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ARCHITECTURAL GRAPHIC STANDARDS

STUDENT EDITION

TWELFTH EDITION

KEITH E. HEDGES, AIA, NCARB
EDITOR-IN-CHIEF

AUTHORED BY
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A NOTE FROM THE PUBLISHER

Over the years, I have seen my fair share of battered editions of *Architectural Graphic Standards (AGS)* in architects' offices; even in the pick-up trucks of construction contractors. As an amateur architect and an author who has written about architecture, I have my own treasured volumes. Why not? *AGS* is a classic and a testament to a long partnership between Wiley publishing and the American Institute of Architects. It may be one of the only professional reference books to have its own history, beginning with *Drafting Culture: A Social History of Architectural Graphic Standards* (MIT Press, 2008), written by practicing architect, historian, and Professor of Architecture at Georgia Tech, George Barnett Johnston.

We do not know why John Wiley (1808–1891), the son of our founder, chose to publish a book for architects and their customers, but he chose well. Andrew Jackson Downing's *Cottage Residences* was published by Wiley & Putnam in 1842. An influential pattern book of houses, it was consulted across America by house builders and led to the widespread construction of residences in the picturesque "Carpenter Gothic" style. It is still in print today. With Downing's book, John laid the foundation for an architecture list that included many reprints of the work of John Ruskin.

The publication of the 12th edition is a defining moment in *AGS*'s 84-year history. As we like to say in publishing, content is escaping the confines of a book. The precursor for this on *AGS* was the introduction of a CD in 1996 and an ebook in 2007. In this edition, however, *AGS* becomes completely digital with its content fully searchable online. There are, of course, those who still treasure a book or prefer both print on paper and digital. The new edition will also be available in book form.

With this fully digital edition, our objective is to make an architect's work life easier. We have deepened our definition of what it means to create a complete and trusted companion for architects in the office, on a worksite, or anywhere one pleases. I haven't seen many architects climb a scaffold with an *AGS* under their arm, but I have seen many with handheld devices.

As Wiley's digital capabilities evolve, we want you, our customers, to find working with our content to be as effortless as possible. We understand this dramatic shift in the context of defining ourselves as a learning company devoted to the educational and professional needs of our customers from the beginning of their architectural education to the end of their professional careers. In premier undergraduate architecture programs with which I am familiar, students work collaboratively in digital environments foreshadowing the work environment at architectural firms where they will be employed. Even in small offices, collaboration in a digital environment is part of the work routine. In short, we at Wiley are ready to meet you, the architect, where, when, and how you work.

We believe deeply in our mission to serve you; we are appreciative of your needs; and we will continue to connect with them as we redefine publishing in a world reshaped by digital experiences.

Peter Booth Wiley

*Chairman Emeritus and Member of
the Board of Directors of John Wiley
& Sons, Inc.*

A NOTE FROM THE AIA

Across the years, *Architectural Graphic Standards (AGS)* has retained its name, and the commitment of the American Institute of Architects (AIA) has remained unwavering in its mission—to provide an indispensable resource for the design and construction industry. However, the content of *AGS*, entirely irrespective of format and media, has changed in significant ways. To serve a rapidly transforming profession, the industry’s bible had to change with it. Consider the expanding range of modern architectural practice. When the first edition of *AGS* was published more than eight decades ago, wellness, resilience, sustainability, and accessibility were not on the profession’s or *AGS*’s radar. The initiative behind Charles George Ramsey and Harold Reeve Sleeper’s first edition (1932) centered wholly around creating a “technical” touchstone of graphic standards for architectural drafting, at a time when architects were actively pursuing their professionalization as a distinct body.

Times change. Today, obesity, an aging population, and the impact of climate change have emerged as among the most urgent issues of the 21st century, issues that lend themselves to design thinking on a global scale. The current scope of architectural services has expanded enormously beyond what could ever have been imagined in the early 1930s in response to client and community needs.

Along with the “what” of architectural practice, the “how” of project delivery has likewise altered, especially in the last decade. Computers and electronic media have compressed time and space, as architecture spreads

globally. Practice is evolving toward greater collaboration. Architects can work more efficiently and creatively, but they require quick access to current technical information, from codes to new building materials, to avoid costly errors.

The 12th edition supports the ways we access and process knowledge—visually. In doing so, the latest edition of *AGS* gives new life to what the Editor-in-Chief Dennis Hall identifies as the intent of the first authors: to produce a graphic-centric resource.

I thank Dennis Hall, his editors, the countless contributors of content—both written and visual—as well as the proofreaders and fact checkers. That so many hands could weave a seamless resource testifies to their dedication to serve our varied, demanding profession.

From the very first time the AIA and Wiley joined hands as partners for the sixth edition in 1970, we have built a valued, mutually supportive relationship that has benefitted generations of architects, growing with and guiding the architectural profession in the pursuit of excellence. Through all the iterations of *Architectural Graphic Standards*, our commitment to quality continues, but never wavers. Use this distinctive new resource well, and prosper.

Robert Ivy, FAIA

EVP/Chief Executive Officer

The American Institute of Architects

ARCHITECTS' TRIBUTES TO *ARCHITECTURAL GRAPHIC STANDARDS*

To mark the publication of the 12th edition of *Architectural Graphic Standards* (AGS) and its digital launch with Architectural Graphic Standards Online (www.graphicstandards.com), Wiley approached architects from some of the most forward-looking practices in the United States; these firms were specifically selected for their strong vision and their engagement in making design and construction. We asked them to each provide a short statement, commenting on what AGS means to them, how it has contributed to their practice, and how they anticipate AGS being used in the future with the further evolution of the digital and data-driven design techniques.

What is marked is the attachment that these prominent architects all have to AGS. This is poignantly expressed by Steven Ehrlich, Founding Partner of Ehrlich Architects in Culver City, California, which won the 2015 AIA National Firm Award:

I treasure my sixth edition of *Architectural Graphic Standards*, which was given to me as a birthday present by my parents in 1973. I had just returned from three years of traveling and practicing architecture in Africa in the Peace Corps, and was starting a residential design-build practice in Vermont. My mother inscribed the book: "May this be the beginning of a very happy and exciting future." My engineer-inventor father, a tough guy, wrote, "Learn it all by heart. But if you need any further info call me. Good luck for good architecture."

I have used the AGS so much over the years that it is now literally held together by duct tape. The launch of the online edition ensures that it will continue to be an essential reference for architects in the digital age. While technology has transformed our profession in thrilling ways, we do not (yet) live in a virtual world: Buildings are still made of wood and steel and mortar.

Steven Ehrlich, FAIA, RIBA

For Robert Siegel, Design Director at Gensler, AGS has been a ubiquitous presence for an architect who thrives on design:

As F.K. Ching's *Form, Space, and Order* is to deciphering the conceptual and formal basis of architecture, *Architectural Graphic Standards* is to creating the built environment. I love to draw and invent. Since I started my practice, I've depended upon *Architectural*

Graphic Standards for its beautifully detailed dimensional diagrams at all scales: from describing the human body in space to defining the turning radii of vehicles. This information helps me to design bespoke buildings and interiors that function perfectly and are easy to use. I imagine that future editions of *Architectural Graphic Standards* will include a detailed and interactive digital model of the human body and of groups of people, both in static and dynamic modes. This information can be integrated into the design process so that the measure of human needs in architecture is more integrated than ever before.

Robert Siegel, AIA, NCARB

Corie Sharples is Principal of SHoP Architects in New York, a firm that has in the last couple of decades helped redefine the relationship between design and construction. Here she describes how AGS represents an essential information tool:

From the founding of SHoP almost 20 years ago, my partners and I recognized that there was an enormous and inefficient division between thinking and doing in architecture. A lot of what we've tried to do since is work to bridge that gap: to unify the process of design with the process of building, to close the distance between theory and practice. We've tried to prove in the real world that the best architectural results, the most creative, come when architects are able to control the process of construction through the intelligent management of building information. We've developed a lot of proprietary methods and technologies over the years to help us get there. But, looking back, even to the time before our firm bought its first computer, we had a copy of *Graphic Standards* by our side. The clarity of images and diagrams in the book was an early inspiration for our own approach to communication. It was our first real information tool: a resource so complete in its technical data that it let our creativity run free.

Corie Sharples AIA

Claire Weisz, Principal-in-Charge of WXY Studio, an award-winning urban design and planning office, also in New York, closes by reminding us not only

how *AGS* provides a visual lexicon, but also how its development over time acts as an effective barometer as summed up by the great Modernist architect Eero Saarinen in a foreword to the 1956 edition:

As far as touchstones of architecture practice go, *Architectural Graphic Standards* is our lexicon. Not only do we need and use the latest edition in our libraries, but we also see the book as a milestone of achievement; as a way to measure the passage of time whereby nothing is lost. Years ago the principal at my first job in architecture rewarded my youthful enthusiasm with his fifth edition from 1956—since the sixth has long been in use. With a foreword written by no other than Eero Saarinen—and in a great-looking font—it remains within close reach of my desk to this day. Not every book has a summary from one of architecture’s luminaries and it doesn’t disappoint in its clear snapshot. Agreeing with his predecessors’ estimate of its value as an essential part of architectural practice, serving to gather facts and references

too complex to be memorized and, perhaps more critically, too scattered to be found in one place in an architect’s office. But in particular I am fond of how he used the wonderful term “contemporaneous” to describe its essential value. That is what is striking about the mechanism of reissuing it as needed by the field. Saarinen in ending his evaluation of *Architectural Graphic Standards* stated that it “will show the future the dizzy speed and expanding horizons of architectural development and practice in our time.” Now after almost 60 years dizzying may be an understatement, but this index to the state of the art of building today still holds its own.

Claire Weisz, FAIA

With thanks to Steven Ehrlich, Robert Siegel, Corie Sharples, and Claire Weisz.

TIMELINE

The increase in size and complexity of *Architectural Graphic Standards* since its initial publication has mirrored the extraordinary accomplishments of architecture in the 20th century.

<i>Architectural Graphic Standards Highlights</i>	Architecture Landmarks
	1910 —→ <i>Pennsylvania Station</i> , New York, New York (McKim, Mead and White)
John Wiley & Sons publishes <i>Architectural Details</i> , a prototype for <i>Architectural Graphic Standards</i>	1924
	1929 —→ <i>La Villa Savoye</i> , Poissy, France (Corbusier)
	1930 —→ <i>Chrysler Building</i> , New York, New York (William Van Alen)
Wiley publishes first edition of <i>Architectural Graphic Standards</i>	1932
	1934 —→ <i>Fallingwater</i> , Bear Run, Pennsylvania (Frank Lloyd Wright)
10,000th copy sold	1936
100,000th copy sold	1947
	1949 —→ <i>The Glass House</i> , New Canaan, Connecticut (Philip Johnson)
Fourth edition published: changes in building technology trigger 80% increase in length over prior edition	1951
Fifth edition published: final edition prepared by Charles Ramsey and Harold Sleeper	1956
	1958 —→ <i>Seagram Building</i> , New York, New York (Ludwig Mies van der Rohe)
	1966 —→ <i>Salk Institute</i> , La Jolla, California (Louis Kahn)
Sixth edition published: first edition edited by American Institute of Architects; incorporates Uniformat organization	1970 —→ <i>John Hancock Center</i> , Chicago, Illinois (Bruce Graham/Skidmore Owings and Merrill)
	1973 —→ <i>AIA Headquarters</i> , Washington, DC (The Architects Collective)
	1977 —→ <i>Centre Pompidou</i> , Paris, France (Richard Rogers and Renzo Piano)
	1978 —→ <i>National Gallery of Art East Wing</i> , Washington, DC (I.M. Pei)
	1982 —→ <i>Vietnam Veterans Memorial</i> , Washington, DC (Maya Lin)
Ninth edition published: incorporates ADA guidelines; new material on building systems and energy-efficient design	1994
First digital version of <i>Architectural Graphic Standards</i> released as CD, version 1.0	1996 —→ <i>J. Paul Getty Museum</i> , Malibu, California (Richard Meier)
	1997 —→ <i>Guggenheim Museum</i> , Bilbao, Spain (Frank Gehry)
1,000,000th copy sold	1999 —→ <i>Reichstag</i> , New German Parliament, Berlin, Germany (Foster + Partners)
	—→ <i>Jewish Museum Berlin</i> , Berlin, Germany (Daniel Libeskind)
Tenth edition of book and version 3.0 of CD published	2001
	2003 —→ <i>The Gherkin</i> , 30 St Mary Axe, London, UK (Foster + Partners)
Graphic Standards franchise expands with the release of <i>Interior Graphic Standards</i>	2004 —→ <i>Seattle Central Library</i> , Seattle (Rem Koolhaas/OMA)
	2005 —→ <i>De Young Museum</i> , San Francisco (Herzog & de Meuron)
In conjunction with American Planning Association, <i>Planning and Urban Design Standards</i> is released	2006
Landscape Architectural Graphic Standards published	2007 —→ <i>Metropol Parasol</i> , Seville, Spain (Jürgen Mayer H)
To celebrate its 75th anniversary, eleventh edition of book and version 4.0 of CD published	
John Wiley & Sons celebrates 200th anniversary	
The American Institute of Architects celebrates 150th anniversary	2008 —→ <i>The Bird's Nest</i> , National Stadium for Beijing Olympic Games, Beijing (Herzog & de Meuron)
	2009 —→ <i>MAXXI Museum</i> , Rome (Zaha Hadid Architects)
Second Edition of Architectural Graphic Standards for Residential Construction book and CD-ROM 1.0 release	2010 —→ <i>Burj Khalifa</i> , Dubai (Skidmore, Owings and Merrill)
Interior Graphic Standards, 2nd Edition and CD 2.0 release	
	—→ <i>Guangzhou Opera House</i> , The People's Republic of China (Zaha Hadid Architects)
	2012 —→ <i>The Shard</i> , London (Renzo Piano)
	2014 —→ <i>One World Trade Center</i> , New York, New York (David Childs of Skidmore Owings & Merrill)
	2015 —→ <i>The Shanghai Tower</i> , Shanghai, The People's Republic of China (Gensler)
Architectural Graphic Standards 12E releases	2016
Architectural Graphic Standards Online launches	

INTRODUCTION

A BAROMETER OF CHANGE

As the go-to book for architects for over eight decades, *Architectural Graphic Standards (AGS)* provides a unique barometer for measuring change within the industry: tracking and assimilating shifts and innovations within the design/construction sector with each new edition. Change has never been more apparent or intense than in the last two decades, as the widespread adoption of technology has prompted significant transformation of the industry. This has had a far-reaching impact not only on the medium in which buildings are designed and constructed, but also on processes, standards, analytics, and ways of delivering professional services. Changes encompass the expansion of project delivery methods and role changes; new building codes and industry practices, which have been extended to include accessibility, sustainability, and building resilience guidelines; new building products and construction methods; and an evolution of new and expanded building information management organizational standards.

While all these changes are significant in the evolution of architectural graphics and the standards of practice of the architect, the expanding range of practice tools now available to architectural professionals has had a much more far-reaching effect. Only three decades ago, architects labored over drafting boards, producing so-called “working drawings” for the purpose of providing the contractor with a complete set of instructions on how to put together the building. Specifications were carefully written to reflect materials and methods of construction. However, as design professionals sought to shift liability away from themselves for the construction issues and new design and production tools increased production efficiency and the ability to manage building information, the final work product of the architect has evolved into “design intent” documentation. This type of construction document is more generic and highly dependent upon contractor coordination drawings and manufacturer’s information, in order to explain the actual building construction. Building codes have recognized these changes in construction documents and have codified some building product manufacturers’ installation instructions, as requirements to provide the minimum information necessary to construct buildings and to protect the health, safety, and welfare of the public.

Now with the 12th edition, *AGS* is undergoing a watershed moment in its own evolution as it shifts from being defined purely by the page and becomes available digitally online for the first time. Content is being liberated from the confines of a book binding and the limits of its previous electronic

formats, whether as an ebook or in a CD form, to become a highly searchable online tool. Though it still remains available in print and ebook formats to provide users with the information in the medium of their choice, the online version fully acknowledges that *AGS* as an indispensable source for design and technical information for practitioners has to reflect the practices of architects of today: a profession that now spends nearly every day on screen and only has seconds available to search for the essential nugget of information it requires.

REVIVING THE GRAPHIC

Despite new online developments, the editorial vision for the 12th edition of *AGS* marks a return to the publication’s essential characteristic—its highly visual quality—which generations of architects have prized. An over-arching aim of this edition has been to restore the more graphic-centric content. This remains true to the primary intent of the original authors, Charles George Ramsey (1884–1963) and Harold Reeve Sleeper (1893–1960); it has also been central to *AGS*’s success across the years as it is entirely in tune with how architects consume and communicate design information. To optimize on the effectiveness of this, it was also our ambition to provide more focused information. The editors constantly asked us, “What do architects need to know about this subject matter?” Our goal was to eliminate unimportant content and concentrate on relevant knowledge, ensuring that information is presented in a manner that is clear, complete, concise, and correct. Finally, we wanted to recognize the evolution of construction documents and were mindful of today’s best industry practices. It is also important to recognize what *AGS* is not. This book is not intended to repeat information in *The Architect’s Handbook of Professional Practice* (American Institute of Architects, 15th edition, Wiley, 2014), regarding firm management, project delivery, or contracts, but complement that knowledge with more technical information on the graphic instruments in the service of the architect. While *AGS* does not focus on building types or spaces, some design information regarding the construction of unique spaces and building types is included. The 12th edition of *AGS* concentrates on the core knowledge of architectural design and the creation of the built environment. As the great architect and educator Mies van der Rohe liked to say: “Architecture begins when you place two bricks carefully together.” Likewise, Mario Botta said, “The first act of architecture is to put a stone on the ground. That act transforms a condition of nature into a condition of culture; it’s a holy act.” Both architects

understood the importance of how to use materials creatively and correctly in creating great architecture. *AGS* will continue to provide architects with the knowledge to understand the elements of a building and the implications of technology and construction as part of the design process.

ORGANIZING AND MANAGING BUILDING INFORMATION

While graphics are a far better medium for communicating design ideas than words, in today's complex world of "big data," words are necessary to convey building performance requirements and other nongraphic information. As architects, we are not only the designers of our buildings, but also the managers of the information necessary to procure, construct, and operate the facility. *AGS* recognizes the importance of terminology as notations on drawings, building code requirements, manufacturer's installation instructions, and for electronic search tools. Careful attention has been paid to ensure the consistent use of proper construction terminology throughout *AGS*. Terminology has been coordinated with the 2010 edition of UniFormat™, MasterFormat™ 2014 Update, the OmniClass Construction Classification System™ tables, and the International Building Code. These building information organizational structures are used in *AGS* as a means of organizing chapters into sections and information within the chapters. We can also expect the future of architectural graphics to be highly dependent upon the ability to organize, retrieve, and reuse information.

THE FUTURE OF ARCHITECTURAL GRAPHICS

Architectural graphics as a part of the architect's instruments of service have evolved and will continue to do so. The interoperability of building information is critical to the future of a profession and an industry that must improve

efficiency in processes and building performance. This is dependent upon our ability to gather, manage, and use building information to achieve better aesthetic, functional, and technical performance of our designs. International efforts in the creation of global unique identifiers (GUIDs) that associate properties of construction objects with specific products is a first step in achieving this goal, but we can only achieve goals we can measure and we must develop practice tools to verify and monitor building performance at every level. These evolving practice tools are only a few of the evolutionary changes in a rapidly expanding industry of traditional and specialty practices. For the last 84 years, *AGS* has sought to provide design professionals, owners, and contractors knowledge regarding best practices in architectural graphics as a means of creating architecture. We recognize the changes and challenges of our industry and are poised to create electronic tools to continue the legacy of Ramsey and Sleeper in sharing design knowledge. The new online version of *AGS* will enable continuous updates of critical information and the latest standards of practice. The ability to link knowledge from a wide array of Wiley design publications and industry experts will make this tool truly indispensable.

The American Institute of Architects (AIA) was founded upon the lofty goal of architects working together to improve our profession and the creation of the built environment through knowledge sharing. I am honored and pleased to have contributed to this worthy goal and the 12th edition of *Architectural Graphic Standards*.

Dennis J. Hall, FAIA, FCSI

*Editor-in-Chief of Architectural
Graphic Standards*

PREFACE

For more than eight decades, the Architectural Graphics Standards (AGS) has been the iconic book, which guided the design of the built environment in the 20th and 21st century North American by bringing complex ideas to visual life like no other comprehensive manuscript. The AGS is an indispensable professional resource that articulates the state-of-the-art in holistic building design and construction through a graphic-centric composition. The visual delivery of information uniquely unites the gap between concept and practice with incredible content breadth and depth.

Revised for the first time since 2008, the AGS Student Edition thoughtfully frames the significantly new and updated content into an academic companion piece suitable for a wide range of design and technical curricula throughout a student's architecture education, and even into the early stages of professional practice. The Student Edition covers the design and documentation process for the building materials and elements of several project types, and features considerably new and updated content such as the emergent theme of resiliency in buildings. A strong index offers direct access to hundreds of architectural elements from over a thousand illustrations.

You will discover that this flagship book is much more than our first 'go-to' resource. The book bears stories of legend. I urge you to find your professor's AGS on her bookshelf and ask. You will see a face light up and regale in a reflective tale of late night studio adventures. Architecture is a passion that burns in many of us, and your new Student Edition is the tinder. Virtually everything needed to realize a design idea is at your fingertips, as you will experience your own swashbuckling tales of enlightenment.

Many thanks to the AIA, and the AGS editors and contributors in establishing the truly exceptional underlying framework; the Wiley team of Margaret, Lauren, Kalli, and others for injecting life into the Student Edition and bringing it to fruition; the advisory board of Chris, Danielle, Leslie, Michael, Randy, Tony, and Traci for their insightful feedback; and my wife Kathy and children Sarah and Brice for their patience and encouragement.

Keith E. Hedges, AIA, NCARB

*Editor-in-Chief of Architectural
Graphic Standards, Student Edition*

SECTION 1

DESIGN PRINCIPLES & CONSTRUCTION DOCUMENTATION

CHAPTER 1

3 Functional Planning

CHAPTER 2

31 Environment

CHAPTER 3

53 Resilience in Buildings

CHAPTER 4

77 Architectural Construction Documentation

FUNCTIONAL PLANNING

1

- 4 **Human Factors**
- 9 **Universal and Accessible Design**

HUMAN FACTORS

Human factors information refers to the variables that affect human performance in the built environment, such as human physiology and human psychology. Data accumulated from the fields of engineering, biology, psychology, and anthropology are integrated in this multidisciplinary field. "Fit" describes a design that uses human factors information to create a stimulating but nonstressful environment for human use. Some areas of fit are physiological, psychological, sensual, and cultural.

ANTHROPOMETRICS AND ERGONOMICS

The field of anthropometrics provides information about the dimension and functional capacity of the human body. "Static anthropometrics" measures the body at rest; "dynamic anthropometrics" measures the body while performing activities defined as "work." Dimensional variation occurs in anthropometric data because of the large range of diversity in the human population. To utilize anthropometric charts effectively, a designer must identify where a subject user group falls in relation to these variables. The factors that cause human variations are gender, age, ethnicity, and race. Patterns of growth affected by human culture cause variation in human measure as well. Percentiles that refer to the frequency of occurrence

describe dimensional variation on anthropometric charts: that is, the mean percentile (50 percent), the small extreme percentile (2.5 percent), and the large extreme percentile (97.5 percent). "Ergonomics" is the application of human factors data to design. This term was coined by the U.S. army when it began to design machines to fit humans, rather than trying to find humans to fit machines.

HUMAN BEHAVIOR

Human behavior is motivated by innate attributes such as the five senses and by learned cultural attributes. Each human has a unique innate capacity to gather sensual information. How that information is understood is determined by personal and cultural experience. "Proxemics" is the study of human behavior as it relates to learned cultural behavior. Human behavior is motivated by the innate nature of the animal, and this behavior is expressed and modified by each person's learned culture and traditions.

INNATE HUMAN ATTRIBUTES

The five senses determine human comfort levels in the environment and are a part of human factors studies.

- *Site:* Behavioral scientists agree that, for human beings, seeing is the most engaged sense for gathering information. Physical form is perceived when visual data is organized into patterns,

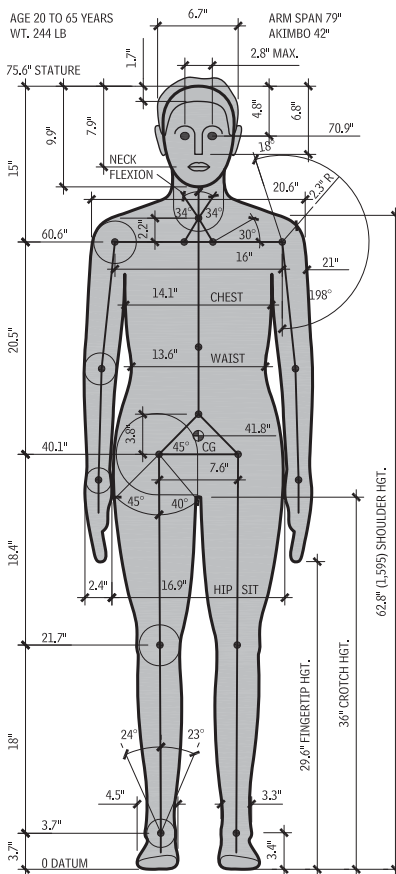
and that data is integrated with memories and emotions. Visual form is perceived as having a context with boundaries. Visual form can be understood to be a dynamic system of directional lines of forces that are innate, kinetic, and independent of the representational content of a form. Once a form's attributes have been perceived, humans tend to give the perceived form symbolic meaning. This meaning is cultural and personal, resulting from associations and past experiences.

- *Touch:* Touch is essential to human development and growth. Texture is learned most completely through skin contact. Human skin is sensitive to temperature, pain, and pressure. Vision and touch are interwoven in sighted humans. Memory of tactile experiences allows humans to understand their environment through visual scanning.
- *Hearing:* Humans can use hearing to determine distances. Sound moves in concentric circles and in horizontal and vertical planes. The ear transmits these airborne vibrations to the brain where it is processed and assigned meaning. The ability to focus hearing is called "sensory gating." The ability to gate sound varies and diminishes with aging.
- *Smell and taste:* Research about smell is difficult to conduct because human sensitivity to smell is highly variable over time and from person to person. A person's sense of smell to an odor can fatigue quickly during exposure. Smell is defined in terms of commonly perceived odors such as flowery, putrid, burned, resinous, and spicy. Taste and smell are closely related in human experience.

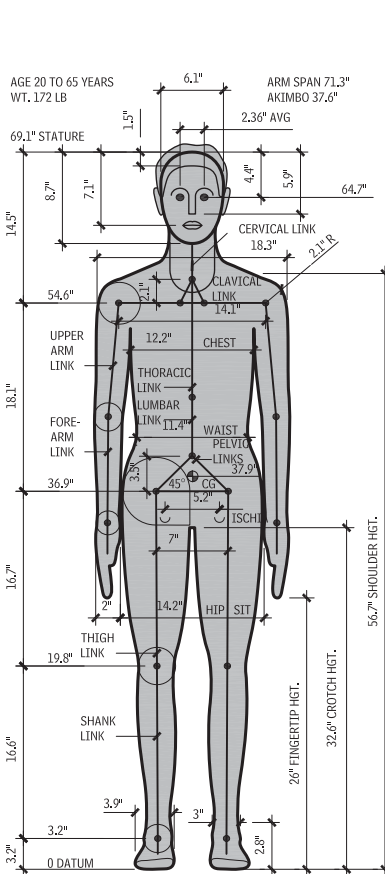
ANTHROPOMETRIC DATA

MEASURE OF MAN—FRONT VIEW

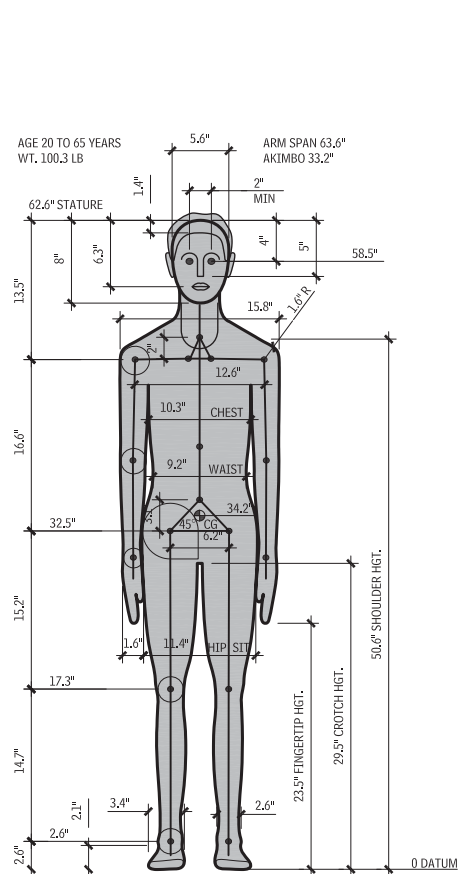
99 PERCENTILE MAN



50 PERCENTILE MAN

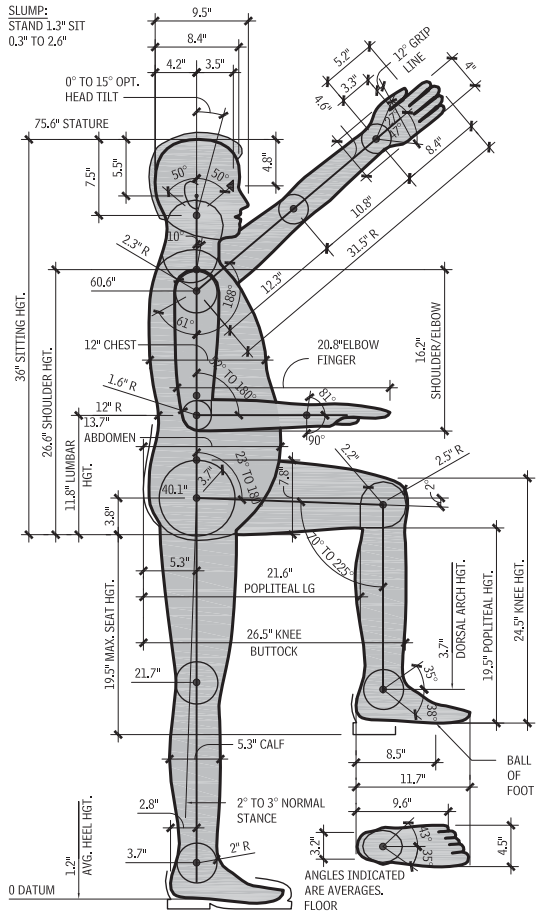


1 PERCENTILE MAN

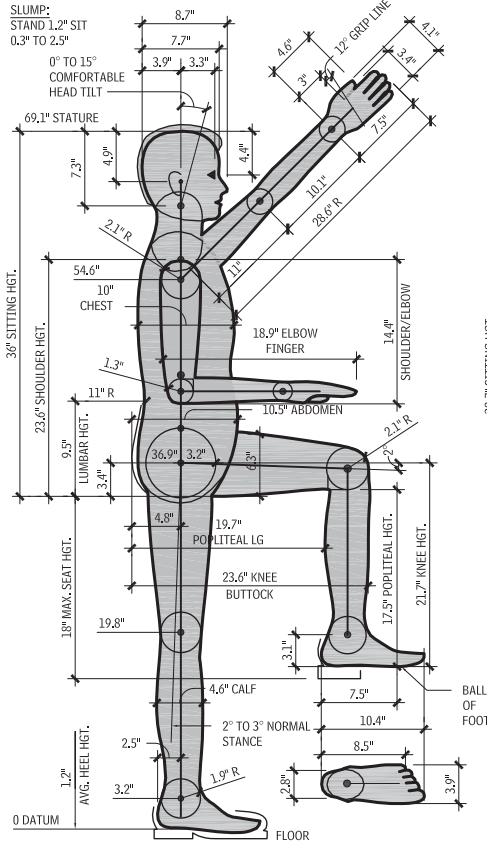


MEASURE OF MAN—SIDE VIEW 1.2

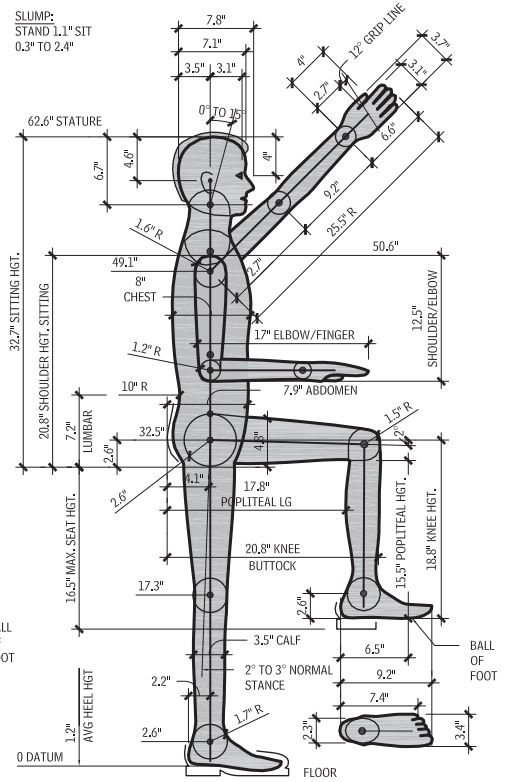
99 PERCENTILE MAN



50 PERCENTILE MAN



1 PERCENTILE MAN



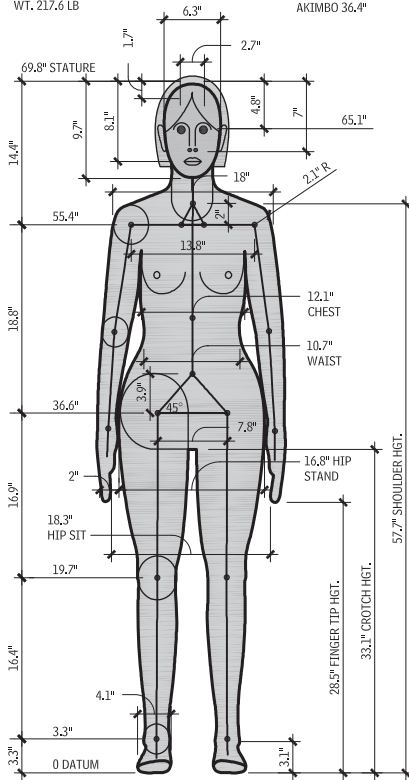
6 FUNCTIONAL PLANNING HUMAN FACTORS

MEASURE OF WOMAN—FRONT VIEW 1.3

99 PERCENTILE WOMAN

AGE 20 TO 65 YEARS
WT. 217.6 LB

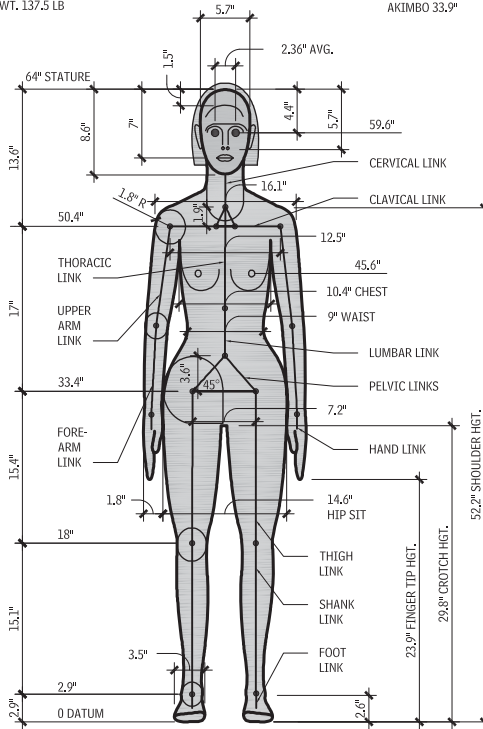
ARM SPAN 70.8"
AKIMBO 36.4"



50 PERCENTILE WOMAN

AGE 20 TO 65 YEARS
WT. 137.5 LB

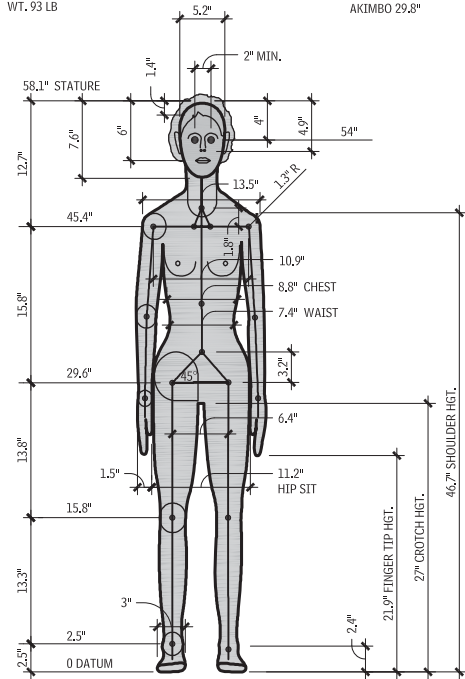
ARM SPAN 65.3"
AKIMBO 33.9"



1 PERCENTILE WOMAN

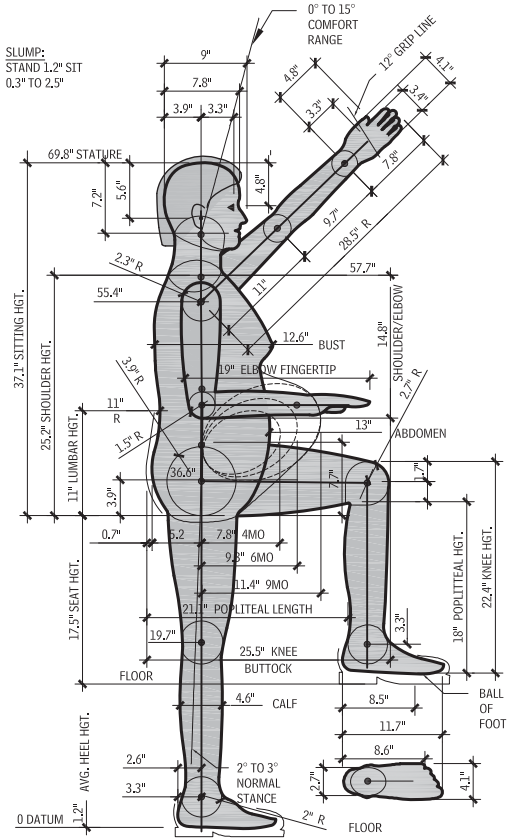
AGE 20 TO 65 YEARS
WT. 93 LB

ARM SPAN 57.9"
AKIMBO 29.8"

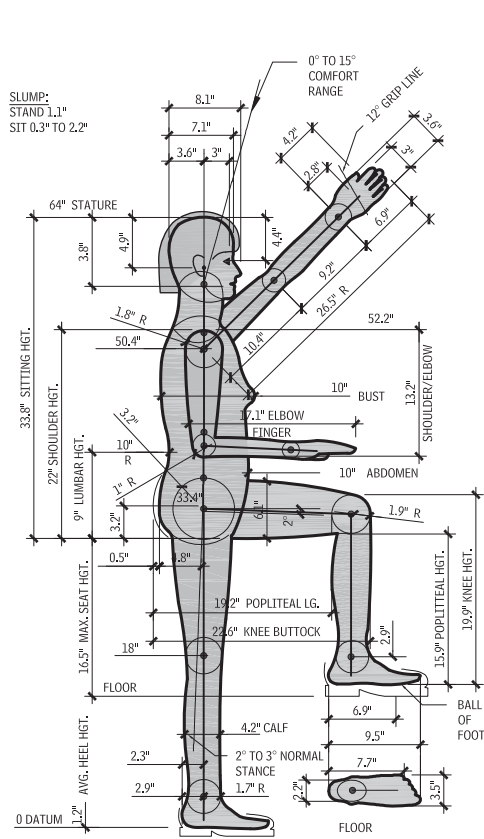


MEASURE OF WOMAN—SIDE VIEW
1.4

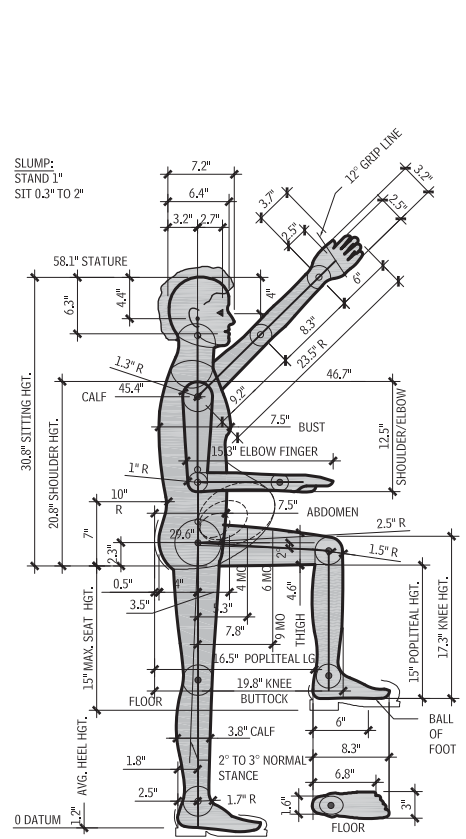
99 PERCENTILE WOMAN



50 PERCENTILE WOMAN

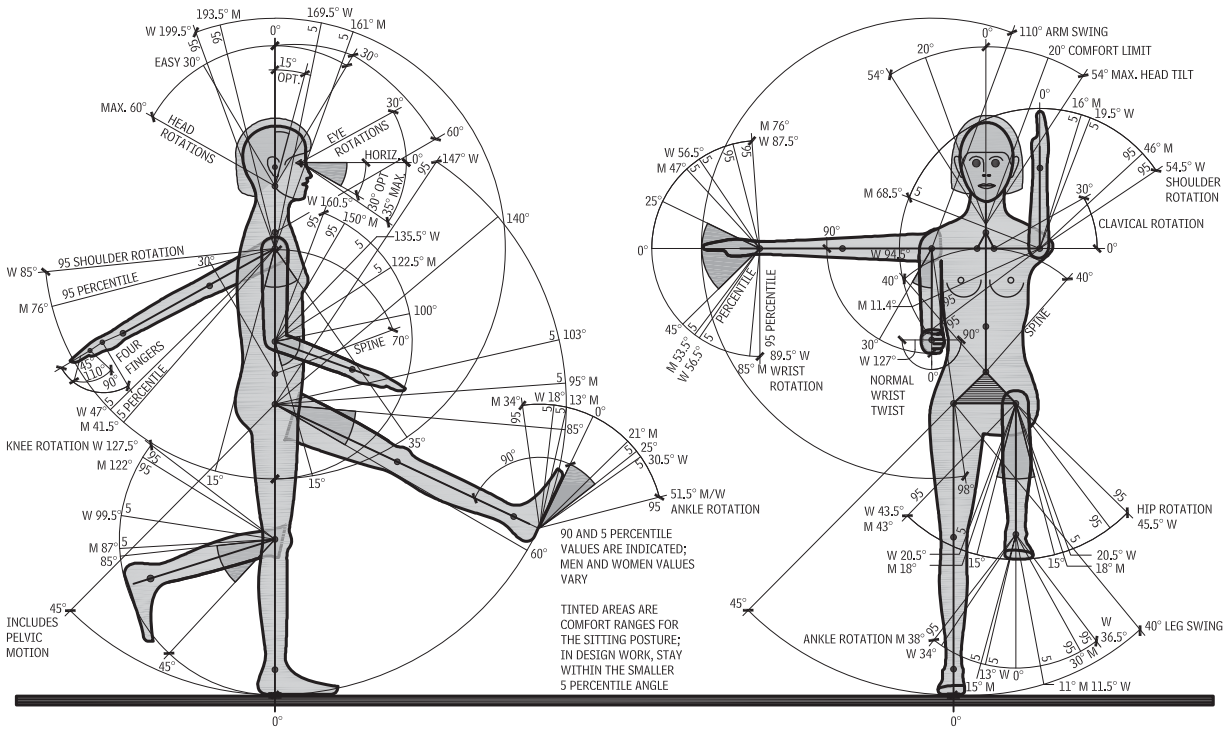


1 PERCENTILE WOMAN

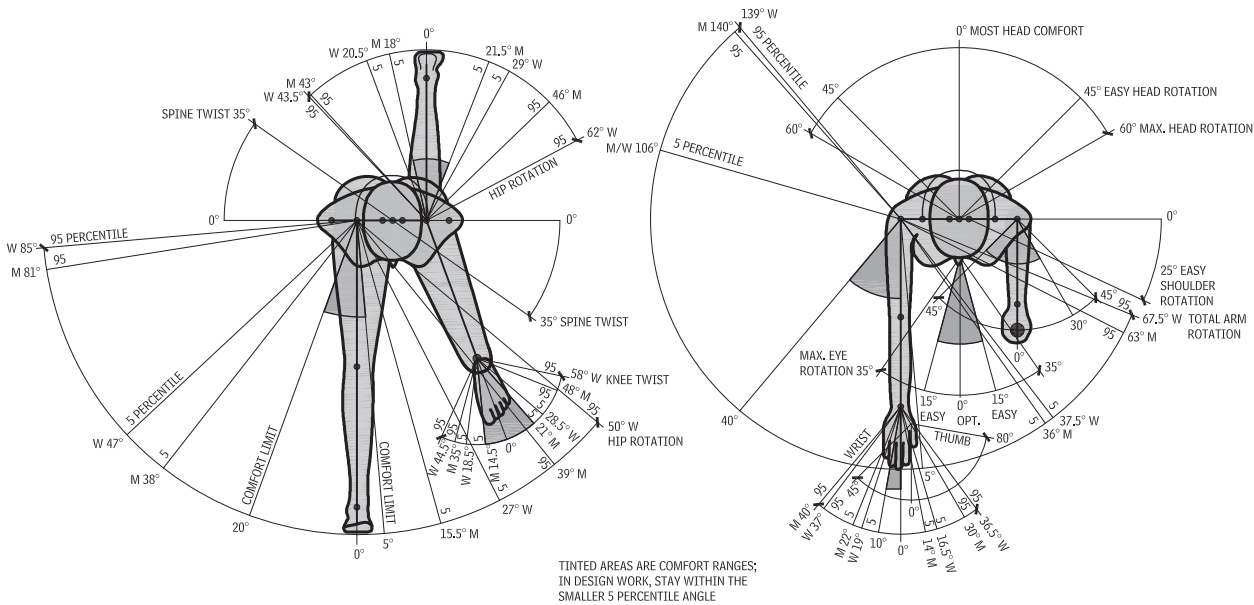


8 FUNCTIONAL PLANNING HUMAN FACTORS

ANGLE MOVEMENTS OF BODY COMPONENTS 1.5



ANGLE MOVEMENTS OF BODY COMPONENTS—TOP VIEW 1.6



NOTE

1.1–1.6 Timeline data adapted from Papilia and Wendkos Olds, 1989.

Contributor:

Alvin R. Tilley, Henry Dreyfus Associates, *The Measure of Man & Woman: Human Factors in Design*, John Wiley & Sons, New York, 2001.

UNIVERSAL AND ACCESSIBLE DESIGN

“Universal design is a process that enables and empowers a diverse population by improving human performance, health and wellness, and social participation” (Steinfeld and Maisel, 2012). Proponents of universal design view it as an approach to good design, and they posit that by considering the full range of human ability across our lifetimes (small/big, young/old, with varying abilities across every size and every stage of life), designers can provide better environments for everyone. In short, “Universal design strives to make life easier, healthier, and friendlier for all people” (Steinfeld and Maisel, 2012). While universal design must also be accessible, it exceeds the minimum requirements of accessible design standards to provide optimum conditions for people with and without disabilities.

Some equate universal design with accessible design; however, there are distinct differences. Accessible design is the design of a certain percentage of features to conform to technical requirements as required by laws such as the Architectural Barriers Act (ABA), the Rehabilitation Act, the Fair Housing Amendments Act (FHAA), and the Americans with Disabilities Act (ADA). It does not guarantee inclusion for everyone, nor does it guarantee good design in a holistic sense.

This section will explain the differences and relationship between these two very different approaches to design. One addresses the full range of human experience and abilities and the other derives from an accommodation model that has a narrower focus. The section will provide details on the basic minimum requirements for accessible design and offer suggestions on where designers should exceed the minimum to provide a more welcoming and inclusive environment for all people by addressing universal design goals.

This section is divided into three subsections:

- **Universal design:** This subsection will provide a background on the philosophy and goals of universal design and present four case studies of universal design in public buildings and housing.
- **Accessible design:** This subsection will discuss the legislative history and regulatory process of accessible design and introduce important federal laws such as the Americans with Disabilities Act (ADA), Fair Housing Amendments Act (FHAA), Architectural Barriers Act, and the Rehabilitation Act.
- **Technical criteria:** This subsection will provide detailed drawings for how to comply with key accessible design standards and provide suggestions on how to exceed those standards to exemplify best practices in universal design.

UNIVERSAL DESIGN

Our bodies and minds are in a constant state of change across our lifetime. We are not static. We are also exceedingly diverse— young and old, small and big, fast and slow; we come in shades of many skin colors and with many different backgrounds, aspirations, and ways of life. Increasingly, we humans are gaining more control over our world, our bodies, and our minds. To design universally is to design for improving the human experience of the built environment for all. It recognizes that the designed environment can improve life experiences at the individual and societal level. Universal design is a manifestation of the increasing control we have over our world, through discovery and application of knowledge. In addition to being a philosophy that puts the needs of people first, universal design has a practical side as well. Universal design is a continual improvement process that seeks to achieve the best possible outcomes with the means available, recognizing that not every project and context has the resources available.

Universal design is most successful when fully integrated within a project. As a design movement, it is the result of a meeting of minds between human-centered design approaches and the disability rights movement. In the 1970s, architect Michael Bednar suggested that the value of “barrier free design,” the term used at the time to address the removal of design practices that discriminated against people with disabilities, extends to all of us, not just

the few barrier free environments (*Barrier Free Environments*, Stroudsburg, PA: Dowden, Hutchinson, and Ross, Inc., 1977).

Ron Mace would give the movement its name and its first definition in his book, *Universal Design: Barrier Free Environments for Everyone* (Los Angeles, CA: Designers West, 1985): “Universal design is the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design.”

In the 1990s, Mace worked with a group of fellow advocates and designers (architects, product designers, engineers, and environmental design researchers) to create the Principles of Universal Design, providing a conceptual framework for implementing universal design as an essential part of good design. The authors of the Principles argued that there was a business case for widespread adoption of the concept—increasing markets through the design of more usable products and environments. This marked a significant shift away from the regulatory approach taken by codes and standards. The Principles included a set of design criteria focused primarily on issues of usability: (1) equitable use, (2) flexibility in use, (3) simple and intuitive use, (4) perceptible information, (5) tolerance for error, (6) low physical effort, and (7) size and space for approach and use.

While the Principles proved to be valuable to early adopters of universal design, proponents of the concept across the world recognized that usability alone is not sufficient to encourage widespread adoption and to address design goals important to the broader population (see Steinfeld and Maisel, 2012). For example, more usable environments alone do not necessarily open opportunities for participation in society for people with disabilities, women, or minority groups. What good is a more usable school building to women if the schools do not provide enough security for their safe education? Additionally, a neighborhood design that does not support walking contributes to increased levels of obesity and further disability, regardless of how usable the buildings in a community might be. In addition, the Principles did not provide any evidence base or benchmarking strategy for achievement. In order to encourage adoption by the broader professional community and public, the Center for Inclusive Design and Environmental Access (IDEA Center) at the University at Buffalo—State University of New York developed eight Goals of Universal Design to complement

the Principles. Each of the eight goals represents specific outcome measures and corresponds to a knowledge base from research in fields including human performance, social participation, and wellness. The first four goals focus on human performance in the knowledge areas of anthropometry, biomechanics, perception, and cognition, while the last four goals address health and social participation outcomes.

EIGHT GOALS OF UNIVERSAL DESIGN

GOAL ONE: BODY FIT

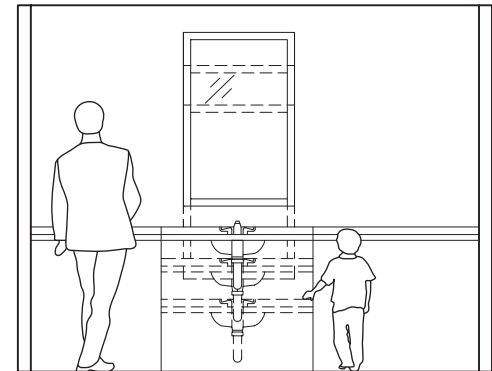
Accommodate a wide range of body sizes and abilities (see Figure 1.7).

GOAL TWO: COMFORT

Keep demands within desirable limits of body function (see Figure 1.8).

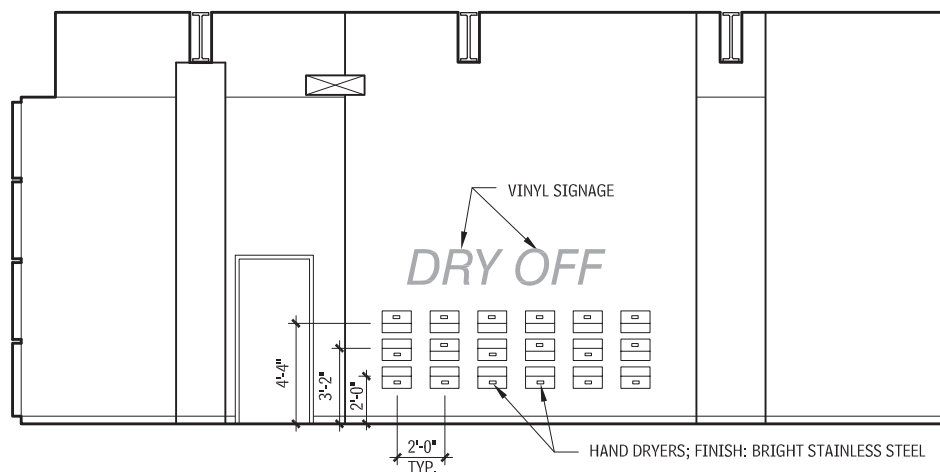
ADJUSTABLE-HEIGHT LAVATORY AND VANITY 1.8

In addition to achieving the goals of body fit and personalization, this adjustable-height lavatory and vanity allows adults and children to comfortably reach the faucets and use the mirror.



WATER PLAY ENVIRONMENT—WALL OF DRYERS 1.7

Architect Koning Eizenberg Architecture and the exhibit designers, Springboard Architecture Communication Design, turned a mundane hand dryer into something more at the Pittsburgh Children’s Museum. They took an object that is simple to use and clear in its utility, multiplied it, mounted it within multiple reach ranges, and transformed it into an experience.



NOTE

1.7 Springboard Architecture Communication Design LLC, Pittsburgh.

Contributors:

Dr. Ed Steinfeld, AIA and Jonathan White, Center for Inclusive Design and Environmental Access (IDEA Center), University at Buffalo, New York