of

[734] Steinfeld et al. 2010.
[735] Steinfeld et al. 2010.
[736] Maisel 2010; Maisel 2011.

anthropometry by qualifying, building upon, and rejecting existing practices defined through human factors, industrial engineering, and rehabilitative medicine.

By all accounts, the IDEA Center's researchers were not aware of anthropometry's problematic histories. In interviews, they repeatedly emphasized that they were scientists who had merely mastered and improved upon an existing human factors method to make it more useful to designers.[737] The researchers insisted upon their scientific objectivity, arguing that while recognizing that their work had important effects in the world, it was not related to more common forms of disability activism, such as protests and sit-ins.[738] They emphasized the scientificity of their work by pointing to the rigor of methods and instruments of measurement produced over a ten year period even before actual research began. At the same time, they conceded that their research defied or often rejected existing epistemological standards of scientificity and that this created challenges for interdisciplinary conversations between scientists and architects, for whom standards of knowledge and rigor are quite different.[739]

The published report of the IDEA Center's recent anthropometry study is a text that is grounded in scientific epistemologies but makes the situatedness of these epistemologies more apparent by arguing for methods that produce more useful and functional knowledge for architects. This middle ground between scientificity and situatedness emphasizes the materiality of built environments, produced through the

[737] Jordana Maisel, Personal communication. October 4, 2011. Buffalo, NY; Clive D'Souza, Personal communication, October 4, 2011. Buffalo, NY. Steinfeld 2011 also noted that in the early planning stages for this research, one of their research assistants had been trained as a physical anthropologist in his master's program and was able to help with the design of research on human dimensions.

[738] An interesting development in these conversations came when I introduced the feminist idea that "the personal is political" and talked about research in feminist science studies or anti-racist approaches to scientific knowledge production. In these cases, the researchers agreed that their work fell more into this category than more direct political action.

[739] Maisel 2011.

application of scientific research, and addresses existing research through new modes of sampling, measuring, and interpreting data. In many ways, the report reverses the positions of feminist epistemologists like Helen Longino, who argue that while scientific research may obey strict standards of rigor within an experiment, its external context may still be subject to social context and construction.[740]

In UD anthropometry, the internal content of the research rejects existing standards of rigor while portraying itself as scientific to granting agencies and epistemic communities of rehabilitation experts, industrial engineers, and human factors specialists. In doing so, it invites us not only to ask how it is possible that UD research would rely upon a scientific research method that had only a century before been used for eugenics, but also to wonder about the status of epistemic activism at the level of specific studies. I now turn to demonstrating that we can view this research as epistemological activism that produces shifts within the practice of anthropometry and the standards of epistemic validity that this practice introduced into 19th and 20th century science.

Historicizing technology

The first way in which the IDEA Center study produces situated knowledge and epistemic shifts is that it historicizes existing disability anthropometry. Rather than treating anthropometric data as a pool of generalizable information, the researchers recognized how previous research designs had actually contributed to an epistemology of ignorance surrounding the anthropometry of shifting assistive technologies. It notes that the previous sample of only 60 wheelchair users was not only inadequate for improving design due to its small sample size. It was also inapplicable to technological advances in

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[740] Longino 1990.

mobility technologies since the 1970s.[741] The development and availability of larger powerchairs and scooters for people with less upper body strength than paraplegic veterans or athletes, as well as the aging baby boomer population, had created new technological possibilities and also shifted space requirements. These shifts, coupled with the higher survival rate for people with spinal cord injuries, have meant that new kinds of bodies exist in the world and require access to public space. For Steinfeld and other proponents of evidence-based design, making these bodies intelligible to designers necessitates evidence for the implementation of effective design.

Some critics, such as Rob Imrie, have argued that UD adopts techno-rational solutions and Enlightenment ideologies of knowledge and technology as progress.[742] No doubt, UD's use of evidence is grounded in a history of technical solutions and guidelines, even while it takes great care to promote itself as going beyond the ADA. However, UD research, in historicizing bodies and technologies, also demonstrates the possibilities for inclusion beyond minimum ADA standards.

Furthermore, in the tradition of the concept of technological essentialism from the philosophy of technology, recognizing the historicity of mobility technologies also complicates the view of what technology is and how it functions in a society.[743] As philosopher of technology Andrew Feenberg argues, technology is not merely enframing, rational, or depoliticized.[744] The design of prosthetic limbs by disabled inventors, such as Bly and Foster (discussed in Chapter 1) is an example of how technology can become a site for interventions within existing techno-rational regimes (such as the normate

[741] Steinfeld et al. 2002, 17; Steinfeld et al. 2010, 84.
[742] Imrie 2012, 876.
[743] Andrew Feenberg, *Questioning Technology* (London: Routledge, 1999); Barad 2007.
[744] Feenberg 1999.

template) and even shift authority to marginalized people. Although the use of anthropometric data to establish accessibility standards could be understood as a kind of technocratic regime, this critique ignores the specificities of evidence-based design research as a corrective to the intuitive expert knowledge of designers operating within a normate epistemology of ignorance.

As Karen Barad's theory of *apparatus* shows, technology plays a role in the intelligibility of phenomena[745] and bridges the boundary between bodies and environments. Shifts in mobility technologies not only necessitate greater societal inclusion, but this inclusion must occur with some degree of technical understanding of the shifting spatial needs of new kinds of body-technology relations. Technology has also become a site of activism and citizen interventions, with resourcefulness and adaptation built around the use of technological devices.[746] Thus, research that responds to these changes rather than privileging the situated technologies, such as manual wheelchairs, that are in fact only usable by certain types of bodies, also refuses to essentialize the technological as a rational and depoliticized solution.

Proportionate sampling and shifts in statistical epistemology

The IDEA Center's study reinterprets the notion of proportionate sampling that is central to the generalizability of research and foundational to statistical methods seeking to ascertain averages and standard deviations. Proportionate sampling conventionally means that if a general population includes 20% individuals of a certain category, the

[745] Barad 2007, 189-222.
[746] For example, hacking, DIY games development, and citizen interventions in technological developments.

study sample must also include the same percentage of those individuals.[747] Generalizing from a small sample to the whole population in this way is the mechanism by which privileged figures, like the normate, become a legitimate representation of the supposedly average body. As I explained earlier in the chapter, the basis of the philosophy of the norm in statistics, as well as the use of the Vitruvian man as the basis of the normate template, is grounded in the generalizability of specific bodies to larger populations. We also see this occurring in early practices of disability anthropometry from Nugent and Goldsmith, in which specific bodies become evidence for general standards.[748]

The IDEA Center's study did not endeavor to achieve this level of generalization because it would not be useful for designing for broad inclusion. As Steinfeld et al. note,

> most people with severe disabilities fall outside [the representation of the whole population] when proportionate sampling schemes are used. This means that disability will be very underrepresented in conventional anthropometric studies. Some studies purposely exclude people with disabilities and older people to keep the results unaffected by 'outlying cases' or people who have widely divergent abilities and characteristics.[749]

Steinfeld et al.'s study sought data that has been controlled out of other studies via sampling. Within the 2010 sample, researchers oversampled for previously underrepresented populations of power wheelchair users. Because more data already exists on manual wheelchair users (a significant portion of the population of mobility aid users), researchers concluded that oversampling power chair users who are least represented in previous studies would not distort their results, but rather ensure some

[747] Steinfeld et al. 2010, 17-18.
[748] Proportionate sampling is sometimes used to justify user-centered design and UD. For example, Molly Story argues, "it is essential to involve representative users in evaluating designs during the development process to ensure that the needs of the full diversity of potential users have been addressed" (Story 2011, 4.11-12). However, Steinfeld et al.'s intervention is that they focus on previously un-represented portions of this population.
[749] Steinfeld et al. 2010, 17-18.

representation of this group.[750] As a result of oversampling outliers, non-normate bodies automatically became the focus of the data set (rather than a deviation from the average). They become qualifications of broader standards, showing that the standards themselves do not reflect the range of human diversity.[751]

As I argued earlier, the bell curve is a material-discursive and epistemic object through which the materiality of specific bodies becomes transmitted and visualized as abstract data. The departure from proportionate sampling has allowed the IDEA Center to contest the visual rhetoric of the bell curve and its privileging of the average or norm and de-centering of standard deviations. One type of image uses a graph to note data about the reach ranges of seated wheeled mobility device users. Within the graph, a figure sits in a wheelchair and reaches out with an arm. The color-coding of the data indicates acceptably inclusive ranges of reach, coded according to the percentile of inclusion (up to 95%). While using some of the graphic conventions of architectural figures, such as the Vitruvian Man, whose arms extend outward into space, the chart rejects the geometric and proportional body in favor of one with a range of possible sizes and functions, complicating the singularity of the normate while remaining intelligible to designers.

Apparatuses and objects of measurement

The IDEA Center study develops methods for making body-environment systems and interactions the object of research. Previous anthropometry used static measurements (called "structural" anthropometry) of bodies at rest and divorced from environmental context. This was in large part due to the available technological apparatuses of

[750] Steinfeld et al. 2010, 83.
[751] It should be noted, however, that there are discussions about introducing this new data into existing disability laws, thereby codifying certain ranges of embodiment yet again.

measurement—carefully calibrated rulers and calipers[752], which could only linearly measure the distance between so-called bodily landmarks. As I explained earlier, these apparatuses required subjects with normate embodiment, typical limb, joint, and bone placement, and who could stand in an upright military position. The result of these material and technological arrangements was that anthropometric data sets could only include able-bodied research subjects.

To remedy the structural and methodological exclusion of non-normate and misfitting bodies, the new UD anthropometry uses both static *and* dynamic ("functional") anthropometry of bodies relating to and using environments and technologies.[753] In doing so, the IDEA Center study also reconceptualizes the status of anthropometric data as evidence. Rather than providing evidence of an underlying and fundamental nature of the body, as in 19th century anthropometry, the inclusion of dynamic measurements recognizes the functional uses of anthropometric data and also recognizes disabled people as functional users of the built environment who have been excluded by design. As Steinfeld et al. note in the proceedings to a 2002 conference on disability anthropometry,

> …structural measurements alone cannot fully predict human performance in real world settings where the body is usually in motion or under stress…This has added another level of complexity to anthropometry because free, or unloaded, movement is not always sufficient to capture the nature of performance in real world tasks.[754]

Whereas *static anthropometry* measures the aberrance of the body from a statistical average, *functional anthropometry* measures the environment's misfit with a range of bodies. For functional anthropometry, bodies are irreducible to their measurements, and measurements are only meaningful when they convey information about how bodies and

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[752] Wilder 1920, 8-9.
[753] Steinfeld et al. 2010, 2; Steinfeld et al. 2002, 16-17.
[754] Steinfeld et al. 2002, 13.

environments act in tandem. Rather than measuring girth or the length of limbs, functional anthropometry measures the body's "movement envelope" and situatedness in space.[755] The body is not an object of medical knowledge, but a measure of social inclusion that becomes perceptible when put into interaction with the built environment. As evidence, inaccessibility becomes measurable and assessable testimony of the environment's fit to the body.

For example, the IDEA Center used three-dimensional modeling technologies developed by industrial engineers to measure and model human bodies in three dimensions.[756] They have been able to use this technology to map the movements of research subjects entering and using simulated public transportation buses and trains. They have also worked with researchers at the Toronto Rehabilitation Institute to take measurements of users inside of weather simulation chambers, thus taking into account movement, reach, and spatial requirements within a variety of contexts.[757]

The range and the philosophy of the norm

As I explained earlier, there are two modes of statistical analysis enabled by the bell curve as a model of data visualization. The first of these is the norm or the average, found at the center of the bell curve. The other, endorsed by Galton as *standard deviation* and by the U.S. military as *range*, describes a diverse sub-population of the overall sample. Ranges can either be specific to certain parts of the bell curve (such as the 25^{th}-75^{th} percentile range) or can describe the entire universe of the sample (the 1^{st}-99^{th} percentiles). Galton was interested in ranges because they specified deviations from the

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[755] Steinfeld and Maisel 2012, 97.
[756] D'Souza 2011; Blanck et al. 2010, 13.
[757] Steinfeld 2011.

norm and could also quantify supposedly superior intelligence or inherited capacities. Standard deviations allowed supposed superiority or inferiority to be an object of measurement. However, military human factors made more productive use of the concept of range, using it to produce fitted clothing, equipment, and vehicle interiors for a range of bodies. This was not the result of a benign orientation toward human variation—it still, after all, excluded all disabled bodies—but resulted from emerging understandings of the body as an efficient machine promoted by industrial engineering, scientific management, and the sciences of thermodynamics and biomechanics. Thus, the military adoption of the range was an incomplete epistemic shift that still privileged and centered a normate range of embodiments.

The IDEA Center study questions the desirability of standardizing design based on average or normate ranges of embodiment, instead valuing data about a range that includes population outliers deemed statistically insignificant. Design for ranges, as in military human factors design, requires flexible solutions to the built environment that can accommodate multiple abilities and embodiments within a single design.[758] For example, adjustable chairs and desks can accommodate bodies with different heights and widths. However, disability access also requires better data about ranges that have been omitted from previous studies—such as the 75th to 95th percentiles of wheeled mobility device users. Thus, the norm of representation within disability anthropometry is often a narrow range rather than the middle range or the average.[759] This is meant to broaden the template for design to include population outliers rather than to prescribe design for only a small segment of the population.

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[758] Data about ranges makes it possible to design, for instance, kitchens in which countertops and the height of cabinets is adjustable to the user.
[759] Steinfeld et al. 2002, 33-34.

Valuing ranges as evidence requires adopting methodological reflexivity about the reliability of standard measurements. Steinfeld et al. found that the diversity in bodies, mobility devices, and environments in their study made it difficult to standardize measurements. Conventional anthropometry methods rely upon able-bodiedness as a norm, requiring subjects to stand upright in difficult poses or to wear certain forms of clothing during research.[760] This is part of the legacy of human factors anthropometric methodologies. Also, the inability to standardize body landmarks for measurement across diverse bodies created "barriers in translating research findings to standards development."[761] However, rather than abandoning standardization in accessibility compliance, the researchers questioned the total objectivity of quantified measurements based on the inadequacies of current methods to yield usable data. Standards can still be set as a result, but will have to be flexible and reflect ranges of interactions between bodies and environments.

Beyond quantification

Finally, in the IDEA Center's study, quantitative data collection was only one part of the overall multidisciplinary research project. In the tradition of environmental design research, the study involved a multidisciplinary team of architects, rehabilitation specialists, gerontologists, occupational therapists, industrial engineers, physical anthropologists, and other experts.[762] The process of defining "measurement variables and procedures" entailed, in Steinfeld et al.'s study, consultation with "experts in anthropometry and ergonomics, human modelers, architects and designers, and

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[760] Steinfeld et al. 2002, 24; Wilder 1920, 2.
[761] Steinfeld 2010, 4.
[762] Steinfeld et al 2010, 2.

clinicians."[763] This meant that epistemic standards and methodologies from all of these fields entered the design of research. In the tradition of user-centered design research established by designers such as Ray Lifchez, the study also included user-experts, such as elderly and disabled users of wheeled mobility devices, who provided feedback on research design in addition to participating in the study.

As I discussed above, Nugent, Goldsmith, and Steinfeld are all non-experts who produced anthropometric evidence to address particular functional needs. Like the astronomers-turned-anthropometrists of the 19th century, their non-expert status is often overlooked because the type of evidence they produced is quantitative and thus more intelligible as epistemically valid or objective data. While the work of scientists like Galton or Quetelet may be retroactively deemed pseudoscientific, disability studies scholars would do well to suspend this type of judgment in the present moment with regard to disability anthropometry because doing so allows evaluation of the shifting terms of expertise within research that privileges non-normate bodies.

Specifically, multidisciplinarity and the use of user-experts shifts the terms of expertise and the value of sources providing valued knowledge for accessible design. To grant greater explanatory power to their statistical data, the IDEA Center used surveys, focus groups, and ethnography alongside anthropometry to identify qualitative factors and preferences that are inaccessible to quantification alone.[764] These qualitative studies rest upon the validity of the experiences and perspectives of spatial inhabitants as valuable knowledge. For example, Steinfeld et al. conducted focus groups with potential anthropometry research subjects in order to define non-invasive research methods of

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[763] Ibid.
[764] Steinfeld et al. 2002, 21, 29.

contact with bodies.[765] In this way, the bodies measured by anthropometry also participated in designing research methods and defining their own consensual limits. This participation departs dramatically from the invasive and often coerced anthropometry conducted in colonial or eugenic contexts.[766]

Conclusion

Disability anthropometry intervenes directly in the built environment by helping to establish legal regulations governing the design of new construction and federal buildings, as well as places of public accommodation. Ironically, UD often positions itself as in opposition to or going beyond these technical legal arrangements at the same time that one of its primary research programs is involved in expanding what standards and laws can accomplish. All of these efforts borrow, build upon, and qualify methodologies and epistemologies from 19th century positive sciences, evidence-based medicine, rehabilitation, and military human factors research. This historical epistemological view of UD research reveals that it has much more in common with the milieus from which it attempts to differentiate itself than it its self-presentation suggests.

At the same time, there are still strains of UD research that operate within more traditional design methodologies, valuing user consultation, precedent, and best practices over quantifiable data. These include research projects to make museum design more accessible to people with cognitive and developmental disabilities occurring at the non-profit Institute for Human-Centered Design (IHCD), led by UD Principles author Elaine

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765 Steinfeld et al. 2010, 2.

766 In her history of the relationship between streamlined design and eugenics, Christina Cogdell demonstrates that optimized design in the 1930s with a "physical and ideological extensio[n] of streamlined bodies" (Cogdell 2004, 192). However, UD research disrupts the very notion of an ideal type by emphasizing flexibility and diversity, the opposites of streamlining.

Ostroff, and research on museum design and autism at the National Museum of American History.[767] These studies emphasize the functional aspects of spatial use and focus on issues such as perception and cognition beyond the spatial requirements of buildings.

The qualitative and quantitative approaches work in tandem, emphasizing accessibility for different parts of the built environment. However, they also demonstrate some of the emerging epistemic tensions between *best practices* knowledge, which emphasizes the accumulation of practical knowledge and intuition by designers, informed by user experiences, and the creation of quantifiable accessibility standards, which privileges statistical data and generalizability that is often abstracted from user preferences even while it accounts for diverse user bodies.

The recent establishment of a Global Universal Design Commission (GUDC) to create international standards for Universal Design tries to take the middle ground by creating qualitative and voluntary standards, based on the evaluation of outcomes rather than the mandate of particular design solutions.[768] Though in its very early stages, the GUDC is an interesting component of UD's epistemic community because it negotiates between more conventional forms of design knowledge and research, such as designerly experience and Post-Occupancy Evaluation, and standardization practices that have been part of barrier-free design since its earliest history.

Nevertheless, in all of these practices, it is necessary to remember the historical basis of the normate template and its role in shifting certain bodies in and out of view as evidence for design. An unexamined paradox of UD is that the epistemic practices upon which it relies so heavily—such as best practices knowledge and anthropometric

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[767] Kaye 2010; Ziebarth 2012.
[768] Steinfeld 2011; Richard Duncan, Personal communication. March 22, 2012. Raleigh, NC.

statistics—can so easily slip back into normate conceptions of *all people* or the *universal* that do not include any mention of human variation that includes disability. These slippages, and their historical conditions of possibility, are only intelligible through the lens of historical epistemology and have not been explored within the existing UD literature. My dissertation creates a framework for exploring the productive work of these shifting scientific practices.

As research on UD as an epistemic community moves forward, the diligent application of ethnographic and analytic methods from Science and Technology Studies, including Feminist Science Studies, and Critical Disability Studies will be necessary to pinpoint and parse out the complex epistemic politics of Universal Design. Questions of epistemic authority, value-explicit design, and evidence-based practice should be central to emerging critical and theoretical analyses of Universal Design, lest the status of the universal be taken for granted as a readily achievable or even instantly desirable outcome of design practice.

Conclusion

This dissertation has produced an historical epistemology of Universal Design that not only contributes a new historical account to the study of the phenomenon, but also introduces critical concepts and approaches that can be useful to future humanistic and social scientific studies of UD. In what follows, I will briefly synthesize the dissertation's key contributions. Then, I will outline directions for future research.

Critical terms

This dissertation has contributed three key critical terms to the study of UD: *bodies as evidence,* the *normate template,* and *disability anthropometry*. While the first and third of these terms already circulate within certain professional milieus, such as medicine and human factors research, I have introduced them here as historical concepts that intervene into existing epistemic regimes. The concept of *bodies as evidence* intervenes in the regime of designerly body-neutrality that upholds the *normate template's ideology of ability*. It builds upon existing work in *evidence-based design* by drawing attention to the primacy of bodies as sources of intelligible evidence.

Disability *anthropometry* is both an historical practice and a paradoxical concept, given the history of anthropometry as a tool of eugenics and scientific racism. Thus, my usage of *disability anthropometry* disrupts existing historical narratives of anthropometric practice, signaling a way of studying disability that disrupts the narrative that measurement is only about quantifying and confirming the valued status of the normate. Finally, *normate template* is a material-discursive concept with a wide range of applications in discussions of the relationship between bodies and designed spaces or technologies. It builds upon existing disability concepts and categories, but also provides a framework for applying methodologies, such as historical epistemology, to disability studies.

Contributions to interdisciplinary fields

Critical design studies

As I explained in the Introduction, the majority of the published literature on UD is produced by its proponents, most of whom are concerned with promoting and marketing the idea. The scholarly literature on the phenomenon is sparse, with the concept either being dismissed for its goal of universality, or rarely explored in depth beyond its concerns with broad accessibility. This dissertation contributes several new ways of thinking about UD to the existing scholarship within design studies and encourages scholarly focus within critical histories and theories of design. First, it theorizes the value-based epistemological practices of UD as part of broader historical and epistemological systems and ideologies. It puts traditional architectural concepts, such as *parti* into conversation with feminist, disability, and new materialist conceptions of *material-discursive phenomena*, allowing these fields to avoid reinventing the wheel with regard to the epistemological and symbolic work of design.

Second, this dissertation historicizes the epistemic frameworks and sources of knowledge that have produced contemporary *user-centered design* within architectural and industrial design. This contribution has two potential impacts. In addition to making the *user* an intelligible historical concept, it shows how treating the *user* as an object of knowledge has produced entire epistemic regimes and research disciplines (such as human factors, rehabilitation, and environmental design research) focused on understanding the body in the context of its environment. The persistence of *user-centered design* in the early 21st century invites design theorists and historians to revisit the critical literature from the 1960s and '70s on person-environment relations, rehabilitation, and environmental psychology as they continue to formulate the theory of *evidence-based design*.

Finally, this dissertation highlights the availability and content of the material archives of UD history, particularly those collections that have not been previously documented or utilized. As these archives become more organized and publicly available, it will be possible to engage in scholarly debates over the disciplinary and ideological foundations of UD practice. It will also become possible for scholars of disability law to investigate the relationships between the historical development of barrier-free and UD approaches.

Critical disability studies

This dissertation's major contribution to critical disability studies emerges from its use of historical epistemology to add greater complexity to the *models framework* of understanding disability as a moral, medical, or social construct. Rather than arguing that the models should be disregarded, I have (in the spirit of historical epistemology) shifted to the use of these models as concepts that can exist in overlapping historical periods, even though their origins may be more specific. Historical epistemology has allowed me to trace the residues of each model in unlikely practices and epistemic regimes. For instance, I have shown the persistence of the moral model in 19th century scientific measurement and have also contested the association of science, medicine, and measurement with completely normalizing practices that are discreet from the social and built environments.

My new perspective on UD's history could only be produced through sustained attention to UD as an epistemic practice, the user and the body as epistemic objects, and scientific methods of study (such as anthropometry) as practices with long-term and changing histories. Likewise, my history of anthropometry, which focuses on epistemic shifts rather than locking the practice into the essentializing position of always being oppressive or reductive, has only been possible to discern through the critical work that UD theory itself has done to make an argument for evidence-based design.

Arguing that UD relies upon medical and scientific knowledge that, in turn, became possible through a moral understanding of bodies and nature does not mean that UD is exempt from the problematic epistemological and methodological practices and ideologies of histories of science. Rather, I have explored the relationality and entanglements of built environments with knowledge, fleshy bodies, and meaning. My intention has not been to produce a normative account, but to show the messiness of histories of the body and design that resist easy judgment. By bracketing the tendency to dismiss measurement as always a normalizing practice, I have been able to empirically test the processes and relations through which normalization, differentiation, and materialization occur within built environments. This new materialist perspective, I hope, can contribute to further studies of the *philosophies of norm* and *measurement* in critical disability studies.

Feminist science & technology studies

Throughout the dissertation, I have gleaned perspectives from a field that I loosely refer to as feminist Science & Technology Studies (STS). This has included the classic work of feminist epistemology in destabilizing the neutrality of knowers, as well as new materialist frameworks that have made it possible to show how material environments are as much discursive, epistemological, and ideological as language and symbolic meaning. The structure and approach to the dissertation have also been heavily influenced by the work of feminist STS scholars, such as Michelle Murphy (2006), Karen Barad (2007), Deboleena Roy (2008), and Elizabeth Wilson (2004). At the same time, I have used a methodology that has more often than not been deployed to study scientific milieus, such as laboratory science, that purport a degree of neutrality from feminist concerns.

What I have shown here is that historical epistemology is, in fact, a feminist disability methodology with a great deal of utility for histories and theories of the body and disability once it is put into conversation with feminist epistemological and ontological concepts. Particularly given the history of the body in design, and the relationship between design and milieus such as rehabilitation and military human factors research, my historical epistemology shows that histories of science and technology must keep feminist concepts in mind if they are to give due diligence to the *normate template* and its attendant ideologies.

Future research

The critical approach to UD history and theory established in this dissertation invites further inquiry into UD's underlying values and interventions into the design disciplines. I identify five key areas of future interdisciplinary work:

UD, perception, and architectural phenomenology

My focus on bodies as evidence in this dissertation was mostly limited to the size, shape, and mechanics of fleshy bodies. However, the normate template also relies upon normate conceptions of perception and cognition. User-centered design, human factors, and rehabilitation research have all contributed to the historical study of mental, sensory, and psychological capacities. Likewise, UD has adopted strategies that focus on facilitating access to perception and cognition. As I explained in Chapter 2, the 1960s milieu of environmental design research, which included psychological and behavioral research, brought these issues into the focus of user-centered design. However, barrier-free design has mostly focused on physical dimensions of accessibility related to mobility or sense perception.

Recently, alliances between architects and neuroscientists have encouraged UD attention to environmental cognition and wayfinding, as well as sensory access.[769] These alliances and continuing UD work in these areas invites engagement from critical humanistic scholars, especially those in feminist science studies, philosophies of mind, and architectural phenomenology. These frameworks can investigate UD's evidence-based responses to normate cognition, perception, and sensation without taking this research for granted as delivering universal and generalizable knowledge about users. Cognitive research on specific types of environmental design, such as museum design, can also complicate existing understandings of participant research and *user-experts* in UD.[770]

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[769] As in the work of John Eberhard, *Architecture and the Brain: A New Knowledge Base from Neuroscience* (Greenway Communications, 2007) and John Zeisel, *Inquiry by Design: Environment/Behavior/Neuroscience in Architecture, Landscape, and Planning* (New York: W.W. Norton & Co., 2006). Eberhard, a previous president of the American Institute for Architects, established alliances between designers and neuroscientists in order to promote neuroscience as an evidence base.

[770] For instance, the work of IHCD on promoting accessible museum design for people with cognitive disabilities that I mentioned in Chapter 2.

UD and legal epistemology

This dissertation has contributed the critical concepts of *bodies as evidence* and *evidence-based design* to the study of UD. These concepts not only contribute to my discussion of UD's role in the history of science, but also further explicate UD's epistemological critiques of the ADA's failures. Scholarship on disability jurisprudence and legal philosophy could use critical evidence-based concepts to compare the scope of UD and the ADA, historicize legal standards of evidence, and analyze the epistemic standards through which certain bodies become intelligible as disabled before the law.

Given the overlapping knowledge producers and evidence bases between UD and the ADA, comparative studies of legal and design epistemology can also contribute to critical discussions of disability and bodies as objects of scientific and medical knowledge. The critical epistemic concepts of *normate template* and *spatial misfit* can provide legal scholars with tools for evaluating the ADA's participation in or departure from medical models of disability. Histories of the ANSI and other best practice guidelines should understand the role of rehabilitative and industry discourses in shaping existing evidence bases, defining the acceptable accessibility needs of qualifying disabled bodies, and promoting access to workplaces and public spaces.

UD and Standardization

As mentioned in Chapter 3, UD proponents have been involved in the formation of the Global Universal Design Commission (GUDC), an entity modeled after LEED certification for green building and design.[771] The GUDC's promotion of evidence-based, voluntary consensus standards is an extension of UD proponents' work on access standards, design principles, and evidence-based design. Although the GUDC's work is still embryonic, its emergence from within UD's epistemic community invites scholarly attention to the role of market-based UD strategies. Ethnographers and sociologists of scientific knowledge could develop organizational analyses of the GUDC, while historians can study its role within long-term histories of UD efforts at standardization. Like the studies of legal epistemology I proposed above, critical work on the GUDC could study the emergence of consensus standards and their relation to the ANSI and legal, technical, and modernist approaches to design.

Added value theories and marketizing discourses

As I discussed in the Introduction, much of the design literature on UD uses marketizing discourses to promote the phenomenon to designers. Although UD positions itself against legal accessibility guidelines, its marketizing discourses conflate consumer access with civil rights access. These discourses take marketability, consumerism, and mass production for granted as value-neutral and necessary to the widespread dissemination of UD. What is missing is a critical and historical examination of UD's emergence within assistive technology and industrial design, two milieus that prioritize the *user* as a consumer and rely upon the marketability of products (rather than their value for inclusion) to promote access.

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[771] Steinfeld and Maisel 2012, 189-190, 213.

Scholarly research on UD has only begun to address the underlying ideological commitments of what Rob Imrie calls the "commodification of access."[772] This commodification underlies the UD concept of *added value,* or the notion that inclusive design not only benefits disabled people, but also a wide range of non-disabled consumers. As I have argued elsewhere, *added value* theories centralize value for normate consumers and make marketability a requirement of acceptable accessibility.[773] This further reinforces the devaluation of disability embodiment by the normate template and emphasizes a majoritarian focus that may not even include disabled consumers.

Future research should examine alternatives to added value theories, such as a social justice emphasis on the theory of *broad accessibility,* which can expand the category of disability but nevertheless privilege misfitting bodies in inclusive design.[774] Recent disability justice work by activists such as Mia Mingus on the notion of "collective access" can also help UD theory develop to include considerations of user-driven design, planning, and engineering.[775] These bottom-up practices can address UD's concerns with de-centering the designer as the privileged source of epistemic authority. They can also contribute to the development of UD theories grounded in social justice rather than *added value*.

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[772] Imrie 2012, 878; Aimi Hamraie, "Designing Collective Access," *Disability Studies Quarterly* (forthcoming September 2013).
[773] Hamraie 2013.
[774] Hamraie 2013.
[775] Mingus, Mia. "Reflections from Detroit: Reflections On An Opening: Disability Justice and Creating Collective Access in Detroit," *INCITE Blog* (2010) and "Changing the Framework: Disability Justice," *RESIST Newsletter* November/December (2010).

UD in the Majority World

While this dissertation has focused on the U.S. context of UD in order to explore its relationship to U.S.-based access laws, barrier-free design, and scientific research practices, inclusive design practices exist throughout the world. International UD proponents have drawn attention to this work, debated terminologies, and critiqued the primacy of U.S.-based approaches in accounts of UD's history and theory.[776] While most of the literature on U.S. and European UD focuses on marketizing discourses, international UD proponents in the *majority world* have addressed issues of economic and racial privilege.[777] In response, U.S. UD proponents have often responded by arguing for the value of UD for promoting development and civil society in the majority world.[778] These debates mirror those occurring in the context of the UN Convention on the Rights of Persons with Disabilities over the role of neoliberal economic policies and approaches in promoting disability human rights.[779]

Further theorization from a feminist and disability perspective can add critical clarity to the philosophies of universalism that circulate within these important policy debates. Whereas the existing literature on international UD focuses on evaluating specific design projects, the historical epistemological framework I have offered here can

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[776] See Sandhu 2011 and also "Part 3: International Perspectives," in Wolfgang Preiser and Korydon Smith, *Universal Design Handbook: 2nd edition* (New York: McGraw Hill, 2011) for studies of international UD in Norway, Japan, France, Germany, Brazil, Italy, and Israel.
[777] Singanapalli Belaram, "Universal Design and the Majority World," in Wolfgang Preiser and Korydon Smith, *Universal Design Handbook: 2nd edition* (New York: McGraw Hill, 2011), 3.1.
[778] Steinfeld and Maisel 2012, 46.
[779] See Aimi Hamraie, "Proximate and Peripheral: Ableist Discourses of Space and Vulnerability Surrounding the United Nations Convention on the Rights of Persons with Disabilities," in Chiara Certoma, Nicola Clewer, and Douglas Elsey (eds), *The Politics of Space and Place* (Cambridge: Cambridge Scholars Press, 2012), 145-171.

offer new ways of thinking about the historical basis of access efforts in law and design in specific international contexts. Using frameworks from transnational feminist epistemology and disability theory,[780] future scholarly on international UD could examine how histories of the body and scientific knowledge, legal access and rights regimes, and practices of vernacular and public design intersect with colonialism, racism, development, and historically and culturally specific framings of disability. This work can ask how philosophies of development, rehabilitation, and reconstruction have been applied to international accessibility contexts, how western designerly expertise has claimed hegemony and been deconstructed in these efforts, and how the movement for UD in the majority world has pushed back against dominant scientific and architectural conceptions of epistemic validity.

Conclusion

Given UD's relatively recent arrival within design discourses, and given the shifting social, ideological, and political contexts enabling certain types of bodies to be in the world, the critical study of UD will continue to be imperative. The role of critical humanistic and social scientific research on UD should be to elaborate upon and test the empirical basis of UD's underlying epistemological, methodological, and ideological investments. Just as UD theories of evidence-based practice have allowed this dissertation to challenge the orthodoxies of theories of disability, feminism, and science, scholarly engagements with UD could also have the potential to participate in and transform its actual practice.

[780] Such as Sandra Harding, *Sciences from Below: Feminisms, Postcolonialities, and Modernities* (Durham: Duke University Press, 2008); Nirmala Erevelles, *Disability and Difference in Global Contexts: Enabling a Transformative Body Politic* (New York: Palgrave MacMillan, 2011).

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