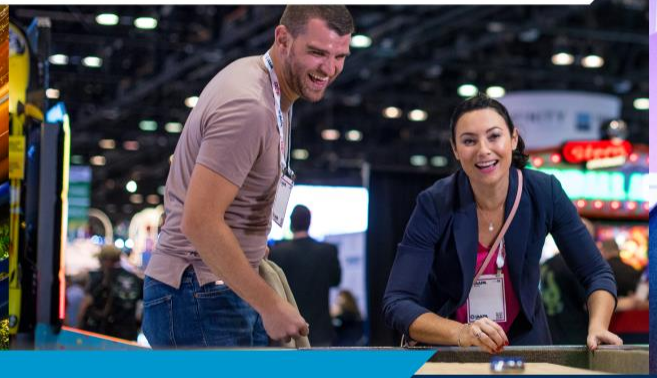
IAAPA® EXPO



CONFERENCE: Nov. 15–18, 2021
TRADE SHOW: Nov. 16–19, 2021

IAAPA.org/IAAPAExpo

@IAAPAHQ | #IAAPAExpo

Pathways and Roadblocks to Inclusivity – a Biomechanical Perspective

William Bussone
CBE Consultants, Inc.

Introduction

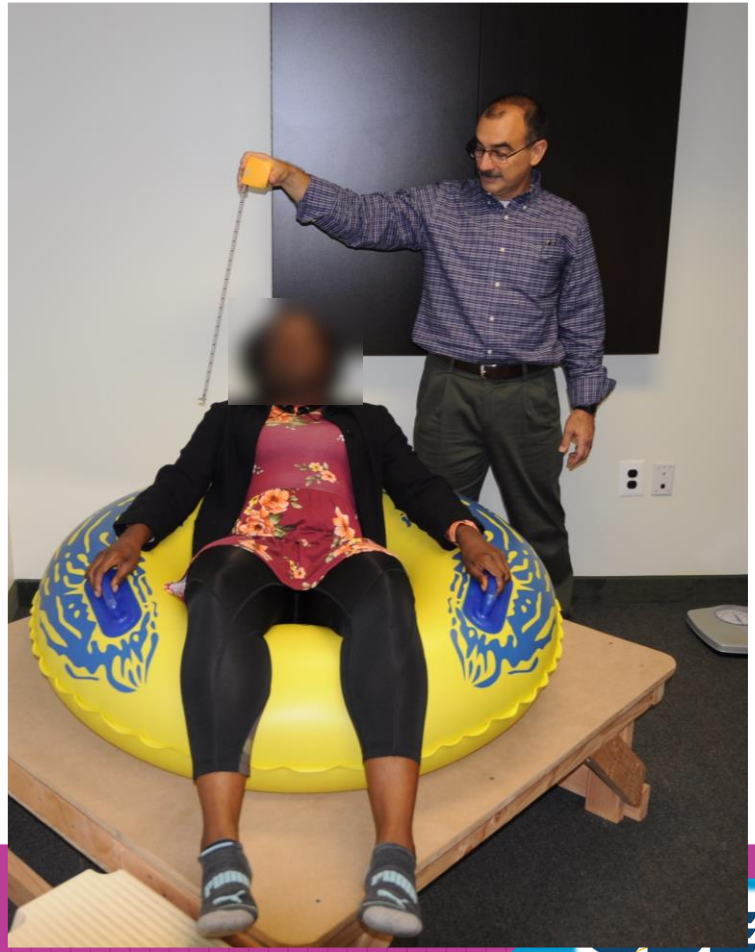
- Inclusivity – including guests of all ages, sizes, abilities, and body types
  - Legal requirements
  - Safety
  - Guest relations
  - Accessibility

Introduction

- Biomechanics – the application of mechanical engineering principles to the biology and physiology of living organisms
- Analyze motions and forces affecting guests on a ride
  - human capabilities
  - incident analysis
  - restraint design
  - hazard analysis

What we do

- We see how people interact with a ride
  - Limitations
  - Capabilities
  - Interactions with restraints
- We see shape and size
  - How that affects design
  - How that affects operations
- ADA
  - “Capabilities necessary for safety”
  - Structure versus function

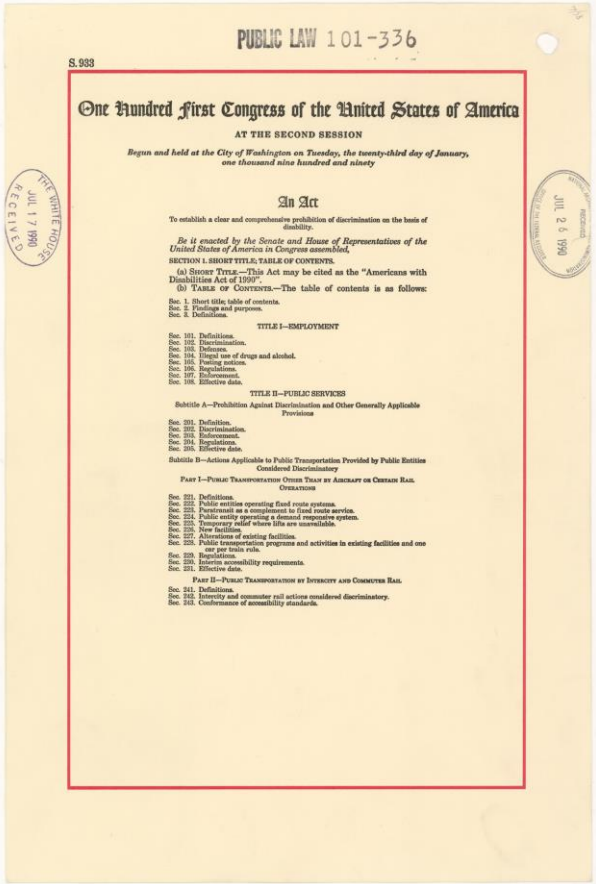


Topics

- Current state of the art
- Obstacles and roadblocks
- Paths forward

State of the Art

- Mandated accessibility
  - Americans with Disabilities Act (ADA)
- Voluntary accessibility
  - Cognitive difference
  - Neuromuscular difference
  - Limb difference
  - Age/size accessibility
- Functional requirements
- Specific hazard analyses



PUBLIC LAW 101-336

S. 933

One Hundred First Congress of the United States of America

AT THE SECOND SESSION

Begun and held at the City of Washington on Tuesday, the twenty-third day of January, one thousand nine hundred and ninety

An Act

To establish a clear and comprehensive prohibition of discrimination on the basis of disability.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SECTION 1. SHORT TITLE; TABLE OF CONTENTS.

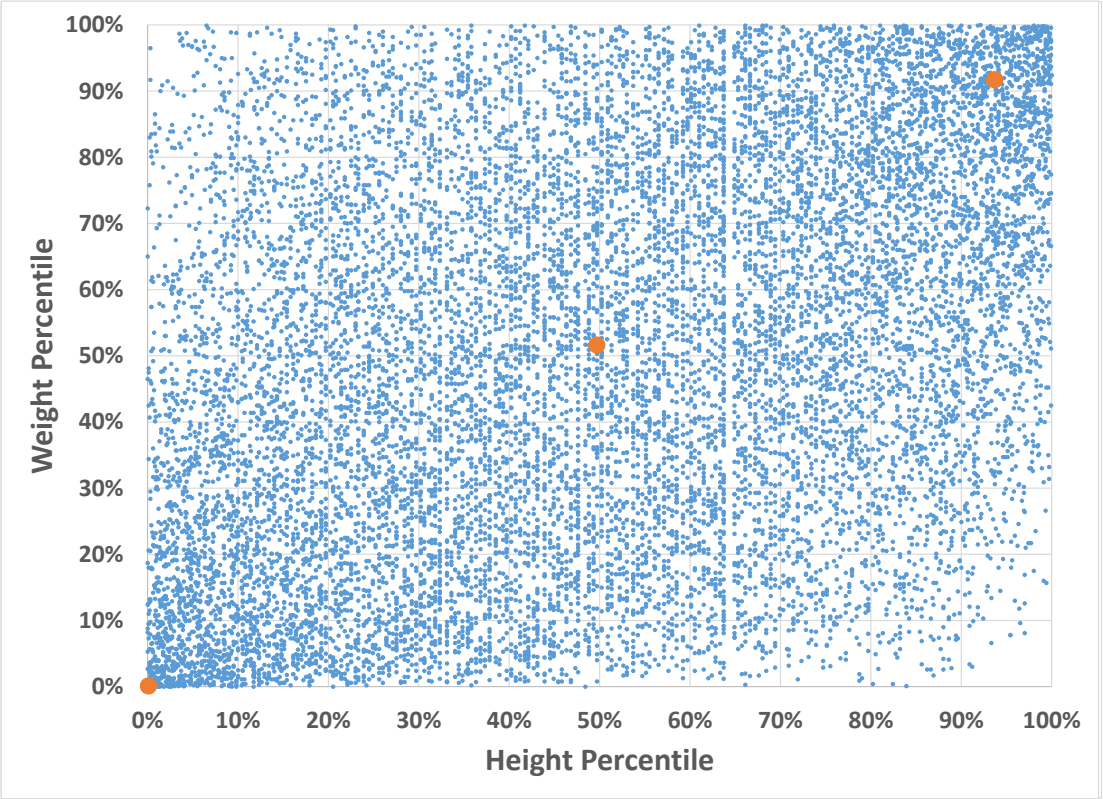
(a) SHORT TITLE.—This Act may be cited as the "Americans with Disabilities Act of 1990".

(b) TABLE OF CONTENTS.—The table of contents is as follows:

Obstacles

- People come in a wide-variety of shapes and sizes!

Obstacles


Weight Percentile
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Height Percentile

Obstacles

- No common language
  - Able-bodied, disabled, handicapped, limb-different, limb-typical, natural, functional, full, intact, bracing, holding, grasping
  - We do not agree on what words to use
  - We do not agree on what a word means
- Without understanding each other, we cannot advance

Obstacles

- Operators can increase revenue and decrease liability by letting everyone ride
- Manufacturers can decrease liability (and costs) by letting no one ride
- In practice, we operate by balancing these
  - How to let everyone who should, ride…
  - But not allow anyone who should not?

Obstacles

- Hazard analyses

HAZARD RISK ASSESSMENT MATRIX

Frequency of Occurrence	Hazard Categories 1 Catastrophic	2 Critical	3 Serious	4 Minor
(A) Frequent	1A	2A	3A	4A
(B) Probable	1B	2B	3B	4B
(C) Occasional	1C	2C	3C	4C
(D) Remote	1D	2D	3D	4D
(E) Improbable	1E	2E	3E	4E

Unacceptable High Medium Low

Hazard	Description	Likelihood	Consequence	Risk Level	Current Control Measure	Further Risk Mitigation Measure	Likelihood	Consequence	Residual risk Level
Fire and electrical shock	During the welding process, there is some flammable substance (paper, thinner) or welding on a wet floor.	B	4	High	No flammable substance, no paper near welding area and equipped with fire extinguisher. Welding warning sign, PPE and clean welding environment is a must. All welders have been attended the welder training from approved agent.	Provide in-house fire safety, welding safety and general safety training for all welders.	D	2	L
Skin burn injury	Welder or worker is affected.	C	3	Moderate	Welder must be equipped with PPE. All welders have attended the welder training from approved agent.	Provide in-house fire safety, welding safety and general safety training for all welders.	D	3	M
Inhalation	During the welding process, worker inhales the welding fume.	D	2	Low	Open area or with electric fan. All welders have attended the welding training from approved agent.	Provide in-house fire safety, welding safety and general safety training for all welders.	E	2	L
Radiation	During the welding process, the worker's skin may be expose partially to the extremely bright flash.	D	2	Low	All welders must wear long sleeves or arm cover or coverall clothing to prevent skin from directly being exposed to the bright flash.	Provide in-house fire safety, welding safety and general safety training for all welders.	E	2	L
Arc-eye or eye hurt by slat	During welding process, bright flash light will appear. And after each welding, the welder needs to remove the slag. If the welder does not have PPE, then the eye will be damaged by the bright flash or slag.	E	1	Low	Welder has been equipped with PPE. All welders have attended the welder training from approved agent.	Provide in-house fire safety, welding safety and general safety training for all welders.	E	1	L

Obstacles

- May not explore all consequences
  - A frequent, serious hazard has the same risk as a catastrophic, occasional one
  - But a hazard analysis may only describe the cause and mitigation for one of these
- Ride countermeasures may be poorly explained

Obstacles

- Rider requirements may be ambiguous
  - Bracing versus holding
  - What is a limb?
  - Structure vs function
- Rider capabilities are hard to predict

Obstacles

- You each best understand your part of the ride experience
  - Rider: your abilities and needs
  - Operator: your ride's operational history and behavior in practice
  - Manufacturer: your ride's conception and design
  - OEM: your component's conception and design (ex: ride vehicle)
- ***Communicate***
  - Rider and operator
  - Operator and manufacturer
  - Manufacturer and OEM
- Are we reporting all the incidents and near-incidents we should be?
  - By standard and statute

Where we are now

- Biomechanical issues
  - People vary in shape, size, and capability
  - Body configuration can also vary in hard-to-predict ways
  - Ride designs make fundamental assumptions about
    - How riders are shaped
    - What capabilities riders have (structural and functional and cognitive)
  - Ride operators interpret the ride design using limited information

Where we are now

- Knowledge gaps
  - Each stakeholder best knows their own domain…
  - …But does not always tell the others
- Mistaken assumptions
  - Sometimes anatomic requirements are really functional requirements…
  - …But not always

Where we are now

- Do the best with what we have
  - Our knowledge of our riders
    - Demographics
    - Accessibility needs/demands
    - Functional analysis
  - Our knowledge of our equipment
  - Our knowledge of our history and experience
  - Data collection
  - Analysis of ride-specific hazards, parameters, and operating requirements
  - Engineering analysis
    - Integrate all of the above into a reasonable go/no-go criterion

Paths Forward

- Find a common language
- Define ride and rider requirements in functional terms
  - What can a rider do, not what do they have
  - What must a vehicle/seat/restraint achieve in order to succeed
  - Easier to use and more flexible than anatomic requirements
- Clear and specific
  - Hazard Analyses should clearly define the problem and the solution
    - Multiple versions of same outcome risk
  - Anatomic requirements, if necessary, should be specific
    - Does “to the elbow” mean a full humerus, some elbow, or a complete elbow?
  - Everyone benefits from better communication

Paths Forward

- Communicate!
  - Review the hazard analysis
  - If you do not know – ask!
    - Talk to your manufacturer
      - They know what the ride is supposed to be
      - They know what they have seen in other installations
    - Talk to your buyer/operator
      - They know what their ride actually is
      - They know what incidents/near-misses they have seen
    - Learn about your riders
- Track near misses, too
  - If you do know – tell!
  - A near incident may become the next incident
  - Communicate to the manufacturer!

The End!