MEETING LOG

SUBJECT: Micromobility Forum

LOCATION: Webinar on GoToWebinar (Virtual)

DATE: September 15, 2020

ENTRY DATE: September 29, 2020

LOG ENTRY SOURCE: Lawrence Mella

ATTENDEES: CPSC has a list of registrants who pre-registered to attend online.

MEETING SUMMARY:
The U.S. Consumer Product Safety Commission (CPSC) staff hosted a webinar forum on the safety of consumer micromobility products. The purpose of the event was to bring stakeholders together for a broadly-focused meeting to exchange information on enhancing the safety of three specific consumer micromobility products: e-scooters, e-bikes, and hoverboards. There were 19 presentations over the course of the day (see *Appendix A: Agenda* and *Appendix B: Presentations*).

Lawrence Mella opened the forum with a brief introductory presentation. There were five sessions: Data, Standards Development, Best Practices for Enhancing Safety, Micromobility Design and Research, and Policy and Consumer Safety.

The Data session revolved around incident data, considerations, and improvements being made to gather more information in the future. The next session, Standards Development, focused on the state of SAE, ASTM, and UL standards related to micromobility. The Best Practices for Enhancing Safety session emphasized the importance of infrastructure for consumer safety, such as bicycle lanes to separate riders from road vehicles. After lunch, the Micromobility Design and Research session provided a technical discussion on topics such as battery systems, R&D testing, vehicle dynamics, rider kinematics, and vehicle intelligence. The final session, Policy and Consumer Safety, highlighted activities on a federal, state, and local level and recommendations for safety activities moving forward. The forum closed with brief remarks and an invitation for attendees to provide any additional micromobility safety enhancement ideas to the CPSC.

CPSC Data Resource Links:
Description of NEISS data: https://www.cpsc.gov/Research--Statistics/NEISS-Injury-Data

Access NEISS data: https://www.cpsc.gov/cgibin/NEISSQuery/home.aspx
Question about NEISS: NEISSweb@cpsc.gov
Question about CPSRMS: Clearinghouse Clearinghouse@cpsc.gov
CPSC general questions: Center, Information Info@cpsc.gov
FOIA request: FOIA can be contacted via https://foiapal.cpsc.gov/palMain.aspx

Appendix A: Agenda

Micromobility Forum Webinar

U.S. Consumer Product Safety Commission
September 15, 2020

9:00 am Introductory Remarks
- Structure of forum and participation
- Brief overview of micromobility (CPSC)

9:15 am Session 1: Data
- EPI staff presentation (CPSC)
- Injury Surveillance Considerations Regarding E-scooter & Other Micromobility Devices (Dr. Katherine Harmon – The University of North Carolina Highway Safety Research Center)
- Discussion

10:00 am Break

10:15 am Session 2: Standards Development
- Standards in the World of New Mobility (Dr. Chris Cherry, John MacArthur, Dr. Ryan Yee - SAE)
- UL Standards for E-Mobility Products (Diana Pappas Jordan – UL)
- Safety Standards ASTM Task Group Update (Dr. Robert W. Whittlesey – ASTM TG Chair)
- Development of Micromobility Safety Standards (James Berg – Spin)
- Discussion

11:30 am Session 3: Best Practices for Enhancing Safety
- Safety Data Limitation and Opportunity for Micromobility (Dr. Chris Cherry – The University of Tennessee Knoxville)
- Remaking Urban Infrastructure For Micromobility (Kay Cheng – Spin)
- Discussion

12:15 pm Lunch Break

1:00 pm Session 4: Micromobility Design and Research

- UL 2272 & 2849: Mitigating Risk of Explosion, Fire, Electrocution (Benjamin Cribb – UL)
- Bird Batteries Design & Development (David Tenhouten – Bird)
- Evolving Safe, Reliable, and Durable Bird Vehicles (Scott Rushforth – Bird)
- Rider Kinematics and Vehicle Dynamics Testing of Electric Scooter Riding (Dr. Tina Garman and Steve Como – Exponent)
- E-bike Market, Demographics and Standards (Morgan Lommele and Alex Logemann - PeopleForBikes)
- Intelligent Shared Mobility (Paul White – Superpedestrian)
- Discussion

2:45 pm Break

3:00 pm Session 5: Policy and Consumer Safety

- Micromobility Research at U.S. Department of Transportation (Shari Schaftlein – DOT)
- Safety of Shared Micromobility Systems (Edward Fu and Laurence Wilse-Samson – Bird)
- Safety and Continued Innovation in Micromobility (Jennifer Huddleston – American Action Forum)
- Consumer Federation of America (Rachel Weintraub – Consumer Federation of America)
- State and Federal Legislation and Regulation Around E-Bikes (Morgan Lommele and Alex Logemann – PeopleForBikes)
- Discussion

4:30 pm Closing Remarks

4:35 pm Adjourn

Appendix B: Presentations

U.S. Consumer Product Safety Commission

Micromobility Forum Webinar
September 15, 2020

Forum will begin at 9AM EST

CPSC Micromobility Forum Webinar

Lawrence Mella
September 15, 2020

This presentation was prepared by CPSC staff. It has not been reviewed or approved by, and may not reflect the views of the Commission.

$1 Trillion

Deaths, injuries, and property damage from consumer product incidents cost the nation more than $1 trillion annually.[1]

The U.S. CPSC is a federal government agency charged with protecting the public from unreasonable risks of injury or death associated with the use of consumer products under the agency's jurisdiction.

[1] https://www.cpsc.gov/s3fs-public/FY2019PBR.pdf

CPSC is committed to protecting consumers from products that pose a fire, electrical, chemical, biological, and/or mechanical hazard.

CPSC's work to improve the safety of the more than 15,000 types of consumer products in its jurisdiction - such as toys, cribs, power tools, cigarette lighters, textiles, and household chemicals – has contributed to a decline in the rate of deaths and injuries associated with consumer products over the past 40 years.

What Is Micromobility?

“Personal Transportation”

“Accessible”

“Convenient”

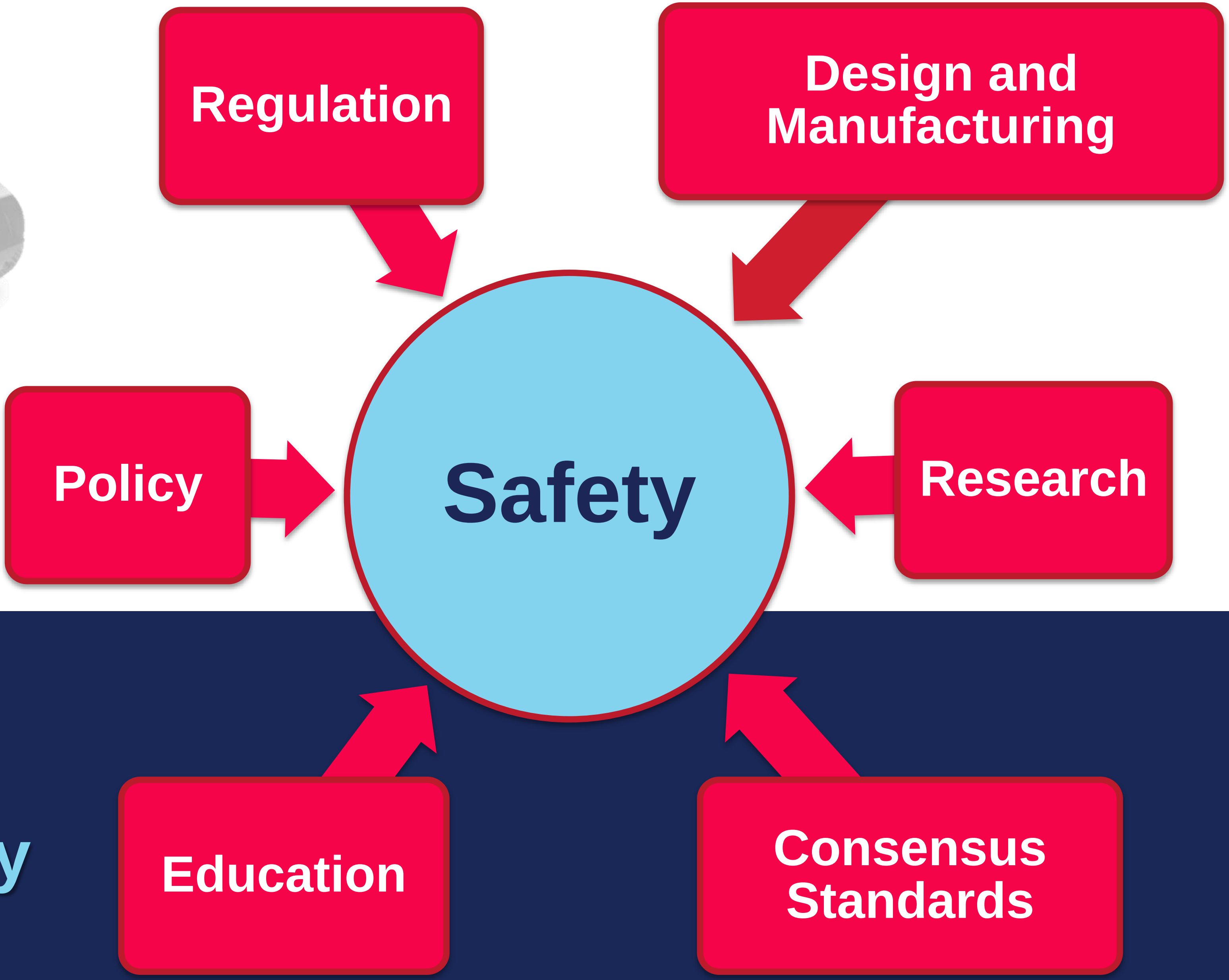
“Low Speed”

“Small Form Factor”

Micromobility and Consumer Safety


- Products
  - E-scooters
  - E-bicycles
  - Hoverboards
- Electrically powered
- Consumer-owned or “ride-share” fleet
- Generally, 20 mph speeds or lower

How can we enhance micromobility safety for consumers?



Enhancing Micromobility Safety

Forum Agenda

- Introduction
- Data
  - *Break (15 min)*
- Standards Development
- Best Practices for Enhancing Safety
  - *Lunch (45 min)*
- Micromobility Design and Research
  - *Break (15 min)*
- Policy and Consumer Safety
- Closing

Forum Process

- Discussion Format

  All speakers will present, followed by discussion/questions.

- Questions

  Questions will be collected via the Questions Box and presented to the panelist(s) during the discussion section of each panel.

- Slide Availability

  Slides and other meeting documentation will be available when the meeting log is posted to the CPSC website. A notice will be emailed to participants once posted.

Thank you!

Lawrence Mella
Mechanical Engineer
lmella@cpsc.gov

UNITED STATES OF AMERICA
CONSUMER PRODUCT
SAFETY COMMISSION

Micromobility Product Incident Data at CPSC

September 15, 2020

Malkah Glaser
James Tark
Karylle Hillard
Li Hui Chen

Micromobility Products

- "Last Mile Solution"
- Focus on e-scooters, self-balancing scooters (hoverboards), and e-bikes
- Trends:
  - Advancements in battery technology
  - Shared-use commercial products have increased
  - Sharing the road

CPSC Data Use

- Set priorities and identify emerging product hazards
- Evidence base for mitigation actions, including :
  - Creating and evaluating product standards
  - Product recalls
  - Develop information and education campaigns
- Inform voluntary standards development organizations to:
  - Develop performance requirements
  - Develop effective labeling, warnings, and instructions

NEISS Overview

- National Electronic Injury Surveillance System
- More than 40-year history collecting emergency room data
- Supports CPSC and other federal agencies
- National geographically representative sample of 96 U.S. hospitals with at least 6 inpatient beds and 24-hour emergency service
- All hospitals code injury data involving consumer products (CPSC jurisdiction)
- Subset of hospitals code data on all traumatic injury (non-CPSC jurisdiction)

NEISS Overview – continue

- System collects ~400,000 product-related CPSC injury reports each year and an additional 350,000 non-CPSC injury reports each year
- More detail is available at: https://www.cpsc.gov/Research--Statistics/NEISS-Injury-Data
- Data can be queried at: https://www.cpsc.gov/cgibin/NEISSQuery/home.aspx
- Usually, each year's NEISS data become publicly available the following April

Example of NEISS Narratives:
E-Scooter and Hoverboard

- 7YOF WAS ON A HOVER BOARD AND WAS DOING CIRCLES WHEN SHE LOST HER BALANCE AND FELL. DX: LT ELBOW FX
- 47 YOM TRIPPED OVER HOVERBOARD AND INJURED FOOT DX SPRAIN
- 13 YOF WAS RIDING A HOVERBOARD & IT SLIPPED OUT FROM UNDER HER, SHE HIT HER FOREAD ON THE CONCRETE- 2 MIN. LOC, CAN'T REMEMBER. DX: CONCUSSION
- 19YOF WAS ON A *** SCOOTER WHEN FELL OFF AND HURT KNEE DX: KNEE CONTUSION.
- 39YOM PRESENTED TO ED AFTER FALLING OFF *** SCOOTER FLIPPED OVER HANDLE BARS.DX:ELBOW FX,FOREHEAD LACERATION
- 16YOM FELL OFF MOTORIZED SCOOTER TODAY AFTER SCOOTER "LOCKED UP" AND HIT HEAD. DX: CONCUSSION WITH LOC
- 19YOM STATES WAS RIDING HIS BICYCLE WHEN AN ELECTRIC SCOOTER RAN IN FRONT OF HIM AND IN ORDER TO AVOID CRASHING HE HAD TO BRAKE REALLY HARD AND FELL FORWARD OVER THE HANDLEBARS. DX: CHIN LAC, ABRAS TO FOREARM AND KNEES.
- 56YO M WAS OUT DRINKING WITH FRIENDS 2 NIGHTS AGO, LEFT BAR AND GOT ON SCOOTER. CRASHED. NO BAL. DX; CONCUSSION, NAUSEA, SHOULDER PAIN.

Other CPSC Surveillance Databases

- Consumer Product Safety Risk Management System (CPSRMS/CPSC360)
  - Injury and Potential Injury Incident Data
  - Death Certificates
  - In-Depth Investigations

Death Certificates

- Separate contracts with 50 states
- Purchase ~ 8,000 certificates annually in certain ICD-10 codes
- Read all and code ~ 5,000 certificates, some will be outside CPSC's jurisdiction
- Lag issues
- Brief narratives, sparse product information

Limitations of CPSC Database

- NEISS specific
  - Underestimated Deaths – only include if occurred in the ED
  - No Non-emergency department treatment
    - doctor's office, school nurse, athletic trainer, urgent care, etc.
  - National Estimates only – sample not designed for regional estimates
- CPSRMS specific
  - Not statistical sample and not nationally representative
  - Underestimates Deaths – only includes those reported to CPSC
  - Might have lengthy lag between event and data collected

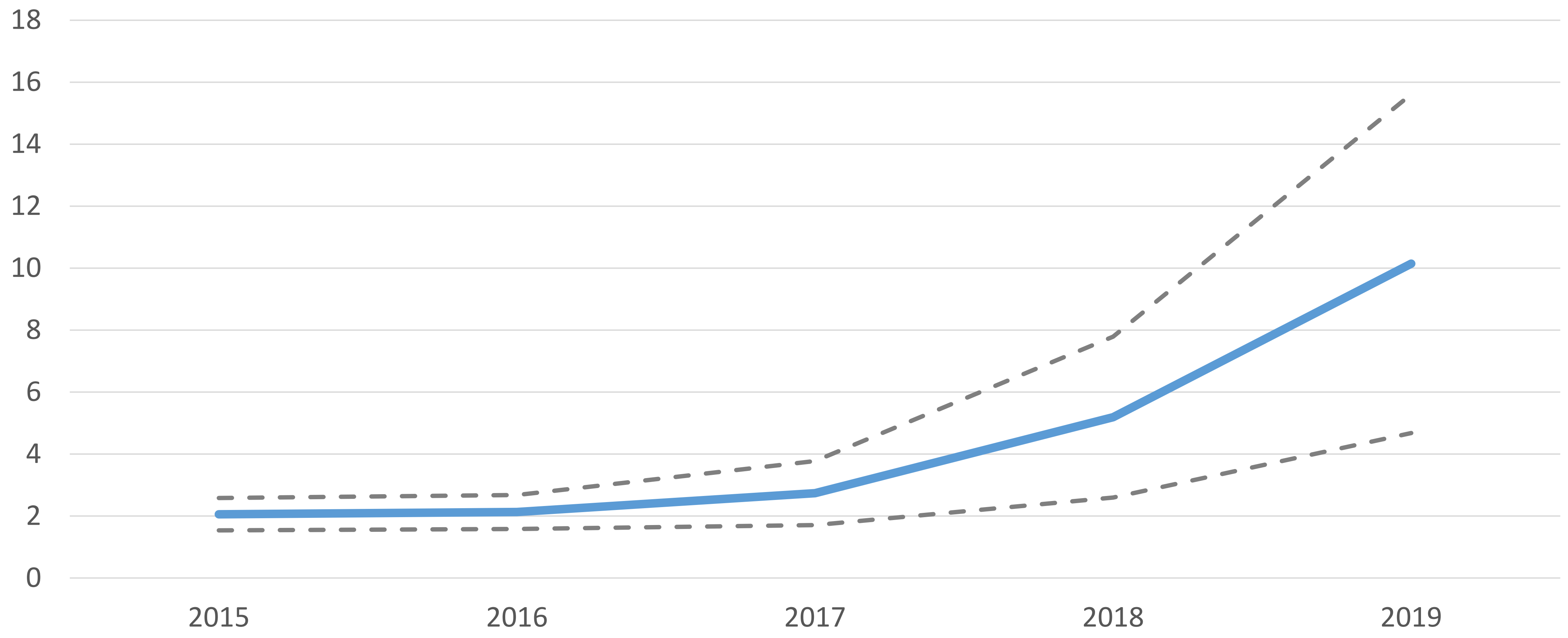
Analysis Example 1: Using NEISS Data to Analyze E-Scooter-Related Injuries

Malkah Glaser
Karylle Hillard
Li Hui Chen

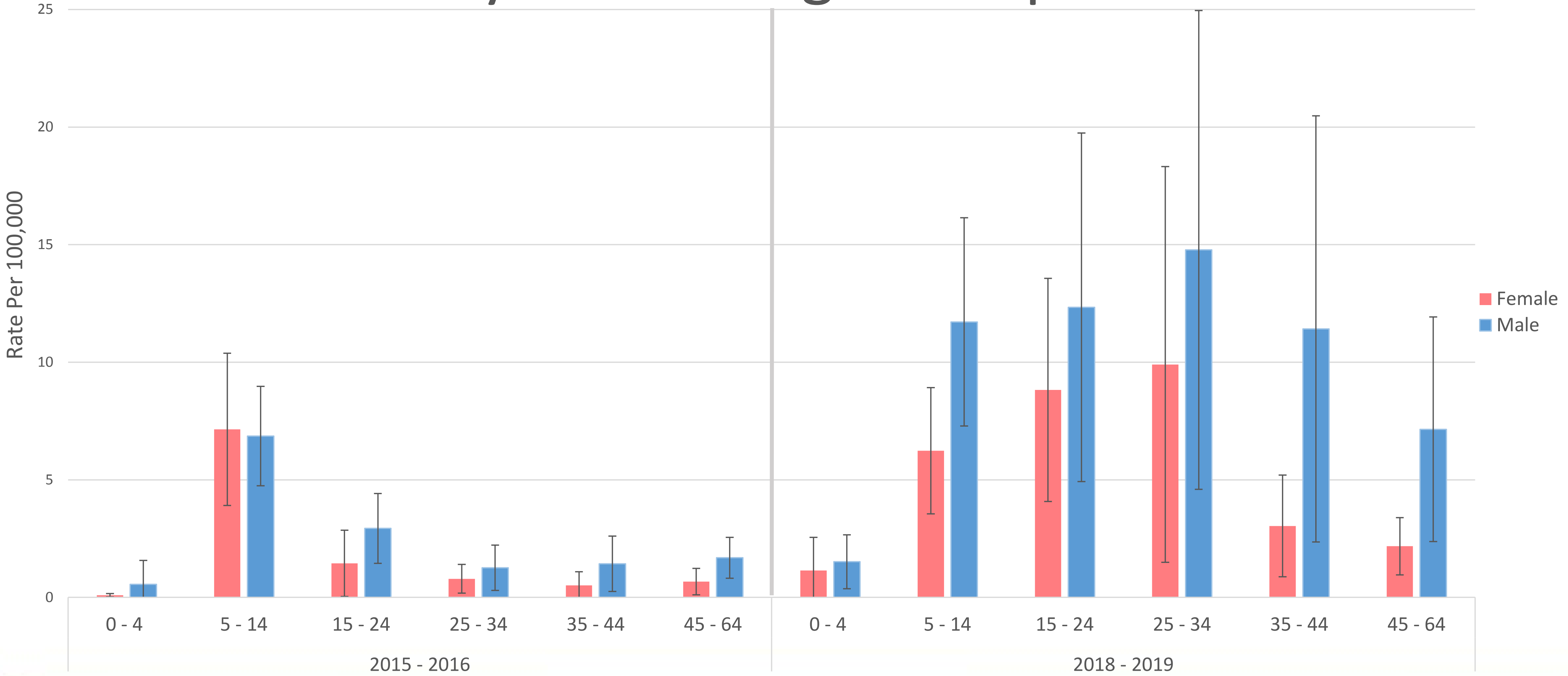
Methods

- Selection Criteria:
  - 5042 NEISS product code – Powered Scooter
  - Definition: electric/powered scooter has two wheels, handlebars, a floorboard that can be stood upon while riding, and a motor that powers the vehicle
  - Excluded patients over the age of 65 (to differentiate from mobility scooters)
  - Removed narratives that specifically referred to hoverboard, skateboard, mobility scooter, or Segway
- Focused on powered scooter-related ED visits for 2015 –2019
- Calculated rates using mid-year census
- Calculated confidence interval using SAS Survey Procedure

E-Scooter-Related ED Visits per 100,000 population, Years 2015-2019



E-Scooter-Related ED Visits per 100,000 population by Sex and Age Group



UNITED STATES CONSUMER PRODUCT SAFETY COMMISSION

Analysis Example 2: Micromobility Annual Report

James Tark

In-Depth Investigations (IDIs) from CPSRMS

- More comprehensive look at how incidents were happening
- Based on reports of incidents in CPSRMS that occurred between 2017 and 2019
- Completed 140 follow-up IDIs related to all micromobility products
- Hazards Identified:
    - E-scooter
        - Brake problems
        - Unexpected power losses
        - Fire hazards
    - Hoverboard
        - Fire hazards
        - Other electrical hazards
    - E-bike
        - Brake problem

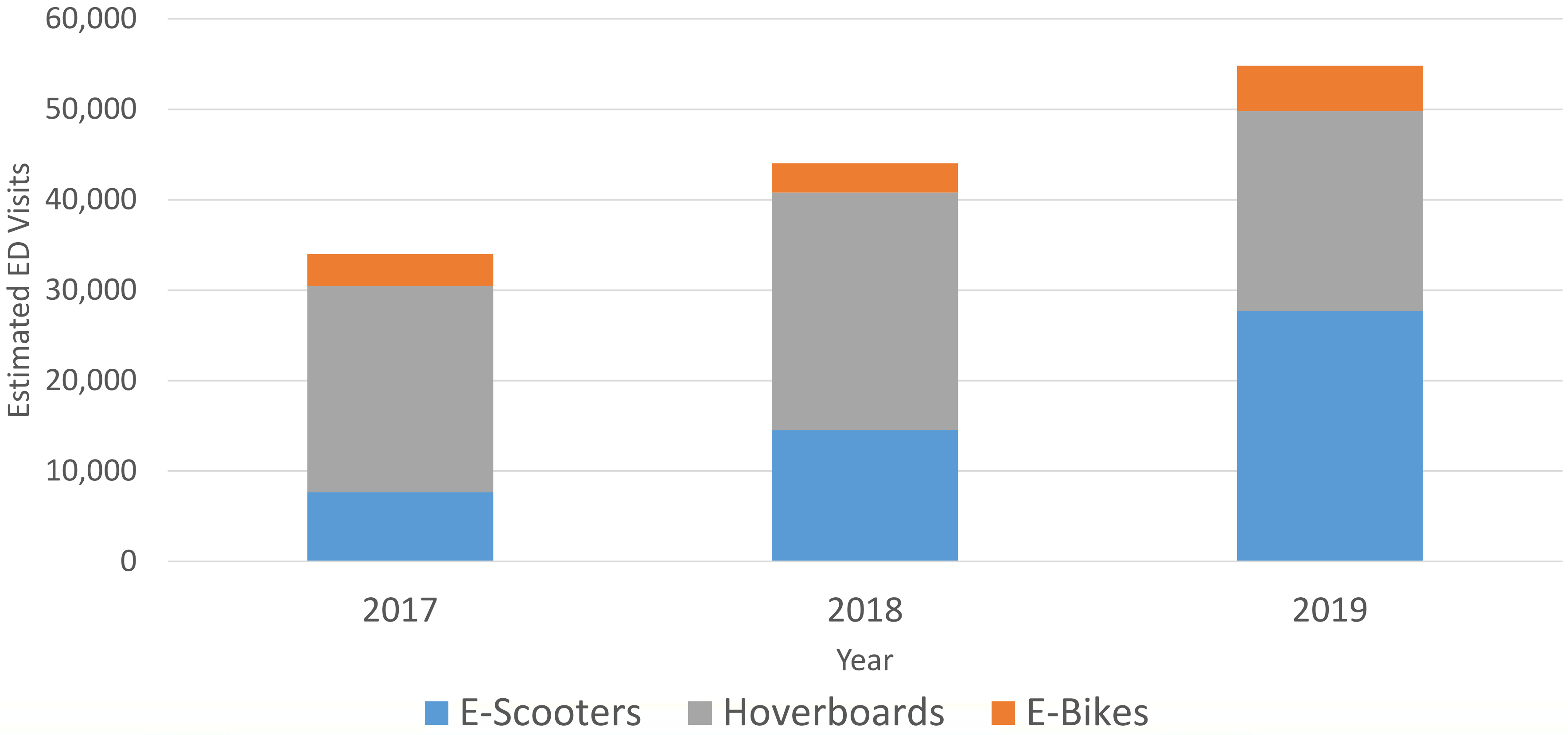
Fatalities

- CPSC staff is aware of 41 fatalities related to micromobility products that occurred in the United States from 2017 through 2019. Due to delays in death certificate reporting, data may be incomplete.

Year	All Micromobility	E-Scooter (Dockless/rental)	Hoverboard	E-Bike
2017	5	1 (0)	4	0
2018	10	5 (2)	0	5
2019	26	21 (7)	0	5
Total	41	27 (9)	4	10

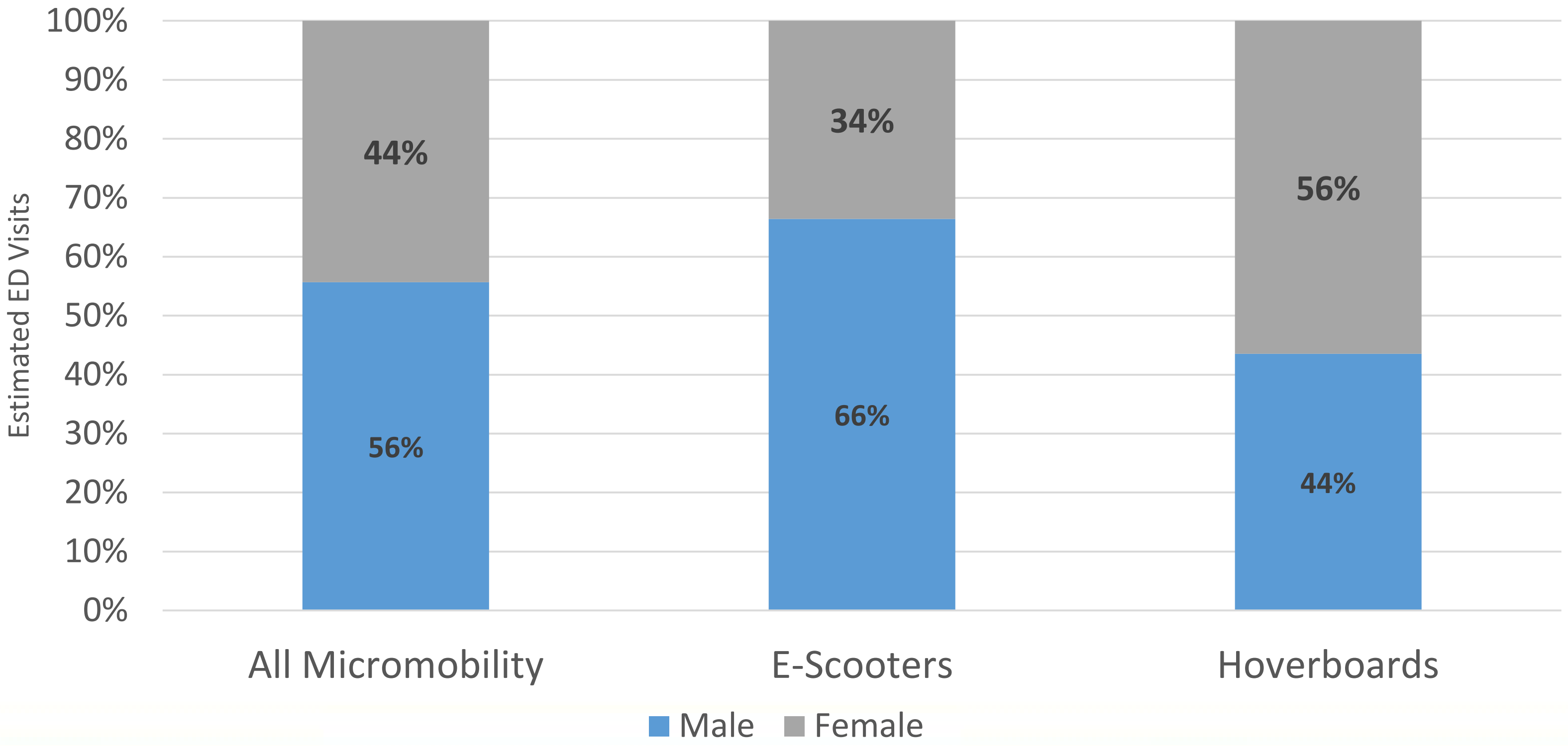
Micromobility-Related ED Visits

- Annual estimated ED visits were 34,000, 44,000, and 54,800 in 2017, 2018, and 2019, respectively.



Micromobility-Related ED Visits: 2017 – 2019 by Sex

- Overall, males experienced higher percentage of micromobility-related, ED-treated injuries
- Females had higher percentage (56 percent) of hoverboard-related, ED-treated injuries



Limitations of Micromobility Annual Report

- For 2018-2019, the annual estimated ED visits, where the NEISS narrative provided enough information to determine that an e-scooter was a dockless rental, did not meet minimum reporting requirement for NEISS.
- Annual estimated ED visits for e-bikes did not meet the reporting criteria from 2017 to 2019.

Data Improvements at CPSC

- Several new product codes replaced old codes in 2020, to improve classification of micromobility devices:
  - 5022-Scooter, powered
  - 5023-Scooter, unpowered
  - 5024-Scooter, unspecified
  - 5025-Hoverboards and powered skateboards
- Telephone/Online survey on possible e-scooter-related incidents
  - NEISS cases involving powered scooters & unspecified scooters treated after 1/1/2020
  - Information collected on scooter, environment, and event

Thank you

Injury Surveillance Considerations Regarding E-scooter & Other Micromobility Devices

Katherine (Katie) Harmon, Ph.D.

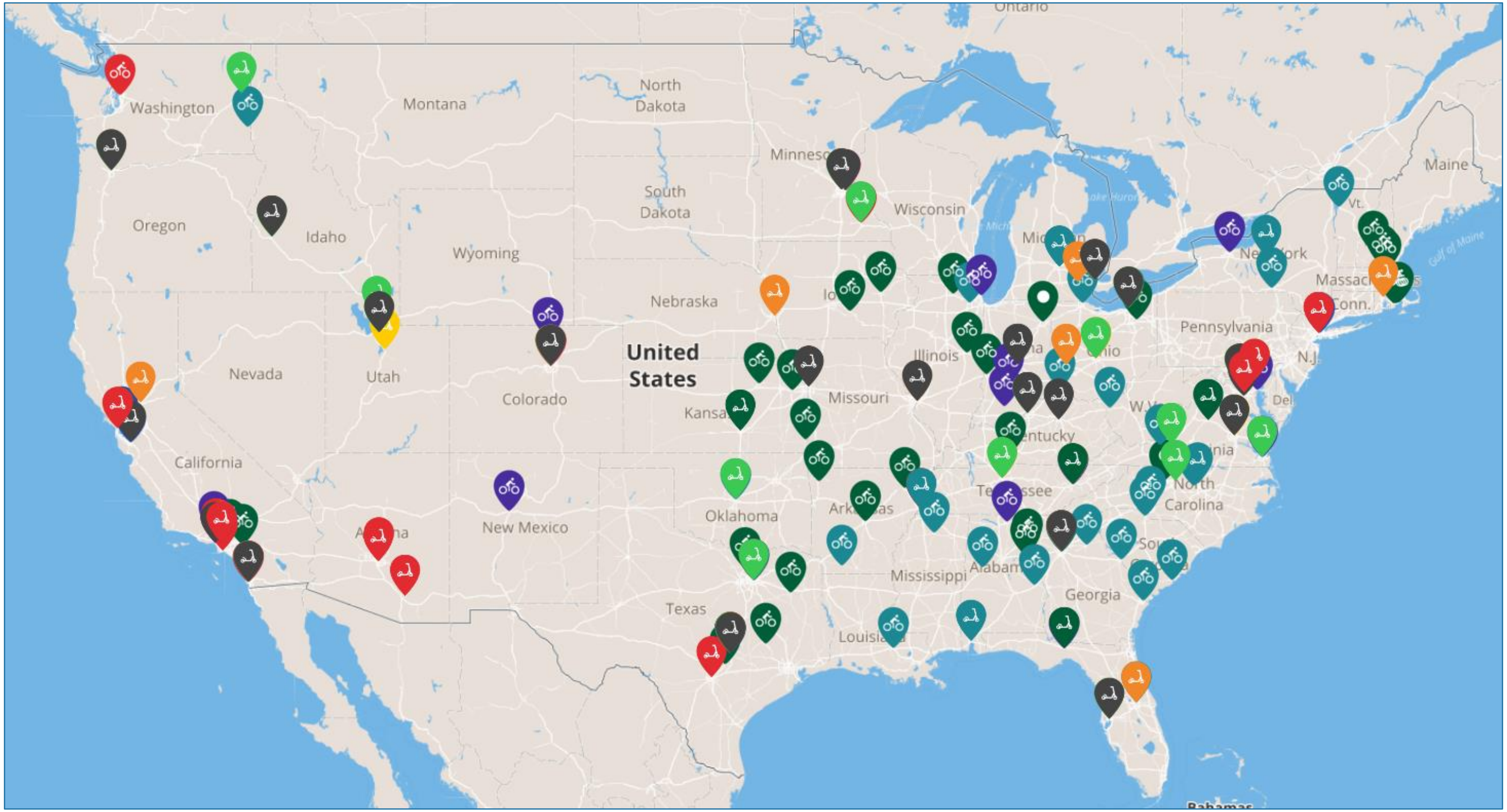
Presentation to CPSC

September 15, 2020

THE UNIVERSITY OF NORTH CAROLINA
HIGHWAY SAFETY RESEARCH CENTER

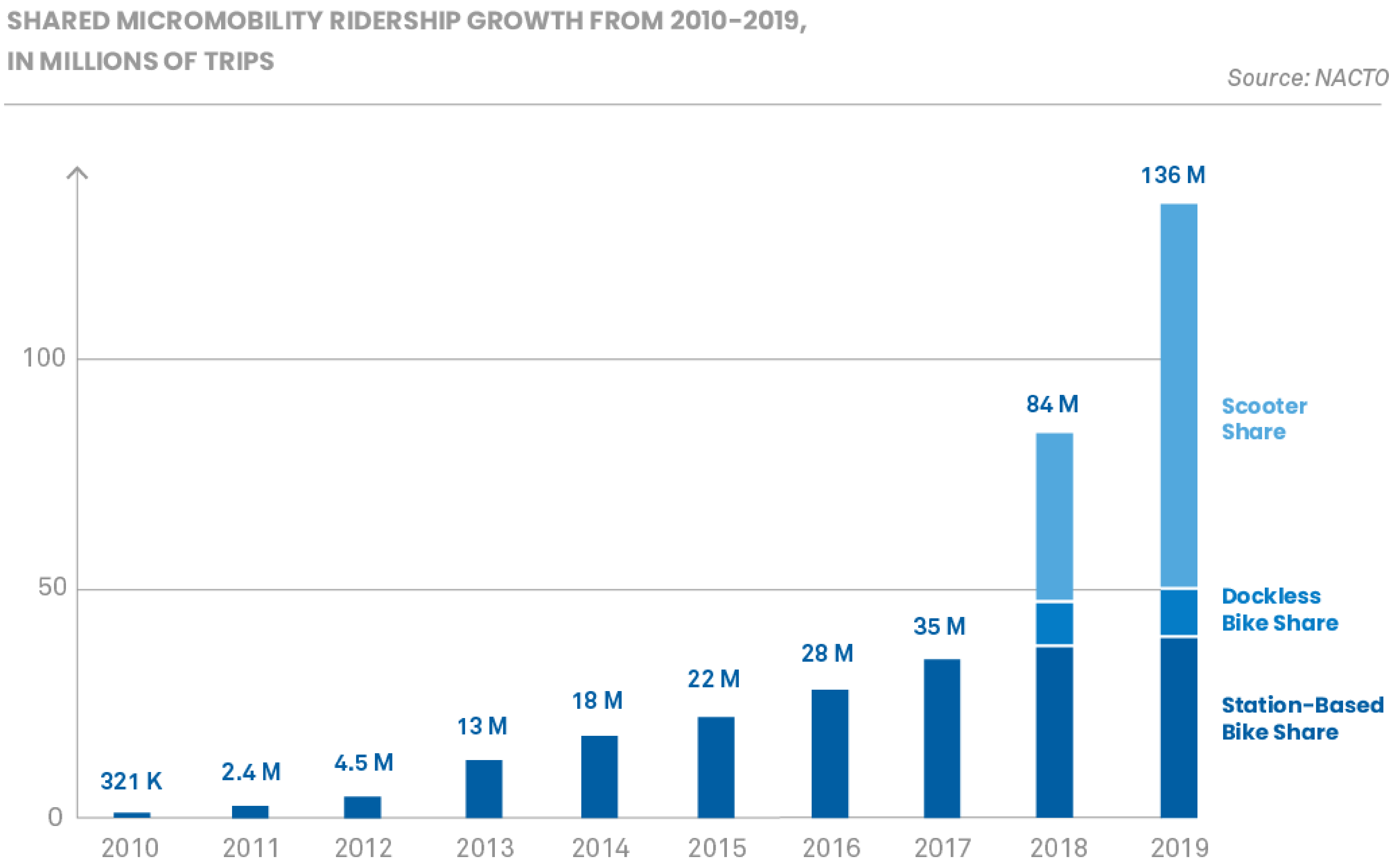
www.hsrc.unc.edu

E-scooter and other micromobility rideshares are expanding to many U.S. cities



Source: Smart Cities Mobility Map, 2021

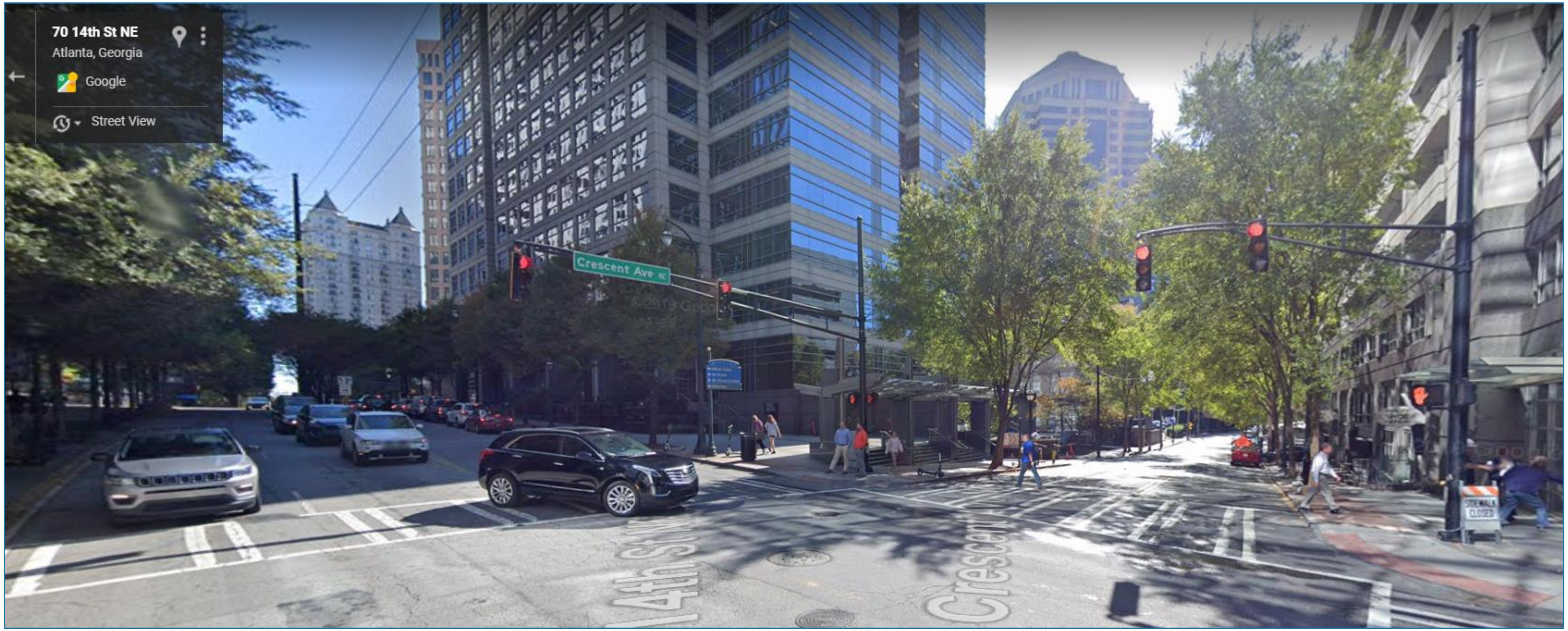
…And ridership is experiencing rapid growth



Source: NACTO, 2020

Increased ridership has not come without costs

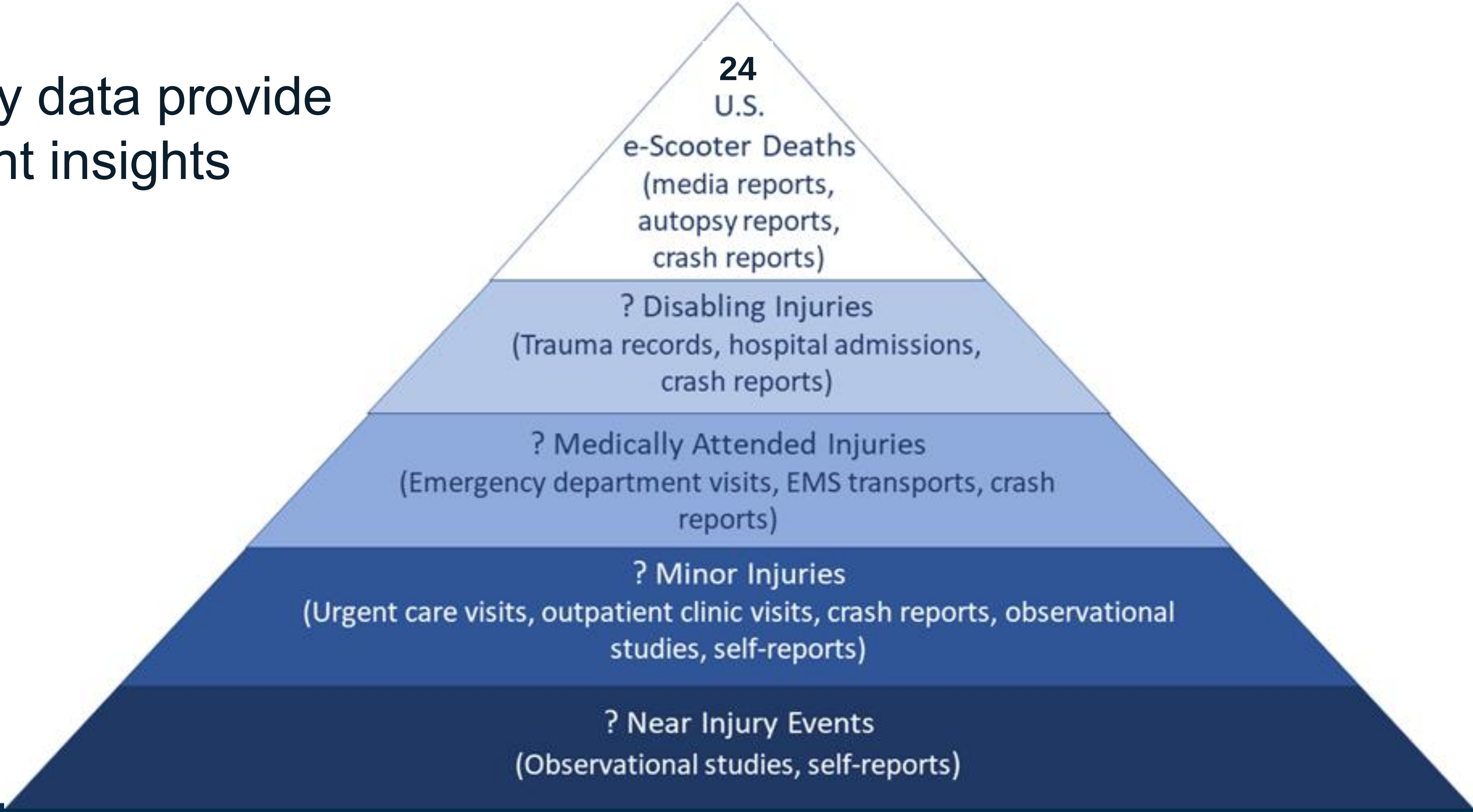
A 34-year old nurse was struck while riding a e-scooter in Midtown, Atlanta in a hit-and run incident. She died five days later from her injuries.



Source: S. Abusaid. Atlanta Journal Constitution, 2019; Google, 2020

What is the risk of death and injury related to e-scooter & other micromobility devices?

Injury and safety data provide us with important insights



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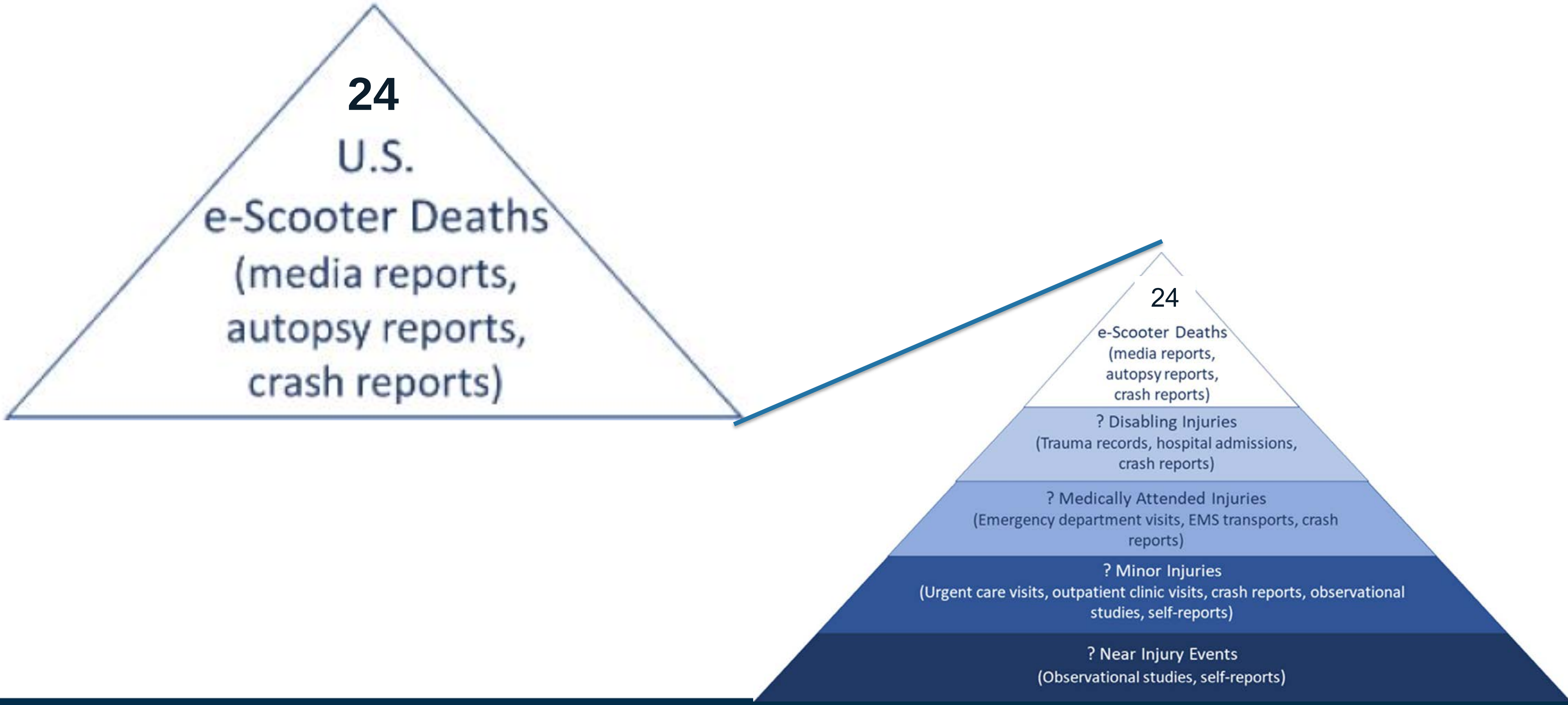
HIGHWAY SAFETY
RESEARCH CENTER

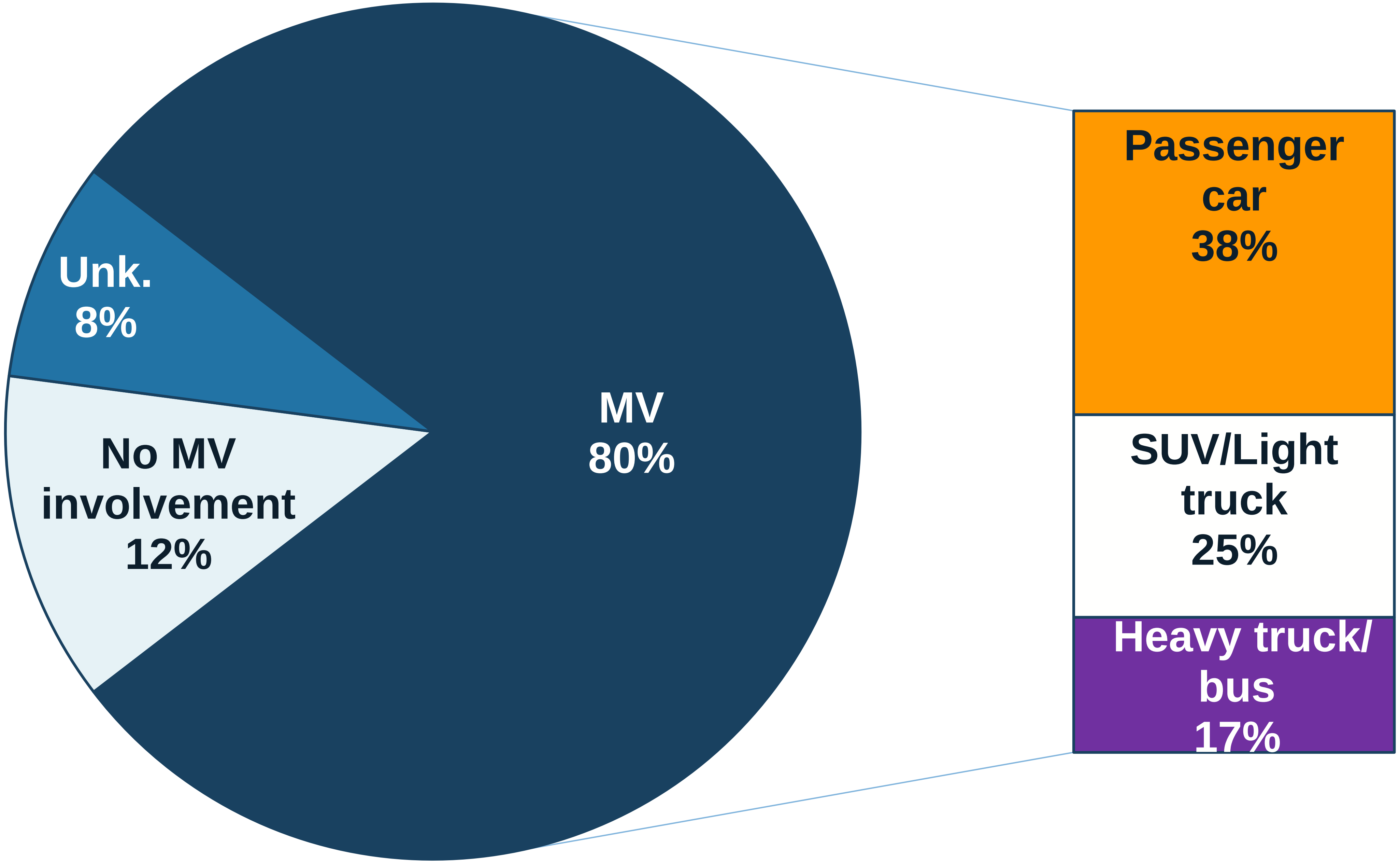
U.S. e-scooter fatalities



U.S. e-scooter fatalities

- 2017: 0
- 2018: 4
- 2019: 18
- 2020: 2

Total: 24 U.S. fatalities

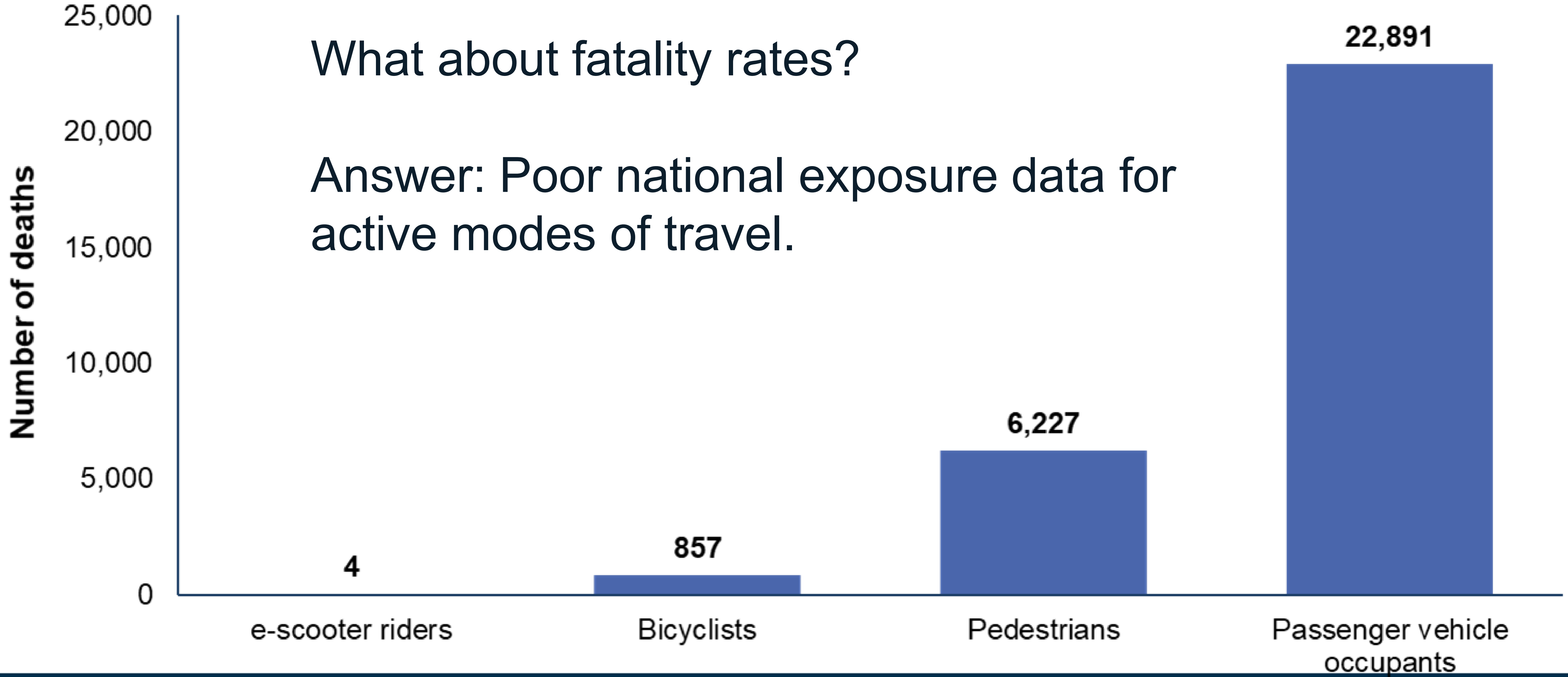


U.S. e-scooter fatalities, 2018

Number of fatalities by person type: NHTSA, 2018

What about fatality rates?

Answer: Poor national exposure data for active modes of travel.



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Source: NHTSA. Fatality Analysis Reporting System Encyclopedia, 2020.

E-scooter & micromobility fatalities

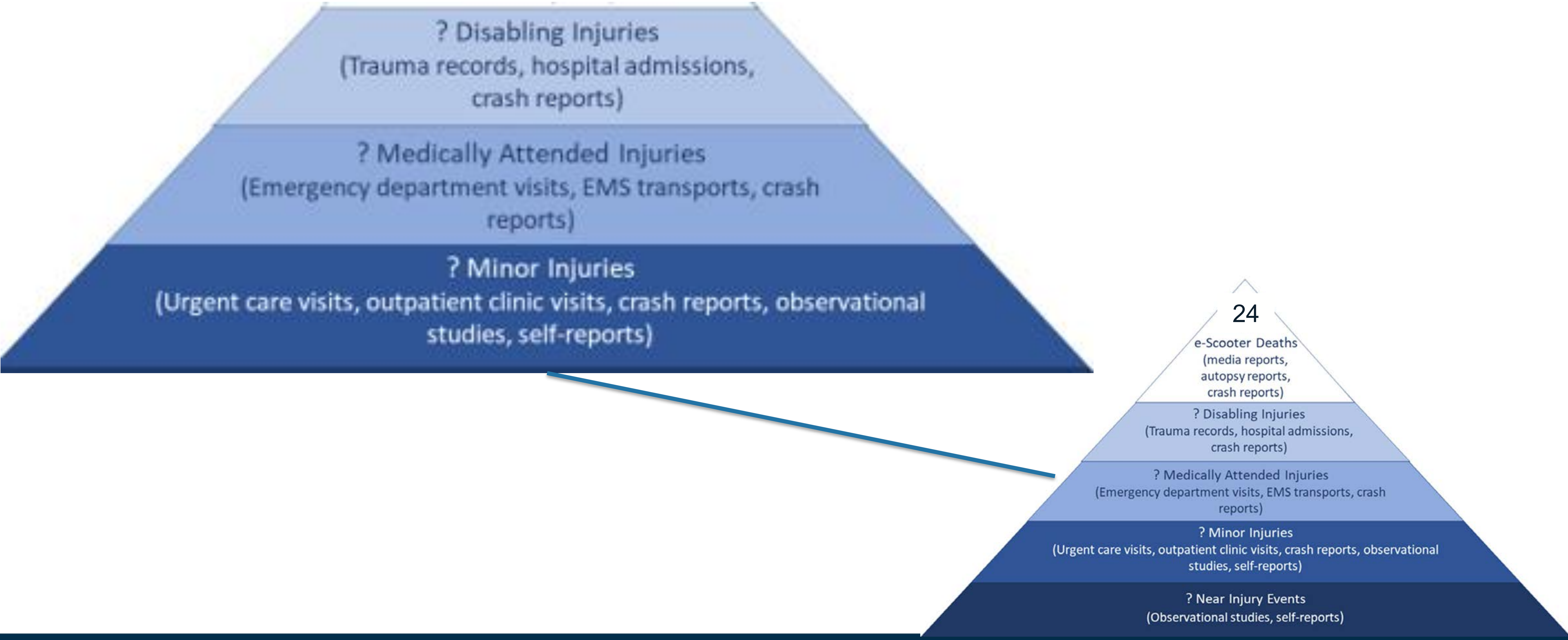
- Current micromobility surveillance tools:
  - No national system in place
  - List of e-scooter fatalities maintained by CSCRS
- Existing data sources:
  - Media
  - Medical examiner/coroner reports & death certificates
  - Police reported crashes
- Current data limitations:
  - FARS does not have a specific code for e-scooter fatalities (this may be changing)
  - Some state crash systems contain codes for e-scooters

FARS/FIRST, 2020

Person Type

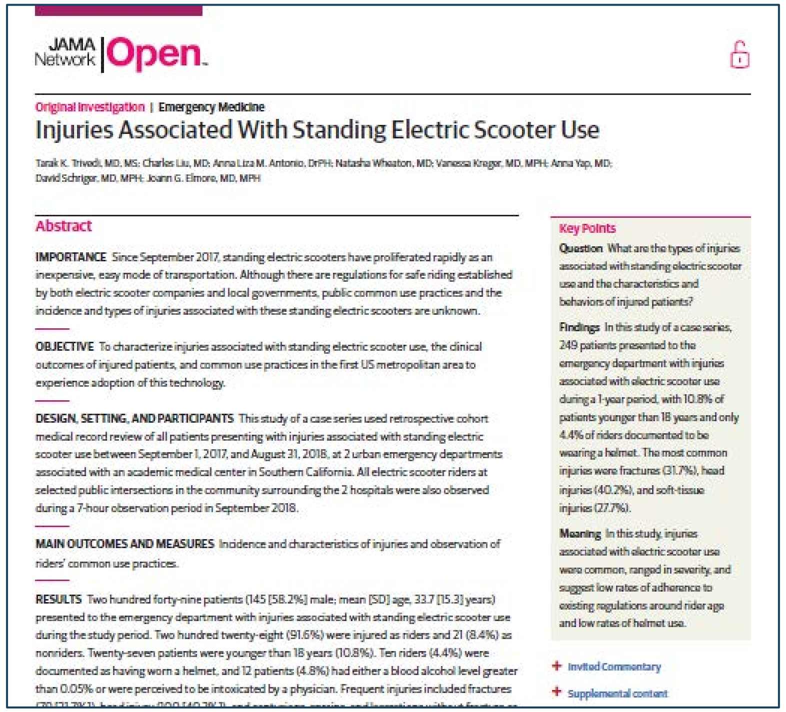
- [ ] Driver of a Motor Vehicle In-Transport
- [ ] Passenger of a Motor Vehicle In-Transport
- [ ] Occupant of a Motor Vehicle Not In-Transport
- [ ] Occupant of a Non-Motor Vehicle Transport Device
- [ ] Pedestrian
- [ ] Bicyclist
- [ ] Other Bicyclist
- [x] Person on Personal Conveyances
- [ ] Unknown Occupant Type in a Motor Vehicle In-Transport
- [ ] Persons In/On Buildings (Since 2007)
- [ ] Unknown Type of Non-Motorist
- [ ] Not Reported (2010 Only)
- [ ] Unknown

U.S. e-scooter injuries



E-scooter injury surveillance studies

- As part of our BTSCRP-10 project, we are building an inventory of e-scooter-related epidemiologic studies, as well as other literature pertaining to e-scooter safety
- Many resources are currently posted on our [PBIC website]



JAMA Network | Open

Original Investigation | Emergency Medicine

Injuries Associated With Standing Electric Scooter Use

Tarak K. Trivedi, MD, MS; Charles Liu, MD; Anna Liza M. Antonio, DrPH; Natasha Wheaton, MD; Vanessa Kreger, MD, MPH; Anna Yap, MD; David Schriger, MD, MPH; Joann G. Elmore, MD, MPH

Abstract

IMPORTANCE Since September 2017, standing electric scooters have proliferated rapidly as an inexpensive, easy mode of transportation. Although there are regulations for safe riding established by both electric scooter companies and local governments, public common use practices and the incidence and types of injuries associated with these standing electric scooters are unknown.

OBJECTIVE To characterize injuries associated with standing electric scooter use, the clinical outcomes of injured patients, and common use practices in the first US metropolitan area to experience adoption of this technology.

DESIGN, SETTING, AND PARTICIPANTS This study of a case series used retrospective cohort medical record review of all patients presenting with injuries associated with standing electric scooter use between September 1, 2017, and August 31, 2018, at 2 urban emergency departments associated with an academic medical center in Southern California. All electric scooter riders at selected public intersections in the community surrounding the 2 hospitals were also observed during a 7-hour observation period in September 2018.

MAIN OUTCOMES AND MEASURES Incidence and characteristics of injuries and observation of riders' common use practices.

RESULTS Two hundred forty-nine patients (145 [58.2%] male; mean [SD] age, 33.7 [15.3] years) presented to the emergency department with injuries associated with standing electric scooter use during the study period. Two hundred twenty-eight (91.6%) were injured as riders and 21 (8.4%) as nonriders. Twenty-seven patients were younger than 18 years (10.8%). Ten riders (4.4%) were documented as having worn a helmet, and 12 patients (4.8%) had either a blood alcohol level greater than 0.05% or were perceived to be intoxicated by a physician. Frequent injuries included fractures

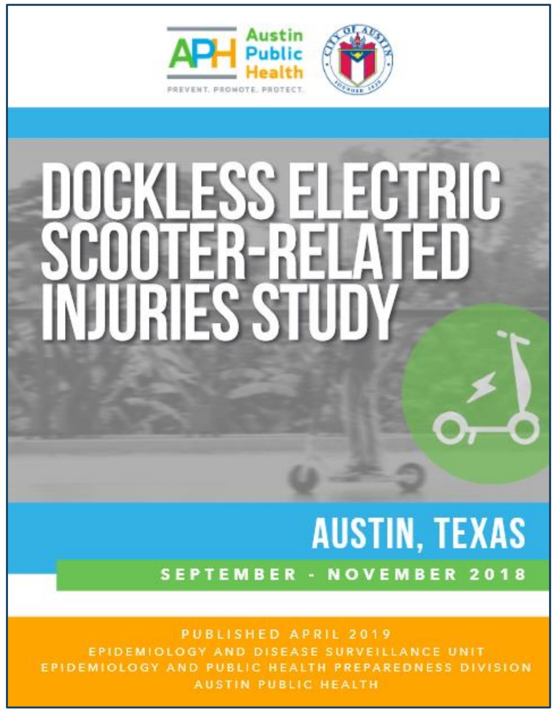
Key Points

Question What are the types of injuries associated with standing electric scooter use and the characteristics and behaviors of injured patients?

Findings In this study of a case series, 249 patients presented to the emergency department with injuries associated with electric scooter use during a 1-year period, with 10.8% of patients younger than 18 years and only 4.4% of riders documented to be wearing a helmet. The most common injuries were fractures (31.7%), head injuries (40.2%), and soft-tissue injuries (27.7%).

Meaning In this study, injuries associated with electric scooter use were common, ranged in severity, and suggest low rates of adherence to existing regulations around rider age and low rates of helmet use.

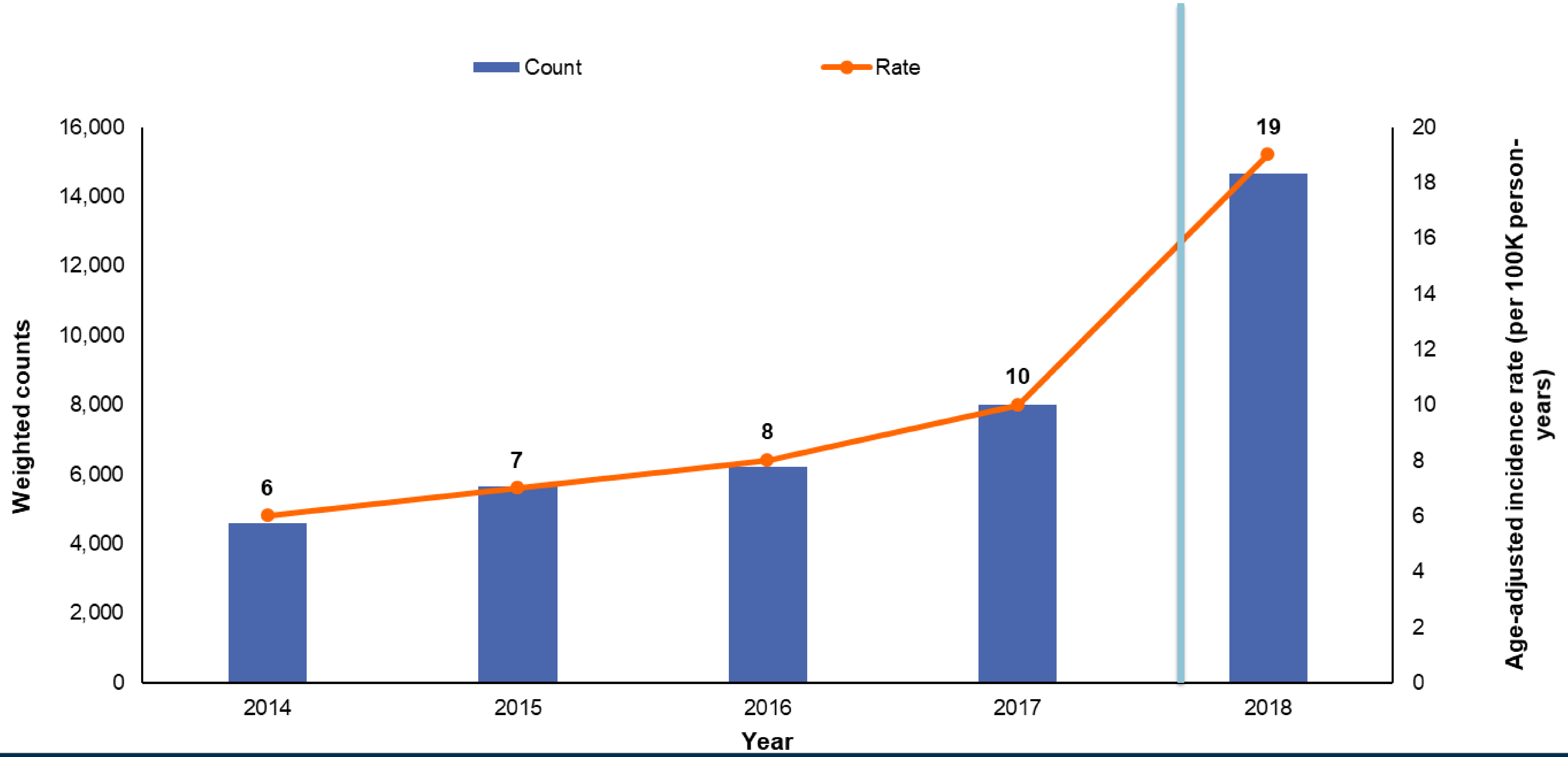
+ Invited Commentary
+ Supplemental content



U.S. population-based e-scooter injury surveillance studies

CPSC NEISS studies

First rideshare launched Sept. 2017



Source: NK Namiri, H Lui, T Tangney, 2019.

Improved NEISS Coding in 2020

- Old NEISS code for dockless rideshare e-scooters:
  - "Powered scooters" (code 5042),"
- New NEISS code for dockless rideshare e-scooters:
  - "Rideshare or rental scooters" (code 5022).

Scooters

Choose among:

Scooters, unpowered **5023**
Scooters, powered **5022**

If scooter not specified as powered,
Use: Scooters, unpowered 5023

If unknown whether scooter is powered or unpowered,
Use: Scooters, unspecified 5024

Hoverboards and powered skateboards **5025**

Mobility carts, electric (for use by patients with physical limitations)
Use: Motorized vehicles, not elsewhere classified (three or more wheels) **1744**

Motorized cooler/scooter combination
Use: Motorized vehicles, not elsewhere classified (three or more wheels) **1744**

One-wheel scooter
Use: Unicycle (activity/apparel/equipment) **1283**

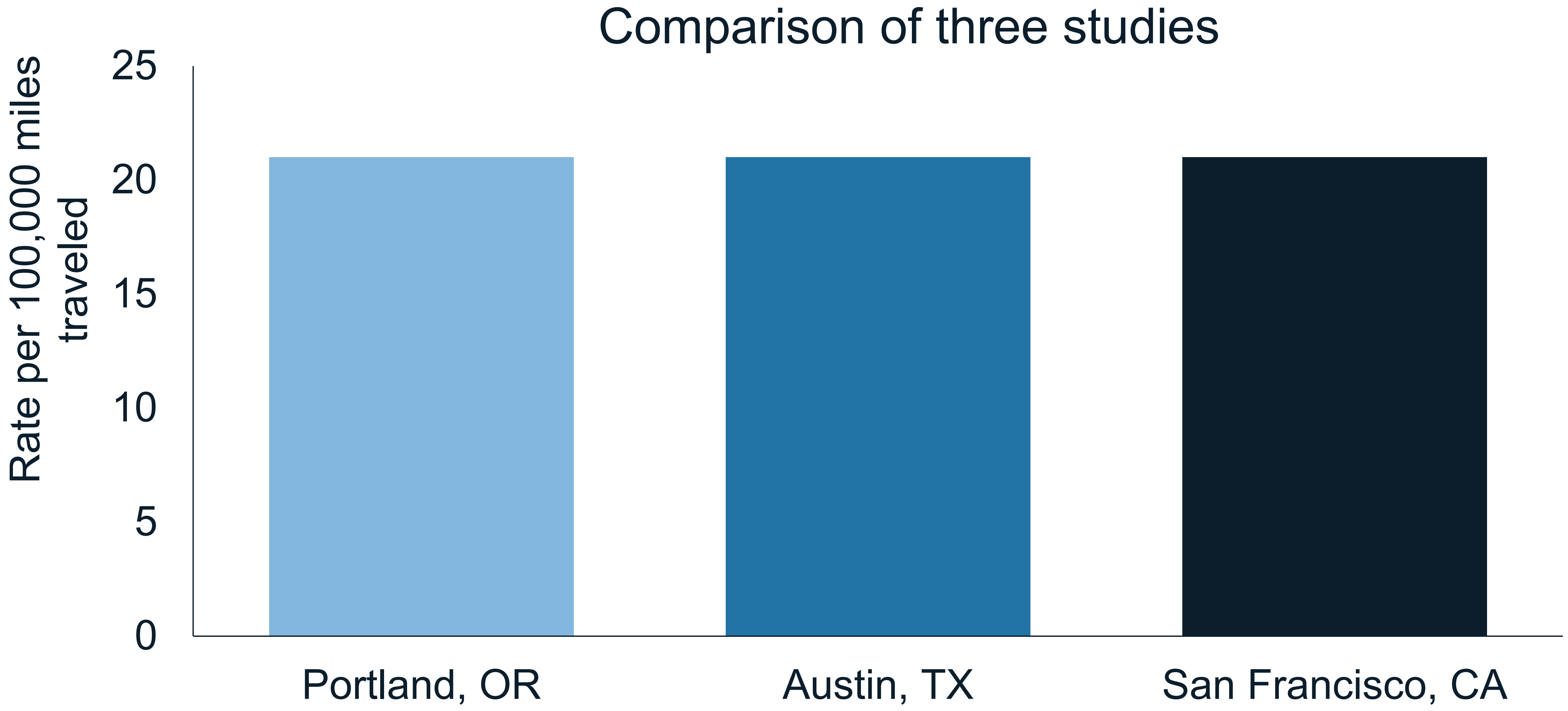
Rideshare or rental scooters
Use: Scooters, powered **5022**

Community/hospital-based e-scooter injury surveillance studies

- Because of the challenges associated with national data sources, most studies have been performed at the community (or hospital) level.
  - Los Angeles, California
  - San Diego, California
  - San Francisco, California
  - Washington, DC
  - Portland, Oregon
  - Austin, Texas
  - Dallas, Texas
  - Salt Lake City, Utah

	Preliminary e-scooter trends		
Characteristic	**Santa Monica Study (JAMA)**	**Austin, TX Study (DPH/CDC)**	**Portland Study (PBOT/Health Department)**
Study period	1 year	3 months	4 months
Setting	2 hospitals	9 hospitals	? EDs/urgent care clinics
Demographics	58% male Mean age: 34 years	55% male Median age: 29 years	Not reported
Injury type	32% had fractures 40% had head injuries	19% had fractures 50% had head injuries (7% TBIs)	7% had TBIs
Hospital admission	6% admitted to hospital	14% admitted to hospital	Not reported
Injury rate	Not calculated	20 per 100K trips; 21 per 100K miles	25 per 100K trips; 21 per 100K miles
Helmet usage (confirmed)	4% of riders	<1%	3%

Number of medically attended injuries per 100,000 e-scooter miles traveled



Hospitalizations/ED visits
Urgent care center visits

Hospitalizations/ ED visits

Hospitalizations/ ED visits

Sources: PBOT, 2018; APH, 2019; VZSF, 2019.

Insights from e-scooter injury surveillance studies

- Most e-scooter riders with medically attended injuries are:
  - Male (50-80%)
  - Working-age adults (mean/median age 29-45)
  - Injured on the sidewalk (as opposed to in-street)
  - Injured due to a fall/collision with non-moving objects
  - Injured during the daytime, but severe/fatal injuries more common at night
  - Not impaired, but impairment more common for severe/fatal injuries
  - Not wearing a helmet (0%-22%*†)
  - Likely to have a head injury (18%-67%*†) and/or fracture (19%-42%)
  - Moderately likely to be admitted to the hospital (6%-67%*†)

*Small sample size;

†Level I Trauma Center

Illustrative example: e-scooter injuries in healthcare data

Probable e-scooter "true positive"				
Age	**Transport Mode**	**Chief Complaint**	**Dx Codes**	**Disposition**
30-39	Walk-in following transport via public transportation	**Bird scooter** accident	F10.920 - ALCOHOL USE, UNSPECIFIED WITH INTOXICATION, UNCOMPLICATED; S00.81XA - ABRASION OF OTHER PART OF HEAD, INITIAL ENCOUNTER *-* V00.831A - **FALL FROM MOTORIZED MOBILITY SCOOTER**, INITIAL ENCOUNTER *-* S40.012A - CONTUSION OF LEFT SHOULDER, INITIAL ENCOUNTER	Discharged
20-29	Walk-in following transport via private transportation	Pt fell off a **lime scooter** on and drove down a flight of stairs at 17 mph. **No helmet**, no head injury. Road rash bilateral.	S20.211A - CONTUSION OF RIGHT FRONT WALL OF THORAX, INITIAL ENCOUNTER *-* V28.0XXA - **MOTORCYCLE DRIVER INJURED IN NONCOLLISION TRANSPORT ACCIDENT** IN NONTRAFFIC ACCIDENT, INITIAL ENCOUNTER *-* S20.212A - CONTUSION OF LEFT FRONT WALL OF THORAX, INITIAL ENCOUNTER *-* S60.512D - ABRASION OF LEFT HAND, SUBSEQUENT ENCOUNTER	Discharged
Probable e-scooter "false positive"				
60-69	Ground ambulance	Patient fell from **rover scooter**. Reports pain in leg.	S42.412A - DISPLACED SIMPLE SUPRACONDYLAR FRACTURE WITHOUT INTERCONDYLAR FRACTURE OF LEFT HUMERUS, INITIAL ENCOUNTER FOR CLOSED FRACTURE *-* V00.831A - **FALL FROM MOTORIZED MOBILITY SCOOTER**, INITIAL ENCOUNTER	Discharged

*The examples provided have been significantly altered to protect patient anonymity – these examples are for illustrative purposes only.

Short-term solution for micromobility injury surveillance

- New modes, new [use of existing] codes!
- Created a combination keyword/ICD-10-CM diagnosis code micromobility definition
- Distributed poster to >1500 individuals in NC, other states, and internationally
- Poster available on the CSCRS website

Longer-term solution for micromobility injury surveillance

- New ICD-10-CM micromobility codes will go into effect in October 2020
- Codes are posted on the National Center for Health Statistic's website

Chapter 20

External causes of morbidity (V00-Y99)

Pedestrian injured in transport accident (V00-V09)

V00 Pedestrian conveyance accident

V00.0 Pedestrian on foot injured in collision with pedestrian conveyance

V00.03 Pedestrian on foot injured in collision with standing micro-mobility pedestrian conveyance

V00.031 Pedestrian on foot injured in collision with rider of standing electric scooter

V00.038 Pedestrian on foot injured in collision with rider of other standing micro-mobility pedestrian conveyance
Pedestrian on foot injured in collision with rider of hoverboard
Pedestrian on foot injured in collision with rider of segway

V00.8 Accident on other pedestrian conveyance

V00.84 Accident with standing micro-mobility pedestrian conveyance

V00.841 Fall from standing electric scooter

V00.842 Pedestrian on standing electric scooter colliding with stationary object

V00.848 Other accident with standing micro-mobility pedestrian conveyance
Accident with hoverboard
Accident with segway

Why are micromobility injury surveillance (& other safety) studies important

- Cities and states are implementing policies and procedures with limited understanding of the problem and limited capacity to evaluate the safety effects of their actions:
  - Curfews
  - Geofencing
  - Requiring helmets
  - Restricting ridership to sidewalk/trafficways
  - Enforcement

Source: pedbikeimages, 2020

BTSCRP-10 ongoing research aims

1. Describe the overall state of use/exposure and safety trends among e-scooter users and markets
2. **Characterize the relationship between e-scooter crashes, injuries, fatalities, and contributing factors (both behavioral and environmental)**
3. Summarize how cities are working to support, manage, and/or regulate the use of e-scooters to prevent and mitigate injuries and provide a series of case studies highlighting real world practices
4. Provide evidence-based strategies and supporting tools for e-scooter safety actions that can be integrated into state and local highway safety plans, policies, programs, and projects

Questions?

Katie Harmon, harmon@hsrc.unc.edu

THE UNIVERSITY OF NORTH CAROLINA
HIGHWAY SAFETY RESEARCH CENTER

www.hsrc.unc.edu

Standards in the World of New Mobility

CPSC Micromobility Forum

September 15, 2020

Introductions

Chris Cherry, PhD
Professor,
U of Tennessee, Knoxville

Chair, SAE Powered
Micromobility Vehicles Cmte

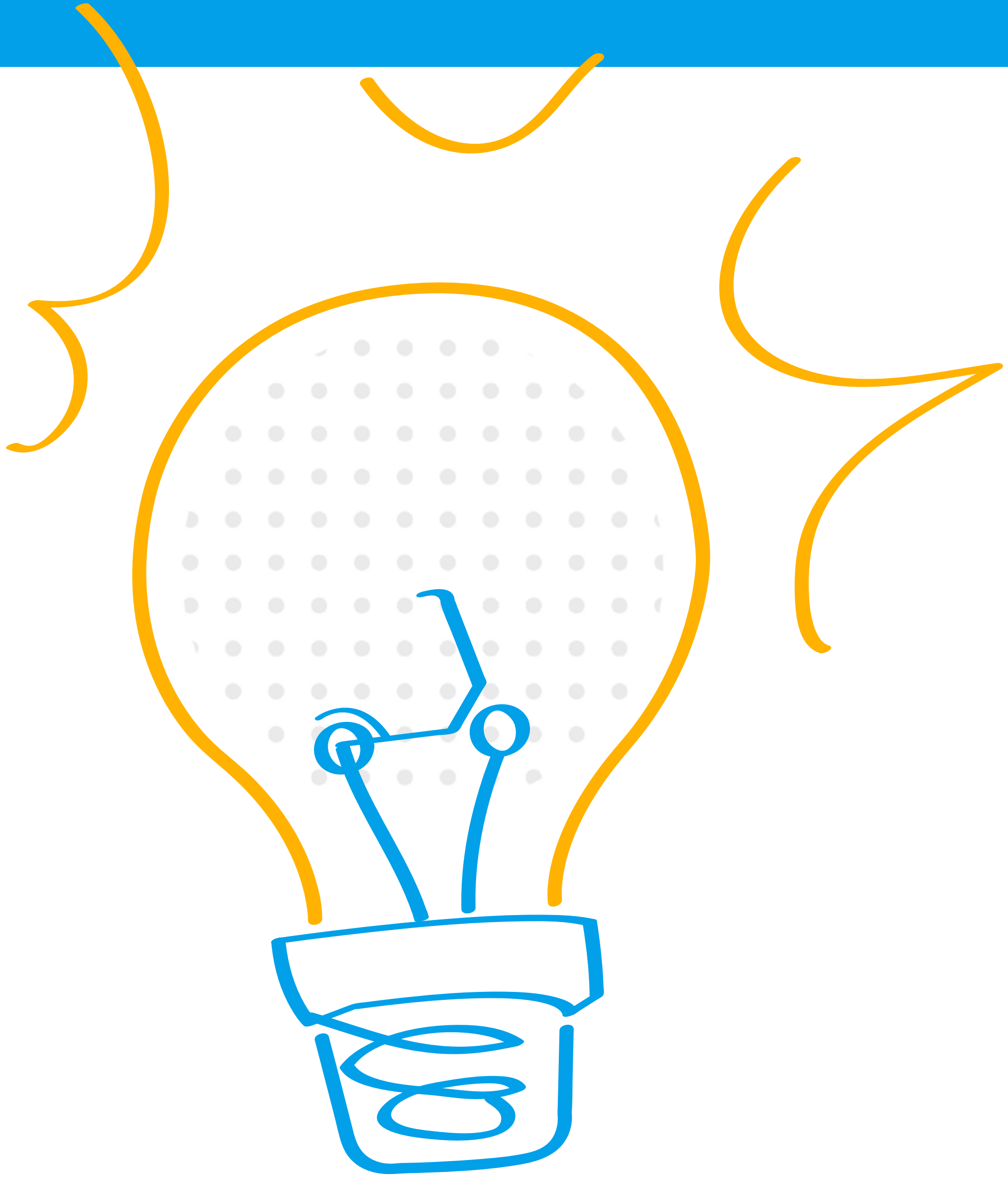
John MacArthur
Research Associate,
Portland State University

Document Sponsor,
SAE J3194

Ryan Yee, PhD
Director Vehicle Compliance,
Bird

Document Sponsor,
SAE J3230

Let’s Standardize



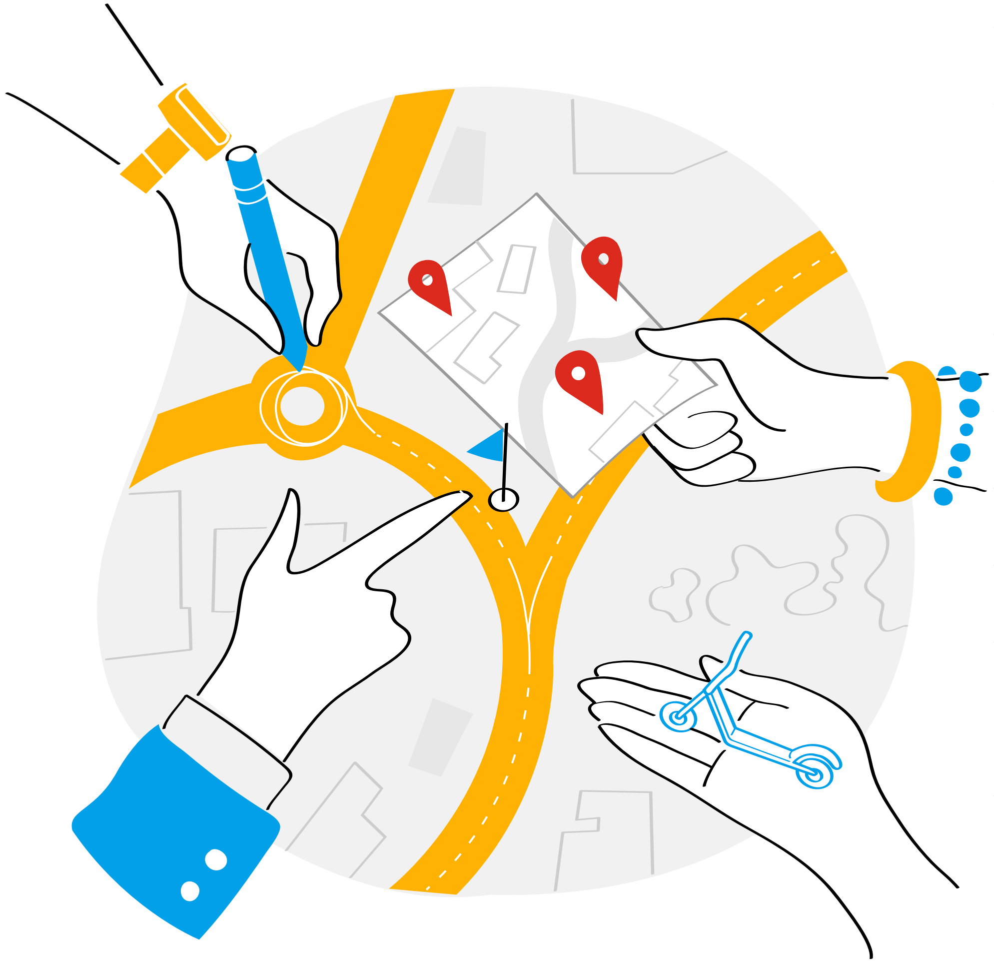
standard **(noun)**

stan·dard | stan-dərd

An agreed upon way of doing things.

E.g. Levels of vehicle automation

Objectives of SAE Standards



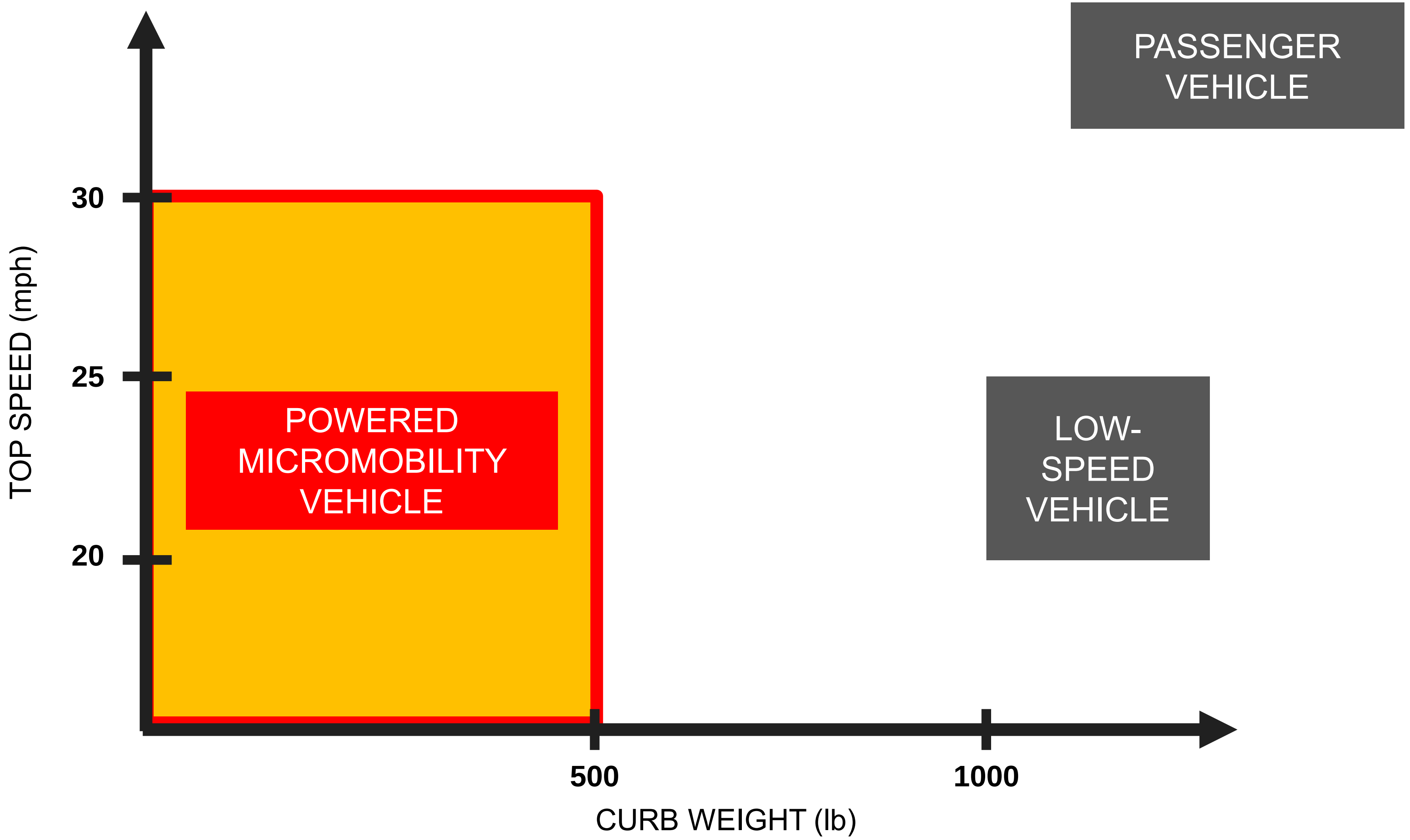
- ***Enhance safety***
- ***Create common language***
- Facilitate trade through reduced regulations
- Harmonize global markets
- Improve or protect the environment
- Increase productivity of processes
- ***Permit common interfaces***
- ***Promote uniform testing or performance***
- Reduce costs

SAE Powered Micromobility Vehicles Committee

Brings together a community of operators, manufacturers, regulators, and researchers to build consensus on micromobility vehicles, starting with terminology J3194 and coming Kinematic Standards (J3230 WIP).

Scope Keywords: Powered, Low Speed, Light Weight, Personal Ground Transport.

SAE J3194™ - Taxonomy & Classification of Powered Micromobility Vehicles

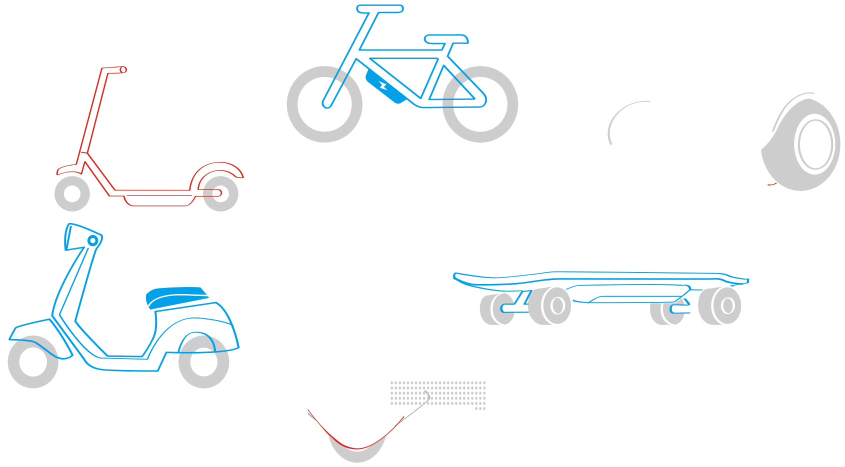


SAE J3194TM - Taxonomy & Classification of Powered Micromobility Vehicles

6 "TYPES"

X

4 "CLASSES"



Speed

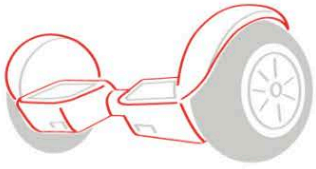
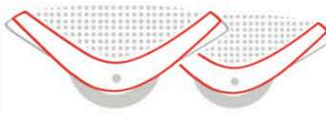
Weight

Power Source

Width

SAE J3194™ - Taxonomy & Classification of Powered Micromobility Vehicles

TYPES OF POWERED MICROMOBILITY VEHICLES[1]

	Powered Bicycle 	Powered Standing Scooter 	Powered Seated Scooter 	Powered Self-Balancing Board 	Powered Non-Self-Balancing Board 	Powered Skates 
Center column	Y	Y	Y	Possible	N	N
Seat	Y	N	Y	N	N	N
Operable pedals	Y	N	N	N	N	N
Floorboard / foot pegs	Possible	Y	Y	Y	Y	Y
Self-balancing[2]	N	N	N	Y	N	Possible

[1] All vehicles typically designed for one person, except for those specifically designed to accommodate additional passenger(s)
[2] Self-balancing refers to dynamic stabilization achieved via a combination of sensors and gyroscopes contained in/on the vehicle

SAE J3194TM - Taxonomy & Classification of Powered Micromobility Vehicles

CLASSIFICATION SYSTEM

The classification system consists of the micromobility vehicle type with descriptors of curb weight, vehicle width, top speed and power source.

Name	Code	Description
Curb weight		
Ultra lightweight	WT1	Curb weight ≤ 50 lb (23 kg)
Lightweight	WT2	50 lb (23 kg) < curb weight ≤ 100 lb (45 kg)
Midweight	WT3	100 lb (45 kg) < curb weight ≤ 200 lb (91 kg)
Midweight Plus	WT4	200 lb (91 kg) < curb weight ≤ 500 lb (227 kg)
Vehicle width		
Standard-width	WD1	Vehicle width ≤ 3 ft (0.9 m)
Wide	WD2	3 ft (0.9 m) < vehicle width ≤ 4 ft (1.2 m)
Extra-Wide	WD3	4 ft (1.2 m) < vehicle width ≤ 5 ft (1.5 m)
Top speed		
Ultra low-speed	SP1	Top speed ≤ 8 mph (13 km/h)
Low-speed	SP2	8 mph (13 km/h) < top speed ≤ 20 mph (32 km/h)
Medium-speed	SP3	20 mph (32 km/h) < top speed ≤ 30 mph (48 km/h)
Power source		
Electric	E	Powered by an electric motor
Combustion	C	Powered by an internal combustion engine

GUIDANCE ON TERMINOLOGY USE

The following naming convention may be used to develop either word- or code-based terms using classifiers and vehicle types.

- Curb weight: 40 lb
- Width: 2 ft
- Top speed: 18 mph
- Propulsion: electric

"Ultra lightweight, standard-width, low-speed, electric standing scooter"

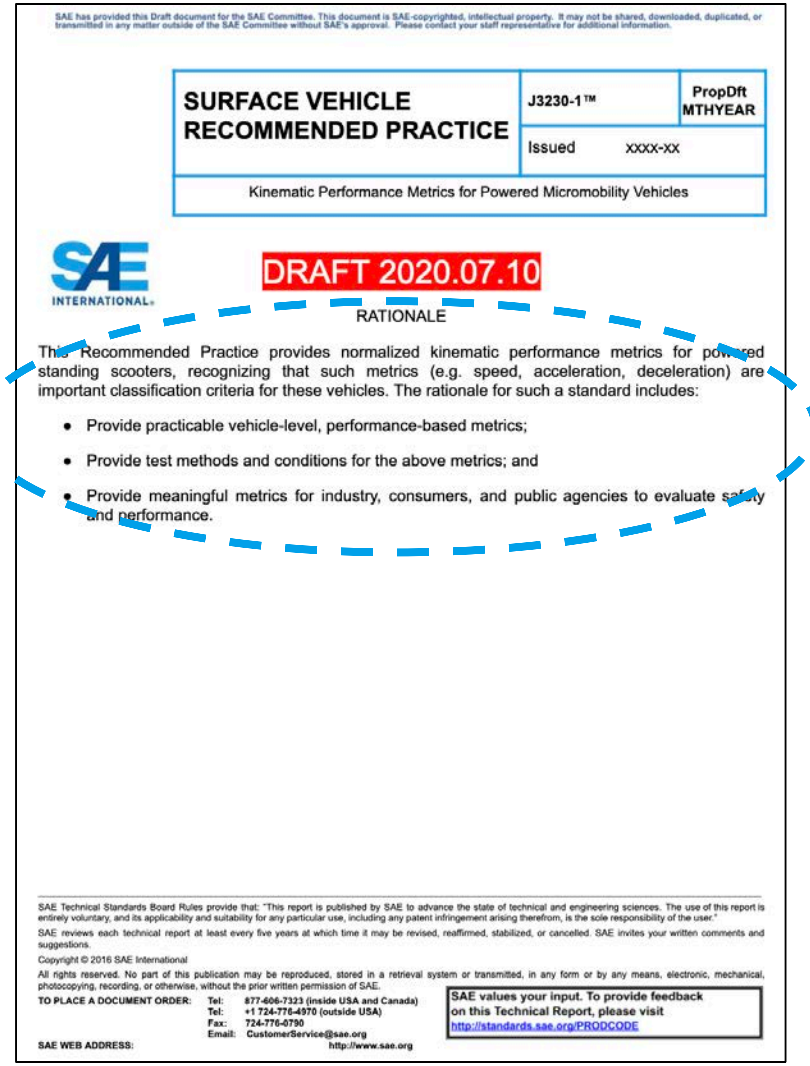
"WT1/WD1/SP2/E standing scooter"

- Curb weight: 190 lb
- Width: 2 ft
- Top speed: 30 mph
- Propulsion: electric

"Midweight, standard-width, medium-speed, electric seated scooter"

"WT3/WD1/SP3/E seated scooter"

SAE J3230™ Kinematic Performance Metrics for Powered Micromobility Vehicles



SURFACE VEHICLE RECOMMENDED PRACTICE	J3230-1™	PropDft MTHYEAR
	Issued xxxx-xx	
Kinematic Performance Metrics for Powered Micromobility Vehicles		

DRAFT 2020.07.10

RATIONALE

This Recommended Practice provides normalized kinematic performance metrics for powered standing scooters, recognizing that such metrics (e.g. speed, acceleration, deceleration) are important classification criteria for these vehicles. The rationale for such a standard includes:

- Provide practicable vehicle-level, performance-based metrics;
- Provide test methods and conditions for the above metrics; and
- Provide meaningful metrics for industry, consumers, and public agencies to evaluate safety and performance.

Rationale

- Provide practicable vehicle-level, performance-based metrics
- Provide test methods and conditions
- Provide meaningful metrics for industry, consumers, and public agencies to evaluate safety and performance

SAE J3230™ Kinematic Performance Metrics for Powered Micromobility Vehicles

Scope

- Test procedures to measure *top speed*, *acceleration*, and *deceleration* of a powered standing scooter
- Consideration given to initial vehicle conditions, operator anthropometry, environmental and roadway conditions, as well as operating domains

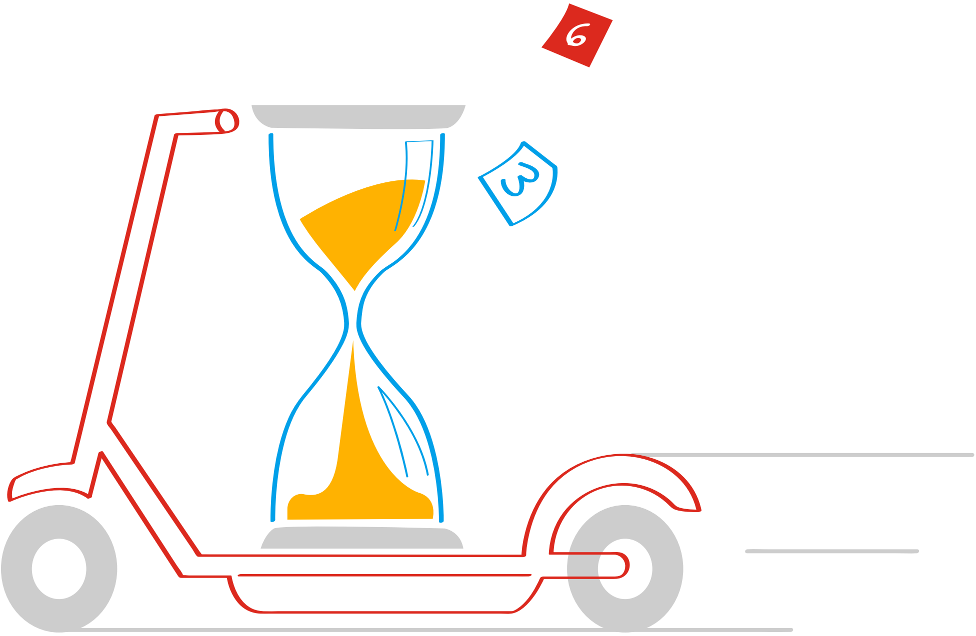
Timeline

- Anticipated publication in Q4 2020

Led by

- Ryan Yee, Bird (Document Sponsor)
- Orpheus Allen, Lime
- Nik Hatzis, Lyft

SAE J3230™ Kinematic Performance Metrics for Powered Micromobility Vehicles



Deceleration Test Scenarios

1. “All brakes nominally engaged” – what happens normally?

2. “Brake redundancy test” – what happens if a brake fails?

3. “Deceleration around geofenced boundaries” – is there operator instability at boundary conditions?

UL STANDARDS FOR E-MOBILITY PRODUCTS

Diana Pappas Jordan
Standards Program Manager
Underwriters Laboratories Inc.

September 15, 2020

UL Standards – At a Glance

OVER **400 UL STPS**

OVER **120 YEARS** OF EXPERIENCE IN STANDARDS DEVELOPMENT

DEDICATED STANDARDS PROFESSIONALS AROUND THE WORLD

OVER **1600 STANDARDS** PUBLISHED

30 + COUNTRIES REPRESENTED ON UL STPS AND COMMITTEES

OVER **4000 VOLUNTEERS** ACTIVELY PARTICIPATING IN UL STANDARDS DEVELOPMENT

UL Standards - Development & Harmonization

Public-Private Partnership Consensus Building Platform

Collaboration with other SDOs

Research & Science-based Standards

Free Online Preview of UL Standards

Respond to market need and short development time

International harmonization and collaboration with IEC and ISO

Support national/regional adoption of UL standards globally

Consensus Standards Development Process

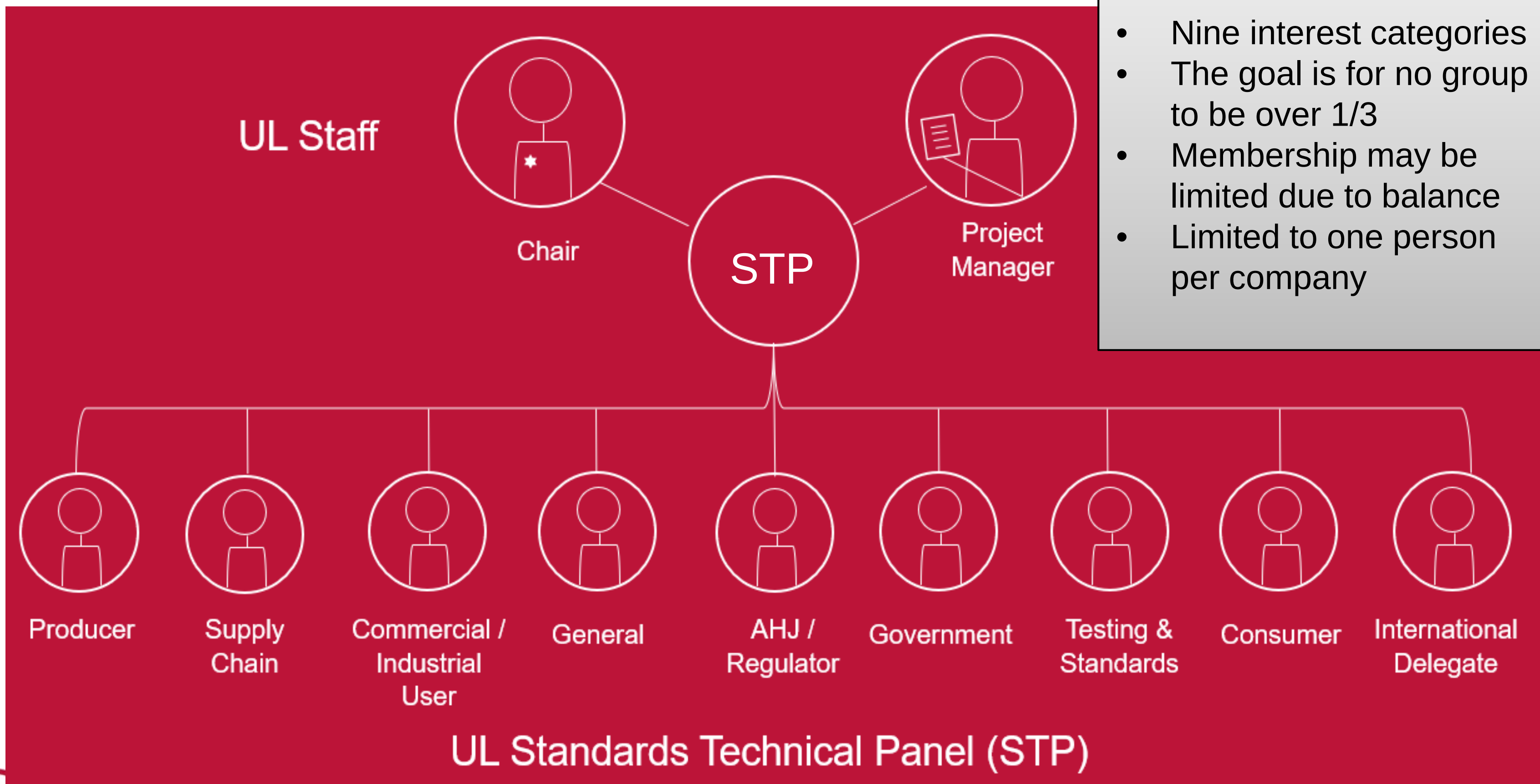
- UL's standards development process is accredited by both ANSI and SCC
- UL standards are developed through Standards Technical Panels (STPs) and (Technical Committees)
- There is no cost to join UL Committees/STPs
- Procedures align with **WTO TBT Agreement** international standards principles for ***consensus***, ***openness***, and ***transparency, due process***

UL Procedures for accreditation published as *Regulations Governing ANSI/UL STPs*
http://ulstandards.ul.com/develop-standards/stps/stp-regulations/

UL Collaborates with Industry for Standards Development

- Standards Technical Panels (STPs) are a central part of the UL Standards process
- STPs serve as consensus bodies for developing, reviewing, and maintaining UL Standards
- STPs are made up of balanced group of individuals
- Participation of open to all interested parties
- Proposals to UL Standards can be submitted at any time
- 24/7 online access to UL Standards documents via UL's online CSDS (Collaborative Standards Development System)

UL Standards Technical Panel (STP)



- Nine interest categories
- The goal is for no group to be over 1/3
- Membership may be limited due to balance
- Limited to one person per company

Hoverboards

Hoverboards

- Battery operated, self-balancing scooters, commonly referred to as “hoverboards”, were a very popular gift for the 2015 holiday season
- Concern from consumer groups, CPSC, retailers and industry led UL to develop UL Outline of Investigation UL 2272, Electrical Systems for Self-Balancing Scooters, which was published on January 29, 2016

Hoverboard – UL Response

Mid-Nov – Dec 1, 2015

- UL technical team is alerted to issue
- News of hoverboards fires gain media attention

Dec 2015- Jan. 2016

UL team works to develop a draft hoverboards standard

Jan 2016

- First draft of UL 2272 written
- Meetings w/key retailers
- Meeting w/US CPSC

Feb 2016

UL announces new UL 2272

Feb 2016

CPSC issues guidance outlining expectation of compliance to UL 2272

Mar 2016

UL holds first standards technical panel (STP) meeting – CPSC participates

July 2016

CPSC announces 10-firm recall

Nov 2016

UL 2272 achieves consensus as a bi-national standard (ANSI/CAN) & broadened to cover other types of e-mobility products

Late 2016/2017

- UL 2272 electrical requirements proposed to be added to ASTM standard
- UL 2272 shared with IEC
- UL, ASTM, CPSC offer joint standards training in China
- UL, CPSC, and Chinese Industry Association offer training to battery manufacturers in China

2018 – Present

Singapore adopts UL 2272 for all motorized personal mobility devices

STP 2272

STP 2272

- 33 voting members

UL 2272

- Standard for Electrical Systems for Personal E-Mobility Devices
- National Standard for the US and Canada

Scope

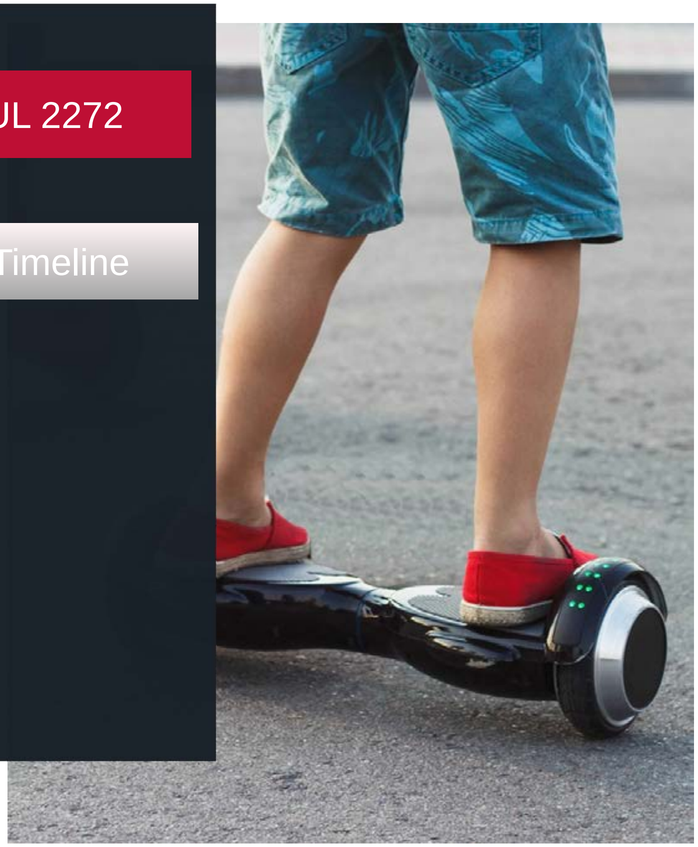
- Covers electrical safety (fire and electrical shock hazards) of the electrical system (e.g. battery, charger, motors, controls and wiring, etc.) for e-mobility devices

Examples of e-mobility devices

- Hoverboards
- Electric Skateboards
- Electric Skates
- Electric Scooters
- Electric Personal Transporters
- Electric Uniwheel

UL 2272

Timeline



- 1st Issue Outline of Investigation — **January 29, 2016**
- 2nd Issue Outline of Investigation — **April 22, 2016**
- 1st Edition Bi-National Standard — **November 21, 2016**

Other Related Standards

ASTM Subcommittee F15.58 on Powered Scooters & Skateboards

Active Standards

- F2641-08(2015) Standard Consumer Safety Specification for Recreational Powered Scooters and Pocket Bikes
- F2642-08(2015) Standard Consumer Safety Specification for Safety Instructions and Labeling for Recreational Powered Scooters and Pocket Bikes

Proposed New Standards

- WK57360 Standard Consumer Safety Specification for Self-Balancing Scooters (Hoverboards)
- WK70724 Commercial Electric-Powered Scooters for Adults

UL and China Partnership on Hoverboards

- In 2016, UL partnered with CPSC and ASTM on a workshop on hoverboard safety.
- In 2017, the China standard for hoverboard safety requirements and testing method was published. Since UL 2272 served as the basis of requirements in the China hoverboard standard, the requirements between the US and China versions are similar, but not completely aligned.
- UL and Standardization Administration of China (SAC) signed a MOU in June 2018, agreeing to cooperate to establish common requirements for hoverboards.
- The MOU also laid out the framework for a joint working group (JWG) between UL and the SAC TC. The JWG consists of representatives from UL 2272 STP and SAC/TC159, National Automation System and Integration Standardization Technical Committee, supervised by China national committee (SAC).
- The JWG has a goal of harmonizing requirements for the US and China. The WG will identify the differences in requirements between the US and the China standards and propose changes to the standards to reduce the differences.
- Once the standards are more closely aligned, the US and China plan to work together to develop a joint proposal to the IEC as appropriate.

ebikes

STP 2849

STP 2849
- 21 voting members

UL 2849
- Electrical Systems for eBikes
- National Standard for US and Canada

Scope
- Covers the electrical system of eBikes powered be a lithium-based, rechargeable battery
- Includes Electrically Power Assisted Cycle (EPAC – pedal assist) and non-pedal assist eBikes

UL 2849

Timeline

1st Issue Outline of Investigation
July 1, 2013

2nd Issue Issue Outline of Investigation
July 18, 2014

3rd Issue Outline of Investigation
November 11, 2016

1st Edition Bi-national Standard
January 2, 2020

Other Related Standards

- 16 CFR, Part 1512 – Requirements for Bicycles
- EN 15194 – Cycles – Electrically Power Assisted Cycles – EPAC Bicycles
- ISO 4210-10 - Cycles - Safety requirements for bicycles - Part 10: Safety Requirements for Electrically Power Assisted Cycles (EPACs)

QUESTIONS?

THANK YOU

Safety Standards
ASTM Task Group Update

Robert W. Whittlesey, Ph.D., P.E.
Task Group Chair

Sept 15 2020
CPSC Micromobility Products Forum

Safety in Context

Safety and Standards

Standards help industries by ensuring consistently safe products are made. This helps elevate the industry and ensure consumers have a safe experience, always.

International Transport Forum "Safe Micromobility" study showed that the ER-visit risk is similar for bikes and scooters.

But as an industry, can we do better?

ASTM

Who is the ASTM?

ASTM International was formerly known as the American Society for Testing and Materials

ASTM issues 13,000+ standards

These are developed by over 30,000 volunteers from more than 150 countries. Anyone can join a committee.

Standards Cover a Wide Range

Everything from metal alloys, cement, leather, plastics, air quality, cannabis, forensic science, solar power, nanotechnology, and more

Process is Key

Each standard is developed and maintained by a main committee which covers a broad topic. Each main committee has sub-committees.

To be clear -- ***I am just an ASTM member*** -- I am not speaking on behalf of the ASTM

Task Group In Context

The ASTM Task Group WK70724 is a task group that is developed by the F15.58 subcommittee

F15

Consumer Products

Committee F15 covers consumer products from toys to bunk beds to shopping carts and more

F15.58

Powered Scooters & Skateboards

Subcommittee F15.58 currently issues F2641 and F2642 covering Recreational Powered Scooters and Pocket Bikes and Labeling

WK70724

Commercial Electric-Powered Scooters for Adults

This task group is working on the new standard, which is yet to be numbered.

History of WK70724

A summary of the Group WK70724 progress to date. Still less than a year old!

Nov 2019

Group is first started

Bird presents to the ASTM to advocate for a scooter standard. Dave Dick of Bureau Veritas inaugurates the group with draft based off of F2641

Jan 2020

First online meeting

Group met for 2 hours to discuss standard over Webex. Plans put into place to host an in-person meeting in Austin in April 2020 including a scooter “showcase” to familiarize group members with the vehicles.

Aug 2020

Second online meeting

Group reconvened after Austin meeting was canceled. Virtual meeting was held to get group reacquainted with the standard.

Group has a wide involvement

Our meetings have drawn many participants, resulting in rich discussion

Ultimately the standard will be up for vote against a balanced panel of voters, but it is encouraging to see the range of interests represented early on

Current Approach

Following the approach of the previous task group chair, Dave Dick, we are using the F2641 as a template for the standard

F2641 is Consumer Safety Standard for Recreational Powered Scooters and Pocket Bikes

While not a requirement, one might expect content in the adult scooter standard to be similar in scope to F2641

Potential Topic Areas for Standard (based on F2641)

- Brakes
- Electrical Systems
- Latching Devices (e.g., foldable handles)
- Curb Impact Tests
- Folding Mechanisms, Hinges, and Clearances
- Fasteners
- Plastics
- Shields and Guards
- Dynamic Strength
- Static Strength

- Wheel Retention
- Grip Retention
- Handle Stem
- Dynamic Brake Test
- Paint
- Material Quality
- Toxicology, Hazardous Substances
- Molded Edges
- Exposed Bolts or Threaded Rods
- Accessible Points
- Accessible Edges
- Labels

Potential Testing Areas (based on F2641)

- Curb Impact
- Dynamic Brake
- Dynamic Strength
- Static Strength
- Grip Retention/Handle Retention
- Guarding
- Handle/Stem Compression
- Handle/Stem Fatigue
- Latching Mechanisms
- Wheel Retention
- Warning Labels - permanency and adhesion
- Method of Measuring Maximum Speed

Would expect, but cannot guarantee, that these topics/tests would be included in the adult scooter standard

What was discussed in August?

Brief sharing of the CPSC compilation of scooter accident data for committee members to review

Remainder of meeting was focused on scope of the standard

Some members wanted standard to be inclusive of both rental and retail scooters, so as to try and get a standard to pass that covered a wider range of vehicles

Other members wanted to narrow the standard to just rental markets because of different testing requirements between rental and retail models

Ultimately the task group has decided to adopt the rental-only approach and will focus on making a standard for rental scooters first; plan to add a standard for retail scooters thereafter

During the new business discussion, there was a request for considering the safety of scooters as it pertains to connectivity - may result in collaboration with F15.75 who are drafting a similar standard

What are the next steps for the committee

Go from task group approval to sub committee (F15.58) for voting

Requires 2/3 approval to pass

After subcommittee approval, then goes to main committee (F15) and society review for voting

Requires 90% approval to pass

During each voting process, any negative votes must be addressed

“Addressed” doesn’t mean enacted

Want to participate?

Planning monthly 1-hr-long meetings to get this standard into “vote-ready” shape!

Our next meeting is:
September 17th, 2020
2:00 - 3:00 PM Eastern Time

Please let me know if you would like to participate
robert.whittlesey@bird.co

SPIN

DEVELOPMENT OF MICROMOBILITY SAFETY STANDARDS

Micromobility Forum

U.S. Consumer Product Safety Commission

September 15, 2020

James Berg

Joined Spin in late 2018

Built up the hardware team

Oversaw development of Spin's JDM and custom hardware development

Now managing R&D

Working on standards development with SAE, UL, ASTM

Before Spin, I did product development for solar power, smart garments, and consumer electronics

SCOOTER DEFINITION

Moped

Kids (Unpowered) Scooter

Powered Kick Scooter for Adults

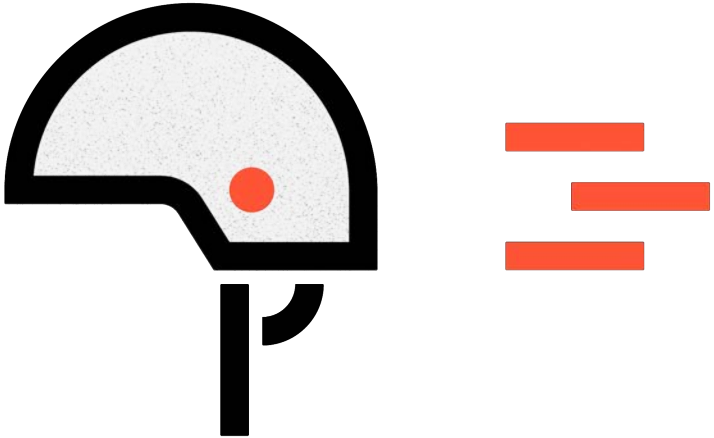
WHY DOES SPIN WANT AN INDUSTRY SAFETY STANDARD?

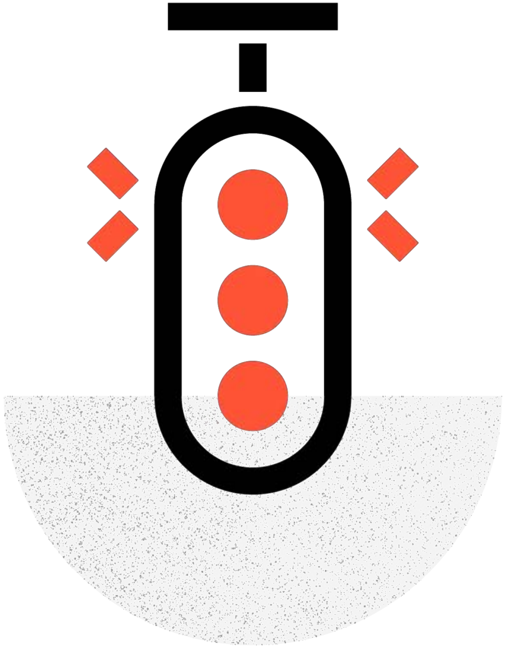
SAFETY

Spin is very concerned with rider safety

Developed our own internal standards for testing scooters in the absence of industry-wide safety standards

Company Values:
Do the Right Thing, Earn Trust





INDUSTRY REPUTATION

We think that the growth of micromobility can be one of the best changes of this decade, and we don't want to see that ruined

A few bad actors can create a negative industry-wide reputation that would hurt everyone

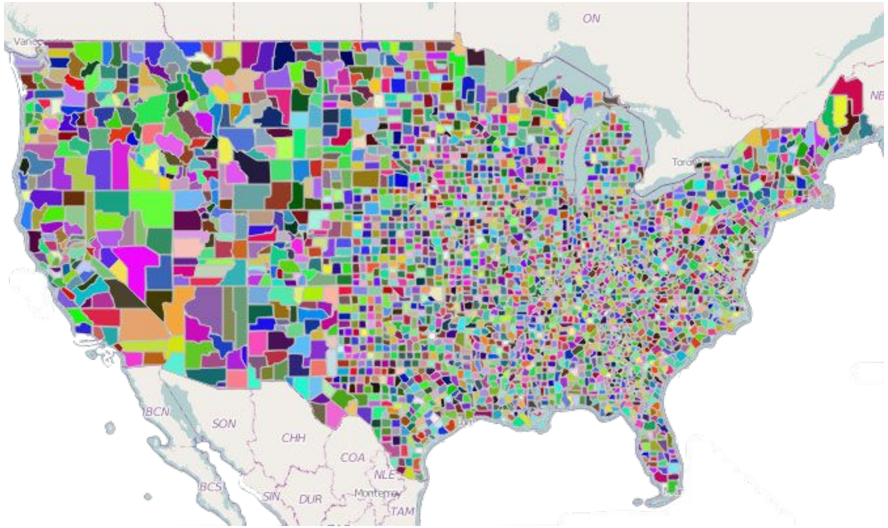
We want to make sure that other operators are equally dedicated

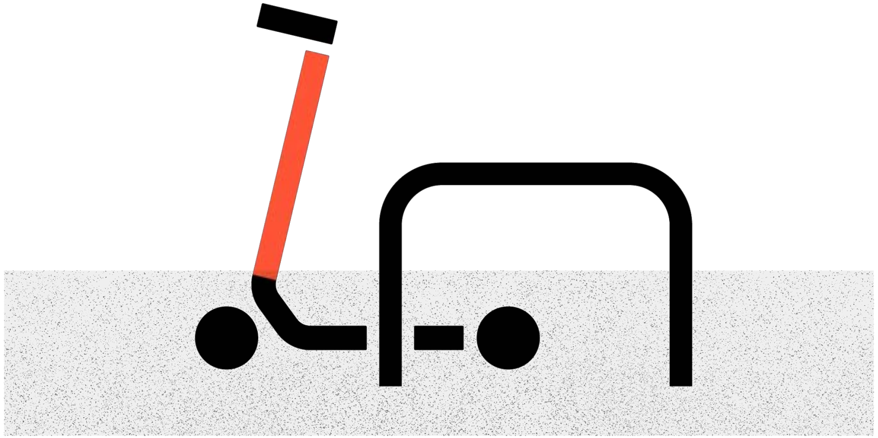
FEWER REGIONAL VARIATIONS

Simplifies city permitting requirements for both the city and for operators

Reduces costly local customizations

Ensures a common experience for all riders





EVALUATION OF NEW MODELS

Common standards are a simpler and lower cost way to help determine if scooters are safe and durable

Long and costly process to work with new partners to ensure that their products meet our internal standards

CURRENTLY, THERE ARE NO SAFETY STANDARDS FOR ADULT-USE POWERED SCOOTERS

WHERE DO MICROMOBILITY RULES COME FROM?

National and state transportation laws

City permits and ordinances

Voluntary standards bodies

SAE INTERNATIONAL™

ASTM INTERNATIONAL

UL

Current Applicable Standards

UL 2271 - Batteries for various vehicle types

UL 2272 - Electrical system for various vehicle types

UN 38.3 - Transporting batteries

RoHS, REACH - Chemical safety

* Not an exhaustive list

No standards related to the scooter behavior or rider safety!

Current Related Standards

Related but don't cover powered kick scooters for adults; for personal use or ride sharing

ASTM F2641 - powered and unpowered scooters for kids
EN 14619 - Unpowered scooters only
ISO 4210 - General bicycle safety
EN 15194 - Safety of e-bike electrical system
* Not an exhaustive list

Current Laws

Germany has most prescriptive specifications to-date	Braking performance, detailed headlight specifications, etc.
State DOT rules	Definition of “scooter,” visibility requirements, max. weight, etc.
City permit requirements	Deployment rules, labeling requirements, cable locks, etc.

LEGAL INTERPRETATION

Headlight requirement from the California Vehicle Code:

"Except as provided in subdivision (b), a lamp emitting a white light which, while the motorized scooter is in motion, **illuminates the highway in front of the operator and is visible from a distance of 300 feet in front and from the sides** of the motorized scooter."

- How much should it illuminate the highway?
- How do you test visibility?
- How far to the side?

WHAT IS LEFT OUT OF THE STANDARDS AND LAWS?

Common definition of what a scooter is

How to measure performance in a common way: speed, braking, etc.

Durability: some tests borrowed from related standards, but nothing addresses concerns of scooter sharing

Rider safety: What is a safe speed? When something fails, how does it break safely?

STANDARDS IN DEVELOPMENT

SAE International

Started in early 2019. Classification section is done, starting on the performance measurement section. Looking broadly at all micromobility vehicles.

ASTM International

Started in early 2020. Focusing more on shared scooters (for now).

UL

Working as the American participant organization for the standard being developed by the International Electrotechnical Commission (IEC)

Staffed by volunteers: operators, manufactures, customer groups, and government representatives from multiple countries. And these groups are open to new people joining.

SPIN'S INVOLVEMENT

Involved from the beginning for all three standards

Worked with ASTM in 2019 to start the formal process of requesting a new standard

I participate in all of these standards committees, and, as they get more specific, we are pulling in other people to bring in their expertise.

THANK YOU.

For more info, contact jamesberg@spin.pm

spin.app

Safety data limitation and opportunity for micromobility

Chris Cherry – Professor in CEE
cherry@utk.edu
and students: Nitesh Shah, Yi Wen

THE UNIVERSITY OF TENNESSEE KNOXVILLE

CPSC Sept 15, 2020

Outline

What have we heard from injury epidemiologists?

What have these epidemiology studies taught us about *transportation* safety?

What data is available and where can it improve to identify system failures?

What are some recommended strategies to improve MM safety?

What have we learned about scooter safety in about a year?

Bird's Global Safety Advisory Board consulting (2019/2020)

We hosted five roundtables to focus on improving scooter safety, attended by a couple of hundred stakeholders.

My role was synthesizing research and drawing policy solutions that:

1. Operators could focus on improving (e.g., vehicle design, rider education, operations) and
2. Public sector could partner with (e.g., infrastructure).

Injury/Epi studies dominate research

- ED, Trauma Centers
- Inconsistent definitions
- Narrow focus rider injury typology
- Little focus on transportation (infrastructure) factors
- Portland, Santa Monica, Baltimore, SF, Austin, San Diego, Miami
- 35 micromobility papers at TRB last year, few addressed safety directly

Common Findings

- Most “single vehicle” & minor
- Media scrutiny of head injuries
- Non-user injuries low
- Hospital admit rate ~10% of ED
- Car crashes ↔ severe injury
  - (10% ED, 50% TC, 80% Fatal)
- Epi-studies don’t link injuries explicitly with car crashes

Unique Insight

- Inexperienced riders *may* have higher injury rates.
- Intoxication/nighttime seems to be a risk factor

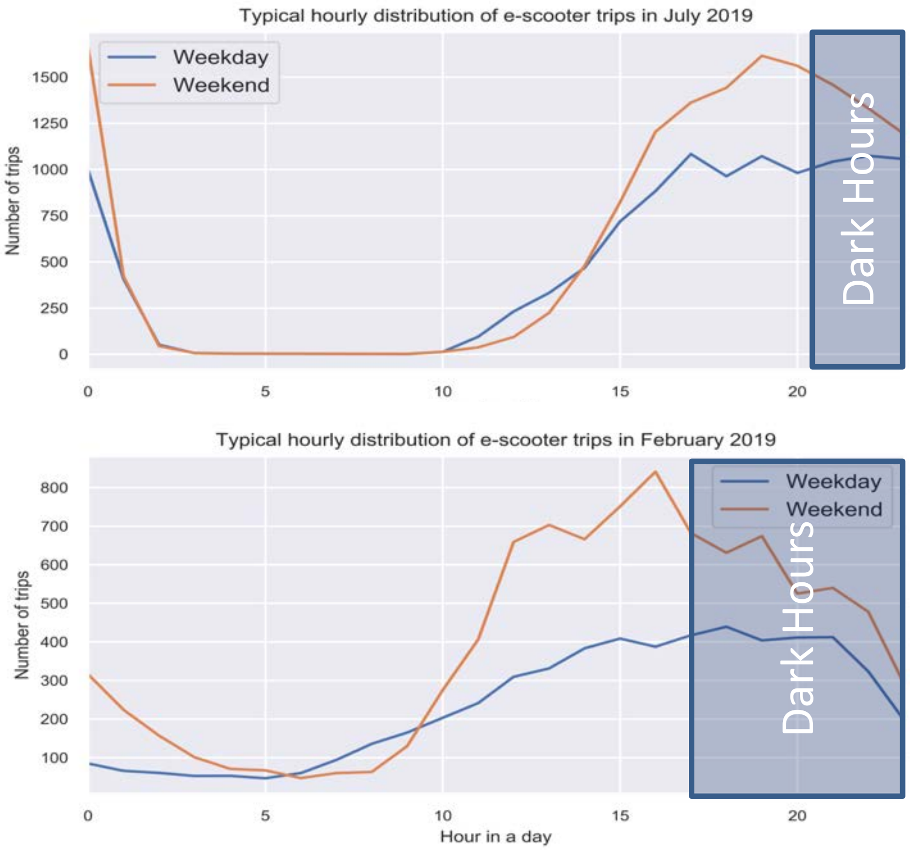
Policy Implications:

- Four key recommendations[1]
  1. Improve infrastructure
  2. Improve education of both car drivers and scooter riders
  3. Improve vehicle design
  4. Protect pedestrian right of way

[1] Bird has adopted these and I agree as I worked with Bird to develop them.
https://www.bird.co/blog/4-key-objectives-bird-global-safety-advisory-board-expansion/

Data can inform

- Nashville has a rich (shared) scooter dataset
- First question, where and why do riders ride?
- Is a “transportation” risk treated similar to a “recreation” risk?
- Injury data should be coupled with trip data



Exposure really matters

e.g., is dark-time risk proportionally higher? What about first time riders?

But how to get more inference

Trip purpose is important for safety and depends on a lot of things:

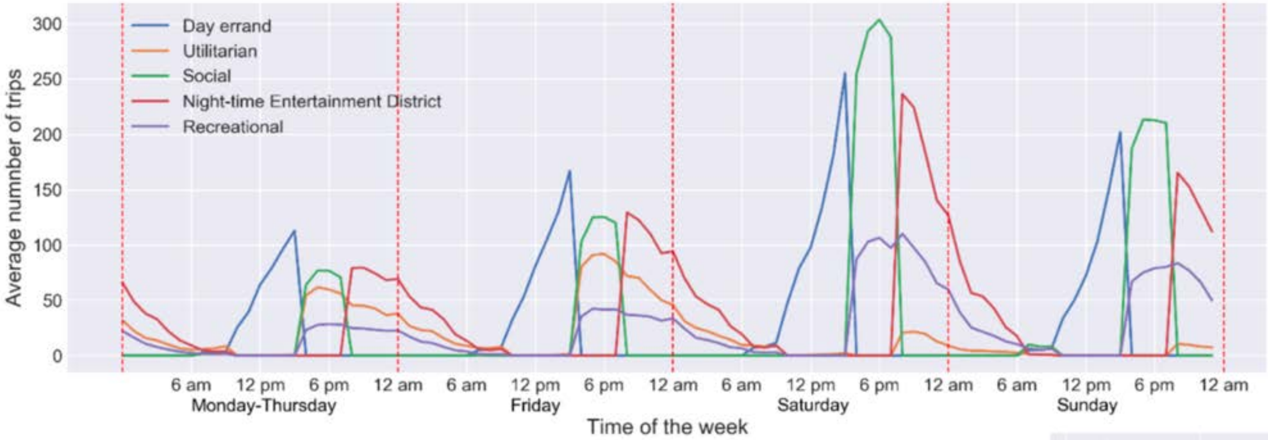
- Origin and Destination
- Land Use (Density/mix)
- Route Directness
- Time of Day
- Weather
- Infrastructure
- Many others

Daytime “errands”

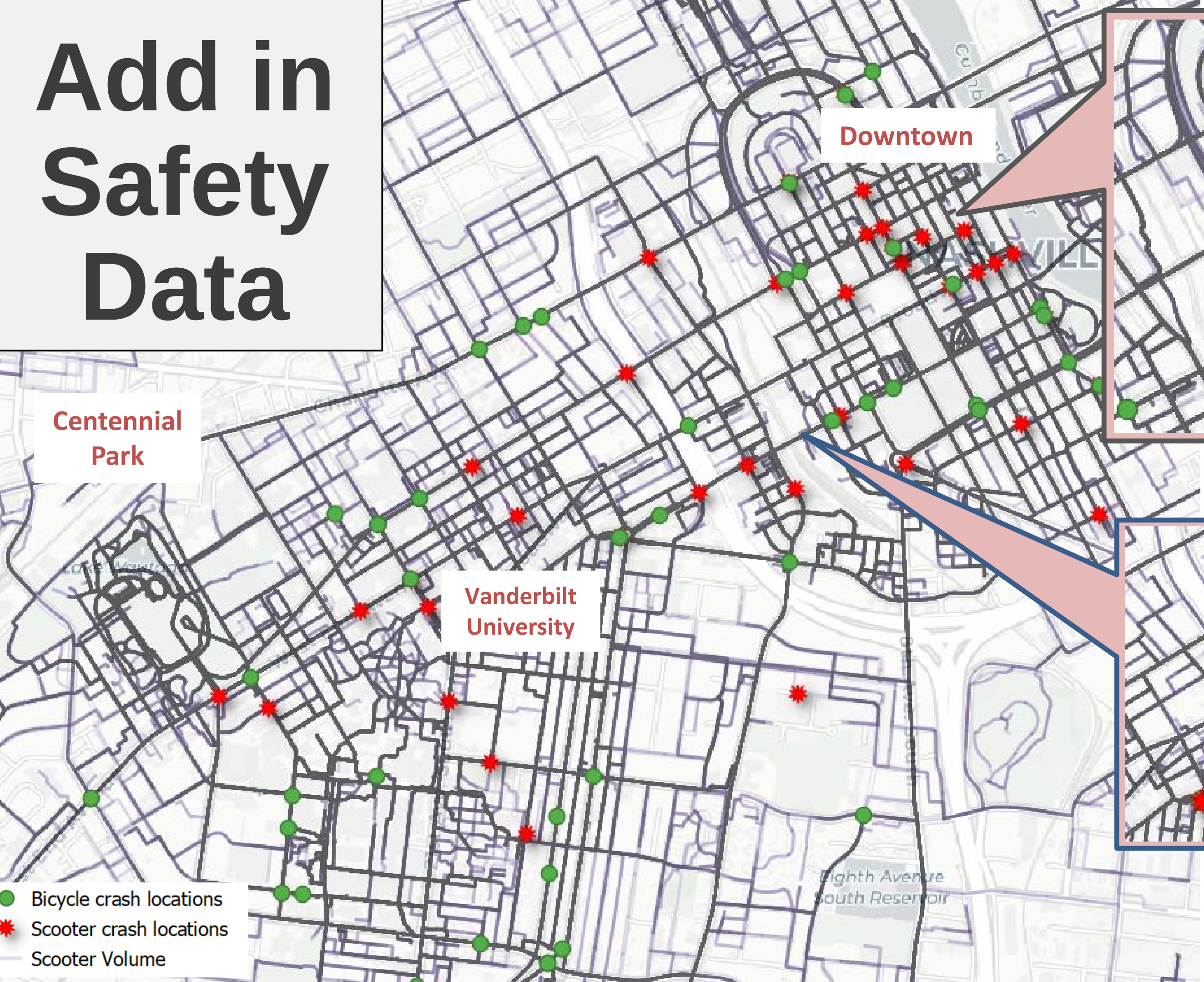
Nighttime Entertainment

Recreation

Informative Trip Patterns



Add in Safety Data



Scooter crash hotspot at Downtown

Street with high crash rate

PBCAT – Crash Typology

Rely on Tennessee's TITAN Police Crash Reporting

- Decent classification of scooter crashes as "Non-Motorist Personal Conveyance" or Bicyclist or Pedestrian. Note: "Pedestrian on an Electric Scooter" added to person type

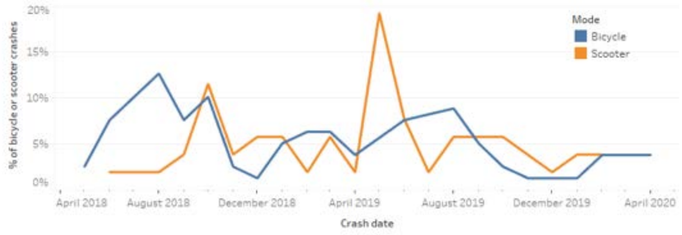
Criteria Specified

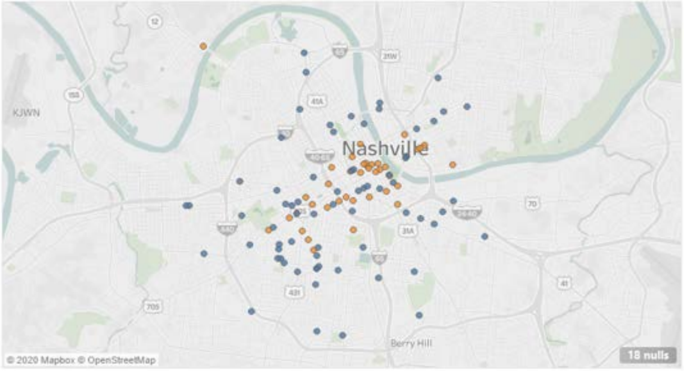
Save Search | Remove All

Property		Value		
The Person Type	is one of:	Pedestrian on Electric Scooter	Edit	Delete
The Date of Collision	is between	5/1/2018 and 5/12/2020	Edit	Delete

Search

Are Scooter Crashes Different than Bicycle Crashes?

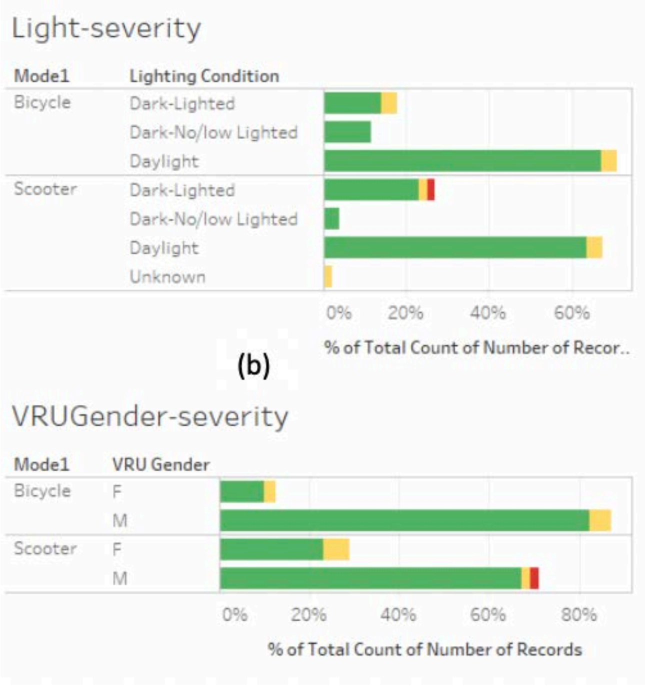


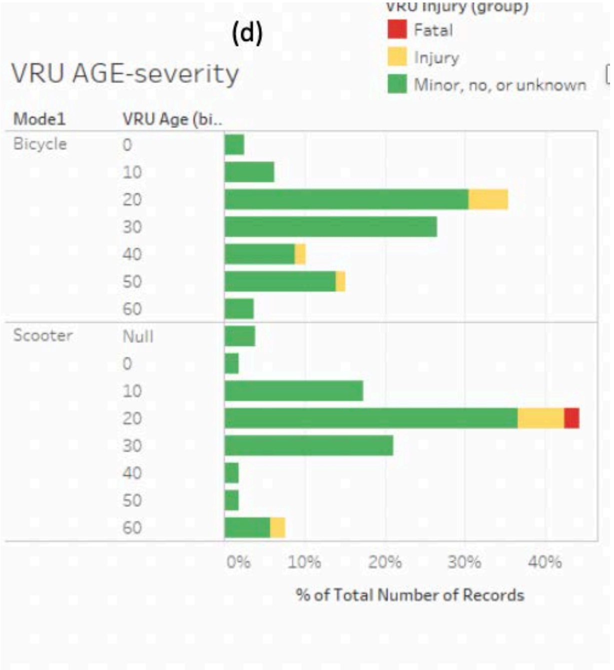


Scrutinized

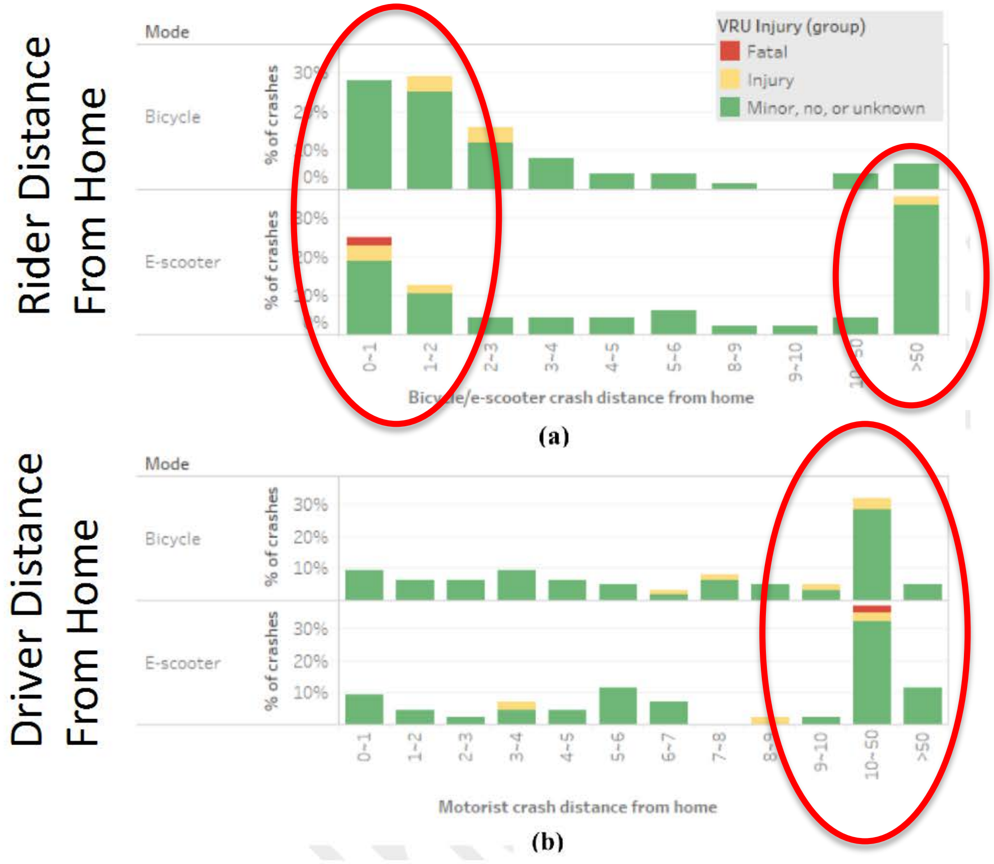
- **51 Scooter Crashes**
- **79 Bicycle Crashes**
- **Same time period**
- **Same geographic bounds**
- **Full crash narratives**
- **None of the drivers or passengers were injured**

Are Scooter Crashes Different than Bicycle Crashes?



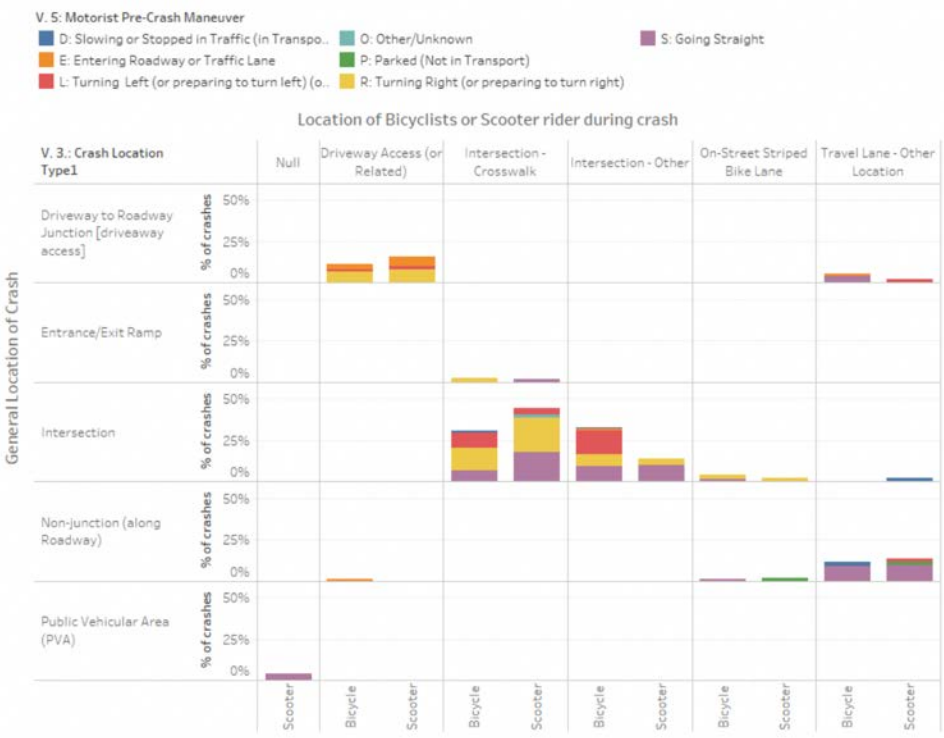


Locals, Travelers, and Suburbanites



THE UNIVERSITY OF TENNESSEE KNOXVILLE

Intersections are so important



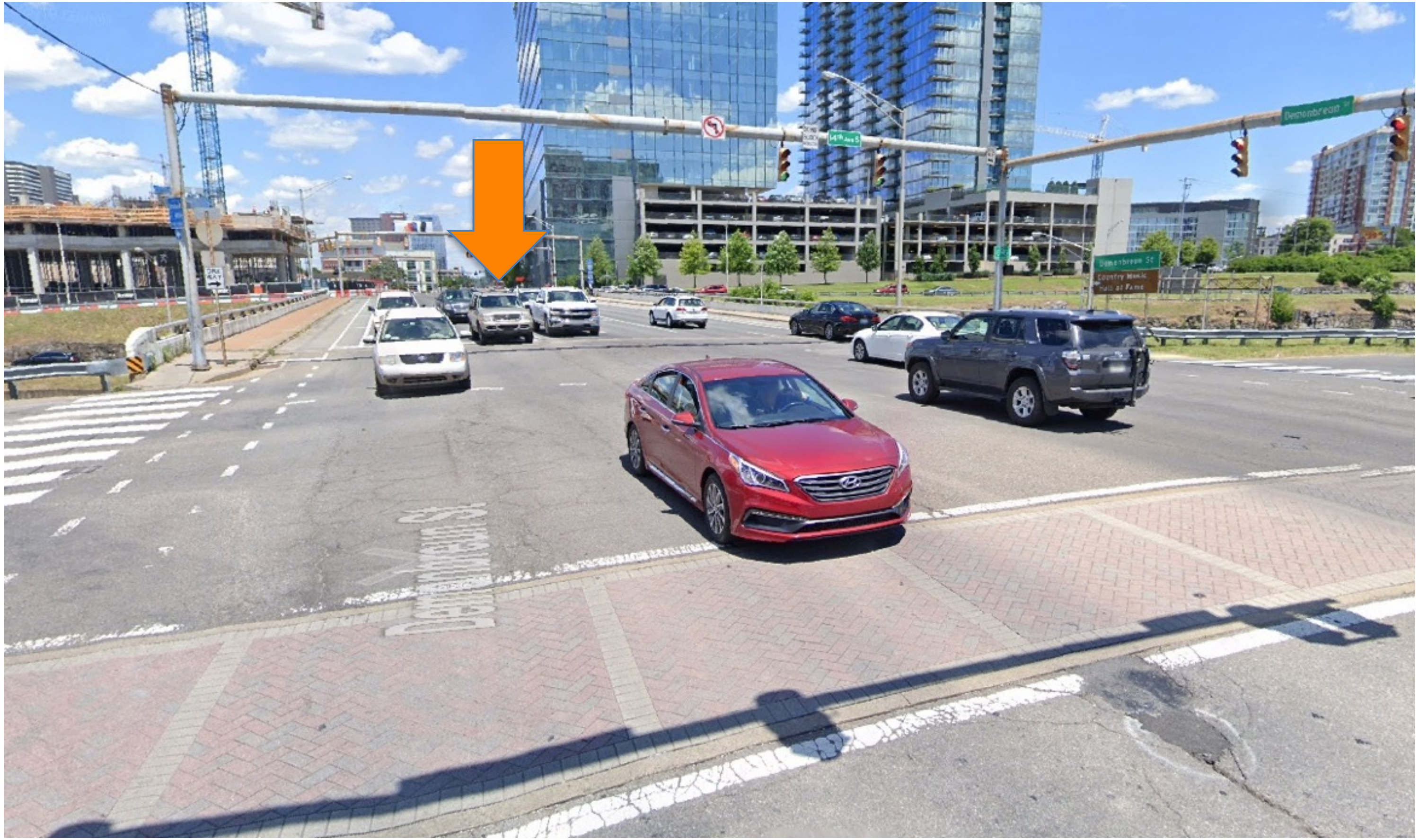
80% of bicycle *and* scooter crashes occur **at intersections**

But…

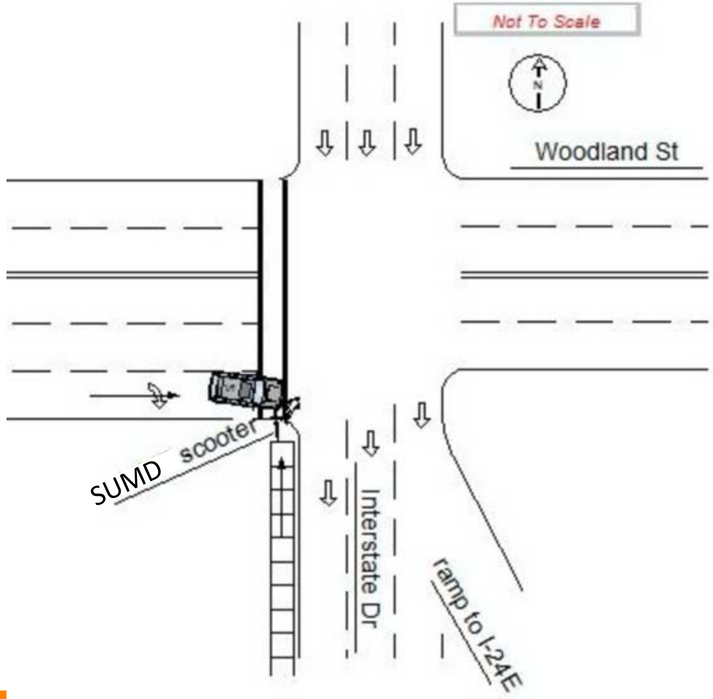
25% of scooter intersection crashes are **right turn/right approach** crashes (2.5 times higher than bicycle). Mostly sidewalk into road.

Bicyclists experience more **car left-turn conflicts** (cars fail to yield)

Scooter Crash



Consider this common case



- Education only goes so far.
- Most drivers reported not seeing approaching scooter.
- Right turn on red is a known pedestrian- and safety-risk.
- Disconnected one-way networks increase risky behavior.
- Intersection design should increase visibility, slow turning vehicles.

Need linked, consistent data for all modes

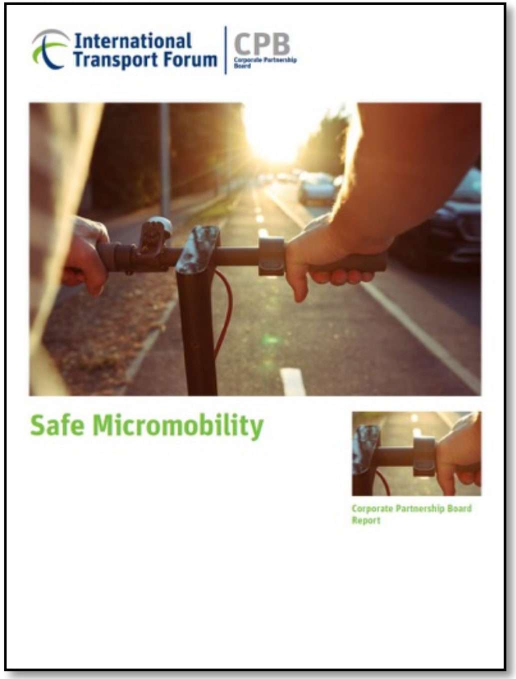
We need to assess transportation *system* risk factors with data. To name a few:

1) Police crash data provides context of injuries
2) Hospitalization provides extent of injuries
3) Probe/count data provides rate of injuries (and pattern of use)
4) Infrastructure data provides tools to reduce injuries

Follow known VRU protection strategies

Read this report

- Focus on severe injuries and fatalities, treat minor injuries as proxies and economic costs
- Improve driver and rider expectation at intersections
  - Protected intersections, driveways, networks
- Build protected and low stress *networks*
- Maintain non-motorized infrastructure
- We need to require better-than-MDS data on all connected vehicles, while maintaining privacy.



Questions:

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Much of this work completed under grant from CSCRS. Collaborative Sciences Center for ROAD SAFETY

REMAKING URBAN INFRASTRUCTURE FOR MICROMOBILITY

Micromobility Forum

U.S. Consumer Product Safety Commission

September 15, 2020

At Spin Streets, we believe that the streets belong to everyone.

Our mission is to impact positive change -- to be advocates for accessibility and safety in our communities.

WWW.SPIN.APP/STREETS


SPIN
SAFE
MAKING OUR STREETS SAFER
AHEAD

SPIN SPACE, SALT LAKE CITY

Working with Salt Lake City and Bike Utah's 1,000 Miles campaign, Spin worked hand-in-hand with the community to redesign an intersection to create a safer and more enjoyable experience for people of all ages by reclaiming space from cars.

SPIN SPACE, SALT LAKE CITY

With help from the City, Team Better Block, and volunteers from the neighborhood, we demonstrated how quickly and easily streets can be redesigned to put people first.

DENVER PARKLET COMPETITION

We teamed up with [Better Block Foundation] and the [Denver Streets Partnership] to sponsor the first-ever international [parklet design competition]. The event culminated in September 2019 on Park(ing) Day when, with the help of Spin and our partners, the six finalists built their designs in parking spaces in Downtown Denver.

DENVER PARKLET COMPETITION

DENVER STREETS PARTNERSHIP

All of the designs included micromobility parking in addition to seating, shading, and other improvements to the parking spaces.

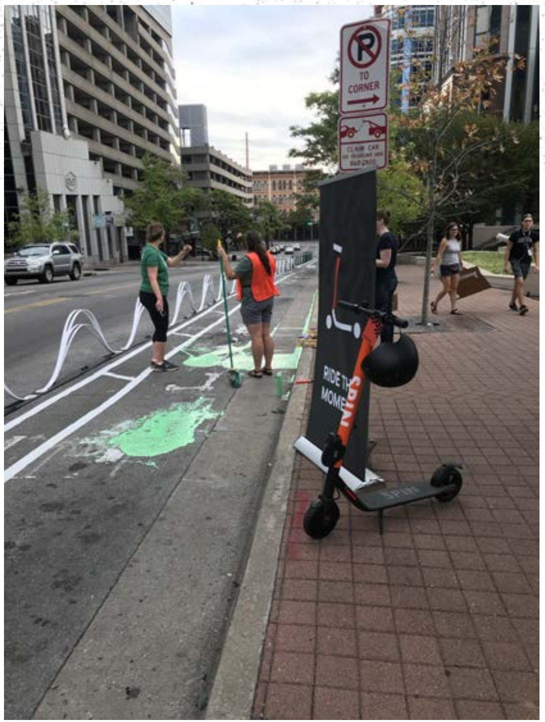
NASHVILLE POP-UP BIKE LANE

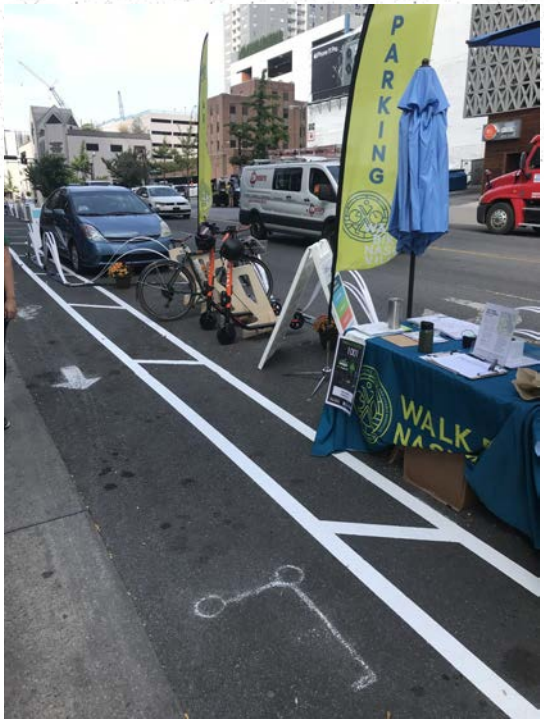
WALK BIKE NASHVILLE

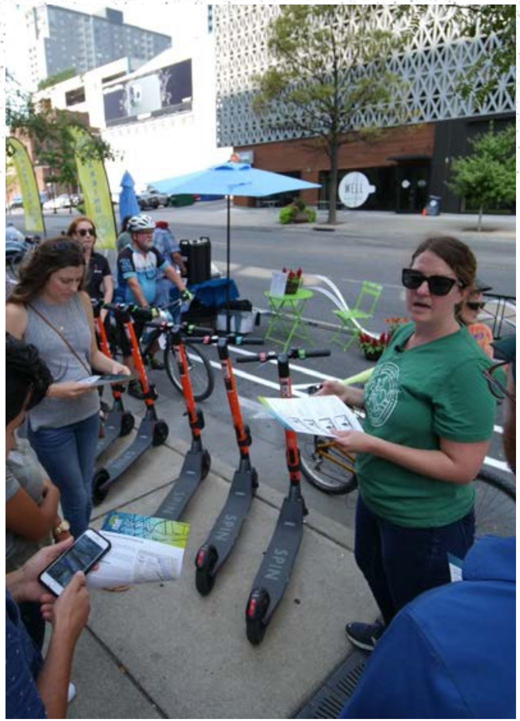
In Nashville, we worked with our partners Walk Bike Nashville to build a multi-block pop-up bike lane on Park(ing) day to allow residents and businesses to experience what their streets could be like with safe infrastructure,

NASHVILLE POP-UP BIKE LANE

WALK BIKE NASHVILLE







We worked to install temporary wave delineators along the route to show how easy, and aesthetically pleasing, a barrier-protected bike lane could be to install in the city's burgeoning downtown. We collected signatures from residents and businesses to show City Council that there was local support.

NYC Play Streets

Street Lab
PROGRAMS FOR PUBLIC SPACE

During the pandemic, as cities realized there was an immediate need to reallocate streets to create safe open space, we worked with the nonprofit Streetlab in New York City to facilitate their Play NYC Initiative, designed to give neighborhoods much-needed space for socially-distanced exercise.

NYC Play Streets

Street Lab
PROGRAMS FOR PUBLIC SPACE

PLAY NYC brings safe, hands-free play for children on closed-off streets in high-need NYC neighborhoods. The set-up includes an obstacle course, exercise activities, and learning experiences.

MILWAUKEE POP-UP BIKE LANE

WISCONSIN BIKE FED

To help make the physical case for bike lanes, we partnered with the Wisconsin Bike Federation to do a quick-build protected bike lane during the annual Santa Rampage bike ride. The temporary project allowed the hundreds of people on bikes and scooters to experience what riding in a protected bike lane feels like. It also allowed observers and passers-by to see a protected bike lane in action.

MILWAUKEE POP-UP BIKE LANE

WISCONSIN BIKE FED

KANSAS CITY OPEN STREETS

CITY OF KANSAS CITY, MISSOURI
PUBLIC WORKS

When Kansas City residents wanted to close their neighborhood streets to through traffic, the City responded with an expedited permitting promise, but didn't have the materials on hand to help those residents put up the barriers and signage they needed to ensure motorists got the message.

KANSAS CITY OPEN STREETS

CITY OF KANSAS CITY, MISSOURI
PUBLIC WORKS

Spin partnered with Better Block Foundation to provide residents who organized for these neighborhood open streets with materials, signage, stencils, and other fun ways of reclaiming their streets for physically-distanced recreation.

ST. GEORGE BIKE LANE

BikeUtah

After the success of the Salt Lake City intersection redesign, we partnered again with BikeUtah for another quick-build demonstration project. This time, it was a temporary protected bike lane in St. George, UT.

ST. GEORGE BIKE LANE

BikeUtah

By partnering with officials and advocates to bring these projects to their communities, we hope to help show people another way to think about their streets is not only possible, but preferable.

DC QUICK-BUILD WORKSHOP

WABA
WASHINGTON AREA BICYCLIST ASSOCIATION

By partnering with the people who live in the communities we serve know best what those communities need to be safer. We partnered with WABA to hear from community members from D.C.'s Wards 7 and 8: how do they experience their streets? What are the improvements their community needs? And, of course, how can we help make these plans happen?

MOBILITY DATA FOR SAFE STREETS

BikeUtah

SUSTAIN CHARLOTTE

WALK BIKE NASHVILLE

BikeWalk NC

BIKE CLEVELAND

denver STREETS PARTNERSHIP

The pilot phase of the Mobility Data for Safer Streets initiative, or MDSS, awarded up 6 advocates around the country with a unique suite of data sources, software tools and physical equipment to gather, analyze, understand, and present data for streets advocacy.

BUILD A BETTER BARRIER

Today's Barriers are often...

...unprotective, high-maintenance, expensive, and unattractive.

BUILD A BETTER BARRIER

presented by SPIN

How can cities create protected space on our streets for people?

Individuals with experience in design, planning, and/or anyone with an interest in creating protected space on our streets were invited to develop ideas for **affordable, innovative, and protected pedestrian and mobility lane barriers**.

BUILD A BETTER BARRIER

presented by SPIN

www.spin.app/better-barrier

APRIL 21	MAY 21	JUNE 26	JULY 28	FALL 2020
Competition Announcement	**Informational Webinar**	**Entries Due**	**Winners Announced**	**Design Prototype Presented**
Official details of the design competition are made publicly available.	Spin will host a webinar to answer questions about the competition.	Submit completed entries for consideration by midnight PST.	1st, 2nd, and 3rd place winners announced.	1st place winner's prototype presented.

BUILD A BETTER BARRIER
presented by SPIN

MEET THE JUDGES

Joseph Barr
Director of Traffic, Parking, and Transportation.
City of Cambridge

Carlos Cruiz-Casas
Assistant Director, Strategic Transportation Planning, Miami-Dade

Ken McLeod
Policy Director, The League of American Bicyclists

Veronica O. Davis, P.E.
Nspiregreen LLC

Sara Studdard
Deputy Director of Local Innovation, People for Bikes

Tom Millar
Transportation Planner, Salt Lake City

Kimberly E. Leung
Engineer – Livable Streets Team Leader, SFMTA

John Abernethy
Product Design Director, D-Ford, Ford Motor Company

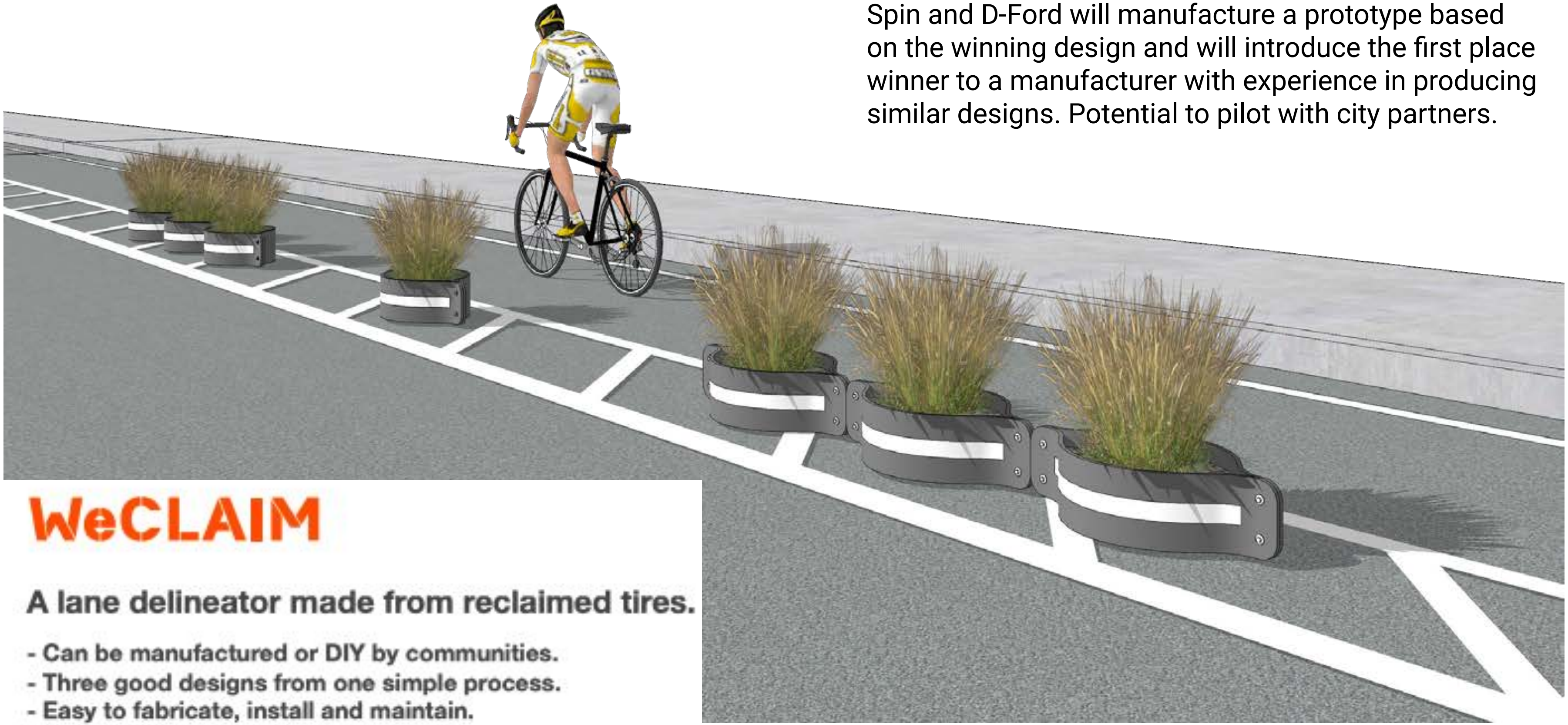
Ashley Z. Hand
Cityfi, Co-Founder and Partner

Jason Roberts
Better Block Foundation

BUILD A BETTER BARRIER
presented by SPIN

ANNOUNCING THE WINNING DESIGNS

The first place winner will receive $1000.
Spin and D-Ford will manufacture a prototype based on the winning design and will introduce the first place winner to a manufacturer with experience in producing similar designs. Potential to pilot with city partners.



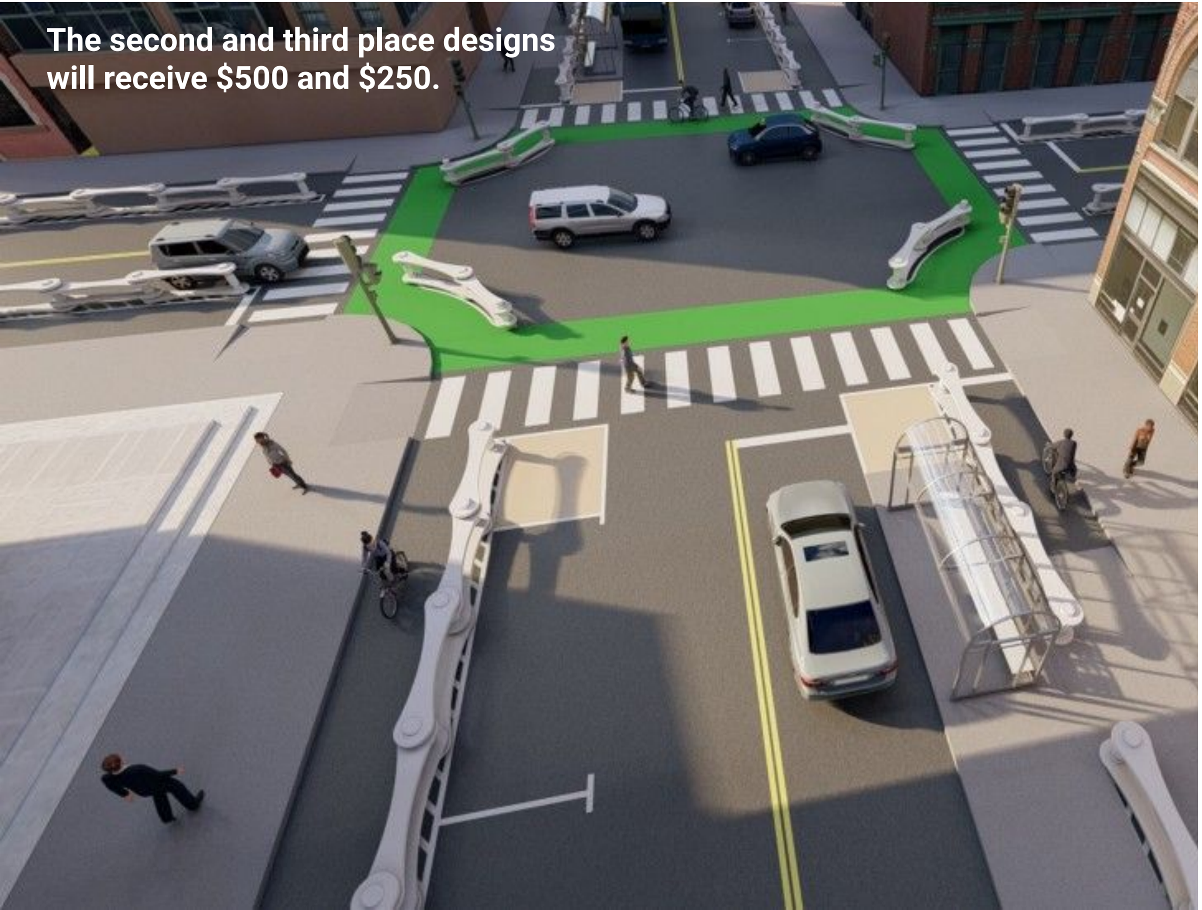
WeCLAIM

A lane delineator made from reclaimed tires.

- Can be manufactured or DIY by communities.
- Three good designs from one simple process.
- Easy to fabricate, install and maintain.

ANNOUNCING THE WINNING DESIGNS

The second and third place designs will receive $500 and $250.



See the winners and runners-up at www.spin.app/better-barrier!

Thank you!

streets@spin.pm

www.spin.app/streets

CPSC Micromobility Forum –

UL 2272 & 2849: Mitigating Risk of Explosion, Fire, Electrocution

September 15th, 2020

Benjamin Cribb

Background

Benjie has been with UL for over 20 years and is the North America Regional Technical Lead for micromobility for the UL Consumer Technology Division.

Personal e-mobility devices, e-scooters, and e-bikes are part of his responsibilities, together with batteries, electrical systems of e-cigarette (e-vaping) products, optical radiation, IT equipment, and consumer electronics products.

He observed standard development of UL 2849 and works closely with UL's standards division in both UL 2272 and UL 2849.

He also leads the North America eastern region engineering team involved with UL Mark services evaluating, testing and certifying product in meeting UL 2272 or UL 2849 as well as battery & charger safety standards.

Mitigation Risk from Explosions and Fires of Battery-Operated Products

1. **2005 to 2006** — Laptops — UL 62368-1
2. **2013 to 2015** — e-Cigarette — UL 8139
3. **2014 to 2015** — Power Bank — UL OOI 2056
4. **2015 to 2016** — Hoverboard — UL 2272
5. **2016** — Cell Phone — UL 62368-1
6. **2017** — Portable Electronics — UL 62368-1
7. **2018** — e-Scooters — UL 2272
8. **2019** — e-Bikes — UL 2849

UL 2272 Personal e-Mobility Devices & UL 2849 e-Bikes: Explosion, Fire, Electrocution Risk Reduction

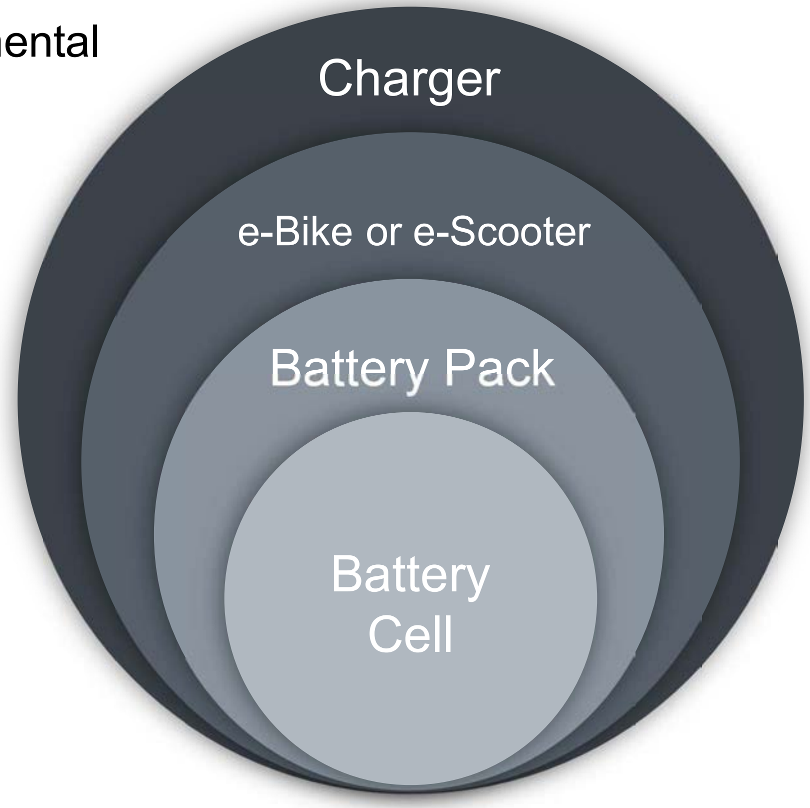
Battery Cell

- Electrical or environmental susceptibility
- Mechanical integrity

Battery Pack

- Prevention of fire propagation
- Balance between cells

System Approach to Safety



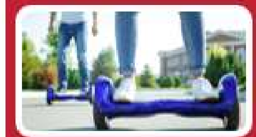
Micromobility Product

- Charging and discharging within battery limits
- Temperature within battery limits
- Susceptible to adverse conditions from application and environment
- Interrupt charging when error with host or charger

Charger

- No electric shock or fire hazard
- Compatible to power requirement of the host

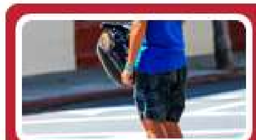
UL 2272 & UL 2849 scope of covered products



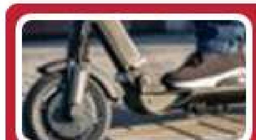
Personal E-Mobility Devices

- e-Scooters, e-Skateboards, e-Roller Skates, Hoverboards, & other personal e-transporter devices.

Typically single rider use



Typically stand when operating



Does not have pedals to operate

Typically not considered for over the road use

E-Bikes

- Electrical bikes that are either pedal assist (pedelec) or non-pedal assist.

Typically single rider use, but may be able to accommodate passengers

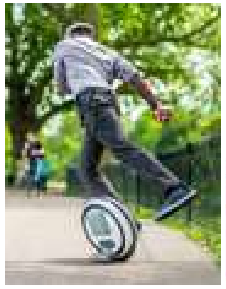
Typically sit when operating

Typically have pedals to operate

UL 2272 & UL 2849: Reduces Risk of Explosion, Fire, Electrocution

Construction & Component Requirements

Major Components	UL 2272	UL 2849
Battery Charger	**UL 62368-1**, UL 60950-1, UL 1310, or UL 1012 (Cl. 11.1)	**UL 62368-1**, UL 60950-1, UL 1310, or UL 1012 (Cl. 23.1)
Traction Battery Pack	Embedded into the UL 2272 Evaluation and Test Program Battery Management System (BMS) **UL 1998 + UL 991** or UL 60730-1 or IEC 61508 (Cl. 16.5)	**UL 2271** or UL 2580; or UL 2054 or UL 62133 + 8 Tests (Cl. 11.1, Cl. 11.2) Battery Management System (BMS) **UL 1998 + UL 991** or UL 60730-1 or IEC 61508-1 or ISO 13849-1, -2 (Cl. 12.7)
Electric Motor	UL 1004-1 (Cl. 18.3)	UL 1004-1 (Cl. 20.3)
Motor Controller	Motor Controller evaluated in the end-product. **Note: UL 2849 varies in approach to Motor Controller compared to UL 2272**	Motor Controllers (Safety Function) Safety Circuits and Safety Analysis **UL 1998 + UL 991** or UL 60730-1 or IEC 61508-1 or ISO 13849-1, -2 (Cl. 12.7, Cl. 20.4)







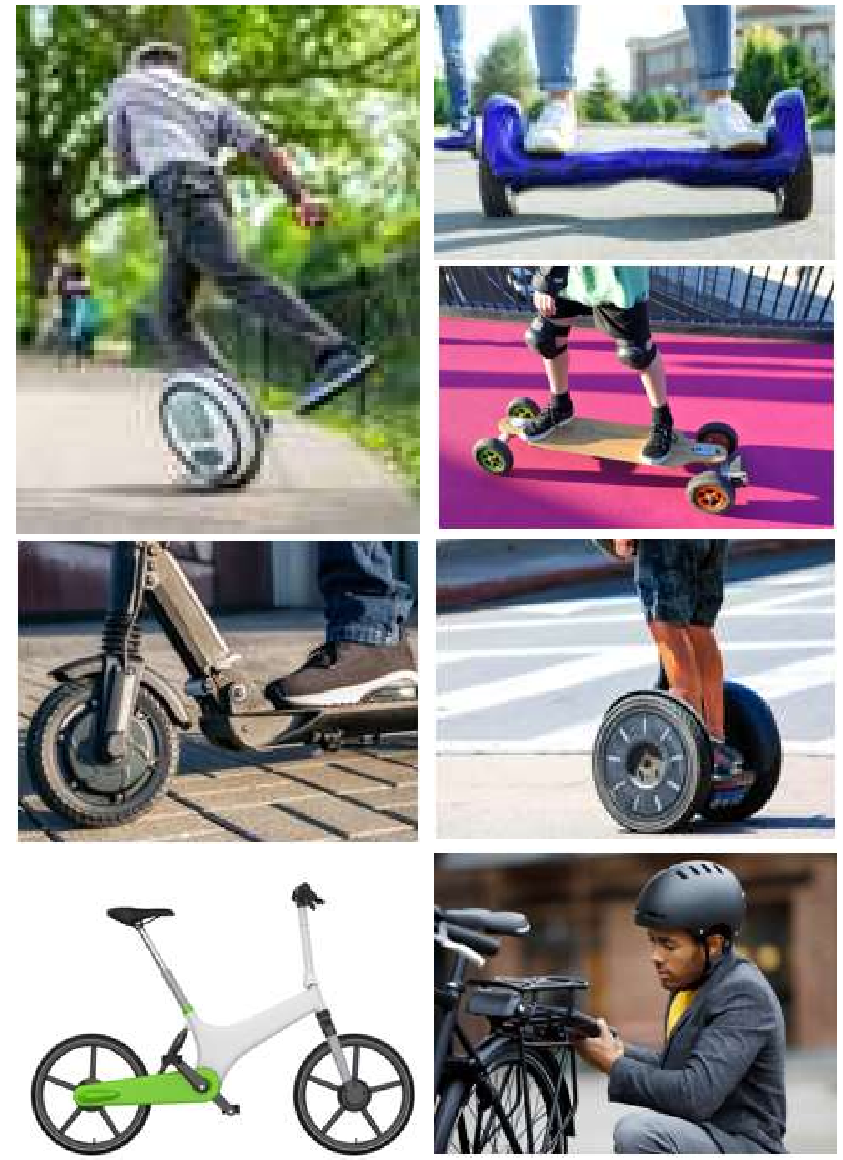
Materials & Other Components Also To Meet Their Respective UL Standards – Adhesives, Cables, Connectors, Cords, Enclosures, Fuses, Insulation, Plastics, Printed Circuits, Thermistors, Wiring, etc.

UL 2272 & UL 2849: Reduces Risk of Explosion, Fire, Electrocution

Testing Requirements

Electrical	Mechanical
Environmental	Motor & Materials

Input, Component Fault, Overcharge, Short Circuit, Overdischarge, Imbalance Charging, Temperature, Isolation Resistance, Dielectric Strength, Leakage Current, Grounding Continuity	Vibration, Shock, Crush, Drop, Impact, Mold Stress, Flexing (Cables/Cords), Strain Relief (Cables/Cords), Handle Loading, Blocked Ventilation
Humidity Conditioning, Water Ingress Protection, Thermal Cycling	Motor Overload, Motor Locked Rotor, Startup Assistance mode, Motor Assistance Control: Pedaling (Reverse/Cessation) & Cut-Off (Braking/Max Speed), Material Flammability, Label Permanence



www.ul.com/micromobility

Empowering Trust®

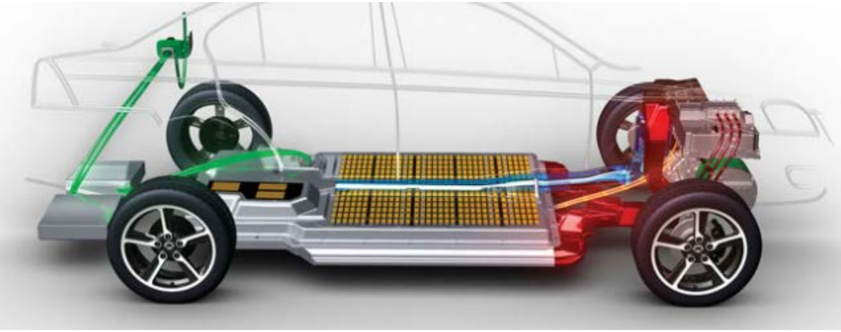
BIRD

Bird Batteries
Design &
Development

CPSC

Background

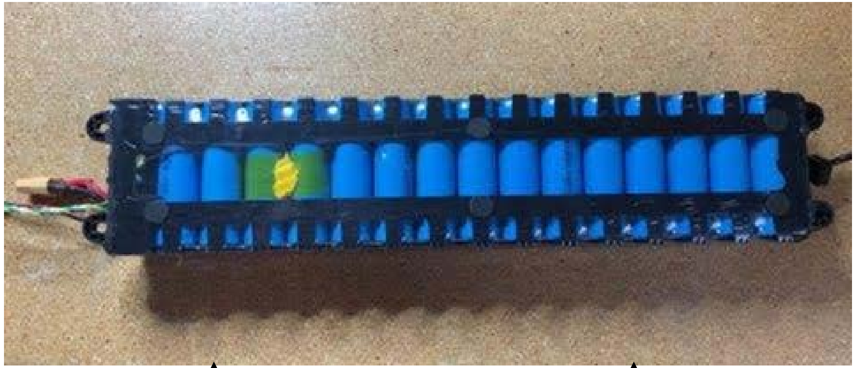
EV Automotive engineering veteran - 20+years. Miles EV, Coda Automotive, Motivo Engineering , Faraday Future , Coda Energy Grid storage, Divergent 3D. I have spent a substantial amount of focus on Battery systems , functional Safety and Validation and have seen a lot of mistakes and a lot of great technology. Bringing this level of industry expertise to Bird to make an even bigger transportation and ecological Impact than EV adoption is a passion






Point of departure - e-scooter battery

This is an example of a battery from the consumer E-Scooters that were the existing tech when Bird started the scooter sharing business.

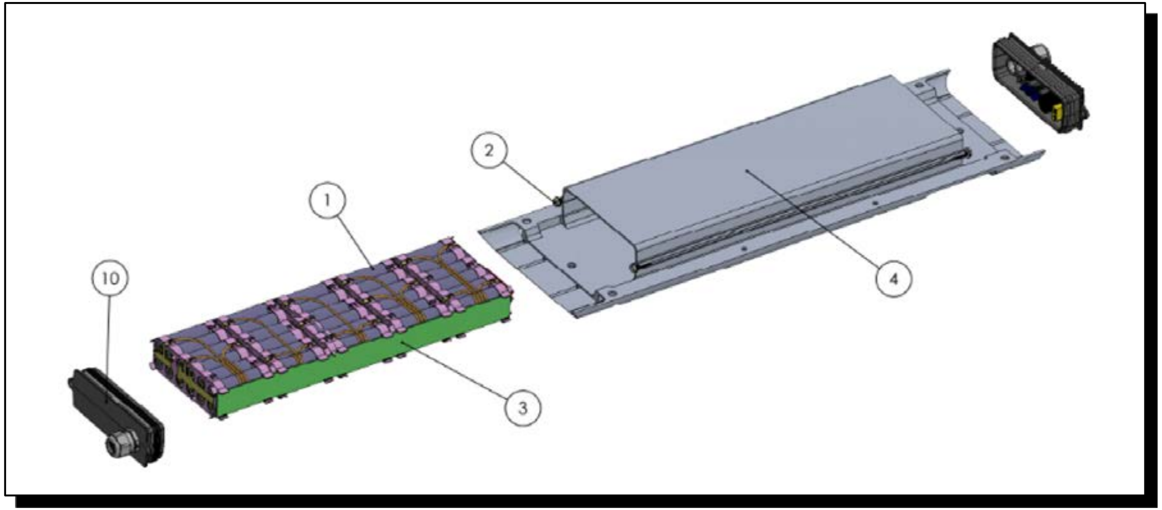


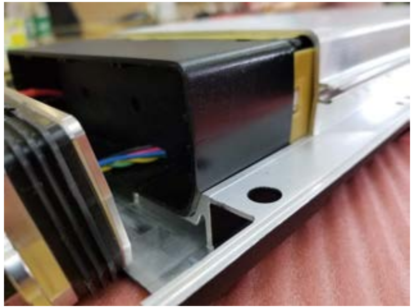
Environmental protection is a plastic shrink wrap and electrical connectors are not weather rated

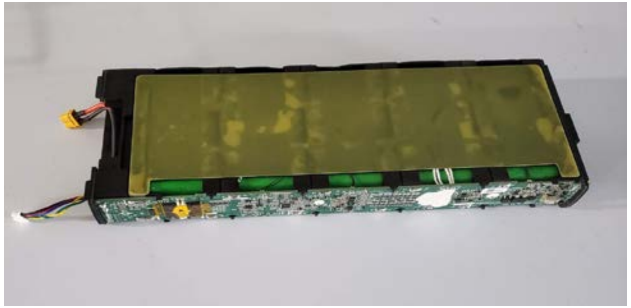
BMS is a very rudimentary safety circuit with almost no advanced features

Bird Two Battery

Bird Battery





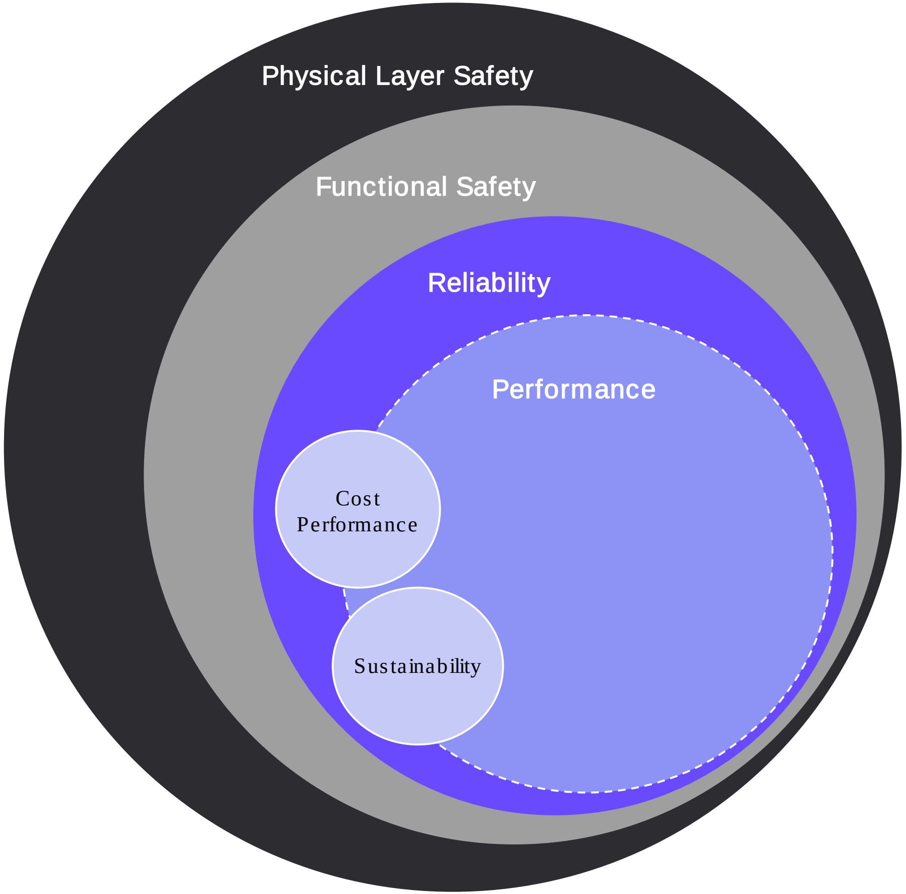


Approach

Batteries can pose a risk since it is the primary energy source of a system. Through design these risks can be mitigated much the same as they are in a gasoline vehicle.

This graphic describes how attributes are prioritized within the boundaries of other attributes.

For example: We cannot make a design decision for reliability if it will compromise Functional safety, and we cannot rely on functional safety controls without a physical layer of secondary protection.



BIRD

Cells

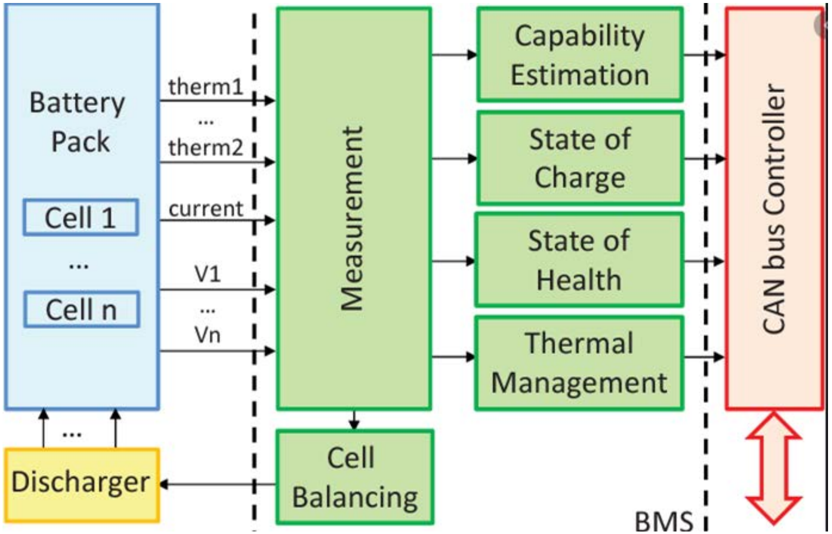
Safety starts with the most basic component of our battery, the cell.

We have an extensive qualification program internally where candidate cells are tested against their manufacturer ratings and beyond.

Battery Management System

The heart of a lithium ion battery pack is the BMS.

All of our electrical protection strategies are backed by multiple layers of protection. Wherever possible, we have implemented an analog layer of protection in addition to the digital ones.



BIRD

Charging

Charging is one of the higher risk modes of operation for Batteries.

Bird has highly managed charging procedures.

Operation

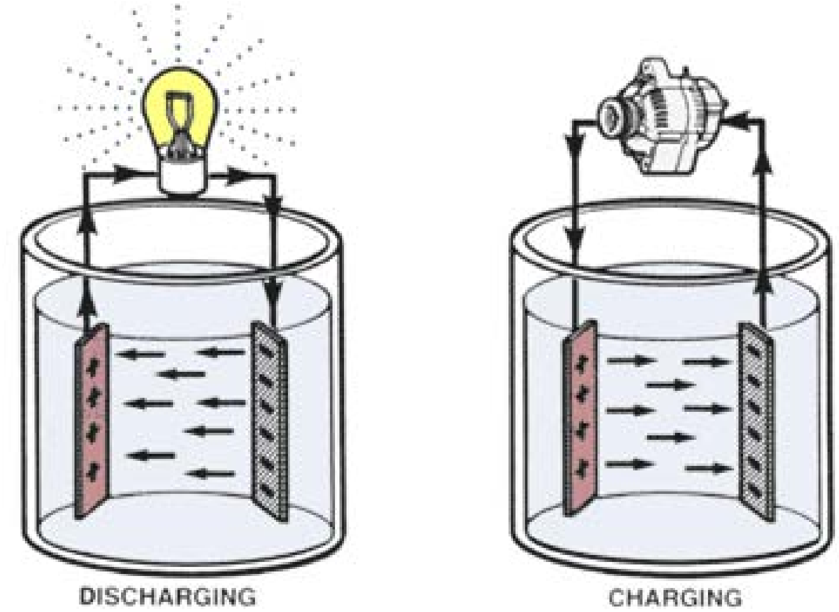
During any operation, our battery is monitoring its temperature, voltage, current and humidity..

Our System can de-rate performance to prevent ever exceeding our limits.

Dynamic Limits and Pre-charge

Our Battery continuously calculates a maximum allowable charge and discharge current rate and sends this to our motor controller so it can adjust maximum power levels dynamically.

A precharge strategy allows us to charge up our motor controller in a controlled manner to prevent overcurrent failure modes



Here is a small excerpt from our diagnostics list

Description	Bit	Model	Group
Indicate error in low-level driver initialization (AFE) on start-up	0	Bird Two	BMS
Indicate system error in pre-discharge state (AFE control error)	1	Bird Two	BMS
Indicate pre-discharge timeout. (Bus-track voltage is bellow pack voltage)	2	Bird Two	BMS
pre-discharge over-current	3	Bird Two	BMS
Charger detected during a discharge state	4	Bird Two	BMS
Pack or mosfet temperature is too high	5	Bird Two	BMS
Pack temperature is too low	6	Bird Two	BMS
End of discharge	7	Bird Two	BMS
CAN RX activity lost.	8	Bird Two	BMS
Failed to change discharge FET state (AFE control error)	9	Bird Two	BMS

Diagnostics

Our battery also has advanced diagnostics that will alert our back end if our batteries are ever damaged or at risk of becoming damaged.

Abuse and setting specs

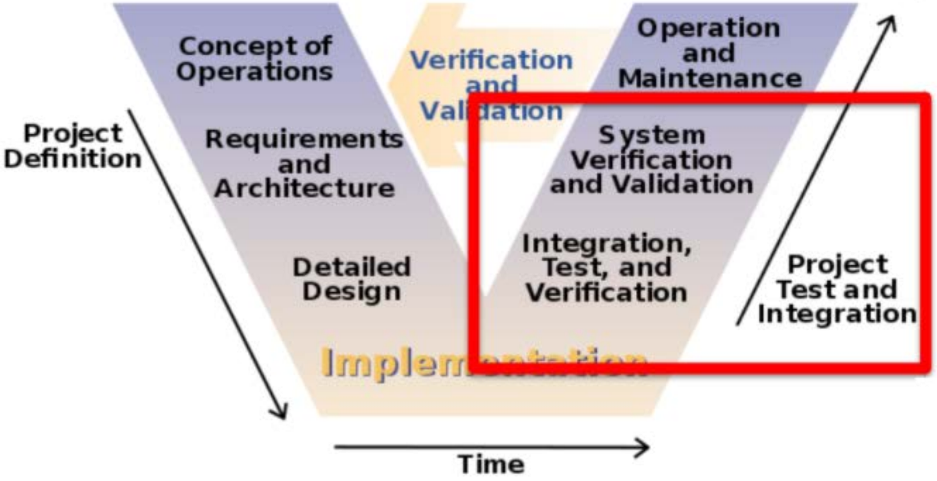
Vandalism and extreme mechanical abuse are more prevalent in micro mobility than you might expect!

Mechanical and environmental robustness is critical and Bird had to raise the bar.

Validation and Certification

To verify all of these measures have been effective we perform extensive testing.

We also certify to the UL 2271 battery standard for light electric vehicles. This goes alongside the 2272 certification that our entire vehicle is certified to. As part of this, our electronics are tested against UL 991.



Excellence
Beyond Safety

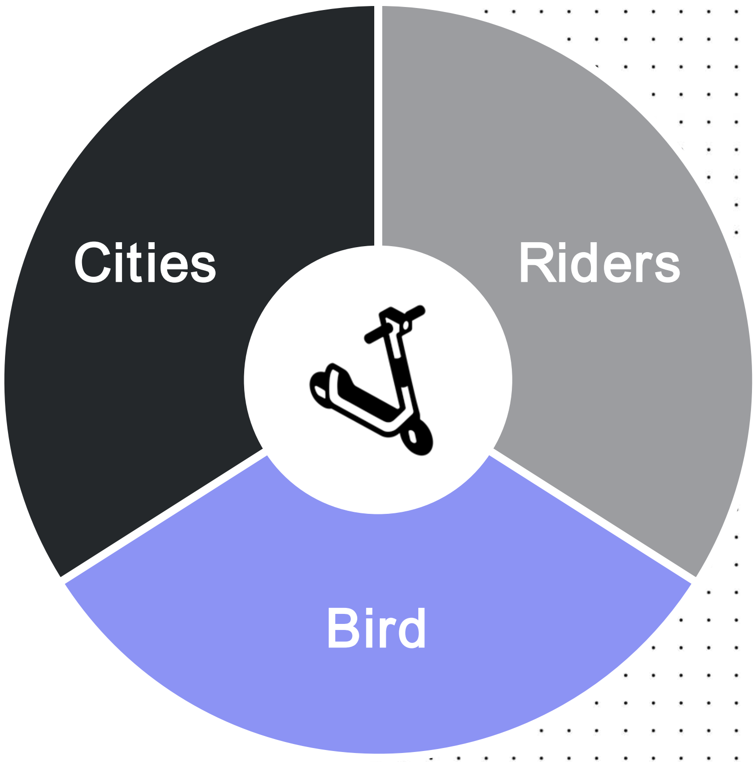
- Efficiency
- Durability / Reliability
- Sustainability
- Capacity Utilization - right sizing capacity
- Structural efficiency
- Serviceability
- Design for Assembly

Evolving Safe, Reliable and Durable Bird Vehicles

Why do we build our own vehicles?

To answer to this question, we had to build a mental and business framework, that starts with our customers.

We listen to the voice of **all of these customers.**



Major themes.

Safety
Our #1 priority

Sustainability
Vital to our core mission

Reliability
Broken vehicles are no fun for anyone

Modern
Easy to locate, responsive to city rules (e.g. speed zones) and fun to drive

Serviceable
Easy to fix

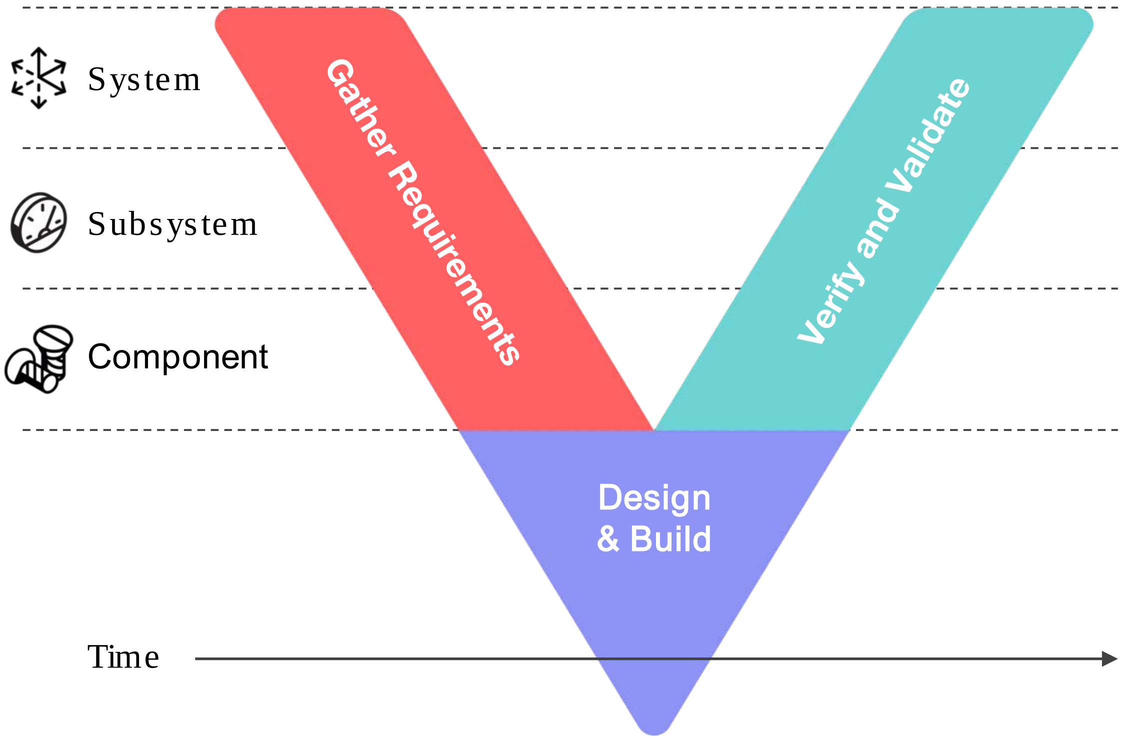
How does Bird approach vehicle design?

Some examples of the requirements from our customers

- Must have state of the art electrical safety, even given extreme use cases and harsh environments
- Must last 24 months of daily use
- Must feel sturdy
- Must be easy to locate
- Must unlock quickly
- Must last longer in between charges
- The list goes on

Getting from concept to delivery a vehicle to a market: The “V” Process

- Requires a lot of upfront planning, integration and testing
- Huge emphasis on validation, each step of the process is validated, from concept to final product
- The validation that the “V” process provides ensures the vehicle will last as long as we say it does
- At end of life, longest-lasting parts recycled back into our ecosystem, to be used on other vehicles



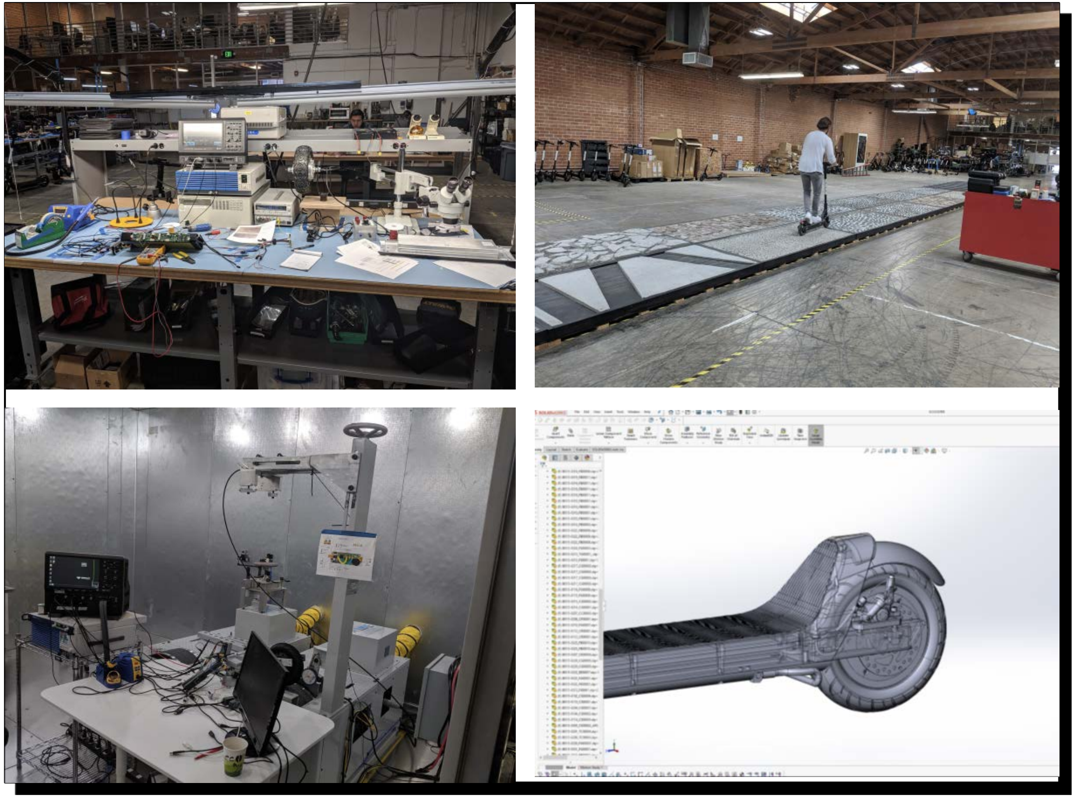
What goes on in our R&D Facility?

Design
Design new vehicles and accessories as well as optimizations to current vehicles

Analysis
Calculations around theoretical loads and scenarios, determine weak points, etc.

Reliability and Feature Updates
From Mechanical to Firmware updates, constant improvements to our vehicles

Validation & Test
Run our vehicles through the ringer to meet internal and external requirements



What are the results of this approach?

Results

Safest battery technology on the market

Bird has industry leading IP67 or IP68 waterproofing in batteries, with each generation get safer and safer.

Safest rider experience on the market

From accelerating, steering and going over bumps to evasive braking, riders are safer on a Bird.

Most durable vehicles on the market

Durability equals sustainability and safety

Most serviceable vehicles on the market

Bird’s vehicles are repaired faster which means they are available to customers quicker.

State-of-the-art vehicle diagnostics

Picture a ‘check engine’ light on steroids

Continual Improvement Over Time

Bird’s vehicles get better over time to to constant improvement of hardware and software.

Bird Two
in action

Exponent®

Rider Kinematics and Vehicle Dynamics Testing of Electric Scooter Riding

Tina Garman, PhD
Steve Como, P.E.

September 15, 2020

Presenters

Steve Como, P.E.
Senior Engineer | Vehicle
scomo@exponent.com
(623) 587-6778

- Education
  - B.S./M.S. in Mechanical Engineering from Worcester Polytechnic Institute
  - Currently pursuing Ph.D. in Systems Engineering from Arizona State University
- Areas of Expertise:
  - Accident reconstruction including low- and high-speed frontal, rear, and side impacts, 3D scanning and photogrammetry techniques, computer simulation, and commercial drone pilot certification, actively involved with Institute of Automated Mobility (IAM) on connected and automated vehicle testing and SAE on-road automated driving (ORAD) committees

Presenters

Tina Garman, Ph.D.
Senior Associate | Biomechanics
tgarman@exponent.com
(623) 587-4156

- Education
  - B.S. in Mechanical Engineering from University of Rochester
  - Ph.D. in Engineering Science and Mechanics from Virginia Tech
  - Postdoc in Orthopedic Biomechanics at Marquette University
  - National Science Foundation Graduate Research Fellow at Virginia Tech
  - NIDILRR Advanced Rehabilitation Research Training Fellow at Marquette University
- Areas of Expertise:
  - Human kinematics, injury potential and injury mechanics in automotive, recreational, and workplace incidents

History of Scooters in the USA

1915
Autoped
First standup powered scooter

1986
Go-Ped
Reintroduced first gas-powered stand-up scooter

2009
Myway
Garage project combining older design with newest technology

2020
350 cities have rideshare programs

1910 | 1920 | 1930 | 1940 | 1950 | 1960 | 1970 | 1980 | 1990 | 2000 | 2010 | 2020

1919
Skootamota
Gas powered scooter

2012
Scoots
Introduced first rideshare program in San Francisco

2017–2018
Bird followed by **Lime** launches e-scooter rideshare programs

Why Test Electric Scooters?

- No federal regulations on Electric Scooters
- In the absence of federal regulation, the operation of any micro-mobility device is governed by the state (or in the absence of state law, the municipality)
- With a lack of uniform regulations, standards committees have been forming to help guide the industry
- With uncertainty surrounding the industry, there is concern regarding accidents, injuries, and liability as these scooters are being operated on public roads and sidewalks, interacting with pedestrians, vehicles, and other roadway obstacles (potholes, speedbumps, etc.)

E-Scooter Regulation at Federal Level

- NHTSA Importation and Certification: Part II Group 2: Motorcycles and Scooters
  - The following scooters or scooter-like vehicles are not "motor vehicles" that must be manufactured to comply with all applicable FMVSS and be so certified to be lawfully imported into the United States:
    - Scooters lacking seats that are operated in a stand-up mode
    - Scooters that are incapable of a top speed of 20 mph or greater

E-Scooter Regulation at State/Local Level

- Local governments have had mixed experiences with passing and enforcing regulations pertaining to e-scooters
  - Much of the market is self-regulating at present. In some cases, deployment has occurred prior to obtaining local permission and ahead of regulation. The deployment has in some cases been reversed
  - State and local governments introducing both regulations as well as educational programs
  - One of the main areas of legislation in 2019 was focused on defining e-scooters, determining whether they can be operated on streets or sidewalks, and setting speed limits

PBOT Portland Bureau of Transportation

The E-Scooter Pilot Program started April 26, 2019 and lasts through December 31, 2020. It follows a 120-day pilot program in 2018 that showed e-scooters have the potential to help reduce congestion and pollution. Following the pilot, PBOT will evaluate the program and engage the public to develop recommendations for permanent rules for shared e-scooter use for the City Council to consider.

A new Pennsylvania bill could overturn Philadelphia's ban on electric scooters

By Gordon Ho | 04/01/19 11:39pm

Cities Use Invisible Geofencing to Control Use of E-Scooters

Cities across California are limiting the type and number of micro-mobility devices that move inside their borders, testing the limits of a technology called geofencing to remotely enforce speed, parking and dead zones.

FOX 13 TAMPA BAY

Gov. DeSantis signs bill lifting sidewalk restrictions on electric scooters

E-Scooter Standards Committees

ASTM INTERNATIONAL

ASTM F2641 - 08(2015)

Standard Consumer Safety Specification for Recreational Powered Scooters and Pocket Bikes

Active Standard ASTM F2641 | Developed by Subcommittee: F15.58

UL

Standard for Electrical Systems for eBikes

UL Standard

Scope

Summary of Topics

Standard 2849, Edition 1

Edition Date: January 02, 2020

SAE INTERNATIONAL

SURFACE VEHICLE RECOMMENDED PRACTICE	J3194™	NOV2019
	Issued 2019-11	
Taxonomy and Classification of Powered Micromobility Vehicles		

Exponent Publications in the Micro-Mobility Space

2019-01-1007 Published 02 Apr 2019

SAE INTERNATIONAL

Behavior of Electric Scooter Operators in Naturalistic Environments

Jay Todd, David Krauss, Jacqueline Zimmermann, and Amber Dunning Exponent Failure Analysis

Citation: Todd, J., Krauss, D., Zimmermann, J., and Dunning, A. "Behavior of Electric Scooter Operators in Naturalistic Environments," SAE Technical Paper 2019-01-1007, 2019, doi:10.4271/2019-01-1007.

Abstract

The use of electric scooters (e-scooters), which are more generally categorized as motorized scooters, has undergone explosive growth owing to "scooter share" programs in which an e-scooter is rented for a limited period of time. The near-spontaneous ubiquity of e-scooters has prompted government and scooter share companies to address issues partly motivated by concerns related to the inclusion of a large population of e-scooters into vehicular traffic. These issues are influenced by the decisions and behaviors of the scooter operators, who, despite being licensed to drive passenger vehicles, potentially have limited experience operating an e-scooter in the presence of traffic. E-scooters are in a relative unique position where they are small enough to negotiate pedestrian traffic, yet fast enough to travel on roadways. This enables an e-scooter operator to change when and where he rides, e.g., from traveling on a sidewalk to riding in a clear traffic lane in order to avoid a group of pedestrians standing at an intersection. Such changes may catch nearby motorists off-guard, thereby increasing the risk of a collision with the e-scooter. The present observational study assessed e-scooter rider behavior in west Los Angeles, a region with a robust presence of rental e-scooters. The large population, preponderance of e-scooters, and high traffic volumes provide an exemplary area to observe not just how drivers and e-scooter riders adapt to one-another's presence, but also the increased risk of an interaction between e-scooters with other vehicles and pedestrians. Operator behavior of rented e-scooters is quantified and reviewed according to current regulations, public concerns regarding e-scooters, and behaviors present that may affect an individual's ability to safely operate an e-scooter in the presence of traffic, including both vehicular and pedestrian.

Introduction

The United States is experiencing a rapid growth in the presence of e-scooters by "scooter-share" companies in cities across the country. For many people, e-scooters are a fun and convenient way to travel short distances. The reported average distance traveled per trip is approximately 1.5 miles [1, 2]. This contrasts with a typical rideshare (e.g., Uber, Lyft) commute, which is more than twice as long across a host of cities and geographic regions [3, 4, 5]. An average e-scooter ride also may be shorter than an average trip on a bicycle for an electric bike-share program [6].

In California, the maximum speed of e-scooters must not exceed 15 mph (CA vehicle code). This is similar to the speed of a commuting cyclist across level terrain [7], and approximately twice as fast as the average speeds of individuals riding (electric and conventional) bicycles through a bike-share program [8]. Relative to a casual cyclist, who likely travels slower than a commuter, the minimum effort to accelerate on an e-scooter increases the potential of e-scooter operators accelerating to 15 mph sooner than on a bicycle or traditional kick scooter, as well as to travel at that maximum speed. By accelerating faster or traveling at a faster speed, the operator may also reduce the time available to avoid a threat, regardless of whether it may be noticeable from a distance, e.g., a pothole, or appears suddenly, e.g., a pedestrian or vehicle crossing her path of travel. Similarly, an e-scooter operator may afford other traffic less time to avoid a collision with the scooter if the e-scooter operator behaves in a sudden, unexpected, or erratic manner. This is conceptually no different than a car driver speeding and not having enough time to avoid a collision with an easily visible, slower object/vehicle moving in its path of travel [9].

The diminutive profile of an e-scooter places it at a further disadvantage relative to larger objects on the roadway, e.g., cars, motorcycles, and possibly bicycles. For the simple fact that smaller objects are less conspicuous, e-scooters are more likely to go unnoticed by drivers of passenger and commercial vehicles, even when the e-scooter is a brightly colored or its operator is wearing seemingly conspicuous clothing. This issue is common to motorcyclists. Drivers consistently demonstrate difficulty perceiving motorcyclists relative to passenger vehicles [10, 11, 12].

The challenge for drivers to be aware of a relatively small e-scooter is not just perceptual, there is also a cognitive component. Task set, or the prioritization of mental processes to prepare and perform an individual task, plays a prominent role in our ability to appreciate the presence of a smaller vehicle or object, for example a motorcycle. Searching for particular visual information in roadway signs (a specific colored arrow indicating one's direction of travel) is associated with an increased failure to perceive an approaching motorcycle, when the motorcycle lacks that visual feature, i.e., the

2020-01-0933 Published 14 Apr 2020

SAE INTERNATIONAL

Patient Demographics and Injury Characteristics of ER Visits Related to Powered-Scooters

Heather N Watson, Christina MR Garman, Jeffrey Wishart, and Jacqueline Zimmermann Exponent, Inc.

Citation: Watson, H.N., Garman, C.M.R., Wishart, J., and Zimmermann, J., "Patient Demographics and Injury Characteristics of ER Visits Related to Powered-Scooters," SAE Technical Paper 2020-01-0933, 2020, doi:10.4271/2020-01-0933.

Abstract

With growing environmental concerns associated with gas-powered vehicles and busier city streets, micro-mobility modes, including traditional bicycles and new technologies, such as electric scooters (e-scooters), are becoming solutions. In 2018, e-scooter usage overtook other shared micro-mobility modes with over 38 million e-scooter trips taken. Concurrently, the societal concern regarding the safety of these devices is also increasing. To examine the types of injuries associated with e-scooters and bicycles, the National Electronic Injury Surveillance System (NEISS), a probability sample of US hospitals that collects information from emergency room (ER) visits related to consumer products, was utilized. Records from September 2017 to December 2018 were extracted, and those associated with powered scooters were identified. Injury distributions by age, sex, race, treatment, diagnosis, and location on the body were explored. The number of person-trips was obtained to perform a risk analysis. An estimated 17,772 injuries were associated with powered scooters. Nearly 45% of injuries occurred in persons aged 10-29 years. Almost 87% of ER visits consisted of patients being treated and released, whereas nearly 11% were hospitalized (the remaining 2% either received no treatment or the disposition was unknown). Common injuries included contusions/abrasions, fractures, and lacerations. Almost 15% of the injuries associated with powered scooters occurred to the face; the head, ankle, lower leg, and knee were other common body parts injured. An estimated 51 million person-trips were taken during this time period, resulting in an injury rate of 346 injuries/million trips. In comparison, 4.7 billion person-trips were taken on bicycles, resulting in an injury rate of 114 injuries/million trips.

Introduction

Electric scooters (e-scooters) are quickly becoming one of the public's favorite choices of micro-mobility transportation, in part owing to "scooter share" programs in which e-scooters can be rented for short-term use. In 2018, trips taken on e-scooters overtook other shared micro-mobility transportation modes, including station-based bike shares, dock-less bikes, and e-bikes [1]. A total of 38.5 million trips were documented in the United States on e-scooters, and e-scooters were available for public use in over 100 US cities [1]. For many users, e-scooters are a fun, convenient, and cost-effective method of transportation.

With the sharp increase in recent usage, questions about the safety of e-scooters are being asked by users and policy-makers alike. Noticeably, it is difficult to make direct comparisons between the relative "safeness" of e-scooters and other micro-mobility modes, such as bicycles, due to differences in user profiles, user experience, user behavior (e.g., speed), and regions of use (e.g., city vs rural areas).

To the best of the authors' knowledge, no studies have directly compared risky riding behavior between e-scooter and bicycle operators; however, a few naturalistic studies have examined risky riding behavior in one or the other. The results of one naturalistic study comparing risky user behavior of bicyclists and e-bike riders showed 47.5% of e-bike riders and 46% of bicyclists traveled opposite to the flow of traffic, 70% of both bicyclists and e-bike riders failed to stop at stop-controlled intersections, on-road speed was higher for e-bikes than regular bicycles (13.3 kph vs. 10.5 kph) but shared-use path speeds of e-bike riders were lower than regular bicyclists (11.0 kph vs. 12.6 kph) [3]. Another study examined risky user behavior of e-scooter operators in a naturalistic observational study using video recordings in west Los Angeles [17]. Results indicated that traveling opposite to the flow of traffic occurred in only 6.7% of e-scooter users and approximately 89.1% of e-scooter users did not wear helmets. These studies suggest that in a naturalistic environment, the riskiest behavior for e-bike and bicycle riders was riding against the flow of traffic and for powered scooter riders, it was riding without a helmet.

Though maximum speed limits vary based on e-scooter type and also by state, e-scooters will typically not exceed a maximum speed of 15 miles per hour (mph). This is comparable to the speed of a commuting bicyclist traveling on level terrain (16 mph) [2], but is about twice as fast as average speeds of individuals using bicycles in a bike-share program (6.5 mph) [3], which may be a closer comparison to situations in which e-scooters are used. Potentially faster speeds on

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SAE INTERNATIONAL

Micro-Mobility Vehicle Dynamics and Rider Kinematics during Electric Scooter Riding

Christina MR Garman, Steven G. Como, Ian C. Campbell, Jeffrey Wishart, Kevin O'Brien, and Scott McLean Exponent Inc.

Citation: Garman, C.M.R., Como, S.G., Campbell, I.C., Wishart, J. et al., "Micro-Mobility Vehicle Dynamics and Rider Kinematics during Electric Scooter Riding," SAE Technical Paper 2020-01-0935, 2020, doi:10.4271/2020-01-0935.

ABSTRACT

Micro-mobility is a fast-growing trend in the transportation industry with stand-up electric scooters (e-scooters) becoming increasingly popular in the United States. To date, up to 350 rideshare e-scooter programs have been launched in the United States. As this popularity increases, so too does the need to understand the performance capabilities of these vehicles and the associated operator kinematics. For example, given the relative weight of the scooter to the rider, tip-over stability is characterized primarily by rider inputs such as body positioning, interaction with the handlebars, and foot placement. In this study, research was conducted using operators of varying body habitus to characterize rider kinematics and vehicle dynamics of these e-scooters currently used in the traffic ecosystem.

A test course was designed to simulate an urban environment, requiring typical maneuvers including turning, pedestrian avoidance in the form of a slalom course, accelerating, decelerating, stopping, and unexpected braking events. The controlled test course allowed for data collection under generally repeatable conditions. A commercially available e-scooter was instrumented to measure acceleration, velocity, steering angle, roll angle, and GPS location. Operators with a range of heights and weights were instrumented with wearable sensors to record the positions, velocities, and accelerations of the head and torso. Additionally, a load cell was mounted on the scooter stem to provide data related to dynamic weight transfer. Results indicated that maximum lean angle and rate in the medial lateral direction reached values of 59 degrees and 783 deg/s, respectively. Average scooter steer angle and roll angle reached values of 49 degrees and 24 degrees, respectively, and maximum stem load was 176 N. Additional straight-line brake testing was conducted to evaluate braking distance and deceleration capabilities of the e-scooter on various surfaces. This study resulted in braking distances of 2.8 m to 5.2 m with accelerations of approximately 0.30-0.35 g, 0.28-0.37 g, and 0.25-0.32 g on asphalt, concrete, and dirt surfaces, respectively.

Introduction

Usage of micro-mobility devices such as stand-up e-scooters are a growing trend, particularly given the advent of commercial app-based scooter sharing organizations [5]. Although traditional push scooters with and without electric boost have existed for many years, the recent increase in popularity has underscored the importance of understanding scooter vehicle dynamics and rider kinematics in order to improve performance and safety. In urban environments, e-scooters are often ridden on sidewalks, in bicycle lanes, and on roadways, where there may be interactions with pedestrians, cyclists, and automobiles. In many cities, scooters are governed at a top speed of approximately 24 kph (15 mph), but they may operate in the same space as pedestrians (approximately 5 kph [3 mph]) and as automobiles (over 40 kph [25 mph]). These speed differentials establish the importance for understanding e-scooter performance in addition to rider kinematics and handling.

The advent of electric assistance for bicycles ("e-bikes") has been studied in naturalistic environments, and riders have been shown to behave differently on e-bikes compared to traditional bicycles [6, 7, 9]. A limited number of studies have been performed to date to analyze the behavior of e-scooter riders in naturalistic environments [8, 13]. A study performed in Los Angeles that analyzed risky riding behaviors found that approximately 22% of e-scooter riders were on the sidewalk, and approximately 7% were traveling in the roadway opposing the flow of traffic [13].

E-scooter rides are relatively short in both time and distance, with one study from Indianapolis finding that rides last, on average, approximately 8 minutes and 1.7 km (1.1 mi) [11]. Despite their brevity, the opportunity for adverse interactions with the environment is high; as ridership has increased, so too have reports of injuries. Studies have estimated that approximately 20 individuals were injured per 100,000 e-scooter trips [2, 4]. Although this value is proportionally small, it is noteworthy that the city of Austin, TX tabulated over 300,000 trips per month alone [2]. In a study of emergency department admissions related to scooter riding, the source of injuries were reported to be the result of falls (approximately 80%), collisions with static objects (11%), and being hit by another moving object (9%) [15]. The news media have reported multiple accounts of fatal e-scooter incidents worldwide, and multiple studies have shown that the most

Exponent Publications in the Micro-Mobility Space

2019-01-1007 Published 02 Apr 2019

SAE INTERNATIONAL

Behavior of Electric Scooter Operators in Naturalistic Environments

Jay Todd, David Krauss, Jacqueline Zimmermann, and Amber Dunning Exponent Failure Analysis

Citation: Todd, J., Krauss, D., Zimmermann, J., and Dunning, A. "Behavior of Electric Scooter Operators in Naturalistic Environments," SAE Technical Paper 2019-01-1007, 2019, doi:10.4271/2019-01-1007.

Abstract

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Introduction

The United States is experiencing a rapid growth in the presence of e-scooters by "scooter-share" companies in cities across the country. For many people, e-scooters are a fun and convenient way to travel short distances. The reported average distance traveled per trip is approximately 1.5 miles [1, 2]. This contrasts with a typical rideshare (e.g., Uber, Lyft) commute, which is more than twice as long across a host of cities and geographic regions [3, 4, 5]. An average e-scooter ride also may be shorter than an average trip on a bicycle for an electric bike-share program [6].

In California, the maximum speed of e-scooters must not exceed 15 mph (CA vehicle code). This is similar to the speed of a commuting cyclist across level terrain [7], and approximately twice as fast as the average speeds of individuals riding (electric and conventional) bicycles through a bike-share program [8]. Relative to a casual cyclist, who likely travels slower than a commuter, the minimum effort to accelerate on an e-scooter increases the potential of e-scooter operators accelerating to 15 mph sooner than on a bicycle or traditional kick scooter, as well as to travel at that maximum speed. By accelerating faster or traveling at a faster speed, the operator may also reduce the time available to avoid a threat, regardless of whether it may be noticeable from a distance, e.g., a pothole, or appears suddenly, e.g., a pedestrian or vehicle crossing her path of travel. Similarly, an e-scooter operator may afford other traffic less time to avoid a collision with the scooter if the e-scooter operator behaves in a sudden, unexpected, or erratic manner. This is conceptually no different than a car driver speeding and not having enough time to avoid a collision with an easily visible, slower object/vehicle moving in its path of travel [9].

The diminutive profile of an e-scooter places it at a further disadvantage relative to larger objects on the roadway, e.g., cars, motorcycles, and possibly bicycles. For the simple fact that smaller objects are less conspicuous, e-scooters are more likely to go unnoticed by drivers of passenger and commercial vehicles, even when the e-scooter is a brightly colored or its operator is wearing seemingly conspicuous clothing. This issue is common to motorcyclists. Drivers consistently demonstrate difficulty perceiving motorcyclists relative to passenger vehicles [10, 11, 12].

The challenge for drivers to be aware of a relatively small e-scooter is not just perceptual, there is also a cognitive component. Task set, or the prioritization of mental processes to prepare and perform an individual task, plays a prominent role in our ability to appreciate the presence of a smaller vehicle or object, for example a motorcycle. Searching for particular visual information in roadway signs (a specific colored arrow indicating one's direction of travel) is associated with an increased failure to perceive an approaching motorcycle, when the motorcycle lacks that visual feature, i.e., the

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SAE INTERNATIONAL

Patient Demographics and Injury Characteristics of ER Visits Related to Powered-Scooters

Heather N Watson, Christina MR Garman, Jeffrey Wishart, and Jacqueline Zimmermann Exponent, Inc.

Citation: Watson, H.N., Garman, C.M.R., Wishart, J., and Zimmermann, J., "Patient Demographics and Injury Characteristics of ER Visits Related to Powered-Scooters," SAE Technical Paper 2020-01-0933, 2020, doi:10.4271/2020-01-0933.

Abstract

With growing environmental concerns associated with gas-powered vehicles and busier city streets, micro-mobility modes, including traditional bicycles and new technologies, such as electric scooters (e-scooters), are becoming solutions. In 2018, e-scooter usage overtook other shared micro-mobility modes with over 38 million e-scooter trips taken. Concurrently, the societal concern regarding the safety of these devices is also increasing. To examine the types of injuries associated with e-scooters and bicycles, the National Electronic Injury Surveillance System (NEISS), a probability sample of US hospitals that collects information from emergency room (ER) visits related to consumer products, was utilized. Records from September 2017 to December 2018 were extracted, and those associated with powered scooters were identified. Injury distributions by age, sex, race, treatment, diagnosis, and location on the body were explored. The number of person-trips was obtained to perform a risk analysis. An estimated 17,772 injuries were associated with powered scooters. Nearly 45% of injuries occurred in persons aged 10-29 years. Almost 87% of ER visits consisted of patients being treated and released, whereas nearly 11% were hospitalized (the remaining 2% either received no treatment or the disposition was unknown). Common injuries included contusions/abrasions, fractures, and lacerations. Almost 15% of the injuries associated with powered scooters occurred to the face; the head, ankle, lower leg, and knee were other common body parts injured. An estimated 51 million person-trips were taken during this time period, resulting in an injury rate of 346 injuries/million trips. In comparison, 4.7 billion person-trips were taken on bicycles, resulting in an injury rate of 114 injuries/million trips.

Introduction

Electric scooters (e-scooters) are quickly becoming one of the public's favorite choices of micro-mobility transportation, in part owing to "scooter share" programs in which e-scooters can be rented for short-term use. In 2018, trips taken on e-scooters overtook other shared micro-mobility transportation modes, including station-based bike shares, dock-less bikes, and e-bikes [1]. A total of 38.5 million trips were documented in the United States on e-scooters, and e-scooters were available for public use in over 100 US cities [1]. For many users, e-scooters are a fun, convenient, and cost-effective method of transportation.

With the sharp increase in recent usage, questions about the safety of e-scooters are being asked by users and policy-makers alike. Noticeably, it is difficult to make direct comparisons between the relative "safeness" of e-scooters and other micro-mobility modes, such as bicycles, due to differences in user profiles, user experience, user behavior (e.g., speed), and regions of use (e.g., city vs rural areas).

To the best of the authors' knowledge, no studies have directly compared risky riding behavior between e-scooter and bicycle operators; however, a few naturalistic studies have examined risky riding behavior in one or the other. The results of one naturalistic study comparing risky user behavior of bicyclists and e-bike riders showed 47.5% of e-bike riders and 46% of bicyclists traveled opposite to the flow of traffic, 70% of both bicyclists and e-bike riders failed to stop at stop-controlled intersections, on-road speed was higher for e-bikes than regular bicycles (13.3 kph vs. 10.5 kph) but shared-use path speeds of e-bike riders were lower than regular bicyclists (11.0 kph vs. 12.6 kph) [3]. Another study examined risky user behavior of e-scooter operators in a naturalistic observational study using video recordings in west Los Angeles [17]. Results indicated that traveling opposite to the flow of traffic occurred in only 6.7% of e-scooter users and approximately 89.1% of e-scooter users did not wear helmets. These studies suggest that in a naturalistic environment, the riskiest behavior for e-bike and bicycle riders was riding against the flow of traffic and for powered scooter riders, it was riding without a helmet.

Though maximum speed limits vary based on e-scooter type and also by state, e-scooters will typically not exceed a maximum speed of 15 miles per hour (mph). This is comparable to the speed of a commuting bicyclist traveling on level terrain (16 mph) [2], but is about twice as fast as average speeds of individuals using bicycles in a bike-share program (6.5 mph) [3], which may be a closer comparison to situations in which e-scooters are used. Potentially faster speeds on

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SAE INTERNATIONAL

Micro-Mobility Vehicle Dynamics and Rider Kinematics during Electric Scooter Riding

Christina MR Garman, Steven G. Como, Ian C. Campbell, Jeffrey Wishart, Kevin O'Brien, and Scott McLean Exponent Inc.

Citation: Garman, C.M.R., Como, S.G., Campbell, I.C., Wishart, J. et al., "Micro-Mobility Vehicle Dynamics and Rider Kinematics during Electric Scooter Riding," SAE Technical Paper 2020-01-0935, 2020, doi:10.4271/2020-01-0935.

ABSTRACT

Micro-mobility is a fast-growing trend in the transportation industry with stand-up electric scooters (e-scooters) becoming increasingly popular in the United States. To date, up to 350 rideshare e-scooter programs have been launched in the United States. As this popularity increases, so too does the need to understand the performance capabilities of these vehicles and the associated operator kinematics. For example, given the relative weight of the scooter to the rider, tip-over stability is characterized primarily by rider inputs such as body positioning, interaction with the handlebars, and foot placement. In this study, research was conducted using operators of varying body habitus to characterize rider kinematics and vehicle dynamics of these e-scooters currently used in the traffic ecosystem.

A test course was designed to simulate an urban environment, requiring typical maneuvers including turning, pedestrian avoidance in the form of a slalom course, accelerating, decelerating, stopping, and unexpected braking events. The controlled test course allowed for data collection under generally repeatable conditions. A commercially available e-scooter was instrumented to measure acceleration, velocity, steering angle, roll angle, and GPS location. Operators with a range of heights and weights were instrumented with wearable sensors to record the positions, velocities, and accelerations of the head and torso. Additionally, a load cell was mounted on the scooter stem to provide data related to dynamic weight transfer. Results indicated that maximum lean angle and rate in the medial lateral direction reached values of 59 degrees and 783 deg/s, respectively. Average scooter steer angle and roll angle reached values of 49 degrees and 24 degrees, respectively, and maximum stem load was 176 N. Additional straight-line brake testing was conducted to evaluate braking distance and deceleration capabilities of the e-scooter on various surfaces. This study resulted in braking distances of 2.8 m to 5.2 m with accelerations of approximately 0.30-0.35 g, 0.28-0.37 g, and 0.25-0.32 g on asphalt, concrete, and dirt surfaces, respectively.

Introduction

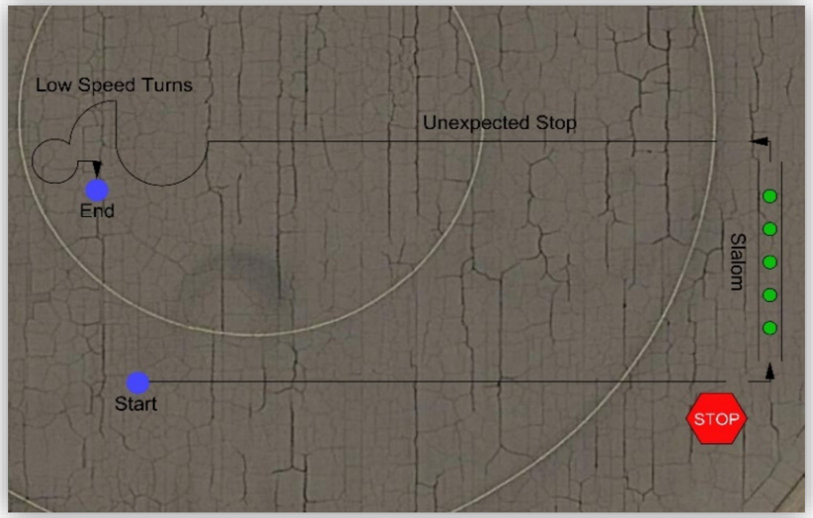
Usage of micro-mobility devices such as stand-up e-scooters are a growing trend, particularly given the advent of commercial app-based scooter sharing organizations [5]. Although traditional push scooters with and without electric boost have existed for many years, the recent increase in popularity has underscored the importance of understanding scooter vehicle dynamics and rider kinematics in order to improve performance and safety. In urban environments, e-scooters are often ridden on sidewalks, in bicycle lanes, and on roadways, where there may be interactions with pedestrians, cyclists, and automobiles. In many cities, scooters are governed at a top speed of approximately 24 kph (15 mph), but they may operate in the same space as pedestrians (approximately 5 kph [3 mph]) and as automobiles (over 40 kph [25 mph]). These speed differentials establish the importance for understanding e-scooter performance in addition to rider kinematics and handling.

The advent of electric assistance for bicycles ("e-bikes") has been studied in naturalistic environments, and riders have been shown to behave differently on e-bikes compared to traditional bicycles [6, 7, 9]. A limited number of studies have been performed to date to analyze the behavior of e-scooter riders in naturalistic environments [8, 13]. A study performed in Los Angeles that analyzed risky riding behaviors found that approximately 22% of e-scooter riders were on the sidewalk, and approximately 7% were traveling in the roadway opposing the flow of traffic [13].

E-scooter rides are relatively short in both time and distance, with one study from Indianapolis finding that rides last, on average, approximately 8 minutes and 1.7 km (1.1 mi) [11]. Despite their brevity, the opportunity for adverse interactions with the environment is high; as ridership has increased, so too have reports of injuries. Studies have estimated that approximately 20 individuals were injured per 100,000 e-scooter trips [2, 4]. Although this value is proportionally small, it is noteworthy that the city of Austin, TX tabulated over 300,000 trips per month alone [2]. In a study of emergency department admissions related to scooter riding, the source of injuries were reported to be the result of falls (approximately 80%), collisions with static objects (11%), and being hit by another moving object (9%) [15]. The news media have reported multiple accounts of fatal e-scooter incidents worldwide, and multiple studies have shown that the most

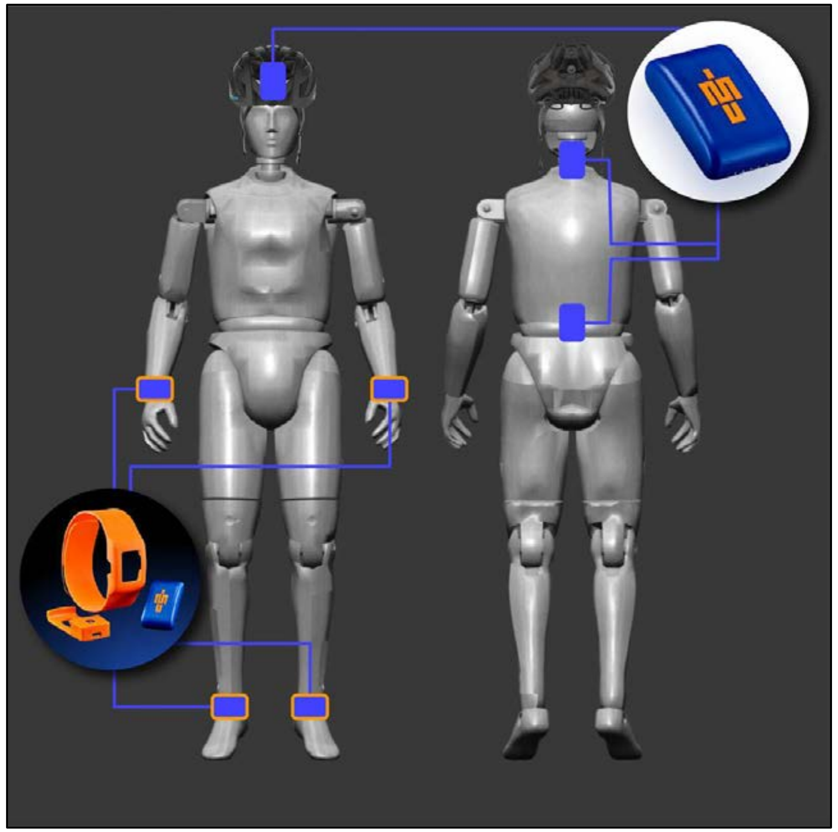
Micro Mobility Vehicle Dynamics and Rider Kinematics During Electric Scooter Riding (SAE 2020)

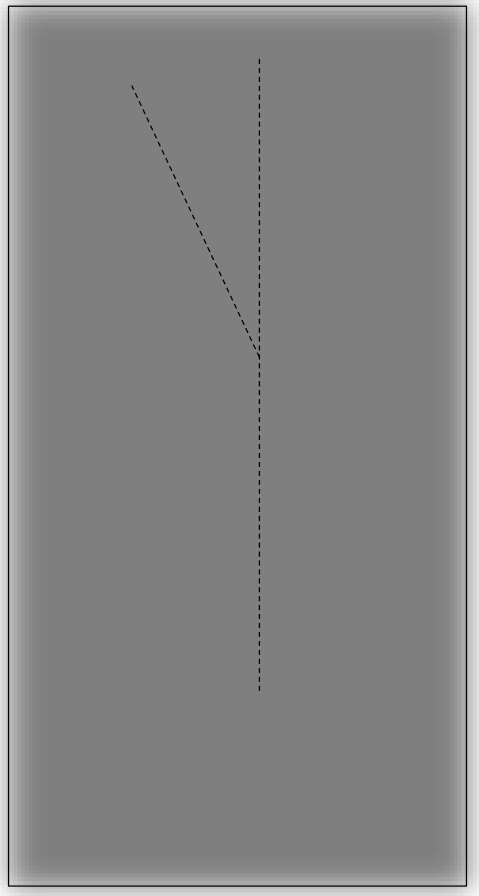
- Research designed to understand rider stability and the capabilities of an electric scooter
- Test course was designed to simulate an urban environment
- Fully instrumented rider and scooter were analyzed



Micro Mobility Vehicle Dynamics and Rider Kinematics During Electric Scooter Riding (SAE 2020)

- Rider Instrumentation
  - Wireless/wearable Inertial Measurement Units (IMU)
  - Aids in characterizing stability by evaluating accelerations at body landmarks
  - Allows for unconstrained and realistic testing scenarios



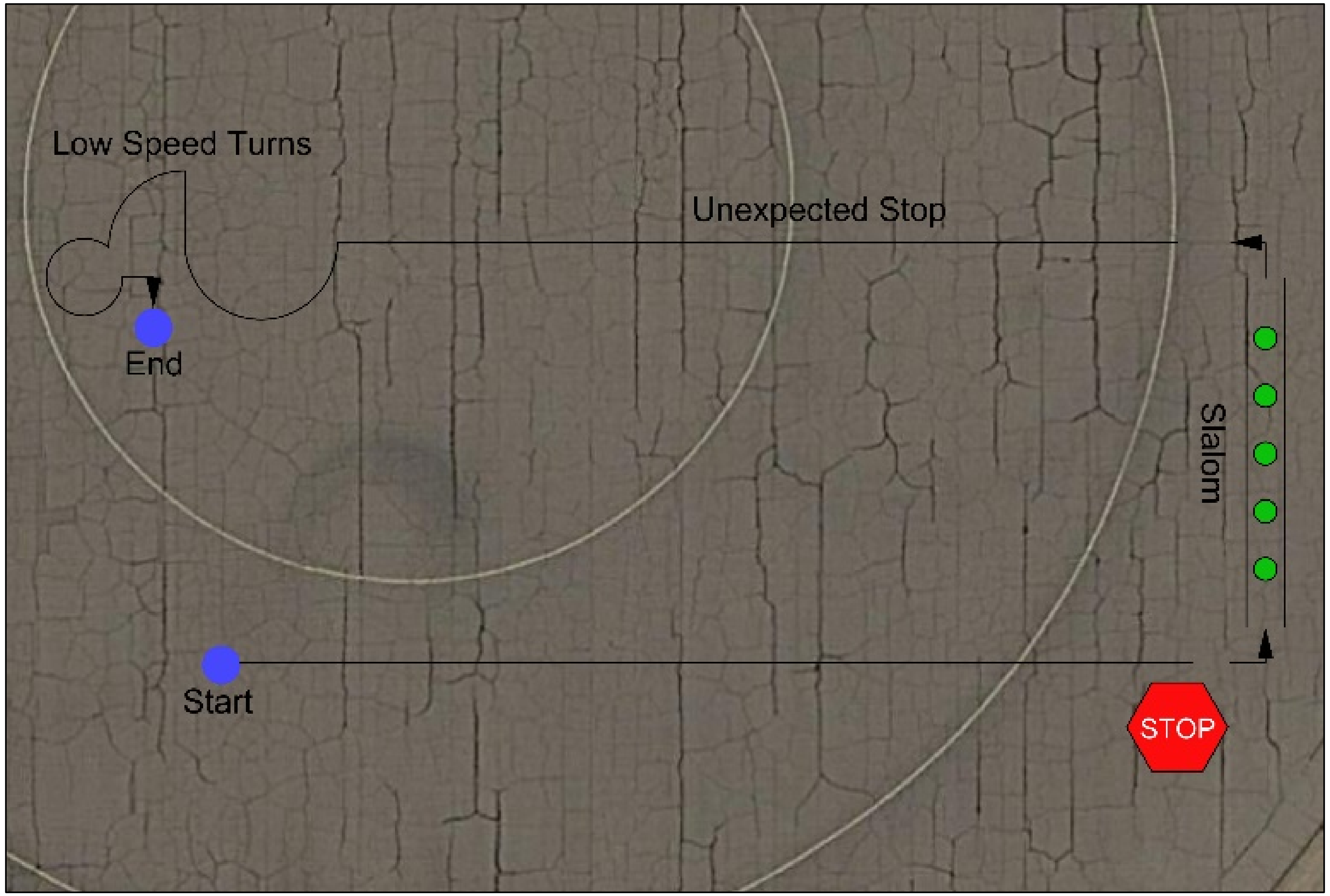


Micro Mobility Vehicle Dynamics and Rider Kinematics During Electric Scooter Riding (SAE 2020)

Diagram #	Instrumentation	Location	Measurement
1	Half-bridge strain gauge	Stem	Stem load (N)
2	Forward-facing video camera	Stem	Real-time video footage
3	Potentiometer	Stem	Zero – Straight forward Positive – Right (60 deg max) Negative – Left (-60 deg min)
4	Rear-facing video camera	Stem	Real time video footage
5	GPS unit	Mounted to scooter base	Long/Lat/Vert Accel (g) GPS Speed (kph) Roll/Pitch/Yaw (deg)
6	Analog	Throttle / Brake	0 V – No Throttle/Brake input 5 V – Max Throttle/Brake input

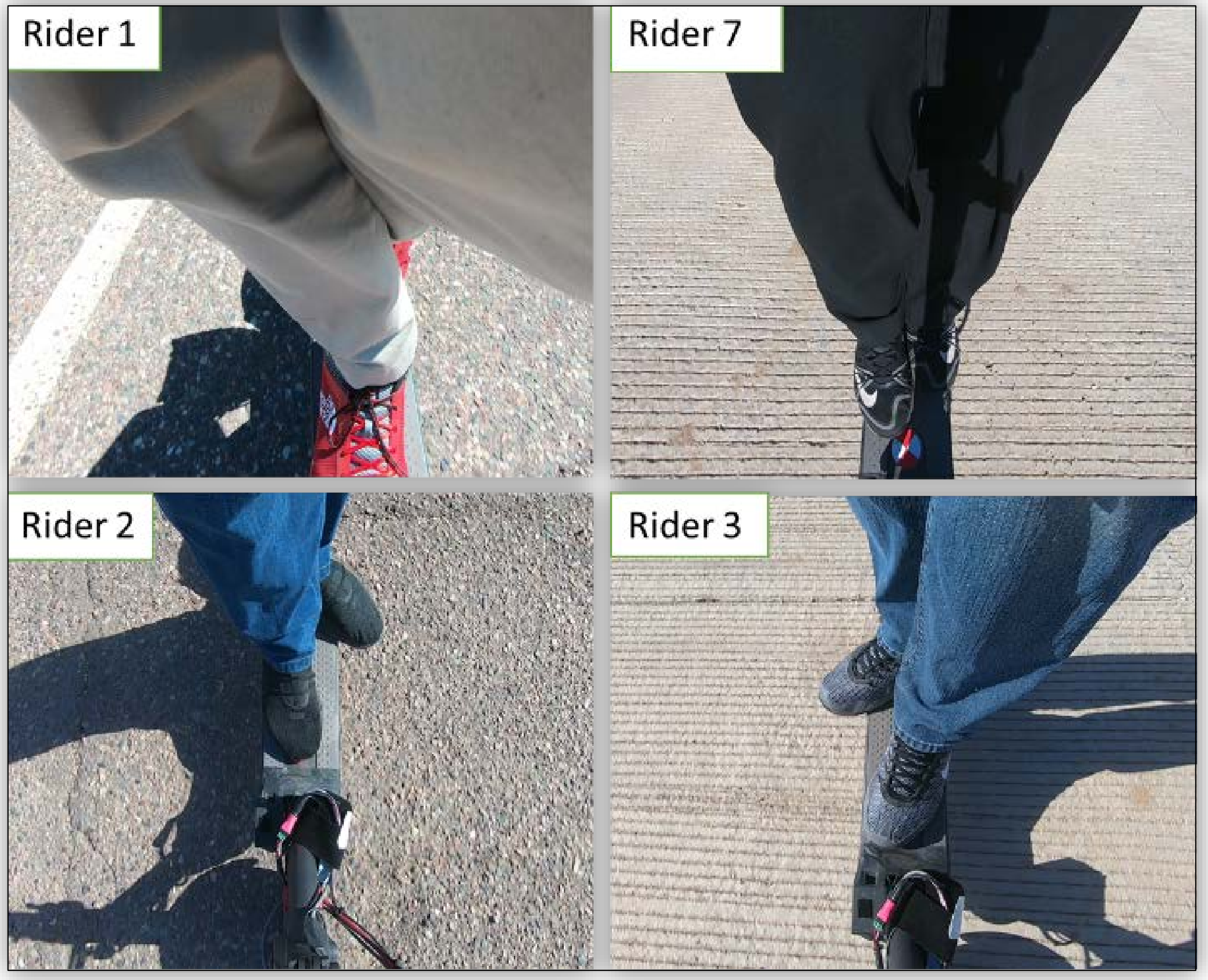
Micro Mobility Vehicle Dynamics and Rider Kinematics During Electric Scooter Riding (SAE 2020)

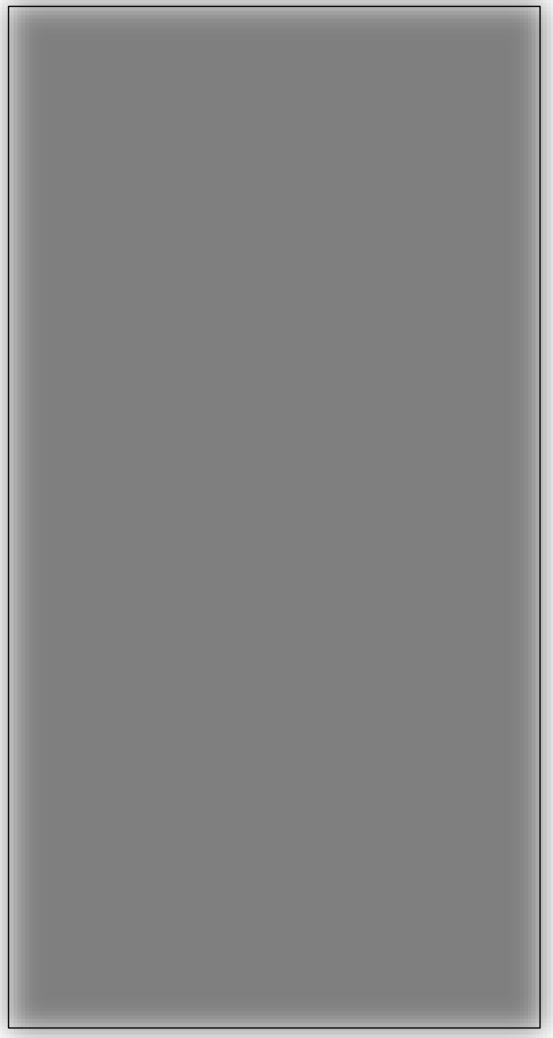
- Testing Environment
- 4 Distinct Maneuvers
  - Start to a slow stop
  - Slalom
  - Unexpected Stop
  - Low Speed Turn

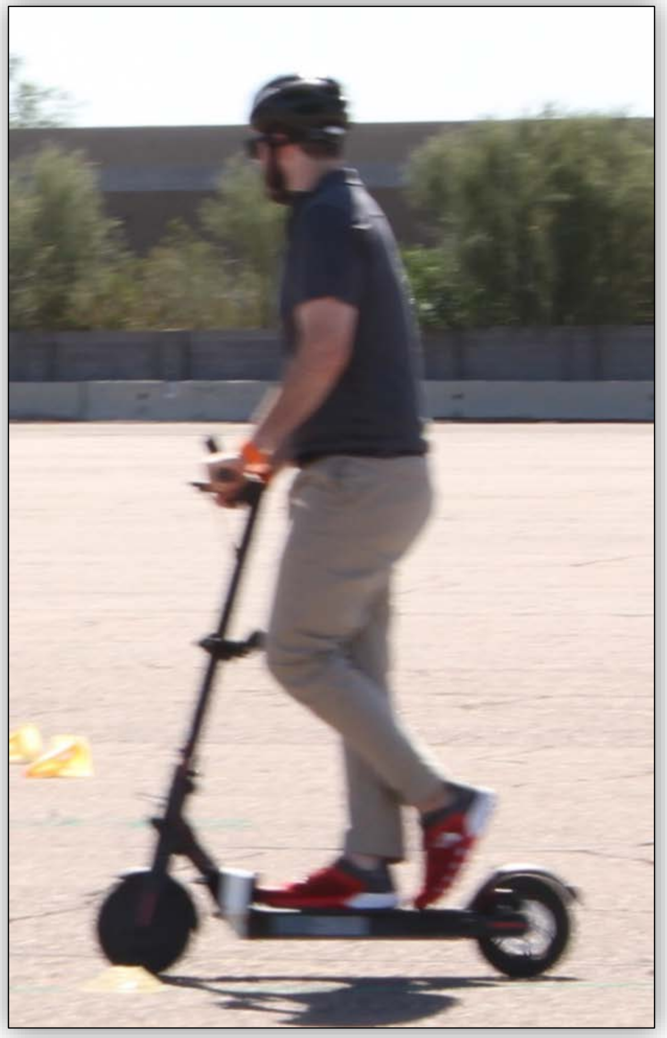


Micro Mobility Vehicle Dynamics and Rider Kinematics During Electric Scooter Riding (SAE 2020)

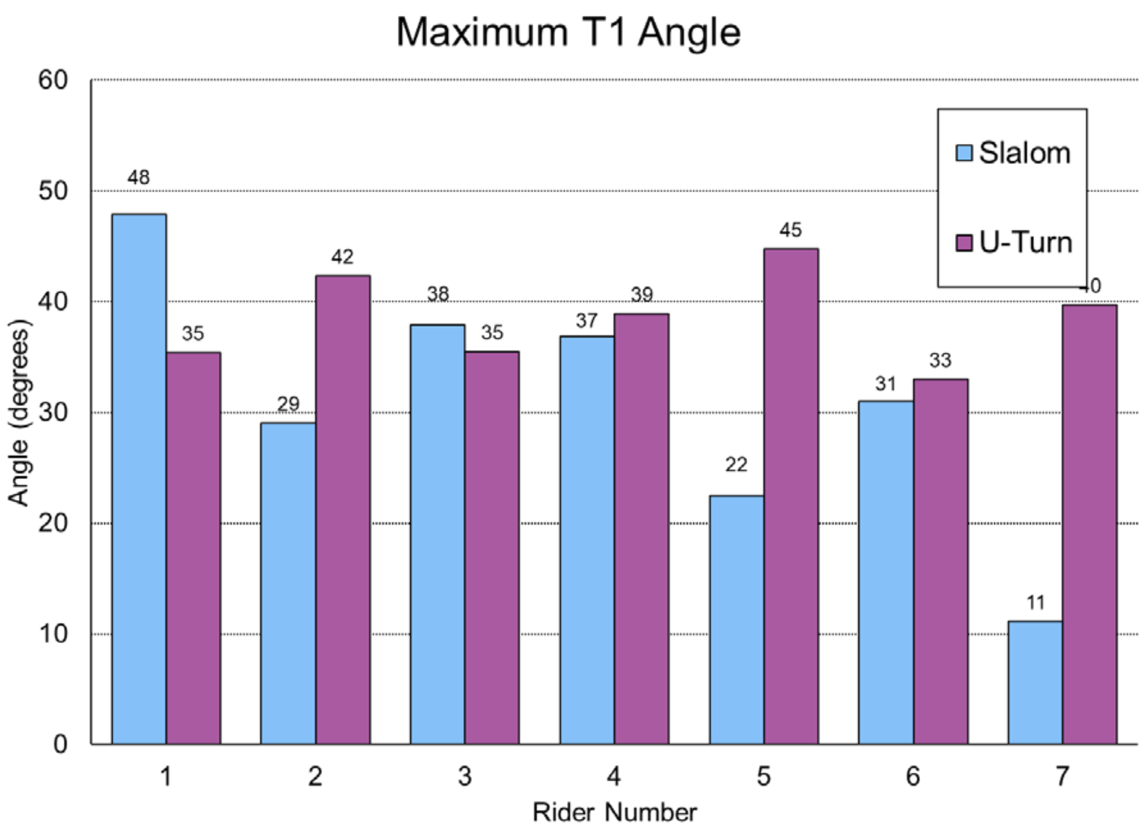
Results

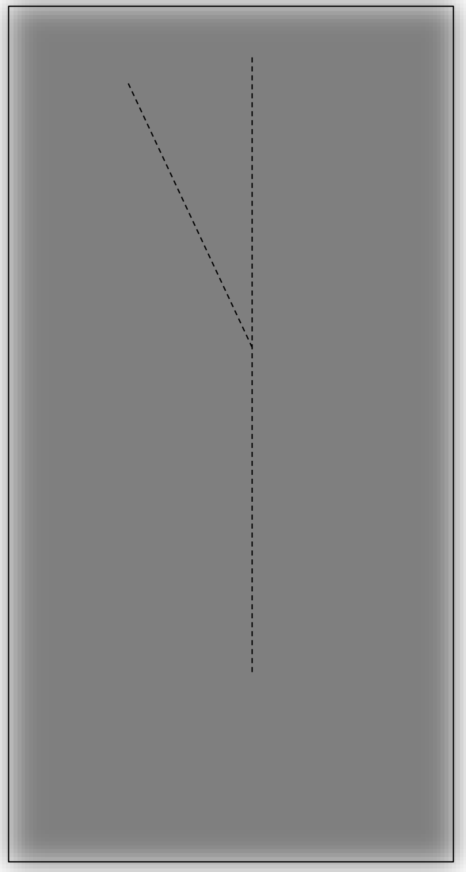


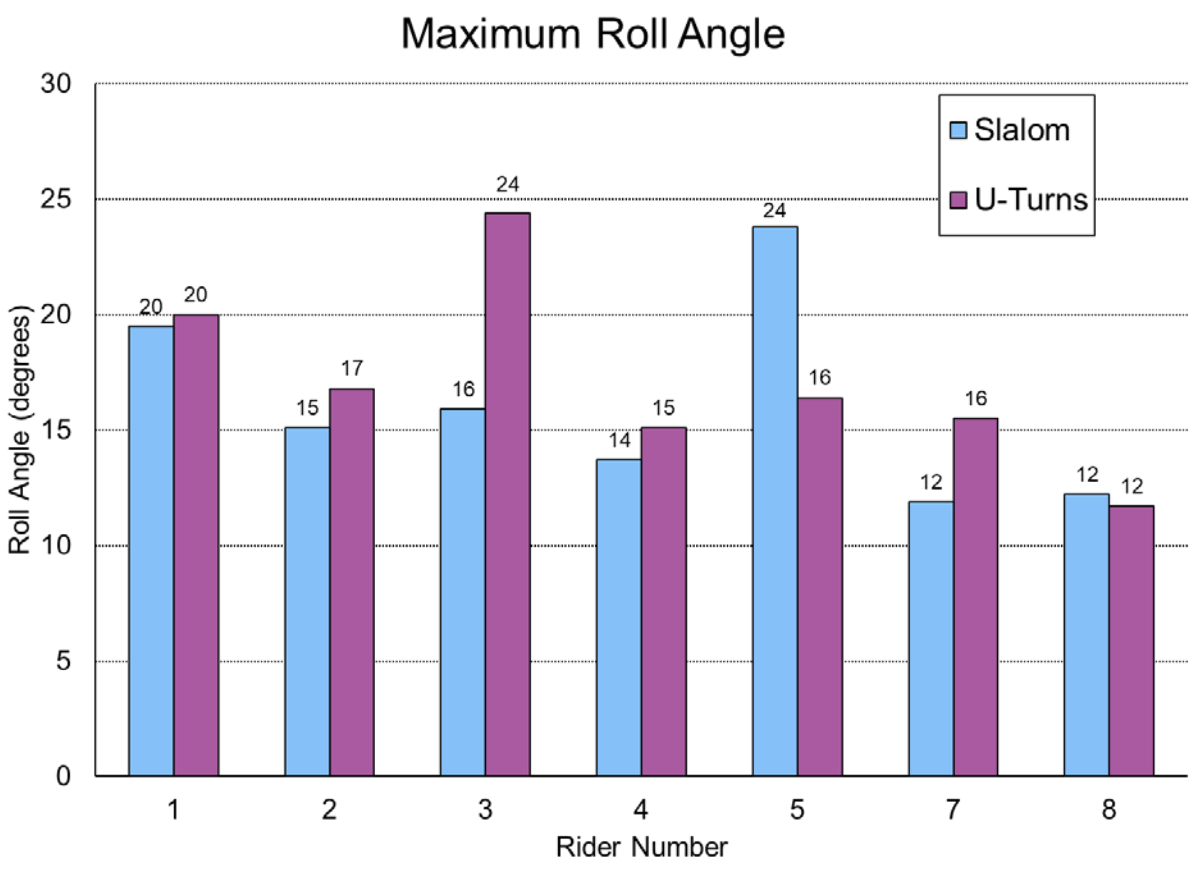


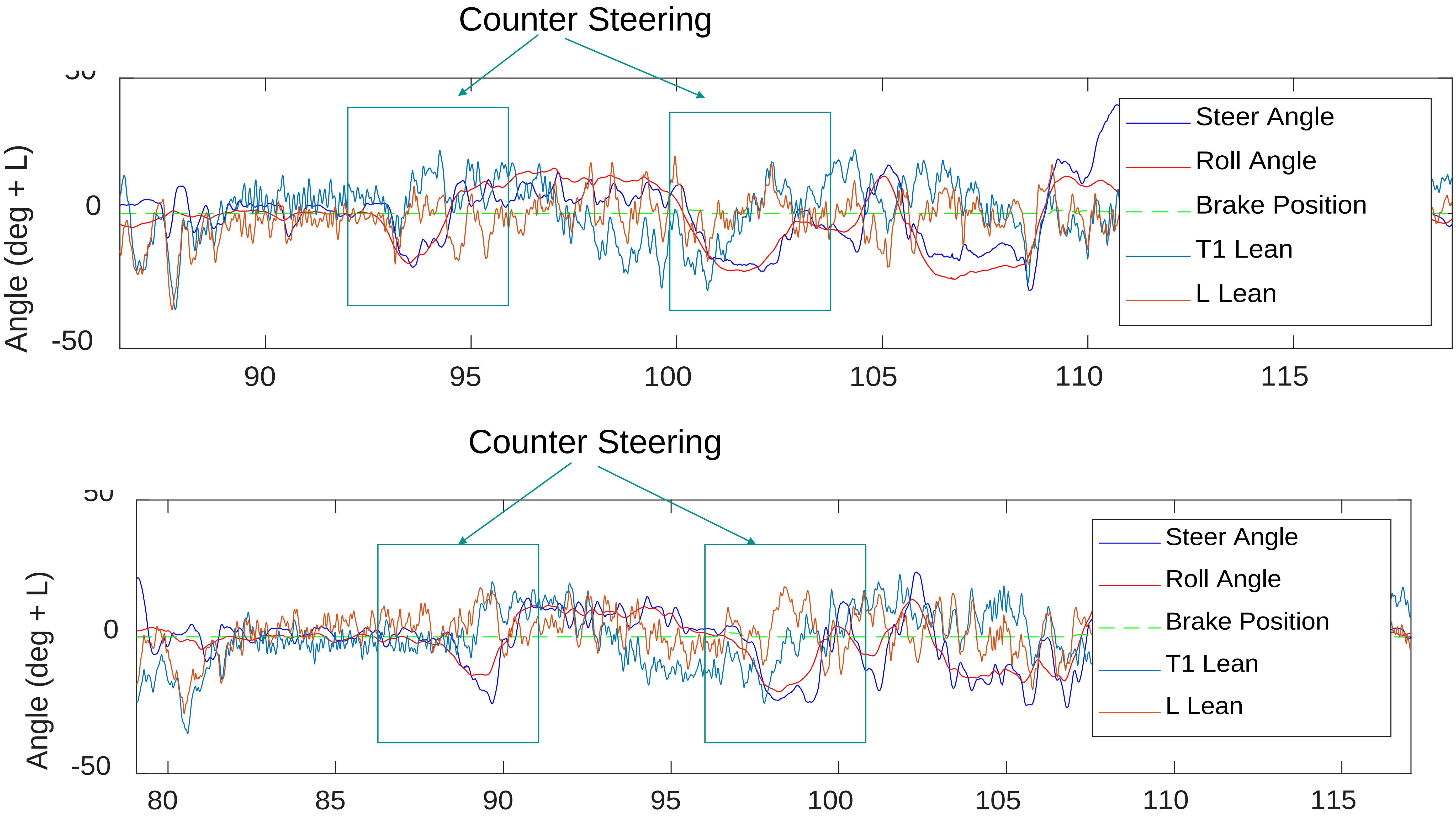


Micro Mobility Vehicle Dynamics and Rider Kinematics During Electric Scooter Riding (SAE 2020)



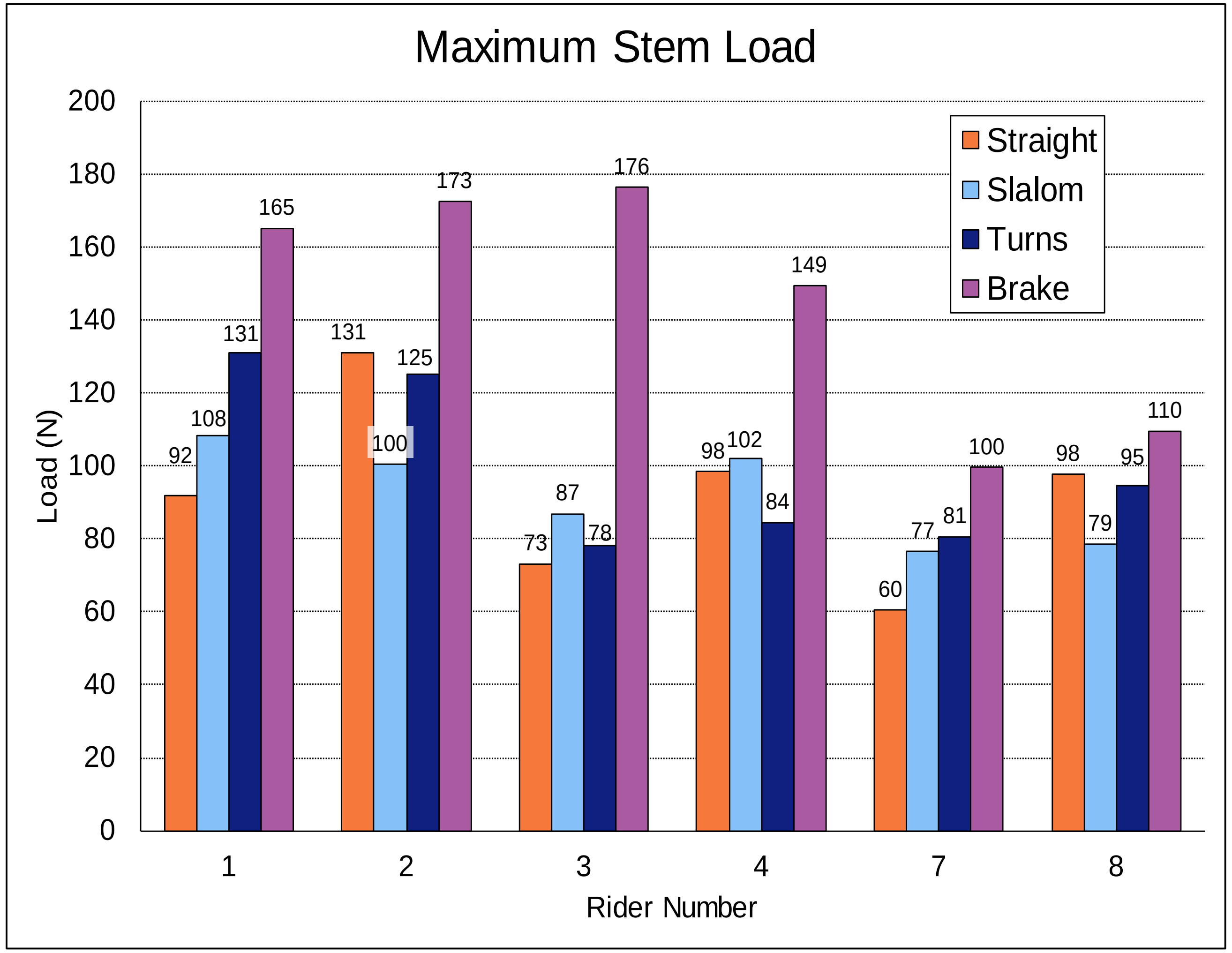


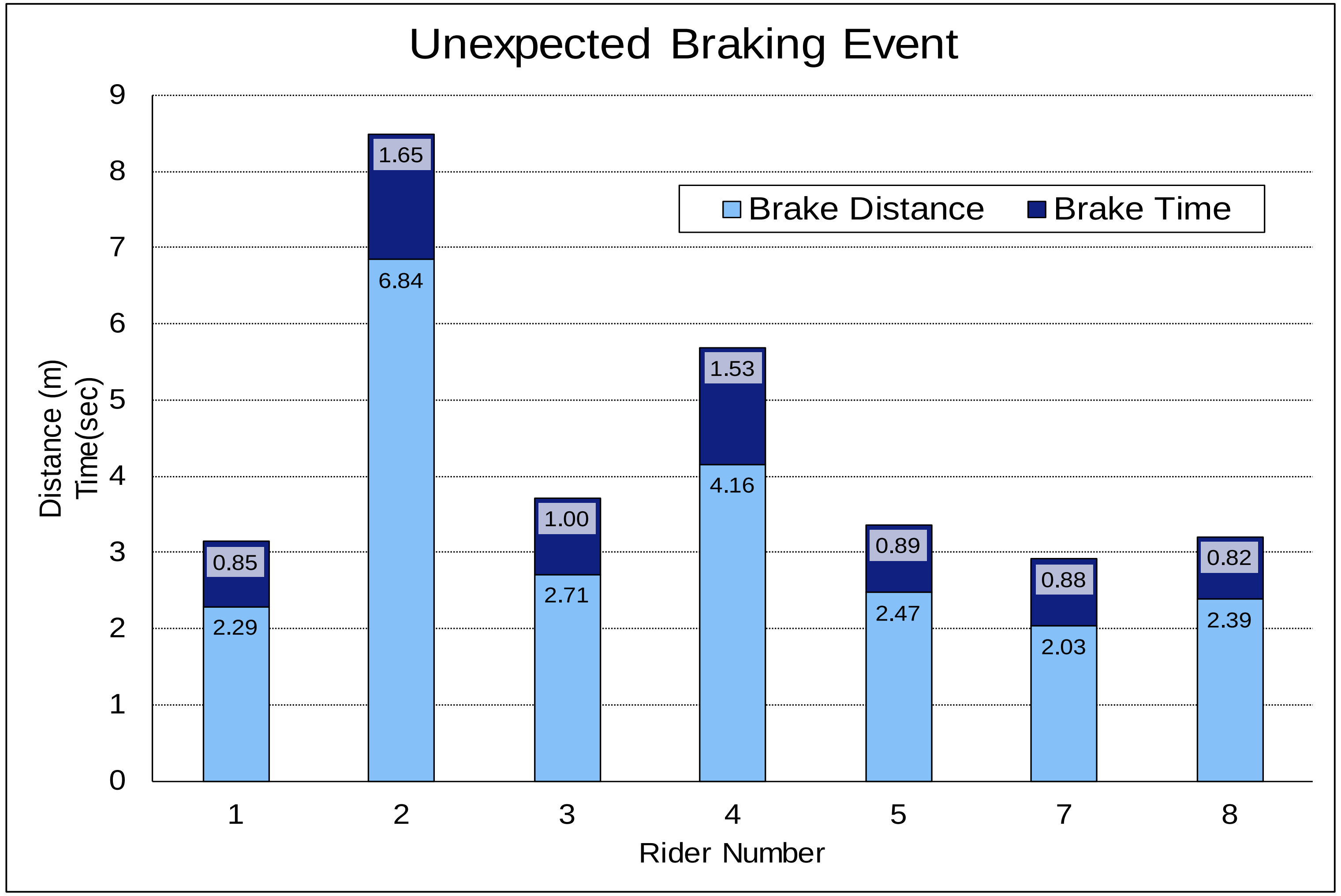


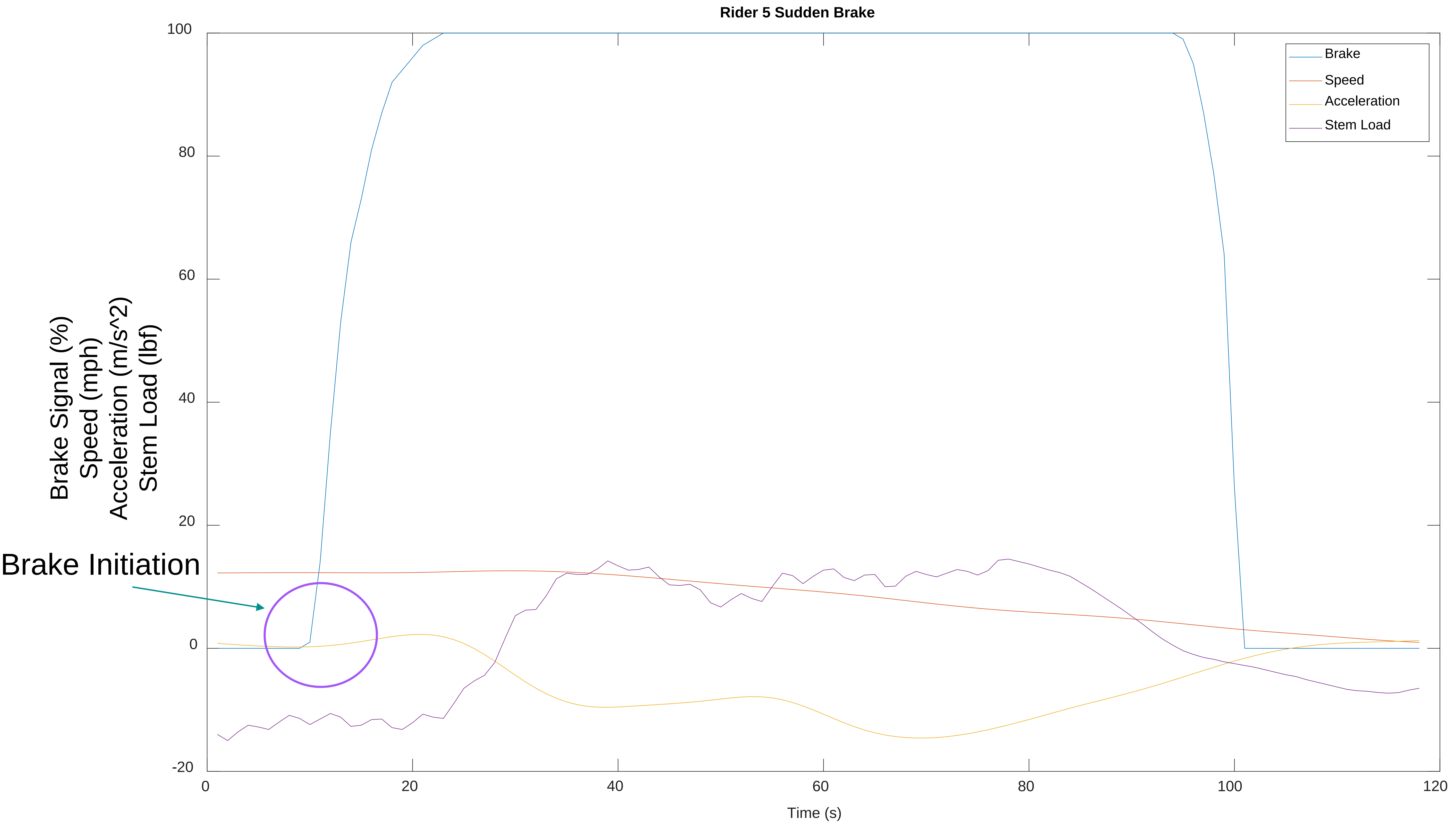


Counter Steering
Angle (deg + L)
50
0
-50
90
95
100
105
110
115
Steer Angle
Roll Angle
Brake Position
T1 Lean
L Lean
Counter Steering
Angle (deg + L)
50
0
-50
80
85
90
95
100
105
110
115
Steer Angle
Roll Angle
Brake Position
T1 Lean
L Lean

Micro Mobility Vehicle Dynamics and Rider Kinematics During Electric Scooter Riding (SAE 2020)

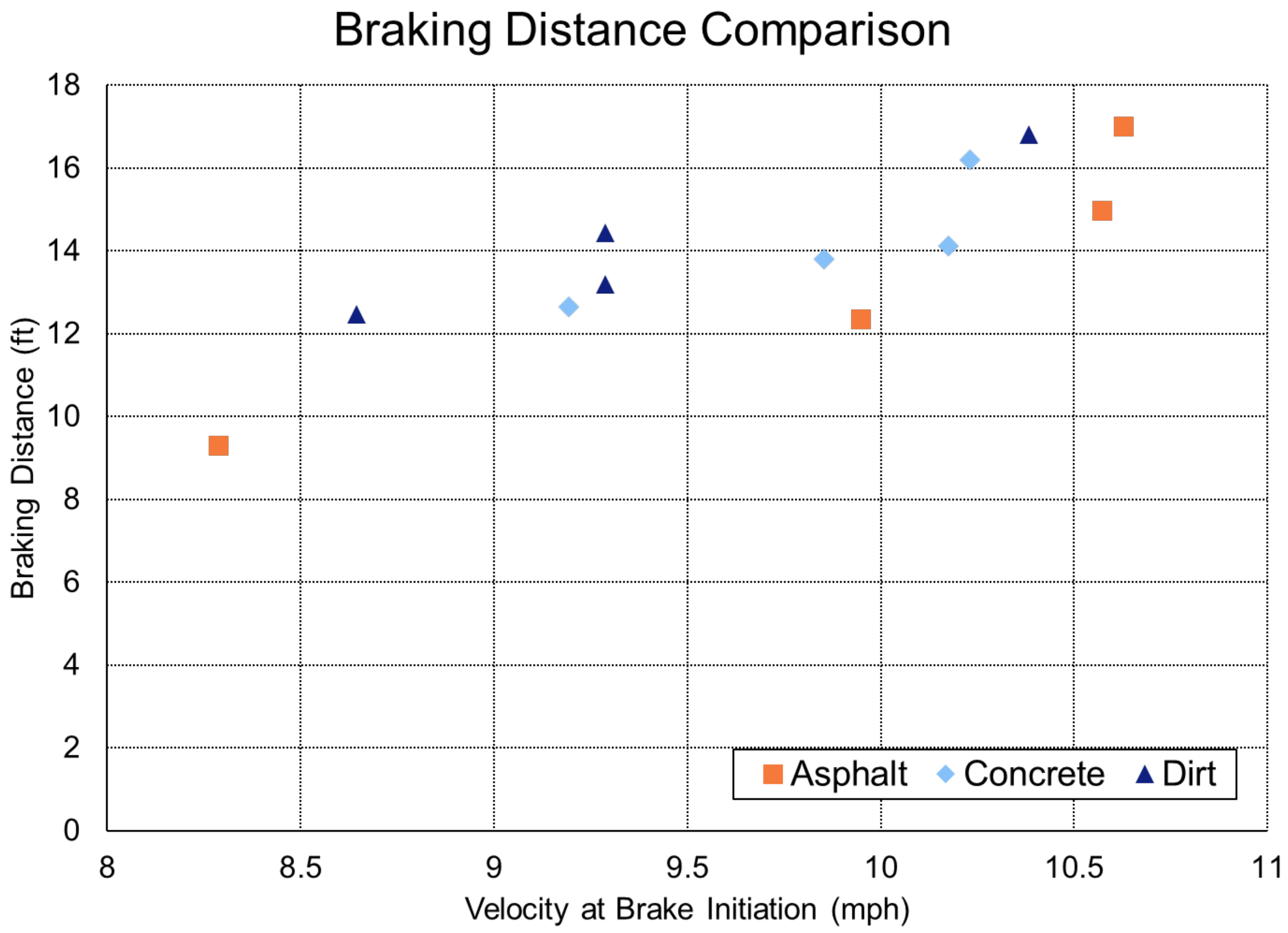


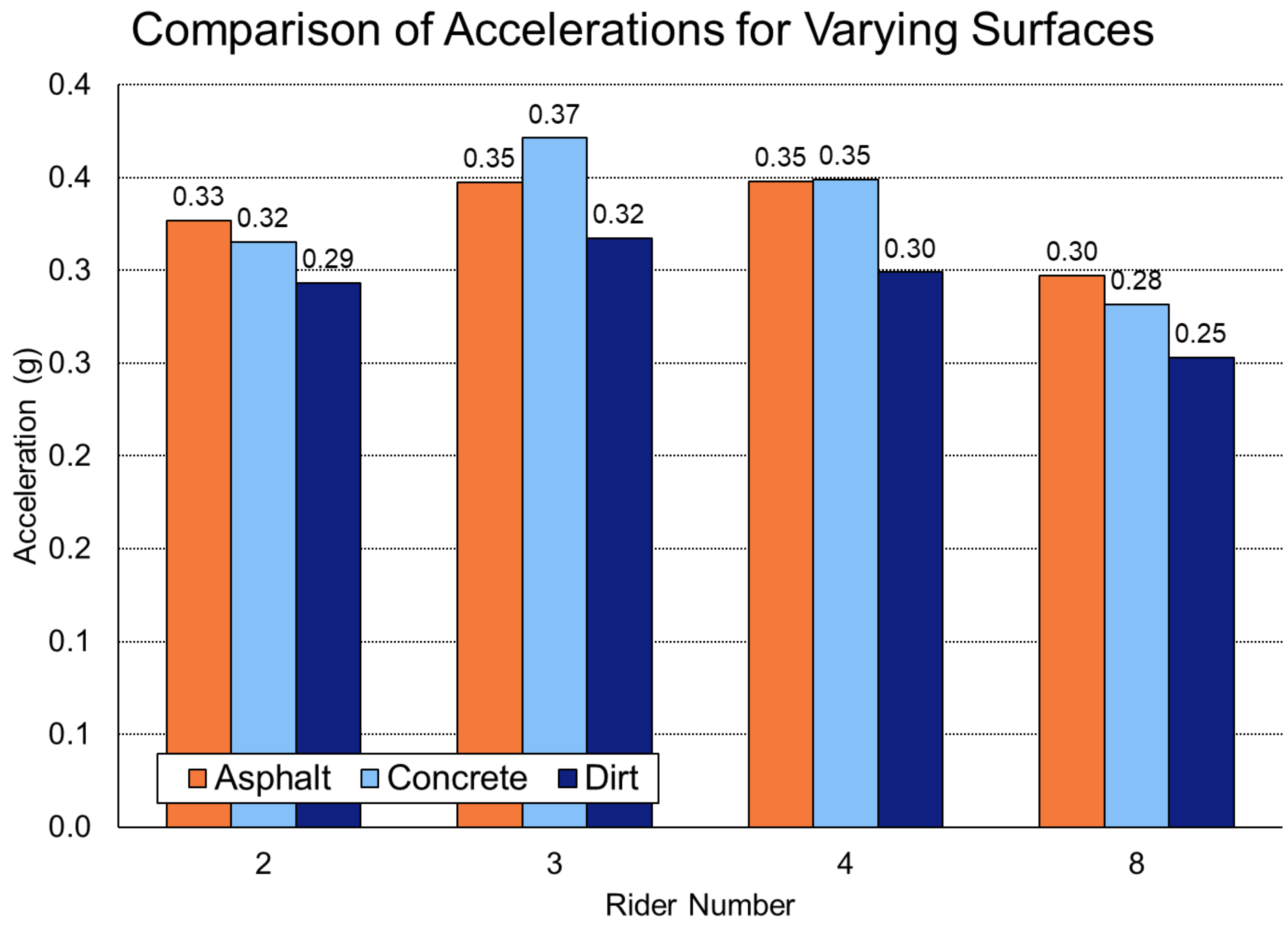




Rider 5 Sudden Brake
Brake Signal (%)
Speed (mph)
Acceleration (m/s^2)
Stem Load (lbf)
Time (s)
Brake
Speed
Acceleration
Stem Load
Brake Initiation
100
80
60
40
20
0
-20
0
20
40
60
80
100
120

Brake Testing





Additional Exponent Work

Test Courses: Terrain Testing

Cobblestone

Rough Road

Potholes

Parking Brake Hill

Data Collection Tools

Dewesoft – Acquisition at 1,000 hz with the capability to stream data during collection

Pressure Foot Board – Strain gauge configuration to measure load on front and back of deck plate

Plex – Acquisition at 100 hz recording vehicle dynamics such as position, velocity, acceleration, yaw, pitch, roll, etc.

Data Collection

Motor Amps

Velocity

Stem Load

Terrain Cam

Trigger Status

Foot Load

Shock Displacement

Pitch

Roll

Accelerations

Steer Angle

Throttle/Brake Position

Stability Across Different Designs and Riders

Conclusions

- E-Scooter research and testing is essential to help further our understanding of performance and safety
- With variability in performance across riders and scooter designs, it is important to develop test methodologies and metrics that help inform best practices and encompass a broad variety of riders
- Quantifying and understanding key metrics can help define safety standards
  - Brake distance
  - Accel/Deceleration rate
  - Stem load
  - Rider stability

Thank you!

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PEOPLEFORBIKES

CONSUMER PRODUCT SAFETY COMMISSION
MICROMOBILITY PRODUCTS FORUM

SEPTEMBER 15, 2020

people for bikes

COALITION

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- PeopleForBikes Coalition
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ABOUT PEOPLEFORBIKES

peopleforbikes

- Sole industry trade association for American manufacturers and suppliers of bicycles and bicycle products.

- Nearly 200 members representing companies of all sizes, and a cross section of the industry.

- Member businesses that serve every facet of the domestic bicycle market:
    - Complete bicycles
    - Complete e-bicycles
    - Parts
    - Components (including electric bicycle systems)
    - Accessories

AGENDA

» Demographics
» Sales data
» Research
» 16 C.F.R. § 1512
» UL 2849

DEMOGRAPHICS

peopleforbikes

- Broad demographics:
  - Couples and households, generally educated and median income.
  - Urban dwellers, aging bicyclists, people with disabilities.
- E-bikes:
  - Provide alternative transportation options.
  - Allow individuals to travel longer distances with less effort.
  - Are inclusive to a wide range of abilities for recreation, health and fitness and errands.
  - Address barriers such as hills, carrying cargo and kids and car ownership.

SALES DATA

- 2019 e-bike market: $15.42 billion.
- Annual total sale of e-bike units:
  - 2016: 17,179
  - 2017: 50,499
  - 2018: 70,143
  - 2019: 124,308
  - 2020 YTD (Jan - June): 115,313

Source: The NPD Group. Numbers understate actual US sales.

STUDIES - SPEEDS

peopleforbikes

- Class 1 and Class 2 e-bikes have a motor that cuts off after the rider reaches 20 mph (not average speed).
- On flat and uphill surfaces, e-bikes travel slightly faster than regular bikes.
- Studies show that e-bikes do not travel significantly faster than regular bicycles and in some instances, are slower, depending on the location and the rider.
- Speeds of Young E-Cyclists on Urban Streets and Related Risk Factors: An Observational Study in Israel
  - Riding speeds of e-cyclists compared to regular cyclists was 3 – 5 mph faster

STUDIES - SPEEDS

peopleforbikes

A review of Empirical European and North American Studies on e-bike safety:

- In Europe, differences between e-bike and conventional bicycle injury risk are diminished, considering both crash rate and crash severity.
- Class 3 e-bikes have the same crash risk as Class 1 e-bikes, but injury severity is slightly higher when they do crash.
- Class 1 e-bikes are marginally faster than conventional bicycles (1.9 mph).
- Speed results in slightly higher conflict rates and safety-oriented maneuvers.
- Class 3 e-bikes travel substantially faster than conventional bicycles.

STUDIES - PERCEPTIONS

peopleforbikes

- Boulder Pilot Project, Colo. (2014):
  - Year-long pilot project to authorize use on city bikeways.
  - Surveyed speed, volume, and gender of e-bike riders, and interactions between multiuse path users, for bikes and e-bikes.
  - Minimal conflicts between trail users, no observed crashes, safe passing, slow recorded speeds.
- Jefferson County, Colo. (2017):
  - Intercept and test ride surveys in parks to understand perceptions and concerns.
  - 67% of park visitors changed their perception of e-bikes after a test ride (toward acceptance).
  - 71% of park visitors did not detect the presence of a class 1 e-bike on the path with them.

STUDIES - USES

peopleforbikes

- 2018 National E-Bike Owner Survey to 1,796 U.S. respondents who own/operate an e-bike

- Barriers are perceived differently by various demographics:
  - Older adults and those with a physical limitation are more highly motivated by effort reduction (recreation).
  - Younger adults and those without a physical limitation are more highly motivated by replacing car trips and making their commute easier, quicker or cheaper (utility).
  - Females are more concerned with topography, carrying cargo/children and keeping up with friends/ family.

- Safety findings
  - Feel safer riding an e-bike than a standard bicycle and value an enhanced sense of safety.
  - Take longer routes to avoid dangerous streets, accelerate more quickly, keep up with traffic.
  - Perceived safety plays a role in whether someone rides, so enhancing one's sense of safety could tap latent demand for bicycling.

16 C.F.R. § 1512

peopleforbikes

- 16 C.F.R. § 1512 sets for requirements for bicycles and electric bicycles.
  - Mechanical
  - Braking
  - Steering system
  - Pedals
  - Drive chain
  - Protective guards
  - Tires
  - Wheels and wheel hubs
  - Fork and frame assembly
  - Seat
  - Reflectors
- E-bike braking systems are independent from the electrical system.

UL 2849

peopleforbikes

- 16 C.F.R. § 1512 does not specify requirements around the electrical system of an e-bike.
- The e-bike industry, prioritizing the safety of its products, developed UL 2849 (published in January 2020) in partnership with UL, and is working to become compliant with the standard.
  - Electrical and fire safety certification
  - Examines the electrical drive train system, battery system and charger system combinations

BIKES + E-BIKES

peopleforbikes

- Bicycles have been widely accepted consumer products for more than 100 years, with a proven safety record.
- E-bicycles are regulated consumer products and subject to existing mandatory federal safety standards.
- E-bicycles are an extension of bicycles, and have a growing, positive track record regarding safety and operation.
- New regulation of e-scooters, hoverboards and other mobility devices should take place separate from the existing regulatory structure for bicycles and e-bicycles.


Q+A
Thank you
peopleforbikes

superpedestrian

INTELLIGENT SHARED MOBILITY

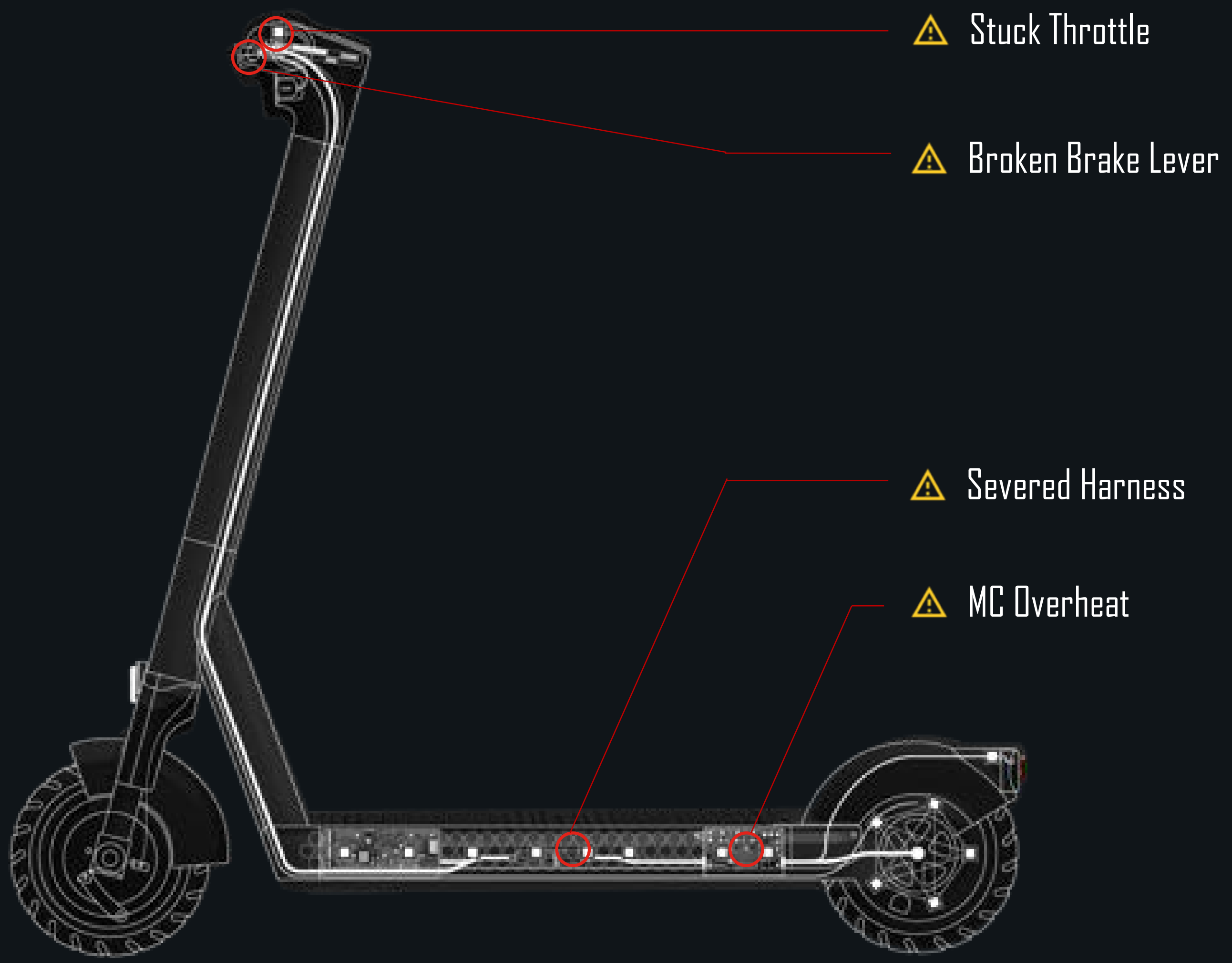
Sept 2020, CPSC


LINK
BIRD
lime

Preventing the Most Common Failures

100+ causes

- BMS overvoltage
- Motor drive overspeed
- Battery cell temps
- Data packet loss
- Sensor calibration
- Disconnected harnesses
- Irregular throttle commands
- Significant Impact
- Component validation
- Powertrain heartbeat



superpedestrian

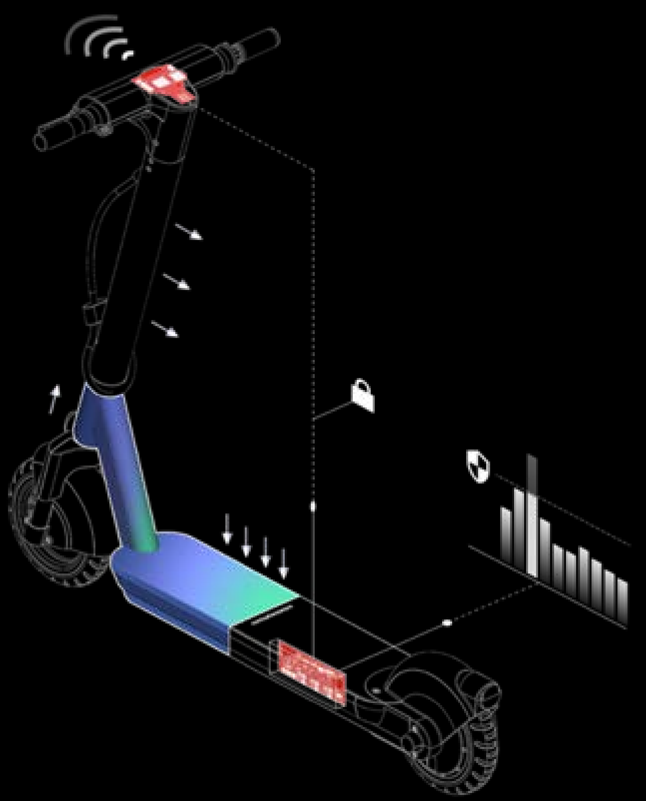
Advantages of Vehicle Intelligence

Autonomous maintenance – replaces daily maintenance	Lower Opex	Longer Lifetime
1. Attenuates power to prevent overheating of the motor and BMS Avoids costly repair & possibly vehicle death	✓	✓
2. Discharges energy to avoid frying boards Avoids electronic failures & vehicle death	✓	✓
3. Prevents unsafe command keep the vehicle and riders safe Avoids potential repair & an unsafe ride experience	✓	

Self protection – reduces repairs and replacements	Lower Opex	Longer Lifetime
1. Self-check confirms the vehicle is safe before each ride Replaces daily check-ups & prevents unsafe rides.	✓	✓
2. Vehicles self-generate service tickets in real-time Reduces vehicle down time & repair diagnosis process	✓	✓
3. Prevents unsafe command keep the vehicle and riders safe Avoids potential repair & an unsafe ride experience	✓	

superpedestrian

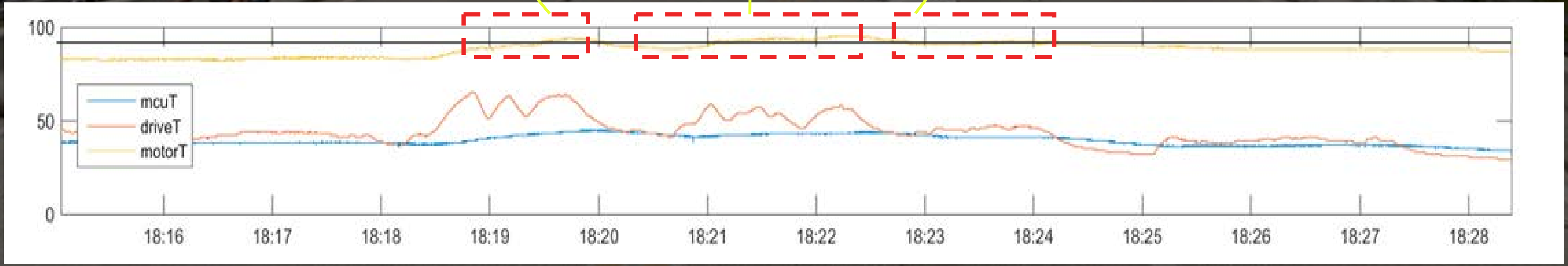
Vehicle Intelligence



A system of 5 CPUs, integrated into each vehicle, that identifies and protects against vehicle malfunctions in under 5 nanoseconds.

Vehicle Intelligence protects powertrain from overheating

Power attenuation lowers motor controller temperature, avoiding failure

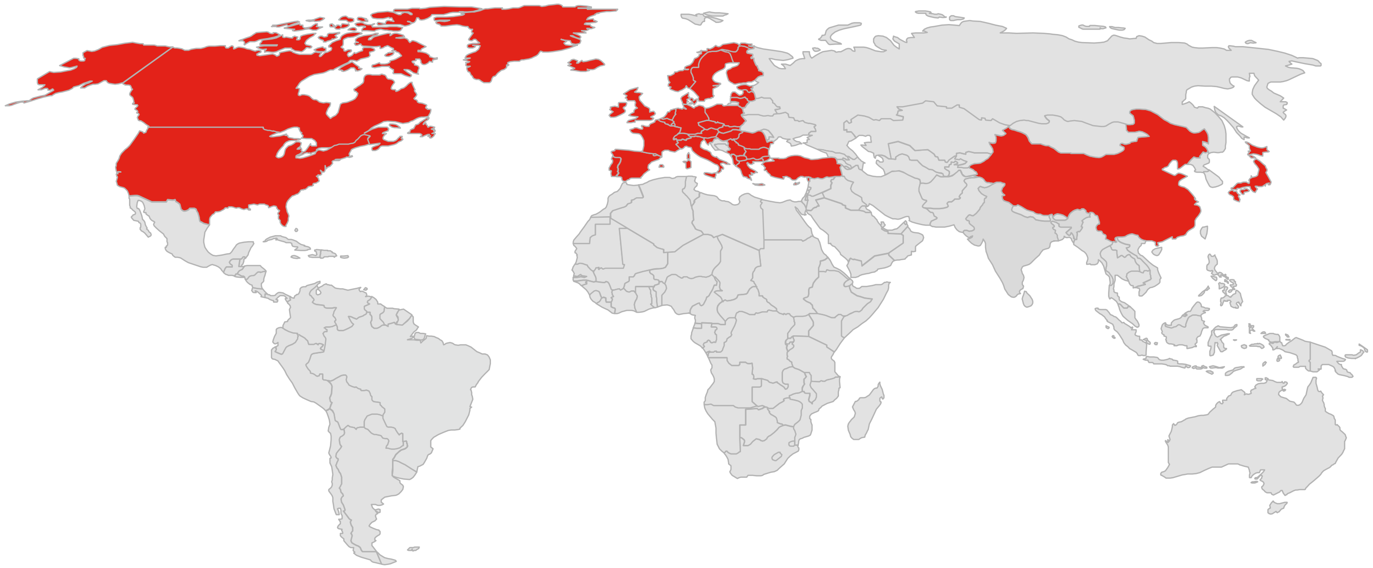


90°C Hazard Warning

Core Motor Component Temperatures (Motor, Motor Drive, Motor Controller)

Vehicle intelligence keeps core components in optimal thermal range, **preventing costly failures** and **fires.**

Backed by an Industry-leading Micromobility Patent Portfolio



Published Patents

- Vehicle Intelligence technology backed by a portfolio of 29 active patents (22 granted, 7 in prosecution).
- Geographies covered include United States, Canada, China, Japan, & EU
- Key patents from 2014 & 2015 include core micromobility technologies such as self-diagnostics, self-protection, fleet data collection, management, security, and more

superpedestrian

Patented intelligent micro-vehicle technologies in 2014

(12) **United States Patent**
Biderman et al.

(10) **Patent No.: US 9,815,363 B2**
(45) **Date of Patent: Nov. 14, 2017**

(22) Filed: **Apr. 6, 2015**

(65) **Prior Publication Data**
US 2016/0009335 A1 Jan. 14, 2016

1. A method of controlling a motorized human-powered vehicle, the method comprising:
detecting a temperature of a drive motor operable to propel the motorized human-powered vehicle, a battery system, or an electronic board within the motorized human-powered vehicle; and
controlling, using a control unit of the motorized human-powered vehicle, a power output from the battery system to the drive motor to maintain the detected temperature below a respective predetermined maximum operational temperature limit for the drive motor, the battery system, or the electronic board within the motorized human-powered vehicle.

(12) **United States Patent**
Biderman et al.

(10) **Patent No.: US 10,259,311 B2**
(45) **Date of Patent: Apr. 16, 2019**

(22) Filed: **Apr. 3, 2015**

(65) **Prior Publication Data**
US 2016/0014252 A1 Jan. 14, 2016

63. A method for diagnosis of a motorized human-propelled vehicle, the method comprising:
receiving operational data from a system mounted to the motorized human-propelled vehicle, wherein the operational data relates to a component onboard the motorized human-propelled vehicle;
detecting, using a control unit mounted to the motorized human-propelled vehicle, that a hazard indicator is present in the operational data; and
using the control unit mounted to the motorized human-propelled vehicle to restrict performance or cease operation of the motorized human-propelled vehicle in response to detecting the hazard indicator.

U.S.Department of Transportation
Federal Highway Administration

Micromobility Research at U.S. Department of Transportation

U.S. Consumer Product Safety Commission
Micromobility Forum Webinar
September 15, 2020

Shari Schaftlein
Federal Highway Administration
Office of Human Environment
Shari.Schaftlein@dot.gov

What is Micromobility?

Micromobility refers to any small, low-speed, human or electric-powered transportation device, including:

- bicycles
- scooters
- electric-assist bicycles (e-bikes)
- electric scooters (e-scooters)
- other small, lightweight, wheeled conveyances

The Rapid Evolution of Micromobility

2008

Docked bikeshare introduced in the United States

2013

Dockless bikeshare pilots begin in cities nationwide

2017

Shared e-scooter fleets deploy rapidly across the country

2018

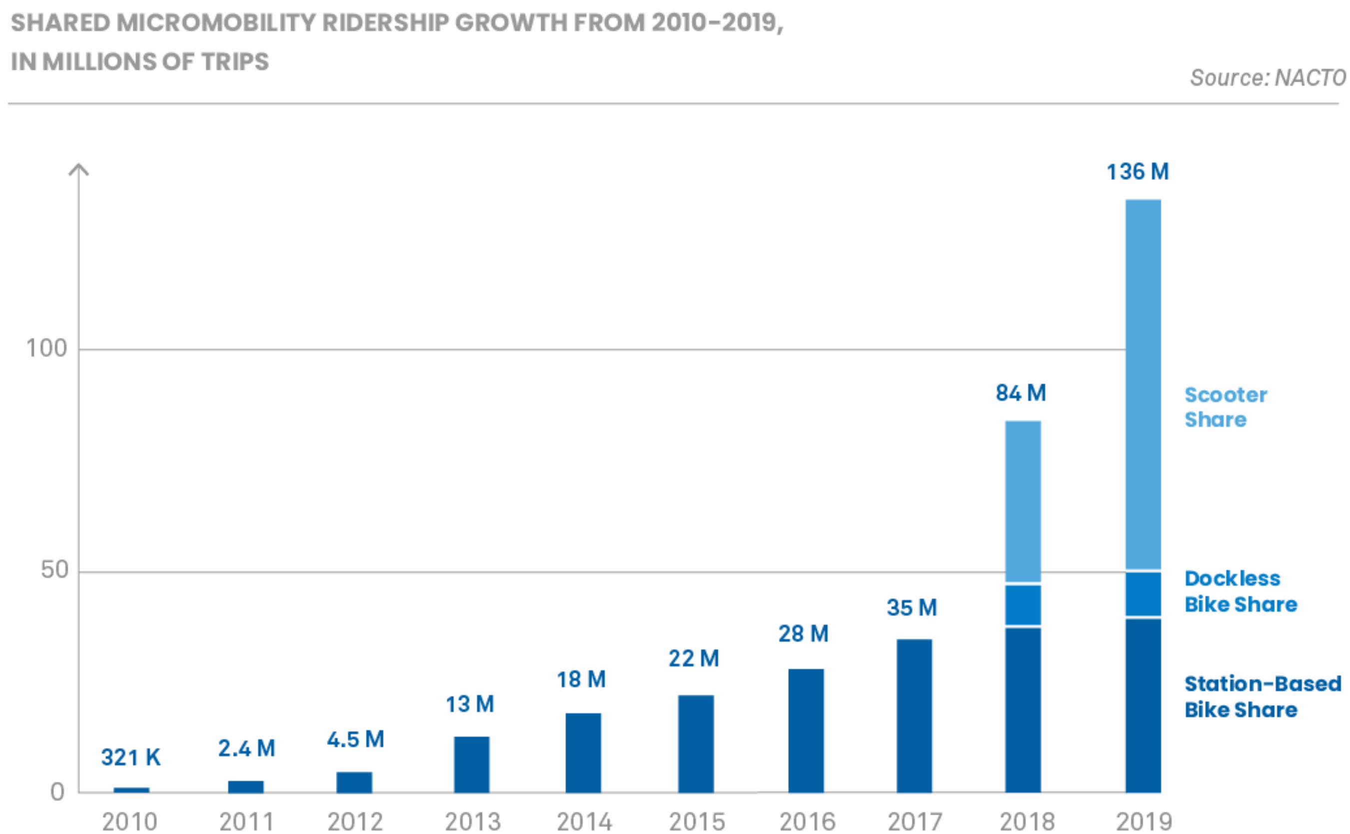
84 million shared micromobility trips are taken nationally

2020+

New micromobility device formats and types emerge

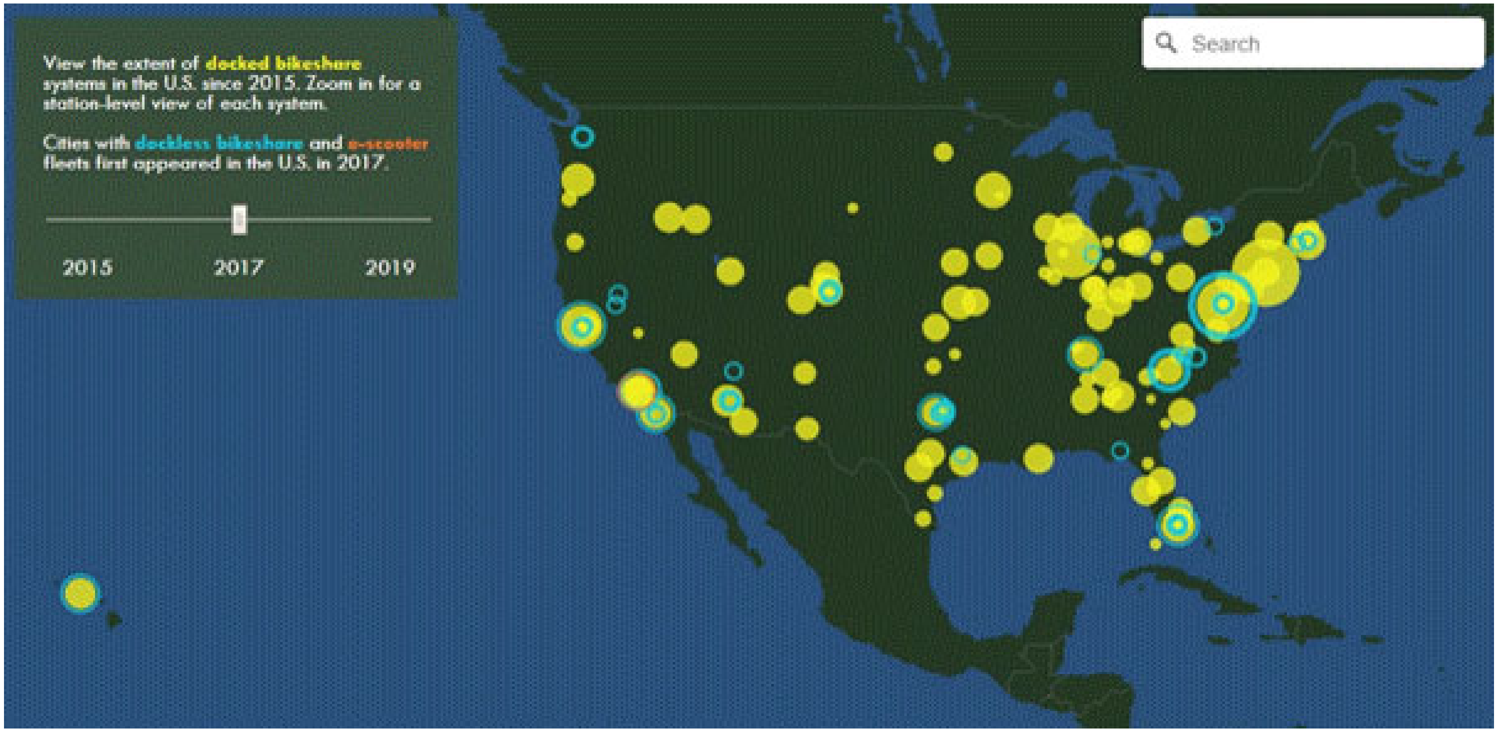
Images sourced from www.123rf.com and www.unsplash.com

136 million trips taken in 2019



Source: National Association of City Transportation Officials (NACTO), *Shared Micromobility in the U.S.: 2019*

Bureau of Transportation Statistics Interactive Bikeshare and e-Scooter Map



Weblink for a demo of the above map: https://www.bts.gov/topics/passenger-travel/bikeshare-and-e-scooters
Weblink for the new map of docked bikeshare ridership: https://maps.dot.gov/BTS/dockedbikeshare-COVID

Micromobility Activities on Federal Lands

- FHWA Interagency Agreement with Forest Service includes: *Assess and Evaluate Emerging Trail Uses*
- Research underway: *The Future of E-Bikes on Public Lands: How to Effectively Manage a Growing Trend*
- National Park Service Emerging Mobility Working Group

Source: https://www.fhwa.dot.gov/environment/recreational_trails/overview/report/2019/

USDOT Micromobility Activities

USDOT Internal Working Groups

- **Mobility Innovation**
  - Maintains a list of current and past mobility research
- **Micromobility**
  - Maintains a list of ongoing micromobility research
- **Mobility on Demand**
  - Tracks research, events, and publications that promote MOD

External Coordination Activities

- APTA Integrated Mobility and Communities Consortium
- TRB Mobility Management Committee
- NSF Smart and Connected Communities
- North American Bikeshare Association

FHWA Research Products

Internal

- Micromobility Memos (Phases 1 & 2)
- Micromobility and Children Research

External

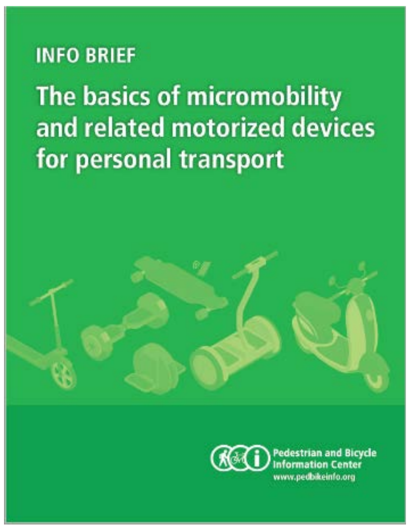
- The Basics of Micromobility and Related Motorized Devices for Personal Transport
- E-Scooter Management in Midsized Cities in the United States
- Case Study – Improving Access and Safety for Shared Micromobility Users in Santa Monica, CA
- Micromobility Fact Sheet and USDOT / FHWA Micromobility Activities Handouts – coming soon!

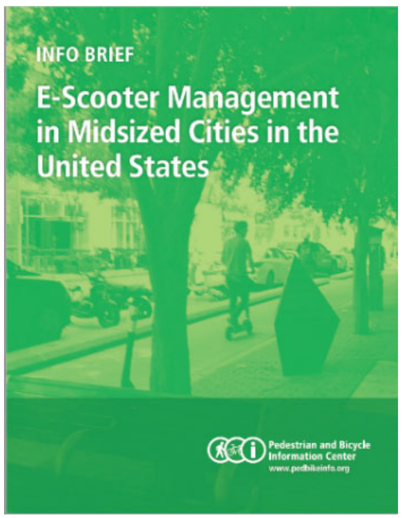
Bureau of Transportation Statistics

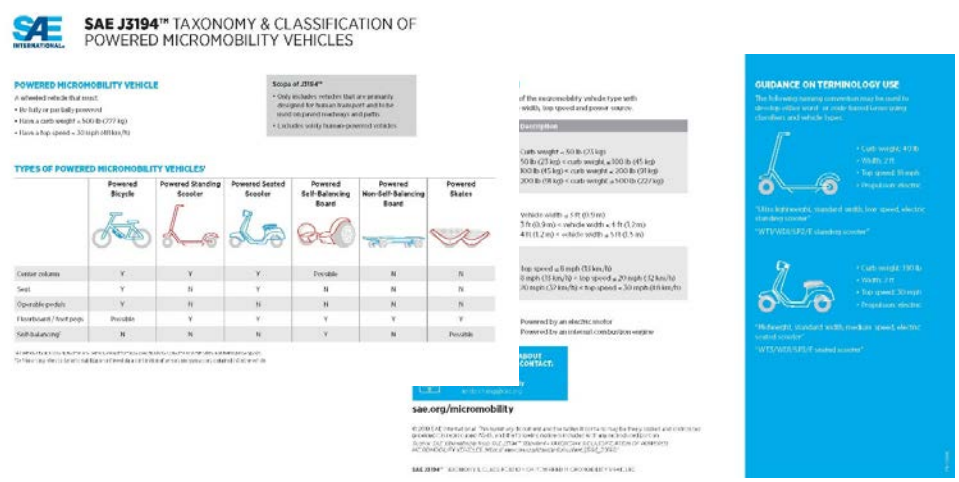
- Interactive Bikeshare and e-Scooter Map
- Interactive Docked Bikeshare Ridership Map

FHWA Communications

- Managed Pedestrian and Bicycle Information Center development of two info briefs: *The Basics of Micromobility* and *E-Scooter Management in Midsize Cities*
- Coordinated with SAE International on development of J3194 Standard: *Taxonomy & Classification of Powered Micromobility Vehicles*







Micromobility and Mobility Innovation Research Under Development

FHWA

- Planning Multimodal Networks in a Connected and Automated Vehicle Future
- Integrating Emerging Mobility into Transportation Management
- Curbside Management Tool & Resources
- Research and case studies on ebikes impacts.

Intelligent Transportation Systems, Joint Program Office (ITS/JPO)

- Mobility on Demand (MOD) Special Studies – Opportunities and Challenges of Shared Micromobility Infrastructure

Transportation Research Board (TRB)

- TCRP B-47: "Impact of Transformational Technologies on Underserved Populations"
- TCRP J-11/Task 37: "Transit and Micro-Mobility (Bikeshare, Scooter-share, etc.)"
- NCHRP 20-05: "Shared Micromobility Policies, Permits, and Practices"


U.S. Department of Transportation
Federal Highway Administration

Environmental Justice Considerations for Connected an

Connected vehicles (CVs) and automated vehicles (AVs) are two rapidly potential to transform our communities and transportation system on a larger scale than anything we have seen since the construction of the U.S. Interstate Highway system. These technologies have justifiably led to high expectations for increased safety and mobility. CVs and AVs also hold strong promise to address the transportation needs of environmental justice (EJ) populations, but barriers to access may affect the full realization of the technologies' benefits.

The Federal Highway Administration (FHWA) defines EJ populations as low-income populations or minority populations who will be affected similarly by a proposed program, policy, or other activity funded by FHWA. As policy discussions, planning, and implementation for CVs and vehicle automation proceed, decision-makers should consider equity concerns and pursue policies to ensure that EJ populations do not experience disproportionately high and adverse human health or environmental effects. Adverse effects may include the denial of, reduction in, or significant delay in the receipt of benefits of FHWA programs, policies, or activities (FHWA Order 6640.23A).

Figure 1: Connected vehicles enable cars to "talk" to one another and this can help to mitigate crashes. (Source: ITS-JPO)

What are Connected and Automated Vehicles?

CVs and AVs refer to two distinct technologies that could potentially work cooperatively. Limited deployment of these technologies has begun and is expected to become widespread over the next 10 to 20 years.

Connected Vehicles

CV technology will enable cars, trucks, buses, and other vehicles to "talk" to each other, to infrastructure (traffic signals), and with other road users (pedestrians with compatible smartphones, for example) using built-in or add-on devices that continuously share important safety and mobility information. CV technology enables communications among vehicles, infrastructure, and personal communications devices operated by passengers, pedestrians, bicyclists, or other road users.

Figure 2: Graphic illustrates continuous communication between a blind pedestrian's smart phone, traffic signal and automobile. (Source: ITS-JPO)

Micromobility Research at USDOT

Lead Agency	Project Name	Project Start Date	Project Completion Date (Expected)	Project Summary
Federal Highway Administration (FHWA)	Integrating Emerging Mobility into Transportation Management	12/20/2018	9/20/2020	FHWA is offering technical support to State and regional agencies integrating shared mobility and mobility-on-demand (MOD) concepts into transportation planning, programming, systems operations, and management.
FHWA	Curbside Management	7/16/2019	1/17/2021	FHWA, in coordination with the Institute of Transportation Engineers, is conducting research on curbside management that explores how communities can better assess, prioritize, and optimize curb space considerations for accessibility, delivery access, and micromobility.
FHWA	Phase II Micromobility Research and Coordination	2/1/2020	11/1/2020	FHWA, with support from the U.S. DOT Volpe Center, has compiled current available information to establish FHWA's definition of micromobility, and consider Federal, State, and local roles in this emerging area. After evaluating information on safety, infrastructure, and equity, FHWA is now developing a prioritized research agenda for micromobility, in coordination with contacts across U.S. DOT. FHWA is also conducting original research about e-bikes, including use of e-bikes on Federal, State, and local public lands.
Intelligent Transportation Systems Joint Program Office (ITS JPO)	Mobility on Demand (MOD) Special Studies – Opportunities and Challenges of Shared Micromobility Infrastructure	5/1/2019	12/31/2020	ITS JPO is studying shared micromobility as a mobility-on-demand tool, specifically exploring safety risks and infrastructure challenges. The study will identify how infrastructure can adapt to better cater to shared micromobility and will summarize strategies that can be employed to reduce risk and increase the potential for these modes with an eye towards infrastructure.
ITS JPO	Impact of New Transportation Providers on the Transportation System	5/1/2019	1/31/2020	ITS JPO, with support from the U.S. DOT Volpe Center, is developing a report that analyzes the impacts of ridehailing services and micromobility on transit ridership. An additional report identifies potential roadblocks impeding the deployment of such new transportation providers at the federal, state, and local level.
ITS JPO	Multimodal and Accessible Travel Standards Assessment	9/18/2018	12/1/2020	ITS JPO is conducting an assessment of standardization needs to support multimodal and accessible travel options, assessing impacts on ITS and related standards that currently exist or are under development, and developing a roadmap for multimodal and accessible travel standardization work. The objective of this work is to develop a framework to inform the selection and prioritization of standardization work, funded by the JPO and others, needed to support the development, testing, and deployment of multimodal and accessible travel technologies, systems, and services.
Federal Transit Adminitration (FTA)	TCRP B-47 "Impact of Transformational Technologies on Underserved Populations"	5/13/2019	10/31/2021	FTA and FHWA representatives are on a TCRP Project Panel with research led by the Texas Transportation Institute to examine how transformational transportation technologies, ranging from micromobility to mobility apps to new vehicle technologies, affect inclusion and accessibility. This project examines possible effects of new technologies on both traditionally and newly underserved populations.

FTA	TCRP J-11/Task 37 "Transit and Micro-Mobility (Bikeshare, Scooter-share, etc.)"	10/1/2019	10/31/2020	FTA representatives are on a Transit Cooperative Research Program (TCRP) Project Panel with research led by the Shared Use Mobility Center to examine the impacts of micromobility on transit usage, the forms of partnerships, as well as the interplays these options have on the built environment and communities. The report will propose a framework for building relationships between transit agencies and micromobility options through partnership.
FHWA	NCHRP20-05"Shared Micromobility Policies, Permits, and Practices" (Synthesis of Information Related to Highway Practices)	5/1/2020	Fall 2021	FHWA representatives are on a National Cooperative Highway Research Program (NCHRP) project panel synthesis. The objective is to document state department of transportation (DOT) policies, permits, and practices with regard to shared micromobility services. Information to be gathered will include (but is not limited to): • DOT definitions of shared micromobility services • Challenges regarding shared micromobility services facing DOTs • DOT policies and regulations • The role of DOTs with regard to shared micromobility services, including coordination with metropolitan planning organizations (MPOs) and municipalities • Documentation of multi-department support required for the planning, operation, and maintenance of these systems • Data collection efforts conducted by and/or shared with DOTs

***updated 9/15/20**

FHWA Program Links and Resources

§ Transportation Planning Capacity Building (TPCB) Shared Mobility
https://www.planning.dot.gov/planning/topic_sharedmobility.aspx

§ Bicycle & Pedestrian Program
https://www.fhwa.dot.gov/environment/bicycle_pedestrian/

§ Environmental Justice, Title VI, Non-Discrimination, and Equity
https://www.fhwa.dot.gov/environment/environmental_justice/equity/

§ Office of Transportation Policy Studies
https://www.fhwa.dot.gov/policy/otps/

§ Intelligent Transportation Systems Joint Program Office (ITS JPO) Mobility-on-Demand (MOD) Program
https://www.its.dot.gov/research_areas/MOD/index.htm

§ National Cooperative Highway Research Program
http://www.trb.org/NCHRP/NCHRP.aspx

§ Transit Cooperative Research Program
http://www.trb.org/TCRP/TCRP.aspx

Safety of Shared Micromobility Systems

Edward Fu
Laurence Wilse-Samson

Presenters

Edward Fu
Senior Regulatory Counsel

Laurence Wilse-Samson
Senior Manager, Policy Research

Safety considerations unique to shared systems

Much safety discussion regarding modern shared micromobility systems focuses on the e-scooter, a new mode to many riders and other road users.

But shared systems also introduce new variables that impact and sometimes confound safety considerations.

Policy

Significant variance between jurisdictions

Governance

User-directed but electronically governed

Interface

Users have a software interface between them and the device

Adoption

Widespread and rapid adoption by users and cities

Policy

Significant variance in policy between jurisdictions.

Speed limits

Where to ride

Availability

Takeaway

Potential area for comparative analysis and research as policy evolves

Governance

Policy on shared micromobility vehicles can be electronically enforced.

Speed limits → speed governor

Where to ride → geofences

Availability → disabling unlocks

Takeaway

Electronic enforcement ensures compliance, but requires a different approach to setting policy

Interface

Users must interact with a software interface in order to use a shared micromobility device.

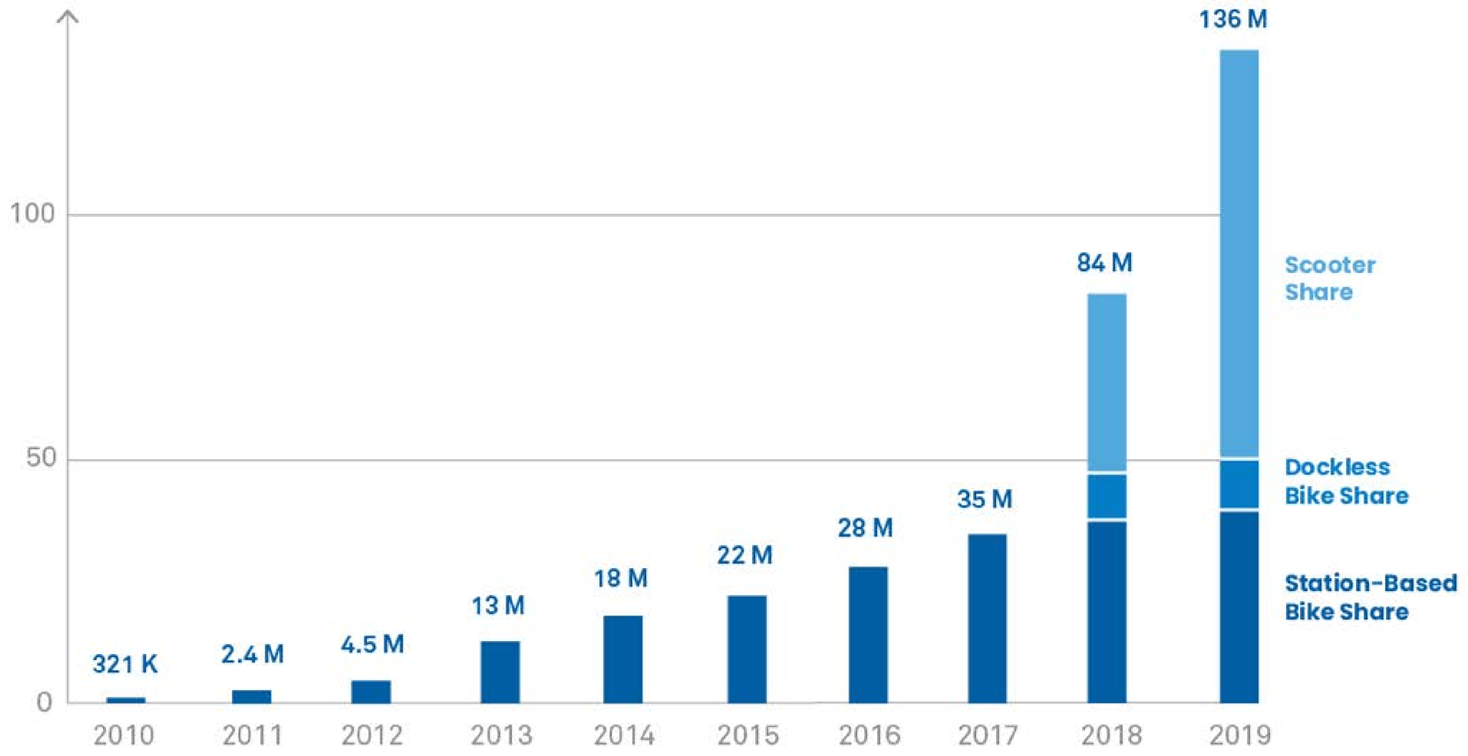
- Rider education / safety quiz
- Helmet Selfie
- Warm-Up Mode
- Messaging after rides

Takeaway

The software interface between the user and the device provides an opportunity to improve safety

SHARED MICROMOBILITY RIDERSHIP GROWTH FROM 2010–2019, IN MILLIONS OF TRIPS

Source: NACTO



Adoption

Broad adoption presents risks:

- Less experienced riders
- Many riders
- Less familiar for other road users
- Lack of bike infrastructure

But also presents opportunity:

- Safety in numbers
- More car trips eliminated
- More situational awareness
- Political will for infrastructure

Takeaways

"Safe systems": Eliminating car trips and adding infrastructure ultimately do more for safe streets than anything else

CFA Consumer Federation of America

CPSC Micromobility Products Forum

September 15, 2020

Rachel Weintraub, Legislative Director and General Counsel

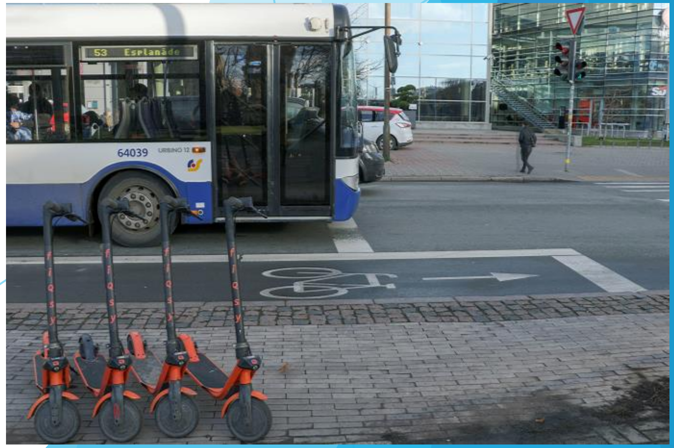
Introduction

- The growth of micromobility products in the Unites States has been profound.
- Along with increased numbers of these products across the country are increased reports of injuries.
- We appreciate that the CPSC is holding this forum and we appreciate the report that the CPSC staff issued this past April, "Safety Concerns Associated with Micromobility Products." (Lee, Douglas, "Safety Concerns Associated with Micromobility Products," U.S. Consumer Product Safety Commission, April 8, 2020, available on the web at https://cpsc.gov/s3fs-public/Report-on-Micromobility-Products_FINAL-to-Commission.pdf?THHIorYXAZ.KiZnobh1o7.7.IN9nNCLo.)
- I will discuss specific micromobility products, known incidents, and recommendations for the CPSC.

Electric Scooters

- According to a January 2020 Journal of the American Medical Association Article, “more than 39,000 electric scooter injuries were treated in emergency rooms across the United States between 2014 and 2018, an increase of 222% over the period. . .
- Nearly a third of patients suffered head trauma . . .
- The most common injuries being fractures (27%), contusions and abrasions, (23%) and lacerations (14%).”

(Namiri NK, Lui H, Tangney T, Allen IE, Cohen AJ, Breyer BN. Electric Scooter Injuries and Hospital Admissions in the United States, 2014-2018. *JAMA Surg.* Published online January 08, 2020. doi:10.1001/jamasurg.2019.5423; Mihalcik, C. (2020, January 9). Electric scooter injuries are sending more and more people to the hospital. Retrieved from https://www.cnet.com/news/electric-scooter-injuries-are-sending-more-and-more-people-to-the-hospital/)



Electric Scooters

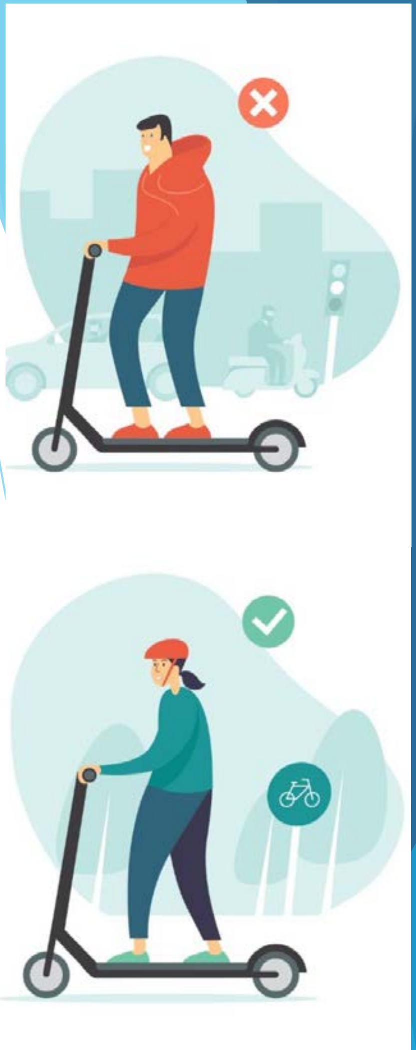
- The CPSC, however, has not released data on electric scooters nor publicly announced efforts to take action to monitor, investigate, track or reduce incidents.
- The CDC and the Austin Public Health Department conducted an epidemiological investigation of these incidents that was published in April of 2019 and found that,
  - "of the 190 injured riders identified:
    - nearly half (48%) had injuries (e.g., fractures, lacerations, abrasions) to the head.
    - 70% sustained injuries to the upper limbs (hands/wrist/arm/shoulder),
    - 55% to the lower limbs (leg/knee/ankle/feet), and
    - 18% to the chest/abdomen; multiple injuries across body regions were possible.

(Austin Public Health, & Centers for Disease Control and Prevention. (2019, April). DOCKLESS Electric SCOOTER-RELATED INJURIES STUDY. Retrieved from https://austintexas.gov/sites/default/files/files/Health/Web_Dockless_Electric_Scooter-Related_Injury_Study_final_version_EDSU_5.14.19.pdf)

Electric Scooters

Many individuals sustained injuries on their:

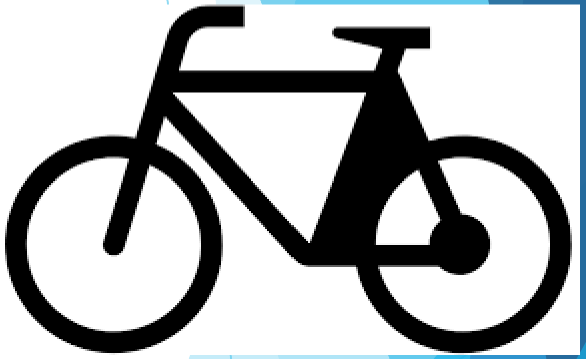
- arms (43%),
- knees (42%),
- face (40%),
- and hands (37%).”
- “Almost half (80) of the injured riders had a severe injury.”
- The study determined “that there were 20 individuals injured per 100,000 e-scooter trips taken during the study period.”
- The **study further determined that, “[t]hese injuries may have** been preventable.
- Only **one of 190 injured scooter riders was wearing a helmet.”**



(Namiri NK, Lui H, Tangney T, Allen IE, Cohen AJ, Breyer BN. Electric Scooter Injuries and Hospital Admissions in the United States, 2014-2018. *JAMA Surg.* Published online January 08, 2020. doi:10.1001/jamasurg.2019.5423; Mihalcik, C. (2020, January 9). Electric scooter injuries are sending more and more people to the hospital. Retrieved from https://www.cnet.com/news/electric-scooter-injuries-are-sending-more-and-more-people-to-the-hospital/)

Electric Bicycles

- Electric bicycles are similarly experiencing increased use and have been associated with increased incidents of injury and death.
- Cities such as Chicago are just starting programs making these products available indicating that other cities are likely exploring similar programs that will increase the numbers of these vehicles across the country.



(https://abc7chicago.com/travel/divvy-rolls-out-new-pedal-assist-ebikes-across-chicago/6340058/)

Electric Bicycles

- According to a recent article published in the Journal of Injury Prevention that analyzed CPSC NEISS data of E-bikes, powered scooters and pedal bicycles from 2000 to 2017:
- While persons injured using E-bikes were more likely to suffer internal injuries and require hospital admission, powered scooter injuries were nearly three times more likely to result in a diagnosis of concussion (3% of scooter injuries vs 0.5% of E-bike injuries).
- E-bike-related injuries were more than three times more likely to involve a collision with a pedestrian than either pedal bicycles or powered scooters, but there was no evidence that powered scooters were more likely than bicycles to be involved in a collision with a pedestrian.
- Seventeen percent of e-bike accident victims suffered internal injuries compared to about 7.5% for both powered scooters and pedal bikes.

(DiMaggio CJ, Bukur M, Wall SP, *et al*, "Injuries associated with electric-powered bikes and scooters: analysis of US consumer product data," *Injury Prevention* Published Online First: 11 November 2019. doi: 10.1136/injuryprev- 2019-043418 and Chander, Vishwadha, "E-bikes show distinct pattern of severe injuries," Reuters Health, 2019 DECEMBER 25, 2019, available online at: https://www.reuters.com/article/us-health-ebike-injuries/e-bikes-show-distinct-pattern-of-severe-injuries-idUSKBN1YT0MV)

Electric Bicycles

- While population-based rates of pedal bicycle-related injuries have been decreasing, particularly among children, reported E-bike injuries have been increasing dramatically particularly among older persons.
- Conclusions E-bike and powered scooter use and injury patterns differ from more traditional pedal operated bicycles. Efforts to address injury prevention and control are warranted, and further studies examining demographics and hospital resource utilization are necessary.

(DiMaggio CJ, Bukur M, Wall SP, *et al*, "Injuries associated with electric-powered bikes and scooters: analysis of US consumer product data," *Injury Prevention* Published Online First: 11 November 2019. doi: 10.1136/injuryprev- 2019-043418 and Chander, Vishwadha, "E-bikes show distinct pattern of severe injuries," Reuters Health, 2019 DECEMBER 25, 2019, available online at: https://www.reuters.com/article/us-health-ebike-injuries/e-bikes-show-distinct-pattern-of-severe-injuries-idUSKBN1YT0MV)

- The CPSC has also conducted at least eight recalls of electric bicycles due to a variety of hazards: fall, crash, and injury hazards.

Hoverboards

- Hoverboards were in the news consistently for causing fires and damaging property in 2016 and 2017.
- The CPSC is aware of at least 250 fire incidents involving hoverboards and the CPSC estimated that CPSC estimates there have been 13 burn injuries, three smoke inhalation injuries and more than $4 million in property damage related to hoverboards.
- But in the first two years that these products were on the market, more people were injured by falls than fires.
- According to an April 2018 article in the Journal of Pediatrics that analyzed NEISS data for children under 18 years of age involving hoverboards and skateboards for 2015 and 2016. The authors found that there were 26,854 injuries serious enough to require emergency department treatment.

(https://www.cpsc.gov/Safety-Education/Safety-Education-Centers/hoverboards; Sean Bandzar, Daniel G. Funsch, Rex Hermansen, Seema Gupta and Andrew Bandzar; Pediatrics April 2018, 141 (4) e20171253; DOI: https://doi.org/10.1542/peds.2017-1253.)

Hoverboards

The Authors found that:

- The mean and median ages for hoverboard and skateboard injuries were 11 and 13 years, respectively.
- In both groups, boys were more commonly injured.
- The majority of hoverboard injuries occurred at home.
- The wrists were the most common injured body part, and fractures were the most common diagnosis in both groups.
- The majority of patients in both groups were discharged from the hospital.
- Approximately 3% of the patients with skateboard injuries and hoverboard injuries were admitted to the hospital.

(Sean Bandzar, Daniel G. Funsch, Rex Hermansen, Seema Gupta and Andrew Bandzar; Pediatrics April 2018, 141 (4) e20171253; DOI: https://doi.org/10.1542/peds.2017-1253.)

Hoverboards

- The CPSC conducted numerous recalls (20) and safety alerts (2) for hoverboards due to fire hazards and
- A new UL standard was developed to address fire hazards.
- The CPSC also conducted an educational campaign focused on the fire hazards caused by hoverboards.
- However, newer products have caused fires indicating that the current voluntary standard may not be sufficiently addressing the fire risks posed by these products.
- The CPSC has not appeared to focus on the fall hazards posed by hoverboards.

(https://www.cpsc.gov/Safety-Education/Safety-Education-Centers/hoverboards and https://www.cpsc.gov/s3fs-public/CPSC-Hoverboard-Safety-Alert.pdf?NaDiKrW4fd88yJaKh1o90Q.nNHrgLMnv; https://dailyhornet.com/2020/new-high-tech-x1-5-hoverboard-linked-to-fire-hazard/; and https://www.bostonglobe.com/2020/04/09/metro/hoverboard-sparks-2-alarm-house-fire-andover/)

Connected Products

- Many micromobility products are connected products.
- The connectivity of an e-scooter or any micromobility product could serve to pose additional hazards to consumers.
- We know of reports that an electronic scooter's Bluetooth module was hacked and that the hacker was able to control the braking and acceleration of the scooter.
- The CPSC must take enforcement action to protect consumers from this unequivocal product safety hazard and from all product safety risks posed by connected micromobility products.

(Newman, L. H. (2019, February 12). The Xiaomi M365 Scooter Can Be Hacked to Speed Up or Stop. Retrieved from https://www.wired.com/story/xiaomi-scooter-hack/)

Protective Equipment

- All micromobility equipment necessitates the use of protective equipment such as helmets.
- Helmets may not be available that are specifically designed to protect consumers from each of these products.
- For micromobility products that are rented on the street, for example, no protective equipment is provided, which increases risks of serious injury to consumers.

Conclusion

- The CPSC should engage in:
  - the documentation of incidents,
  - the study of deaths and injuries,
  - leading efforts to enforce reporting obligations,
  - recalling unsafe products,
  - track and release incident data,
  - supporting policies that reduce the severity and incidence of injury and death, and
  - the education of consumers about safe operation of these vehicles.

Contact Information

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PEOPLEFORBIKES

CONSUMER PRODUCT SAFETY COMMISSION
MICROMOBILITY PRODUCTS FORUM

PRESENTATION 1

SEPTEMBER 15, 2020

peopleforbikes

COALITION

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ABOUT PEOPLEFORBIKES

peopleforbikes

- Sole industry trade association for American manufacturers and suppliers of bicycles and bicycle products.
- Nearly 200 members representing companies of all sizes, and a cross section of the industry.
- Member businesses that serve every facet of the domestic bicycle market:
  - Complete bicycles
  - Complete electric bicycles
  - Parts
  - Components (including e-bike systems)
  - Accessories

STATE E-BIKE LAWS

peopleforbikes

- States regulate the use of e-bikes on streets and bikes paths.
- PeopleForBikes created and advanced modern, harmonized standards for state e-bicycle regulation using three classes of e-bike.
- 43 states regulate e-bikes like bicycles, of which 28 have the three class system.
- 7 others have no e-bike definition, and electric bicycles may be regulated under another vehicle class such as “moped” or “motorized bicycle.”

THREE E-BIKE CLASSES

- Class 1: Pedal assist, maximum assisted speed 20 mph.
- Class 2: Throttle assist, maximum assisted speed 20 mph.
- Class 3: Pedal assist, maximum assisted speed 28 mph.
- 20 mph and 28 mph motor cut offs are not the average user speed.

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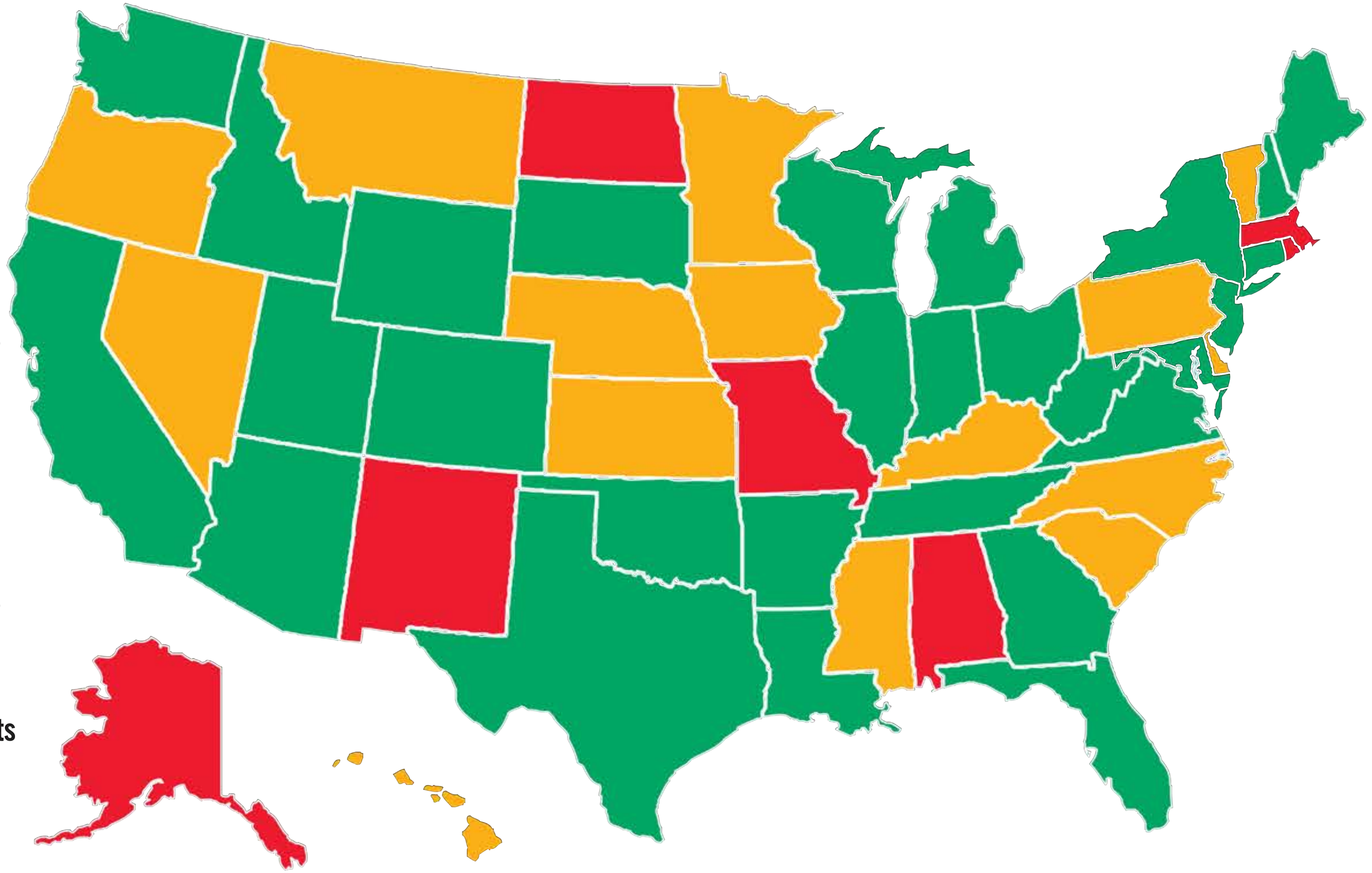
E-BIKE REGULATIONS

MODEL LEGISLATION	» States that have enacted the PeopleForBikes model law, which defines and regulates three classes of e-bikes.
ACCEPTABLE	» Regulated as a bicycle » Passengers allowed » No age minimum » No licensing or registration required » Can use existing bike infrastructure
PROBLEMATIC	» Regulated as a moped or motor vehicle » Confusing equipment + use requirements » Confusing licensing + registration requirements » Confusing access to bike infrastructure



CLASS STICKER

» The model law requires that manufacturers and distributors of electric bicycles apply a class label that is permanently affixed, in a prominent location, to each e-bike.

EXAMPLE OF GENERIC CLASS LABELS

CLASS 1: 350W // 20MPH

a) CLASS 1
350W // 20mph

b) CLASS
1
350W
20mph

c) CLASS
1
350W
20mph

CLASS 2: 500W // 20MPH

a) CLASS 2
500W // 20mph

b) CLASS
2
500W
20mph

c) CLASS
2
500W
20mph

CLASS 3: 350W // 28MPH

a) CLASS 3
350W // 28mph

b) CLASS
3
350W
28mph

c) CLASS
3
350W
28mph

TAKEAWAYS

- Bipartisan issue.
- Class system by appreciated by public safety officials, transportation planners and land managers.
- Cities generally align ordinances with state law.
- States have chosen to regulate electric scooters and other shared micromobility devices separately from e-bikes. Unlike these products, electric bicycles enjoy widespread ownership by private individuals and they are not primarily a shared device

PRODUCT SAFETY LAWS

- E-bicycles have been defined in federal statute as a bicycle subject to the Consumer Product Safety Act for the purposes of product safety, manufacturing and first sale since 2002:
  - 15 U.S.C. § 2085 (16 C.F.R. § 1512).
  - Same requirements as bicycles:
    - Federal safety standards.
    - Detailed mechanical requirements.
    - Assembly, braking and structural integrity requirements.

- Key points from 15 U.S.C. § 2085:
  - Pedal or throttle-assist bicycles.
  - 750 watt limit.
  - Maximum speed of 20 mph under motor power alone.
  - No specified maximum speed when operating under combined human and motor power.

VOLUNTARY E-BIKE STANDARDS

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- Three class state regulatory system:
  - Clarifies an important ambiguity in federal product safety law, which does not specify a maximum pedal-assisted motorized speed that e-bicycles may travel.
  - Addresses and enables local government use regulation.
- Complete e-bicycle electrical system standard:
  - Voluntary standard published by Underwriters Laboratories.
  - UL 2849, Standard for Electrical Systems for E-bikes.
  - Adherence by most, if not all, companies manufacturing e-bicycles or the electrical system for e-bicycles.

BIKES + E-BIKES

- Bicycles have been widely accepted consumer products for more than 100 years, with a proven safety record.
- E-bicycles are regulated consumer products and subject to the same mandatory federal safety standards as bicycles.
- E-bicycles are an extension of bicycles, and have a growing, positive track record regarding safety and operation.

DISTINCTION FROM OTHER DEVICES

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- Bikes and e-bicycles are different products with different histories, design standards and usage than e-scooters and hoverboards.
- Given these differences it would be appropriate to study matters pertaining to e-bicycles that fall under its jurisdiction separately from e-scooters and hoverboards.
- Any new regulation of e-scooters, hoverboards and other mobility devices should take place separate from the existing regulatory structure for bicycles and e-bicycles.

Q+A

Thank you

people for bikes