

# ACRP is an Industry-Driven Program

- ✈ Managed by TRB and sponsored by the Federal Aviation Administration (FAA).
- ✈ Seeks out the latest issues facing the airport industry.
- ✈ Conducts research to find solutions.
- ✈ Publishes and disseminates research results through free publications and webinars.



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# Opportunities to Get Involved!

- ✈️ ACRP's Champion program is designed to help early- to mid-career, young professionals grow and excel within the airport industry.
- ✈️ Airport industry executives sponsor promising young professionals within their organizations to become ACRP Champions.
- ✈️ Visit ACRP's website to learn more.



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# Join us for the 2018 ACRP Symposium on Research in Progress ...at the TRB Annual Meeting!

**Date:** Sunday, January 7, 2018

**Time:** 8:00 am to 4:00 pm

**Location:** See the TRB Annual Meeting Program  
<http://www.trb.org/AnnualMeeting/InteractiveProgram.aspx>

With a special interactive session on  
*Alternatives to Surveys*  
*Will be available via webinar!*

Webinar registration:  
<https://register.gotowebinar.com/register/555971740472566787>

**Questions?**

Email us at: [Plsymposium@erg.com](mailto:Plsymposium@erg.com)

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# ACRP | INSIGHT EVENT

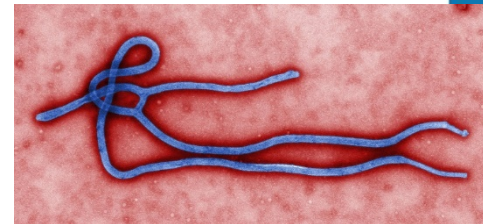
## Airport Roles in Reducing Transmission of Communicable Diseases

March 6 – 7, 2018 • Washington, D.C.

### Featured speakers:

- CAPT Martin Cetron, MD – Director, CDC's Division of Global Migration and Quarantine (DGMQ)
- Dr. Ansa Jordaan – Chief, Aviation Medicine Section, International Civil Aviation Organization
- Dr. Petra Illig – Aviation Medical Services, Alaska
- Dr. Kamran Khan – St. Michael's Hospital, Toronto

Moderated discussion by outbreak responders from Dallas-Fort Worth, New York City, Phoenix, and Portland.



Ebola virus virion  
by CDC microbiologist, Cynthia Goldsmith

**Register for FREE:**  
[bit.ly/ACRPMarchEvent](http://bit.ly/ACRPMarchEvent)

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# Upcoming ACRP Webinars

**January 18, 2018**

Uses of Social Media During an  
Airport Emergency

**January 31, 2018**

Transportation Network Companies:  
Challenges and Opportunities  
for Airport Operators

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# Additional ACRP Publications Available on this Topic

**Report 25:** Airport Passenger Terminal Planning and Design

**Report 52:** Wayfinding and Signing Guidelines for Airport Terminals and Landside

**Report 55:** Passenger Level of Service and Spatial Planning for Airport Terminals

**Report 130:** Guidebook for Airport Terminal Restroom Planning and Design

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# Today's Speakers

**Jim Harding – Gresham, Smith, and Partners; and  
Laurel Van Horn – Open Doors Organization**

## **Presenting**

*Report 177: Enhancing Airport Wayfinding for the  
Elderly and Persons with Disabilities*

---

**Richard Carman and Deborah Jue – Wilson Ihrig  
Joel Lewitz – Audiovisual Consultant**

## **Presenting**

*Report 175: Improving Intelligibility of Airport  
Terminal Public-Address Systems*

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TRANSPORTATION RESEARCH BOARD

# Enhancing Wayfinding and Public Address Systems for a Positive Traveler Experience

**Wednesday, December 13, 2017**  
**2:00pm to 3:30pm ET**



# Purpose

Discuss research from the [Airport Cooperative Research Program](#) (ACRP)'s [Research Report 175](#): Improving Intelligibility of Airport Terminal Public Address Systems and [Research Report 177](#): Enhancing Wayfinding for Aging Travelers and Persons with Disabilities.

## Learning Objectives

At the end of this webinar, you will be able to:

- Identify how practices and recommendations for assisting aging travelers and persons with disabilities are based on the principles of universal design
- Describe the wayfinding accessibility audit checklist
- Understand the guidelines for developers of mobile apps for aging travelers and persons with disabilities
- Understand how to provide practical and actionable information that airports and their consultants can use in designing, procuring, installing and operating, training, and maintaining PA systems





# ACRP Report 175: Improving Intelligibility of Airport Terminal Public Address Systems

Richard Carman

Deborah Jue

Joel Lewitz

# ACRP 07-14 Research Team

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## **Wilson Ihrig**

Richard Carman

Deborah Jue

Gary Glickman

## **HKS Architects**

Rick Lee

Lee Glenn

## **AV Consultant**

Joel Lewitz

## **CCD (Human Factors)**

Adam Parkes

David Watts

Karen Jackson

## **Cross-Spectrum Acoustics**

Herb Singleton

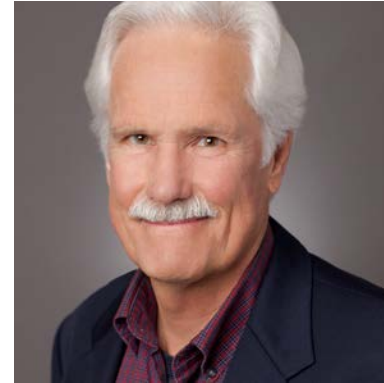
## **Chips Davis Designs**

Chips Davis



# Presenters

Richard A. Carman, PhD, PE  
Principal Investigator  
Emeritus Senior Principal, Wilson Ihrig



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Deborah A. Jue, INCE-USA  
Principal, Wilson Ihrig

Joel A. Lewitz, PE, FASA, FAES  
AV design consultant



# ACRP Report 175

## Oversight Panel

Timothy M. Mitchell, Boeing (Chair)

Christopher Blasie, Rockwell Collins/ARINC Airports

Alan G. Hass, Landrum and Brown

Darryl K. McDonald, Austin Commercial, LP

Heather McKee, Denver International Airport

Amiel Porta, San Diego County Regional Airport  
Authority

Holly Cyrus, FAA Liaison

Theresa H. Schatz, Senior Program Officer

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# Objective

The objective of this research is to develop design guidelines to improve public-address speech intelligibility for passenger processing-interfaces for all types and sizes of airport terminal environments.

These guidelines are intended to be used by airport operators and design consultants.

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# Participating Airports

Anchorage International Airport  
Broward County Aviation Department  
Burlington International Airport  
City of Chicago/Department of Aviation  
City of Boise/Boise Airport  
City of Phoenix Aviation Department  
City of San Antonio/SAAS  
Corpus Christi International Airport  
Dallas/Fort Worth International Airport  
Denver International Airport  
Fairbanks International Airport  
Fort Wayne International Airport  
Los Angeles World Airports  
Maryland Aviation Administration  
Maryland Aviation Administration (BWI)  
McCarran International Airport

Metropolitan Airports Commission  
Monterey Regional Airport  
Nantucket Memorial Airport  
Oakland International Airport  
Philadelphia International Airport  
Pittsburgh International Airport  
Portland International Airport  
Prince George Airport Authority  
Salt Lake City/Department of Airports  
San Diego County Regional Airport  
San Francisco International Airport  
Savannah Airport Commission  
Seattle-Tacoma International Airport  
Stockton Metropolitan Airport  
Wichita Airport Authority

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# Overview of research

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## Acoustics, PA Design and Human Factors Research

- Literature review (some relevant info from other large public spaces)
- Industry survey (perceptions, understanding of underlying issues)
- Field measurements (document existing conditions) and Passenger survey

## Synthesis and Analysis

- Apply relevant information and studies
- Find common ground between best practice for acoustics and field measurements

## Guidelines

- Practical information for design and operations
- Key take-aways include
  - Four design parameters
  - Two operations principles



# Components of Speech Intelligibility Design

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## Speech Intelligibility of PA Systems

### Architectural Design

Room  
Acoustics

Ambient  
Noise

Room  
Shape and  
Volume

Human  
Factors

### PA System Design

### Announcement Quality

Training  
and  
Operation

Human  
Factors



# Guidance Highlights: Design

1. **Use a Speech Transmission Index (STI) 0.60 target**
  - Performance testing occurs at night
  - Daytime operations will result in a lower STI (~0.50)
2. **Use PA system that provides 10 to 15 dB signal-to-noise ratio**
  - Use typical daytime ambient noise conditions
3. **Ensure adequate acoustically absorptive treatment**
  - Nominally 15 to 25% of surface area
  - Suitable reverberation time is critical to achieving speech intelligibility
4. **Where ceiling heights are higher than 24 ft**
  - Use professional input for acoustics and PA system design
  - Avoid ceiling-mounted loudspeakers in these types of spaces



# Guidance Highlights: Operations

1. **Require commissioning to verify and optimize the PA system prior to sign-off or acceptance**
2. **Prepare announcements so they take advantage of human response to broadcast information (human factors)**

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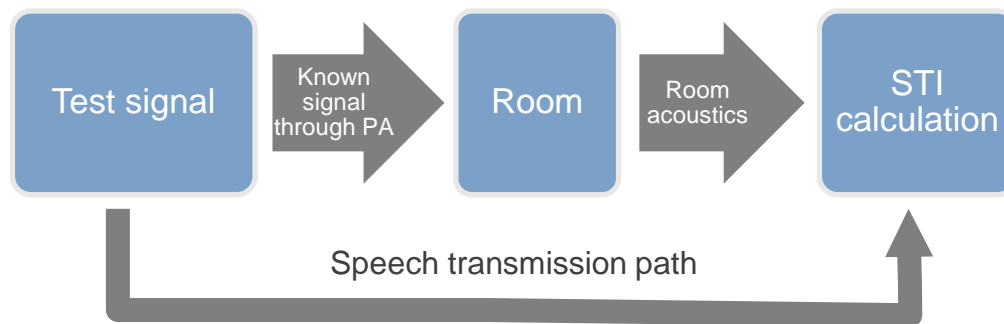


# Speech Transmission Index (STI)

Objective measure of how the transmission speech path affects intelligibility [0 to 1]

Takes into account physical, site-specific factors that affect the intelligibility of transmitted speech

Based on the field measurements conducted for the research, a target STI 0.50 has been identified for daytime conditions.



STIPA test signal



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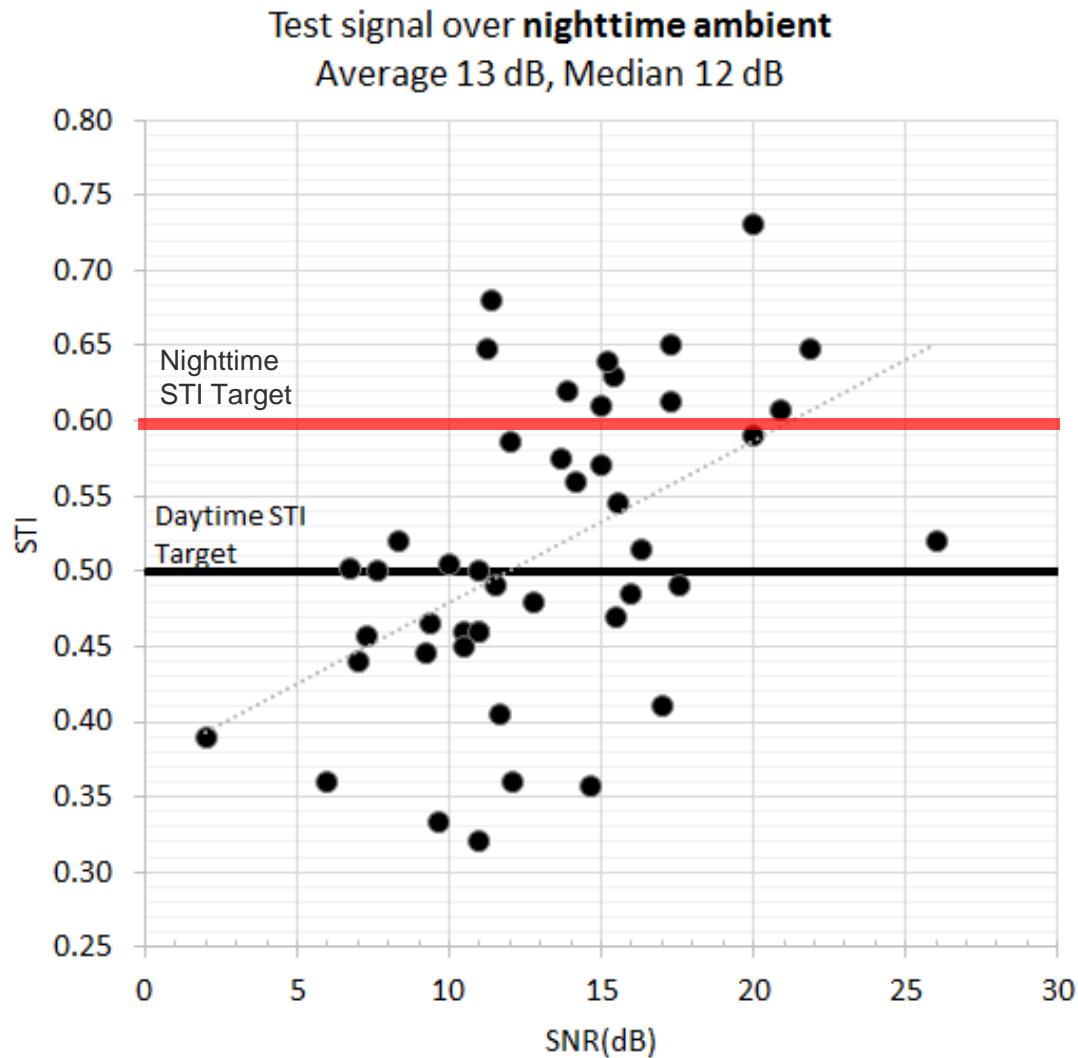
# Examples of STI Qualification Bands

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STI Range	Typical Uses	Comments
0.66–0.75	Theaters, courts, assistive listening systems, classrooms, concert halls	High speech intelligibility
0.62–0.65		Good speech intelligibility
0.58–0.61	Concert halls, modern churches	High-quality PA systems
0.46–0.53	Public spaces, cathedrals	Acceptable for voice address (target 0.50)
0.42–0.45	Difficult (challenging) spaces	
0.00–0.41		Not suitable for PA systems

# Signal-to-Noise Ratio (SNR)



# Daytime vs. Nighttime

These STI measurements are typically made during off-operation periods with low ambient noise conditions.

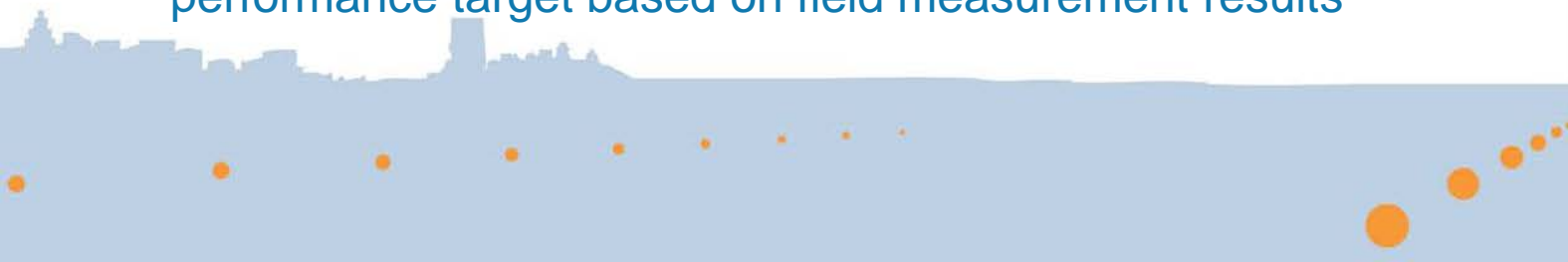
Daytime ambient conditions were 7 dBA higher than nighttime conditions.

The SNR during daytime operations would thus be much lower

Mathematically calculating a daytime STI based on the daytime ambient sound environment can result in an STI that is, on average .20 points lower than the nighttime condition.

To achieve a daytime STI of 0.50, it may be necessary to provide a design that achieves STI 0.60 to 0.70 during the quieter nighttime period.

Practically speaking it may be difficult to achieve 0.70 in passenger terminal environments, thus STI 0.60 was derived as a performance target based on field measurement results

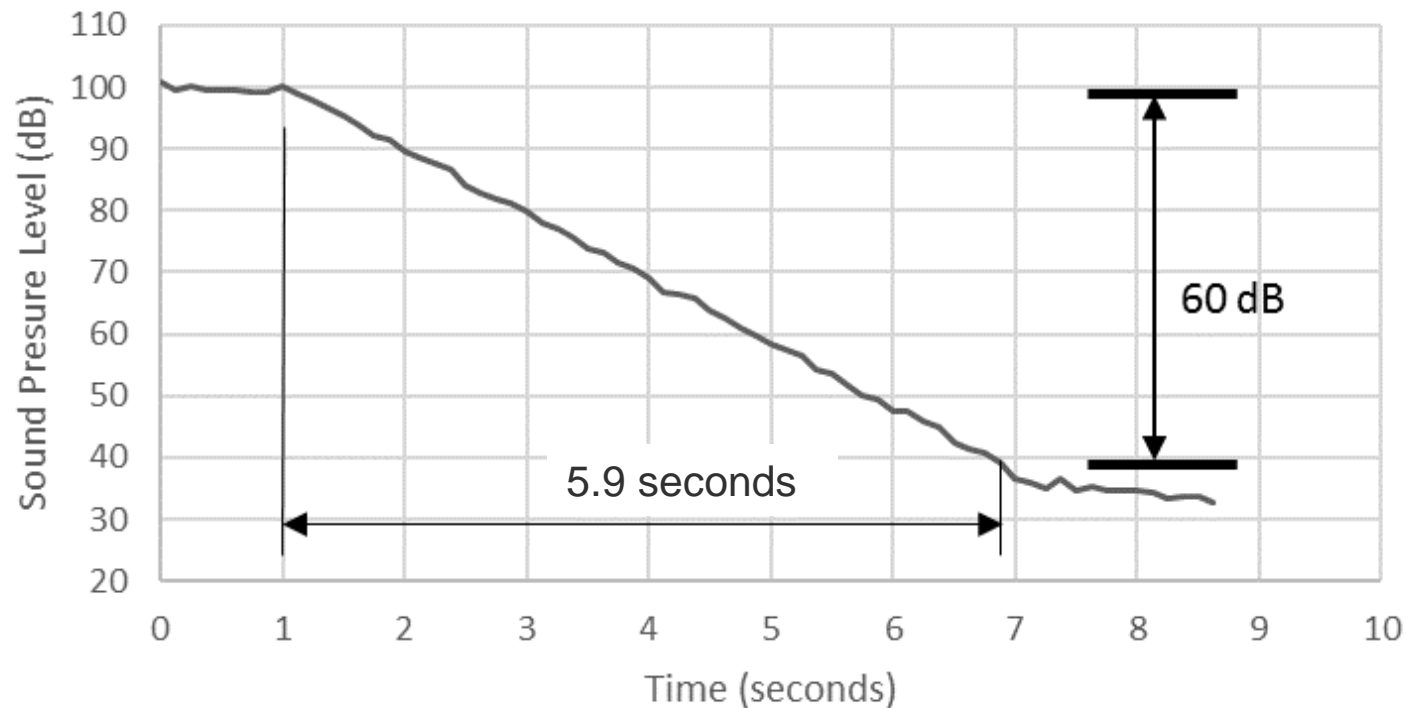


# Reverberation Time ( $RT_{60}$ )

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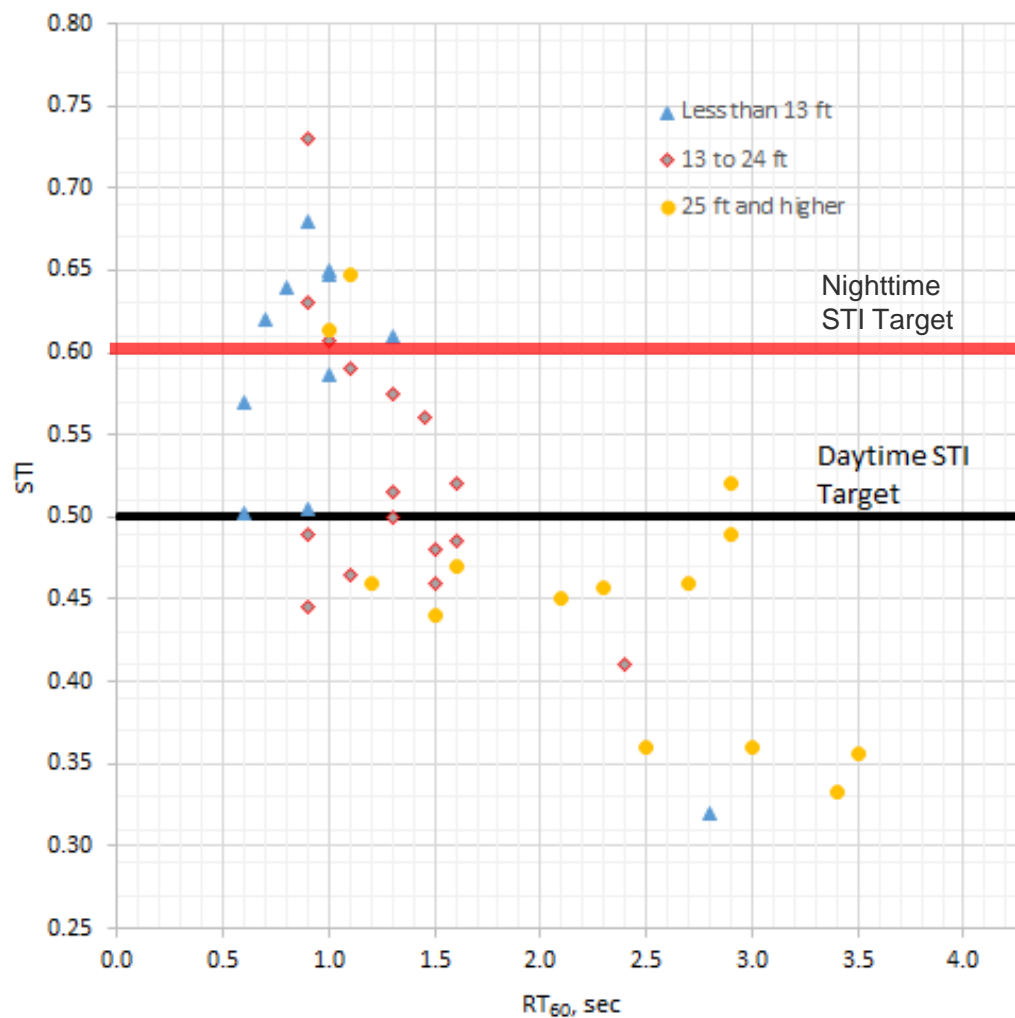
Reverberation Time





# RT<sub>60</sub> and Ceiling Height

RT<sub>60</sub> at 2,000 Hz grouped by Ceiling Height



# Ceiling Height

**It is desirable to adhere to a median ceiling height close to 13 ft. to achieve the daytime STI target.**

**Suitable design for areas with 13 ft. ceilings is generally straightforward to achieve**

- Limited input required from design professionals in acoustics or PA system design.

**Ceiling heights greater than 24 feet are poor candidates for ceiling-mounted loudspeakers**

- Input from an acoustical consultant is essential
- Other types of loudspeakers are typically required



# Commissioning

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PA system design and performance in the built environment can be simulated with software

Real-world conditions often require site-specific tweaks in the gain and equalization settings

Integrator (installing contractor) can and should do this, but speech intelligibility experience is sometimes limited

Professional commissioning is important to verify and optimize proper installation, but this step cannot overcome poor design

Bring in a qualified third-party commissioning agent



# Announcements and Human Factors

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Use key words, or “hooks” at the beginning of the announcement to draw passenger attention to PA messages

Clearly state if information presented is a change to that previously given

Keep messages simple and concise

Announcements should be spoken clearly and at a measured pace

Play or announce important messages twice consecutively

Minimize audio clutter

Consider using the female voice for specific types of announcements where factors challenge listeners and reduce attention or intelligibility (e.g., international terminal, text-to-speech)

Flight information, and updates, should be presented consistently across PA announcements and FIDS to avoid conflicts and confusion



# Lower level gate STI 0.39



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# Lower level gate area

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## TECHNICAL DATA

Daytime ambient noise level	64–69 dBA Leq
Announcement SPL	74 dBA Leq
Nighttime ambient noise level	58 dBA Leq
STI range	0.29–0.39
Uniformity	+/- 1 dBA
Reverberation Time (RT <sub>60</sub> )	2.9 sec at 500 Hz 3.5 sec at 2,000 Hz

## ARCHITECTURAL / ACOUSTICAL DETAILS

Ceiling height	31 to 42.5 feet
Finishes	Terrazzo floor, gypsum board, partial coverage with perforated metal ceiling tiles.

## PA SYSTEM DETAILS

PA system type	Digital
Paging microphone type	handheld paging
Loudspeaker type	Wall mounted speaker pairs at gates to supplement original high ceiling mounted system
Loudspeaker spacing	4 speakers, 2 at each gate
Ambient sensing microphones	Yes

# High-ceiling space STI 0.69



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# High-ceiling space

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## ***TECHNICAL DATA***

Daytime ambient noise level	62 dBA Leq
Announcement SPL	73 dBA Leq
Nighttime ambient noise level	52 dBA Leq
STI range	0.62 to 0.69
Uniformity	+/- 1 dBA
Reverberation time (RT60)	1.1 sec at 500 Hz 1.1 sec at 2,000 Hz

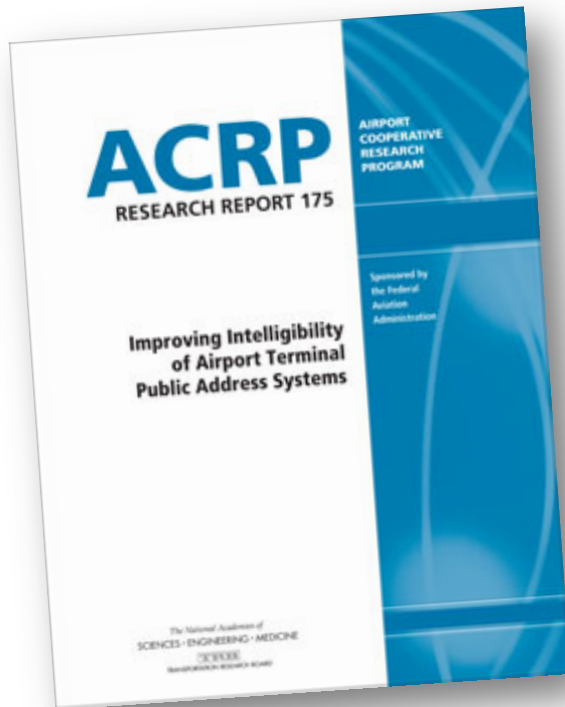
## ***ARCHITECTURAL / ACOUSTICAL DETAILS***

Ceiling height	30–38 feet
Finishes	Terrazzo floor, acoustical ceiling tile, gypsum board interior finishes

## ***PA SYSTEM DETAILS***

PA system type	Digital
Paging microphone type	Omnidirectional push talk
Loudspeaker type	Ceiling-mounted loudspeakers
Loudspeaker spacing	28–36 feet (ceiling-mounted loudspeaker spacing)
Ambient noise sensing microphones	Yes

# For additional information:



## ACRP Report 175 *Improving Intelligibility of Airport Terminal Public Address Systems*

- Richard Carman  
[rcarman@wiai.com](mailto:rcarman@wiai.com)
- Deborah Jue  
[djue@wiai.com](mailto:djue@wiai.com)
- Joel Lewitz  
[jlewitz@lewitz.com](mailto:jlewitz@lewitz.com)

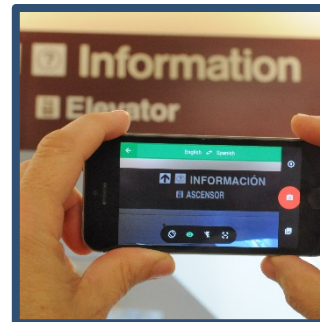
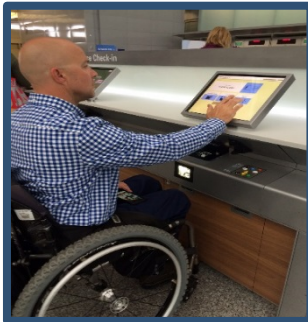
<http://www.trb.org/main/blurbs/176329.aspx>

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# ACRP 177

## Enhancing Wayfinding for Aging Travelers and Persons with Disabilities



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# RESEARCH TEAM

- Gresham, Smith and Partners (Principal Investigator)
- Open Doors Organization
- Arora Engineers
- Georgia Tech - Center for Assistive Technology and Environmental Access
- University of South Florida - Center for Urban Transportation Research
- John Duval
- Southwest Airlines

## PRESENTERS



Laurel Van Horn  
Open Doors



Jim Harding  
GS&P

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# RESEARCH PERIOD

- Research was conducted from 2014 to 2016
- Guidebook published October, 2017

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# PREVIOUS RESEARCH

- **ACRP Synthesis 51:** Impacts of Aging Travelers on Airports
- **ACRP Report 52:** *Wayfinding and Signing Guidelines for Airport Terminals and Landside*

The purpose of **ACRP 177: Enhancing Wayfinding for Aging Travelers and Persons with Disabilities** is **NOT** to repeat the content in **ACRP Report 52**

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# CURRENT RESEARCH

Project 01-31: Innovative Solutions to Facilitate Accessibility for Airport Travelers with Disabilities

Lead Investigator: Laurel Van Horn, Open Doors Organization

Synthesis 04-19: Incorporating ADA and Functional Needs in Emergency Exercises

Project 04-21: Emergency Communication Models for Persons with Disabilities and Non-English Speakers

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# OBJECTIVE

The key overall goal of the guidebook's content is to:

Engage the reader, understand the user, and equip the reader with the **WHO, WHAT, WHY** and **HOW** an airport can...

*Create a difference that creates change...*

*...that promotes Independent Travel.*

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# OBJECTIVE

In order to achieve the overall objective of helping aging travelers and persons with disabilities to **travel independently**, an airport has to consider more than just helping these customers know where to go.

Unless a comprehensive list of considerations are addressed, these customers will encounter issues that affect their ability to **travel independently** regardless of their wayfinding abilities.

Therefore, guidebook 177 is about more than just wayfinding; it is about a customer experience aimed at promoting **independent travel** for aging travelers and persons with disabilities



# ORGANIZATION

**Chapter 1:** Introduction **WHY**

**Chapter 2:** Understanding the Needs of Aging Travelers and Passengers with Disabilities using Universal Design **WHO**

**Chapter 3:** Wayfinding Strategies via Visual, Verbal, and Virtual Communication **WHAT**

**Chapter 4:** Airport Planning & Design Considerations

**Chapter 5:** Departing Customer Journey

**Chapter 6:** Arriving Customer Journey

**Chapter 7:** Connecting Customer Journey

**Chapter 8:** Wayfinding Technologies for Aging Travelers and Persons with Disabilities  
**APPLICATION & IMPLEMENTATION**

} **HOW**

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# Chapter 1 Introduction

**WHY** *this research is important*

Over a 10-year period, the DOT Annual Reports to Congress showed a **139%** increase in disability complaints for all air carriers.

Roughly half these complaints are due to wheelchair service failures

	Total # of Disability Complaints Received by Domestic Carriers	Total # of Disability Complaints Received by Foreign Carriers	Total # of Disability Complaints Received by All Carriers
2004	10,193	1,325	11,518
2005	12,194	1,390	13,584
2006	12,075	1,691	13,766
2007	13,926	1,364	15,290
2008	12,557	1,449	14,006
2009	15,496	1,572	17,068
2010	19,347	1,654	21,001
2011	18,953	2,419	21,372
2012	20,584	2,859	23,443
2013	21,965	3,281	25,246
2014	24,044	3,512	27,556

Source: U.S. Department of Transportation Annual Report of Disability-Related Air Travel Complaints

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# Chapter 1 Introduction

*WHY this research is important*

**Objective:** to help airports successfully *communicate information* to aging travelers and persons with disabilities to help them *find their way* using the *principles of universal design*.

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# Chapter 1 Introduction

**WHY** *this research is important*

What is **Wayfinding**?

**Information** *systems that guide people through a physical environment and enhance their understanding and experience of the space.*

Source: Society for Experiential Graphic Design

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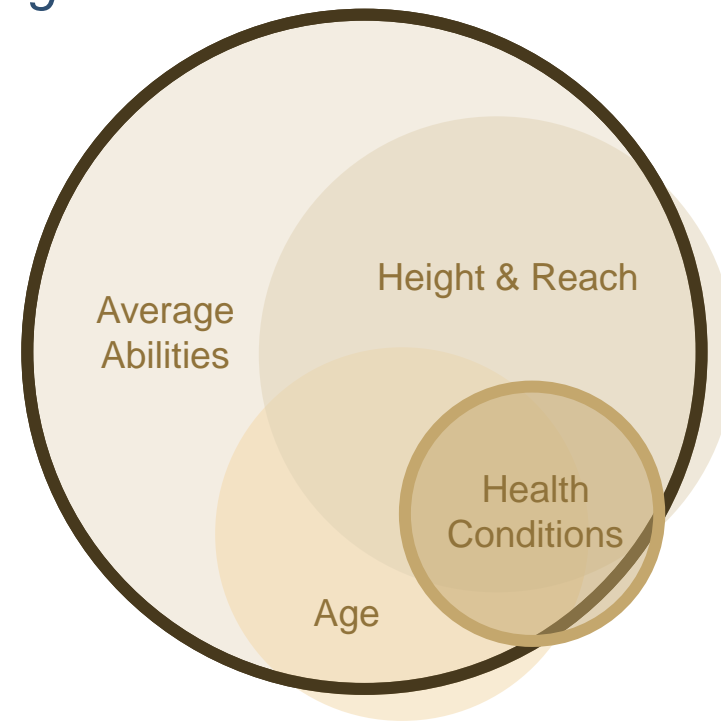
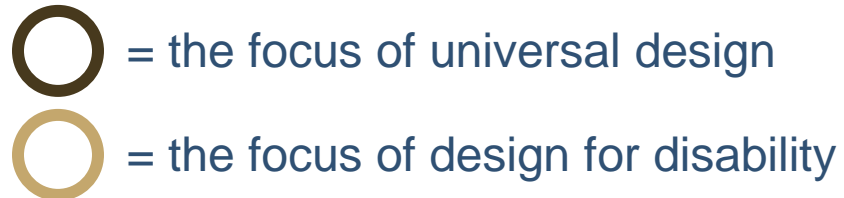
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# Chapter 2 Principles of Universal Design

- Understanding **WHO** are the different types of passengers with disabilities and aging travelers
- Outlines universal design and its principles, illustrating their application in airports

**Why?** Because Universal Design benefits almost everyone





# Chapter 2 Principles of Universal Design

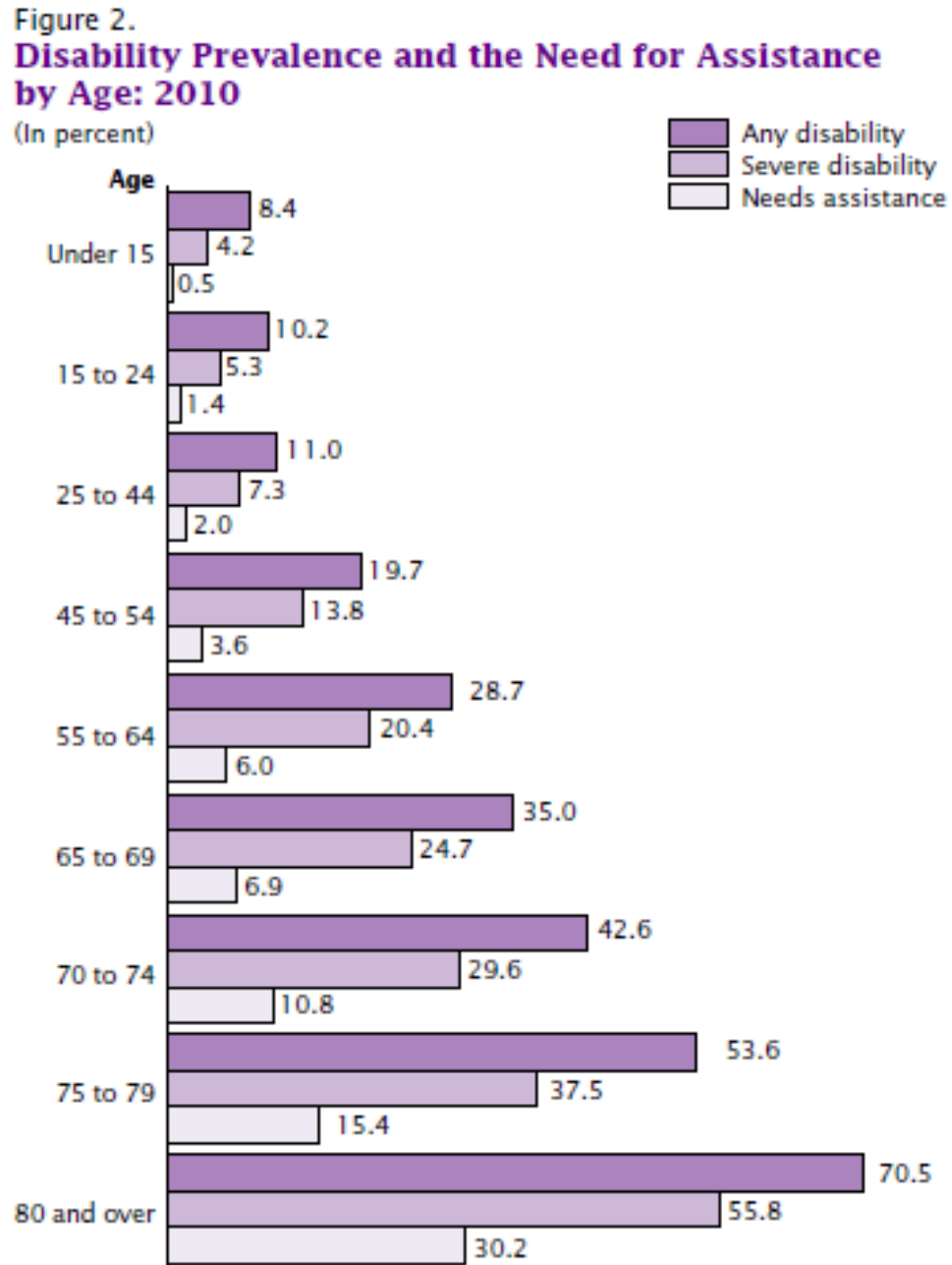
***WHO** are the different types of passengers with disabilities and aging travelers?*

- Broad disability categories include blind and low vision, deaf and hard of hearing, ambulatory and non-ambulatory, and intellectual disabilities including autism and dementia.
- Very important to understand that each person with a disability is an individual with **unique** needs.
- For example, the needs of a traveler with late onset vision loss will be different from someone born partially sighted, even though their visual acuity is more or less identical. Coping skills, psychological makeup, past travel experiences and much more have a role to play.
- Because of these individual differences that the primary focus must be on creating universal accessibility, enabling wayfinding by all travelers regardless of ability, rather than meeting the assumed needs of a general disability type.



# Chapter 2

While disability affects all age groups, its prevalence rises steeply with age.



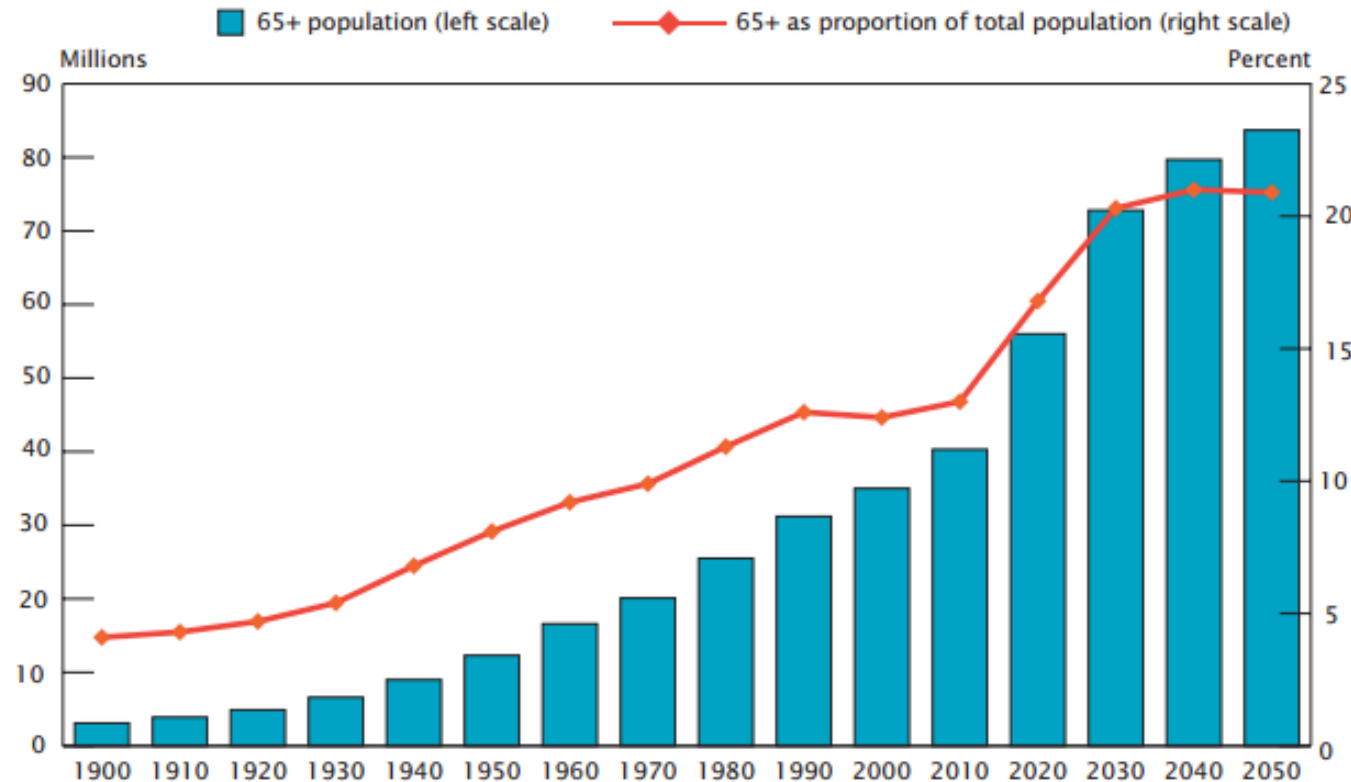
Source: U.S. Census Bureau, *Americans with Disabilities: 2010*

# Chapter 2 Principles of Universal Design

Figure 1-1.

## Population Aged 65 and Over: 1900 to 2050

(For information on confidentiality protection, nonsampling error, and definitions, see [www.census.gov/prod/cen2010/doc/sf1.pdf](http://www.census.gov/prod/cen2010/doc/sf1.pdf))



Sources: 1900 to 1940, and 1960 to 1980, U.S. Bureau of the Census, 1983; 1950, U.S. Bureau of the Census, 1953; 1990, U.S. Bureau of the Census, 1992; 2000, U.S. Census Bureau, 2001; 2010, U.S. Census Bureau, 2011; 2020 to 2050, U.S. Census Bureau, 2012a; 1900 to 2010, decennial census; 2020 to 2050, 2012 National Population Projections, Middle series.

*Population Aged 65 and Over: 1900-2050*

Source: U.S. Census Bureau, *65+ In The United States: 2010*

# Chapter 2 Principles of Universal Design

*Wireless Use and Device Type – is there a technology divide based on disability and age?*

- *Americans with disabilities (SUN) vs.*
- *General population (PEW)*

Table 2 Wireless Use and Device Type (All respondents with a disability)

Do you own or use a cellphone, smartphone or tablet?	SUN	Pew
Cellphone or smartphone	84%	91%
Cellphone, smartphone or tablet	91%	--
If you own or use a cell phone or tablet, what kind do you use? (Check all that apply)		
Basic cellphone (e.g., Motorola Razr, Pantech Breeze, Nokia 6350)	31%	35%
Smartphone (e.g., iPhone, Android phone, BlackBerry, Windows phone)	54%	56%
Tablet (e.g., iPad, Kindle Fire, Galaxy Tab, Google Nexus)	31%	34%
Other (iPod Touch, Nook, Kindle, netbook, laptop)	6%	--

# Chapter 2

- *Appropriate language*

By acknowledging the person first, one is recognizing that this individual is more than just their disability.

Therefore, person-first language is used throughout this guidebook, e.g., "a man who is blind" rather than "a blind man."

Source: Open Doors Organization

DO SAY	DON'T SAY
✓ Person with/who has a disability	✗ The disabled, handicapped, physically challenged
✓ Non-disabled, able-bodied	✗ Normal, healthy
✓ Uses a wheelchair	✗ Wheelchair bound, confined to a wheelchair
✓ Birth injury, congenital disability	✗ Birth defect, deformity
✓ Person with a physical disability	✗ Crippled, lame, invalid
✓ Has a speech disability	✗ Has a speech defect, dumb
✓ Person who is blind, has low vision	✗ The blind, blind people, vision impaired
✓ Person who is deaf, hard of hearing	✗ The deaf, deaf people, deaf and dumb, hearing impaired
✓ Person with an intellectual, cognitive or developmental disability	✗ Stupid, retard, retarded, slow, subnormal, mentally challenged
✓ Person with epilepsy, seizure disability	✗ Epileptic, has fits, spastic
✓ Person of short stature, little person, dwarf	✗ Midget



# Chapter 2 - Principles of Universal Design

- Example of universal design **Principle 2 - Flexibility in Use:**
- The design accommodates a wide range of individual preferences and abilities.



Trace EZ  
Access Keypad

Source: ACRP 177 Research Team

# Chapter 3 Wayfinding Strategies - 3 V's

**WHAT** type of information is needed to communicate with the various passenger types



VISUAL



VERBAL



VIRTUAL



TACTILE



# Chapter 3 Wayfinding Strategies - 3 V's

## "3 V's" of Communication

U.S. GATEWAY AIRPORTS											
CUSTOMER SATISFACTION FACTORS		1	2	3	4	5	6	7	8	Grand Total	
	VISUAL	Ease of finding their way inside airport	84%	81%	82%	79%	86%	81%	72%	89%	82%
	VERBAL	Helpful staff	84%	80%	88%	83%	82%	82%	72%	80%	81%
	VIRTUAL	Flight information screens	82%	77%	77%	75%	84%	81%	76%	82%	79%
	Cleanliness	77%	78%	82%	73%	81%	76%	70%	85%	78%	
	Short lines at customs	70%	81%	78%	71%	67%	62%	68%	76%	72%	
	Free Wi-Fi	62%	67%	72%	73%	70%	68%	76%	67%	69%	
	Universal symbols	63%	55%	71%	69%	64%	44%	48%	59%	57%	
	Short walking distance	36%	44%	50%	40%	49%	25%	38%	48%	41%	
	Shopping & restaurants	31%	41%	49%	28%	40%	22%	32%	40%	36%	

1  
2  
3

Source: ACRP Report 161 - results from eight U.S. gateway airports, show percentages of the level of customer satisfaction for each factor surveyed

# Chapter 3 Wayfinding Strategies - 3 V's

## Visual Communication



Age 20



Age 60



Age 75

Human vision deteriorates with age, with older adults often experiencing significant vision problems in low-light environments. The above images show how much aging changes the relative transmission of light through the optic media for viewers of ages 20, 60 and 75

→ departures

→ departures

Uniform, legible typefaces like the sans-serif font, Frutiger Bold, as it would be seen by a viewer with no vision problem (left) compared to an example of how it would be perceived by a viewer experiencing a loss of light and focus (right). Despite loss of resolution, the message remains legible.

Source: *Typography and the Aging Eye: Typeface Legibility for Older Viewers with Vision Problems* by Paul Nini (01.23.06).

# Chapter 3 Wayfinding Strategies - 3 V's

## *Verbal Communication*

Call center, information desks,  
Roving ambassadors with tablets

Training is key—disability  
awareness and communication,  
familiarity with airport access  
features

Virtual support—airport  
accessibility database,  
video relay interpreting,  
language translation, etc.



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Verbal communication is a very important part of the wayfinding experience for aging travelers and persons with disabilities.

A building's design should allow people to use its features in more than one prescribed way, e.g., standing and seated, as at this information desk at Tampa International Airport.

### **UD Principle 2. Flexibility in Use:**

The design accommodates a wide range of individual preferences and abilities.



# Chapter 3 Wayfinding Strategies - 3 V's

## *Virtual Communication via Pre-trip Planning*



# ACRP

## AIRPORT COOPERATIVE RESEARCH PROGRAM

The ability to plan in advance via digital media is becoming more and more effective. For older adults and pax with disabilities, advance knowledge can greatly enhance the wayfinding experience. The Wayfinding Accessibility Audit Checklist recommends including a link for disability-related information and resources. The preferred LOS is to have a link on the home page. A higher LOS would have the link visible above the scroll

LAX

# Chapter 3 Wayfinding Strategies - 3 V's

## *Virtual & Verbal Communication – Help Point Kiosk*



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Accessible help/call points are easy-to-use communication devices that provide means for arriving travelers needing accessibility information or assistance to connect to a remotely located service provider.

These devices help provide convenient points for people with disabilities to initiate their wayfinding experience upon their arrival at the terminal.



# Chapter 3 Wayfinding Strategies - 3 V's

## *Tactile Communication*



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Uses of tactile information can be less obvious. For instance, clear delineation between a hard surface floor in the main concourse, versus a soft, carpeted surface in a hold-room seating area creates a shoreline that can provide a detectable, navigable path. A similar concept can also be applied to the boarding gate area. For those with low vision, contrasting light and dark colors provide an additional cue.



# Chapters 4, 5, 6, & 7 – Applying the 3 V's

- 4. Airport Planning and Design
- 5. Departing Customer Journey
- 6. Arriving Customer Journey
- 7. Connecting Customer Journey

***HOW** to create a difference that creates a change and where appropriate **WHY** it is important.*

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# Wayfinding Accessibility Audit Checklist

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First of its kind consolidated tool that merges both **wayfinding analyses** AND **accessibility audits** into a single all-inclusive assessment.

Includes wayfinding strategies and accessibility features relevant to a passenger's specific disability.

The following key factors must be evaluated:

- Organized by journey segment: Departing - Arriving - Connecting & key touch points
- Type of disability or functional limitation accommodated
  - Mobility, Vision, Hearing, Cognition
- 3V's of communication: Visual - Verbal - Virtual
- Standards and/or regulations or other guidance that apply

# Recommendations and/or Requirements

Chapter 5								
Wayfinding Audit Checklist								
DEPARTING PASSENGER (D)								
REF #	Recommendations & Requirements	3V's	Vision	Hearing	Cognition	Mobility	Standards Reference / Guidance	Completed
Section 5.1: Arrival Point - Curbside (AP)								
D-AP.01	Accessible drop-off points for people with disabilities have been designated by the airport, appear on web, mobile and terminal maps and directories and are appropriately signed for easy viewing from roadways.	Visual Virtual	X	X	X	X	Passenger loading zones scoping and design: 2010 ADAAS 209 and 503	
D-AP.02	Walking surfaces are stable, firm and slip resistant, inside and outside terminals and parking garages, and have no openings more than 1/2".	Visual	X	X	X	X	2010 ADAAS 302.3	
D-AP.03	Visual and auditory signals are in place at pedestrian crossings with traffic lights, with adequate crossing time for those who move more slowly.	Visual	X	X	X	X		

D-AP.03

Visual and auditory signals are in place at pedestrian crossings with traffic lights, with adequate crossing time for those who move more slowly.

# Type of communication

Chapter 5								
Wayfinding Audit Checklist								
DEPARTING PASSENGER (D)								
REF #	Recommendations & Requirements	3V's	Vision	Hearing	Cognition	Mobility	Standards Reference / Guidance	Completed
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D-AP.03

Visual and auditory signals are in place at pedestrian crossings with traffic lights, with adequate crossing time for those who move more slowly.

# Types of disability

Chapter 5							
Wayfinding Audit Checklist							
DEPARTING PASSENGER (D)							
REF #	Recommendations & Requirements	3V's	Vision	Hearing	Cognition	Mobility	Standards Reference / Guidance
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D-AP.03

Visual and auditory signals are in place at pedestrian crossings with traffic lights, with adequate crossing time for those who move more slowly.



# Standards reference

Chapter 5								
Wayfinding Audit Checklist								
DEPARTING PASSENGER (D)								
REF #	Recommendations & Requirements	3V's	Vision	Hearing	Cognition	Mobility	Standards Reference / Guidance	Completed
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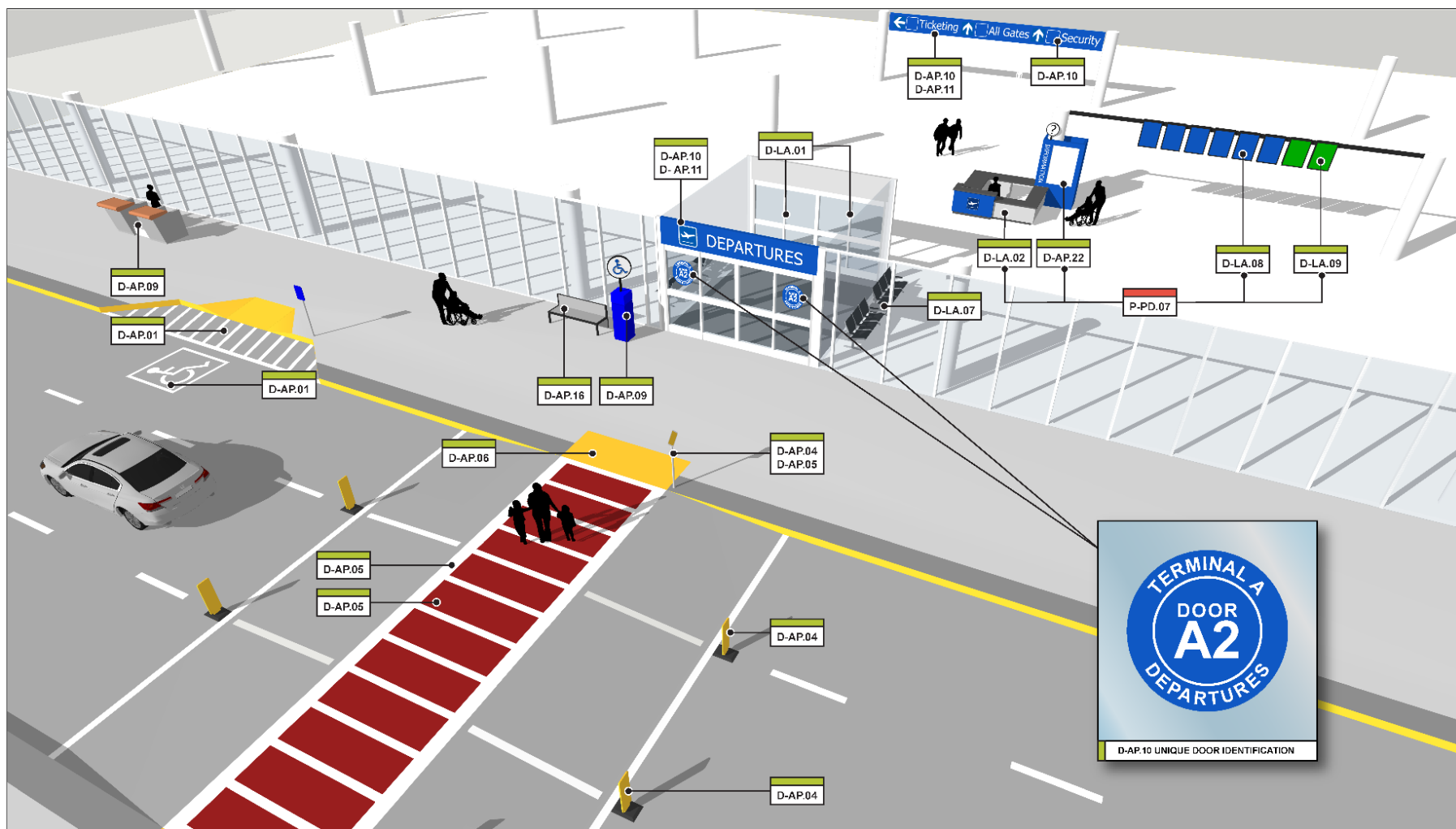
D-AP.03

Visual and auditory signals are in place at pedestrian crossings with traffic lights, with adequate crossing time for those who move more slowly.

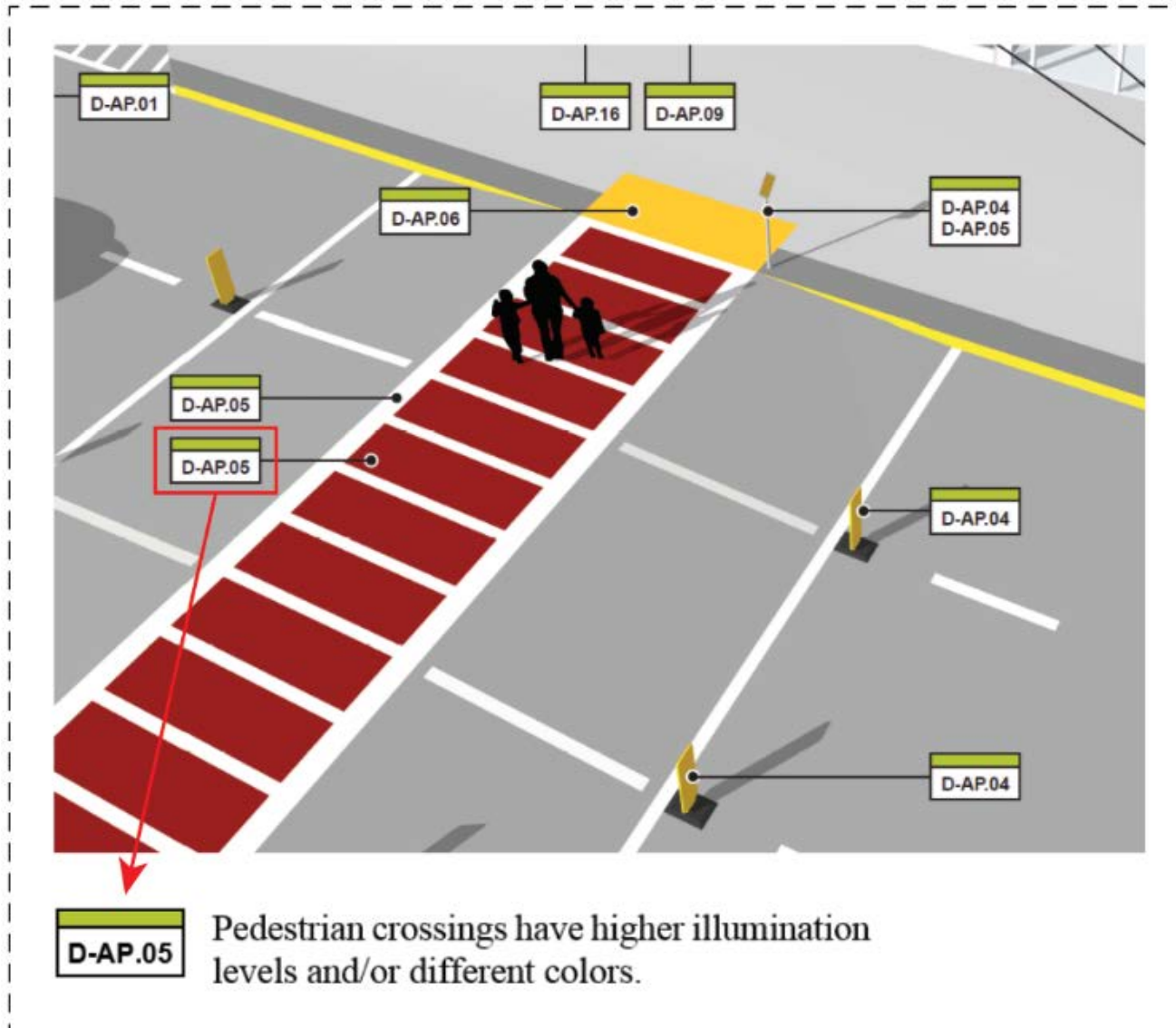


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*Checklist is illustrated in 3D virtual airport model*



# VIRTUAL MODEL



*Unique reference number labels in the 3D virtual model correlate with the checklist*

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# Chapter 4 Airport Planning & Design

## Chapter 4: Airport Planning and Design Considerations (P)

Section #	Section Description	Section Code
4.1	Airport Planning and Design	PD
4.2	Staff Training	ST
4.3	Database Environment/Management	DB
4.4	Website	WS
4.5	Mobile Application	MA
4.6	Call Center	CC



# Chapter 4 Airport Planning & Design

## *Planned adjacencies*



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## AIRPORT COOPERATIVE RESEARCH PROGRAM

There are planned adjacencies at key decision nodes for information sources:

Virtual, e.g., Flight Information Display Systems (FIDS)

Verbal, e.g., staff positions and information desks

Visual, e.g., airport directories, etc.

# Chapter 4 Airport Planning & Design

*Pre-trip planning information*



When you exit the  
Terminal A Arrivals area.

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Online virtual tour for pre-trip planning is captioned 2 that uses both captioning for those who cannot hear as well as audio for persons who are blind or have low vision

**BOS**



# Chapter 5 Departing Customer Journey

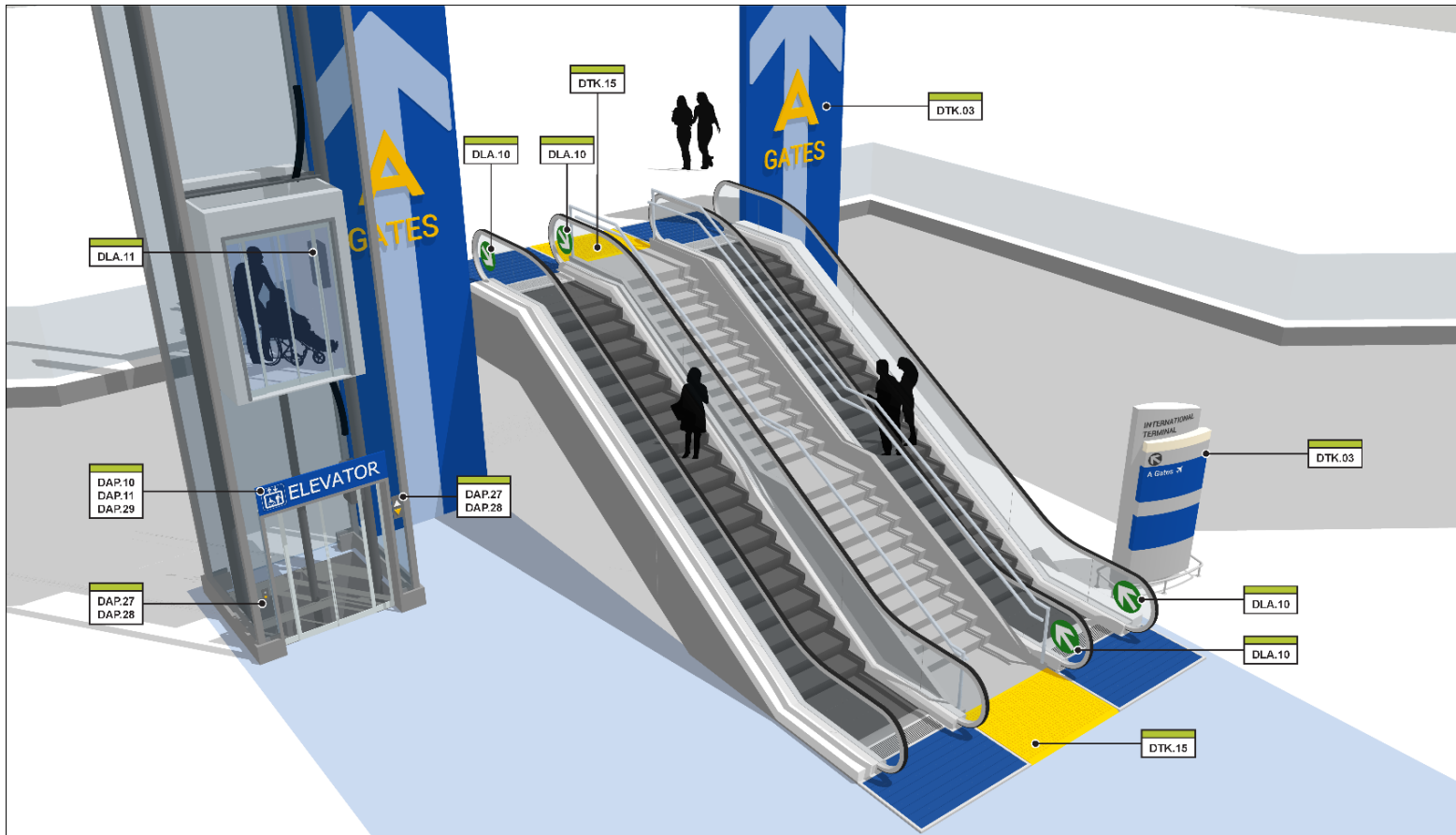
## Chapter 5: Departing Customer Journey (D)

Section #	Section Description	Section Code
5.1	Departure Arrival Points	AP
5.2	Parking	PK
5.3	Rental Car	RC
5.4	Lobby Area	LA
5.5	Ticketing	TK
5.6	Security Checkpoint	SC
5.7	Vertical Transition	VT
5.8	Gate Area	GA
5.9	Airline Support	AS
5.10	International Flights - Passport Control	IN



# Chapter 5 Departing Customer Journey

## *Vertical Transitions: Section 5.7*



- Intuitive
- Clear line of sight
- Adjacency

# Chapter 5 Departing Customer Journey

## *Vertical Transitions: Section 5.7*



**ACRP**

### **AIRPORT COOPERATIVE RESEARCH PROGRAM**

Escalators include visual reinforcement of operating direction.

Simple, bold graphic indicators help customers with cognitive issues, as well aging travelers who may struggle with visual acuity, know which escalator to use at vertical transitions, and also helps mitigate safety concerns associated with escalators



# Chapter 5 Departing Customer Journey

## *Vertical Transitions: Section 5.7*



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## AIRPORT COOPERATIVE RESEARCH PROGRAM

Elevators that have glass doors promote open sight lines and ease of identification.

The consequence of architectural design that hides essential vertical transportation is adding extra signage and wayfinding.

# Chapter 5 Departing Customer Journey

## *Vertical Transition: Intuitive design*

- Over-signing is commonly used to compensate for the complex floor plan layouts where wayfinding is a chronic problem.
- Increases in plan complexity are directly related to decreases in wayfinding performance. The presence of signs is not able to compensate for wayfinding problems due to the complexity of the floor plan.
- The next 2 slides are a comparison of non-intuitive versus intuitive wayfinding at vertical transitions and **WHY** architecture plays a critical role.



# Chapter 5 Departing Customer Journey

*Vertical Transition: Non-intuitive design*



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The Prague International Airport (PRG), illustrates the challenges of trying to overcome non-intuitive architecture that dictates counterintuitive passenger circulation at the bottom of the escalators.

PRG

# Chapter 5 Departing Customer Journey

## *Vertical Transition: Intuitive design*



# ACRP

## AIRPORT COOPERATIVE RESEARCH PROGRAM

By comparison, escalators at the Zurich Airport provide simple, clear and bold visual graphics that support intuitive wayfinding in ways that can help customers with cognitive disabilities.




# Chapter 6 Arriving Customer Journey

## Chapter 6: Arriving Customer Journey (A)

Section #	Section Description	Section Code
6.1	Airline Support	AS
6.2	Gate Area	GA
6.3	Baggage Claim Carousel	BC
6.4	Lobby Area	LA
6.5	Ground Transportation	GT
6.6	Rental Car - On-site	RC
6.7	Parking - On-site	PK
6.8	International Flights	IN


# Chapter 6 Arriving Customer Journey


## Service Animal Relief Area (SARA) at DTW McNamara





Find

Restrooms


 Restrooms


 Men's


 Family Restroom


 Women's


Services & Amenities


 Airport Information—near Gate A38


 ATM


 Children's Play Area


 Delta Need Help? Center


 Foreign Currency—Central Link


 Lost & Found—Building 610

 Pay Phones / TTY


 Pet Relief Area—near Gate A34


 Reflection Room—Central Link

 Shoeshine



Find

 Shop

 Reset

Services & Amenities

Delta Need Help Centers

Restrooms

Delta Sky Clubs

The Westin Hotel

ATM

Bottle Filling Station

Foreign Currency

Freedom Center

Kids Play Area

Lost & Found

Phone Banks

Religious Reflection Room

Service Animal/Pet Relief

Shoe Shine

Smoking Area

Vending

Wi-Fi





Indoor, post-security area to allow Service Animals or Pets to relieve themselves. Passengers must adhere to the posted guidelines.

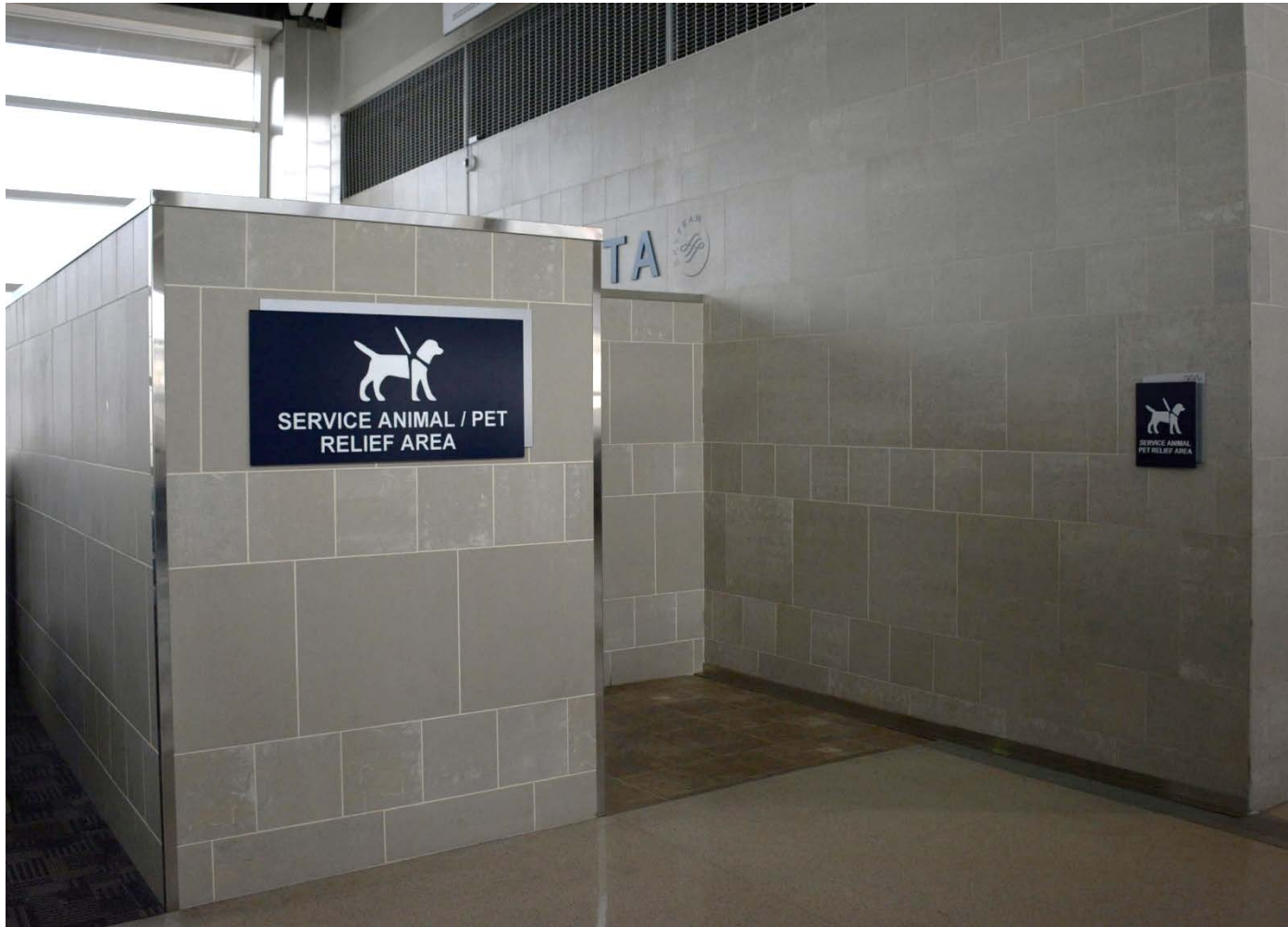
Interactive digital technology

List gate # nearest to the amenity

Shows route and photos of the destination

# Chapter 6 Arriving Customer Journey

## Service Animal Relief Area (SARA)



Large sign with pictogram

Smaller sign with visual, tactile and Braille lettering and pictogram, positioned per ADA standard

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## AIRPORT COOPERATIVE RESEARCH PROGRAM

Service Animal Relief Area (SARAs) available airside are centrally located to minimize walk times, have appropriate directional and identification signage, appear on maps and directories. 49 CFR Part 27.71 requires SARAs airside with limited exceptions.

Location of the SARA at DTW is communicated **virtually** through the interactive directories, that show route and photo of destination to help with recognition and confirmation **visually**.



# Chapter 6 Arriving Customer Journey

## *International arrivals*



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## AIRPORT COOPERATIVE RESEARCH PROGRAM

Signs, visually indicate lanes for employees and people with disabilities. This benefits those not being escorted, especially those with hidden disabilities.

Color-coded wayfinding in the Customs and Border Patrol area at BOS helps visually guide persons with disabilities with advance education prior to the queue and confirmation at queue entry point.

BOS

# Chapter 6 Arriving Customer Journey

## *International arrivals*



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Dedicated lanes for  
persons with disabilities  
at Boston Logan  
International Airport

**BOS**



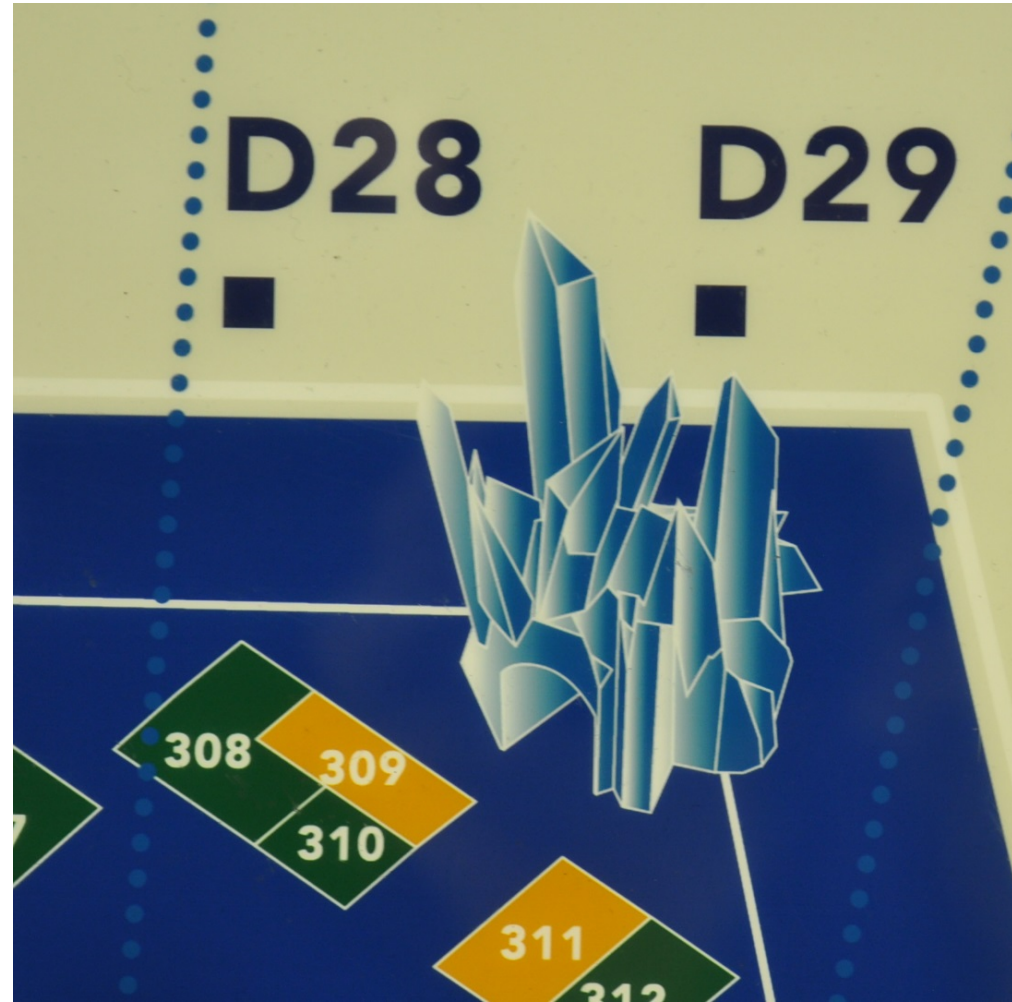
# Chapter 7 Connecting Customer Journey

## Chapter 7: Connecting Customer Journey (C)

Section #	Section Description	Section Code
7.1	Airline Support - Same Airline / Same Terminal	AS
7.2	Gate Area	GA
7.3	Terminal Transportation	TT
7.4	Airline Support - Same Terminal / Different Airline	AS

# Chapter 7 Connecting Customer Journey

## *Landmarks*



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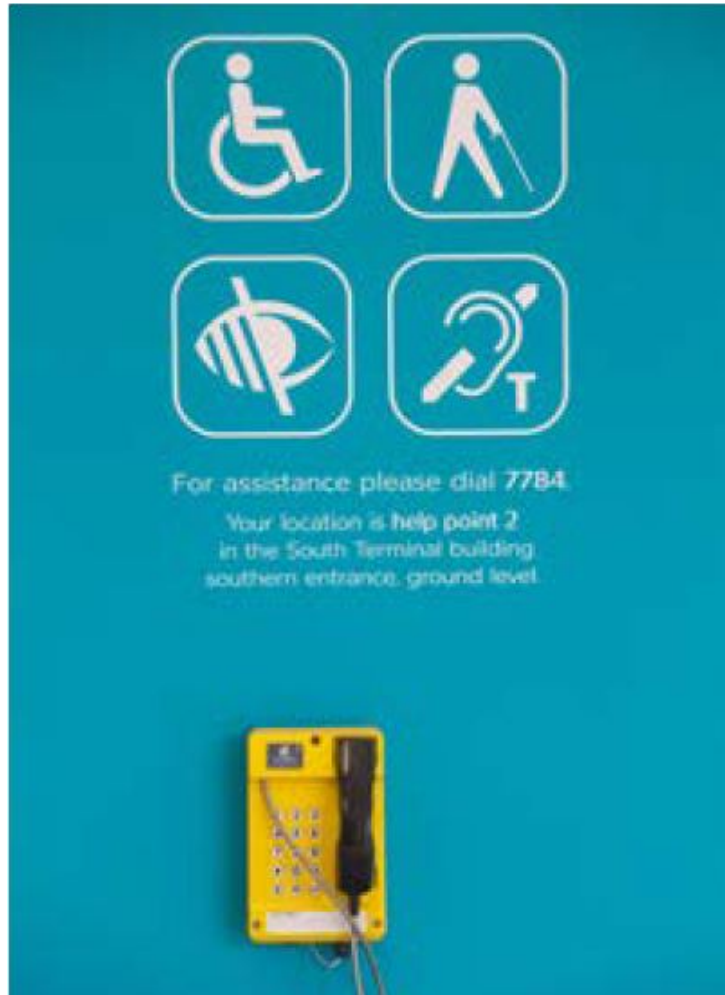
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Providing information that can help customers establish relationships between concrete landmarks and graphic representations on maps is one way to help aging travelers and persons with disabilities navigate a complex airport environment and confirm they are on the correct path to find their connecting gate. Example at DFW shows how artwork, in this case a castle, can be used as a recognizable landmark for navigation.

**DFW**

# Chapter 7 Connecting Customer Journey

## *Help points*



Located at regular intervals along the concourse, including at major decision points

Identified by visual and tactile signage.

Information includes the location of the courtesy phone.



# Chapter 8 Wayfinding Technologies for Aging Travelers and Persons with Disabilities

Technology that shows **HOW** to *create a difference that creates a change* and where appropriate, **WHY** it is important.





# Chapter 8 Wayfinding Technologies

- 8.1 Overview
- 8.2 Accessible Websites
- 8.3 Mobile Wayfinding APPS
- 8.4 Accessible Help/Call Points
- 8.5 Interactive Kiosks
- 8.6 Digital Wayfinding Directories
- 8.7 FIDS (Flight Information Display System)
- 8.8 Hearing Loops
- 8.9 Visual Paging

## APPLICATION & IMPLEMENTATION

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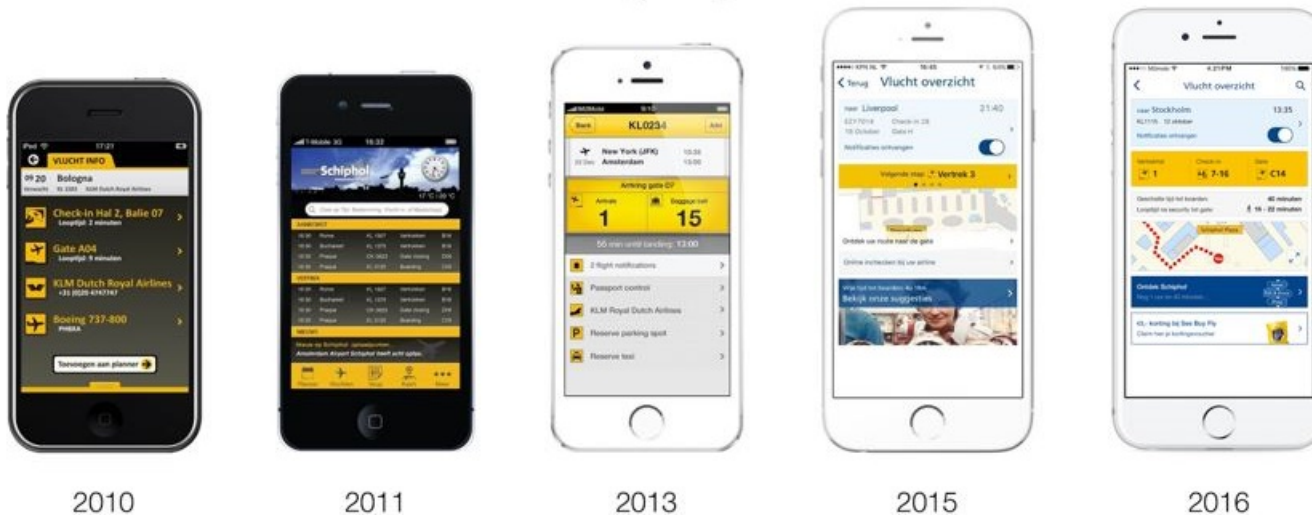
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# Chapter 8 Wayfinding Technologies

## Section 8.3 Mobile Wayfinding APPS

Current mobile applications for airport wayfinding do not meet the needs of users with disabilities. The research team asked participants to download and test award-winning and industry-leading applications from airports around the world, such as the airport app at Amsterdam Airport Schiphol that is now in its fifth generation.



# Chapter 8 Wayfinding Technologies

## Section 8.3 Mobile Wayfinding APPS

Each airport's app was rated for functionality or capability as it pertained to the **universal design principles** as good (4), fair (3), poor (2), and absent (1). The scores were averaged over the users and applied to each category. In general, the applications tested demonstrated great usability for users without disabilities, but scored poorly for **users with disabilities**.

Airport	Equitable Use		Flexibility in Use		Simple and Intuitive Use		Perceptible Information		Tolerance for Error*		Low Physical Effort		AVG Score
	Utility	Usability	Utility	Usability	Utility	Usability	Utility	Usability	Utility	Usability	Utility	Usability	
5	3.00	1.40	1.00	3.00	1.80	2.30	1.00	1.60	1.00	1.00	2.00	2.00	1.76
3	3.00	2.20	1.00	2.60	1.75	2.00	1.00	1.30	1.30	1.00	2.00	1.80	1.75
2	2.00	1.60	1.00	3.00	1.75	2.00	1.00	1.60	1.00	1.00	2.00	2.00	1.66
4	3.00	1.20	1.00	2.00	1.50	2.00	1.30	1.30	1.00	1.00	2.00	2.00	1.61
1	2.00	1.60	1.00	1.60	1.50	2.00	1.00	1.50	1.00	1.00	2.00	1.80	1.50
6	2.00	1.20	1.00	2.30	1.75	2.30	1.00	1.30	1.00	1.00	1.00	1.75	1.47
11	2.00	1.20	1.00	2.00	1.66	2.30	1.30	1.30	1.00	1.00	1.00	1.75	1.46
10	2.00	1.00	1.00	2.00	1.80	2.30	1.30	1.30	1.00	1.00	1.00	1.75	1.45
7	2.00	1.00	1.00	2.30	1.75	1.90	1.00	1.10	1.00	1.00	1.00	1.75	1.40
9	2.00	1.00	1.00	2.00	1.80	1.90	1.00	1.30	1.00	1.00	1.00	1.75	1.40
8	2.00	1.00	1.00	2.00	1.75	1.90	1.00	1.30	1.00	1.00	1.00	1.75	1.39

\*Tolerance for error features were tested - however, yielded very few results when not physically on-site at the airport.

Airports tested listed in alphabetical order included:

- Amsterdam
- Copenhagen
- Dallas Fort Worth
- Dubai
- Fort Lauderdale
- Frankfurt
- Heathrow
- Miami
- Munich
- San Francisco
- Zurich

## Section 8.3 Mobile Wayfinding Apps

- In general, the applications demonstrated great usability for users without disabilities, but scored poorly for users with disabilities.
- There are indoor and outdoor wayfinding apps that function well for a specific user group, e.g., vision loss, cognitive disability, reduced mobility
- However, to date, **no single application** has been developed that provides essential route information **useful to all users.**

# Chapter 8 Wayfinding Technologies

## *Section 8.3 Mobile Wayfinding APPS*

- Provides a set of research-based guidelines for mobile app developers (e.g., airlines, airports, third parties) to improve existing apps or create new ones
- Designed to maximize the utility and usability for all travelers, especially aging individuals and travelers with disabilities
- Based on utility and usability testing of a prototype wayfinding app at ABIA and Georgia Tech
- Relevant regardless of underlying positioning technology (e.g., beacons, WiFi trilateration, visible light, camera)





# Chapter 8 Wayfinding Technologies

## Section 8.3 Mobile Wayfinding APPS

The mobile app guidelines consists of 19 criteria, e.g.: *Design Your Application for a Wide Range of Devices to Low Physical Effort*

Example of Do's and Don'ts from **Low Physical Effort**

DO	DON'T
<ul style="list-style-type: none"><li>✓ Locate buttons along the top, bottom and sides of the interface where they can be easily found and pressed.</li><li>✓ The order defined for screen reading elements should match the logical order in which the information should be presented to the user.</li><li>✓ When re-opening the application after an accidental shutdown, bring the user back to where he/she left off.</li><li>✓ Minimize scrolling and other repetitive actions such as double tap and hitting “next” after every direction.</li><li>✓ Maximize accuracy by making buttons as large as possible with sufficient space between them.</li></ul>	<ul style="list-style-type: none"><li>✗ Locate buttons in the middle of the interface where interaction isn't obvious.</li><li>✗ Read elements on the screen out of logical order.</li><li>✗ When re-opening the application after an accidental shutdown, restart the application at the first screen.</li><li>✗ Require interactions with the screen when they aren't needed.</li></ul>

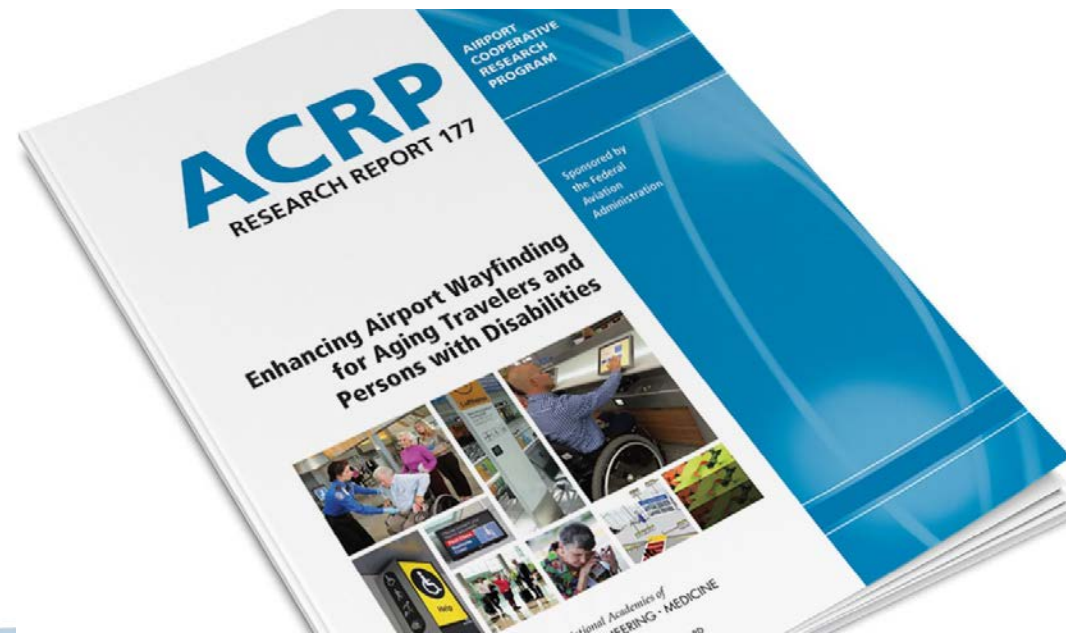
# SUMMARY

The cumulative result of **ACRP 177** will equip airports with the information they need to

*create a difference that creates a change...*

*...that promotes Independent Travel*

*for aging travelers and persons with disabilities*



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# QUESTIONS?



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WILSON IHRIG  
ACOUSTICS, NOISE & VIBRATION



G R E S H A M  
S M I T H   A N D  
P A R T N E R S



# Panelists Presentations

<http://onlinepubs.trb.org/onlinepubs/webinars/171213.pdf>

*After the webinar, you will receive a follow-up email  
containing a link to the recording*

# Get Involved in ACRP

- Submit a research idea to ACRP.
- Volunteer to participate on a project panel.
- Prepare a proposal to conduct research.
- Get involved in TRB's Aviation Group of committees.
- Take part in the Champion or Ambassador Programs.

For more information:

<http://www.trb.org/acrp/acrp.aspx>

# Take Part in the *Careers in Motion* Networking Fair



EVENT HOSTED IN PARTNERSHIP WITH:

Mobility Lab™

Eno  
Center for Transportation

YOUNG PROFESSIONALS in TRANSPORTATION

COMTO  
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WIS  
Advancing Women in Transportation

APTA  
AMERICAN PUBLIC TRANSPORTATION ASSOCIATION

**NEW**

## INDUSTRY EMPLOYERS AND WORKFORCE CHAMPIONS!

Join us at the **new** *Careers in Motion* Fair!

The *Careers in Motion* Fair is a networking event planned to support expansion of the multi-modal transportation workforce. The event will provide an opportunity for prospective employers from a wide range of sectors to meet with young to seasoned professionals interested in working for their organizations.

Event attendees will be conference registrants whose careers and professional interests span across multiple transportation-related disciplines. Hiring managers will be onsite to network and offer career information and advice. **TRB's Young Members Council will coordinate professional development programming and content.**

The *Careers in Motion* initiative helps serve the mission of TRB's new Diversity and Inclusion Task Force—to facilitate making diverse and inclusive involvement a core value for TRB staff, volunteers, contract awardees, projects, and the transportation communities TRB serves.

**January 7, 2018 | 10:00 a.m. – 2:00 p.m. | Table Fee: \$1,250**

Please contact Patrice Davenport at [pdavenport@nas.edu](mailto:pdavenport@nas.edu)

**TRB** TRANSPORTATION RESEARCH BOARD

<http://bit.ly/CareersInMotionFair>