Ergonomic & Anthropometric Product Assessment- Bird and Lime Scooters

Human Centered Design

Michael Armstrong, Julio de Pereda, Yunuo Huang
Dahee Kim, Rob Stout, Iris Sun

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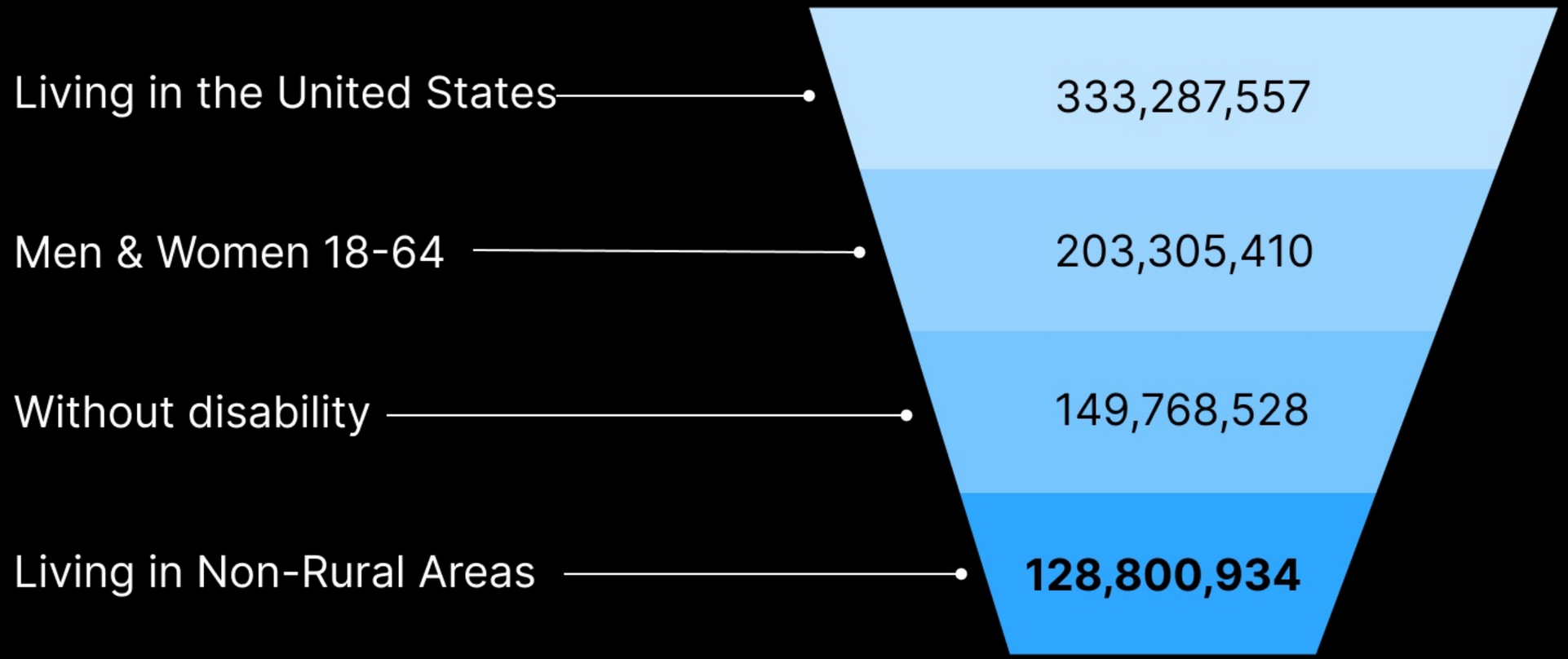
OVERVIEW

USERS | TASK ANALYSIS | PRODUCT DESCRIPTION | EVALUATION APPROACH | DATA UTILIZED | DESIGN SUGGESTIONS

Defining the User



https://www.inclusivecitymaker.com/disability-statistics-in-the-us/

https://www.cdc.gov/ncbddd/disabilityandhealth/infographic-disability-impacts-all.html

https://www.census.gov/quickfacts/fact/table/US/PST045222

Average(ish) Users

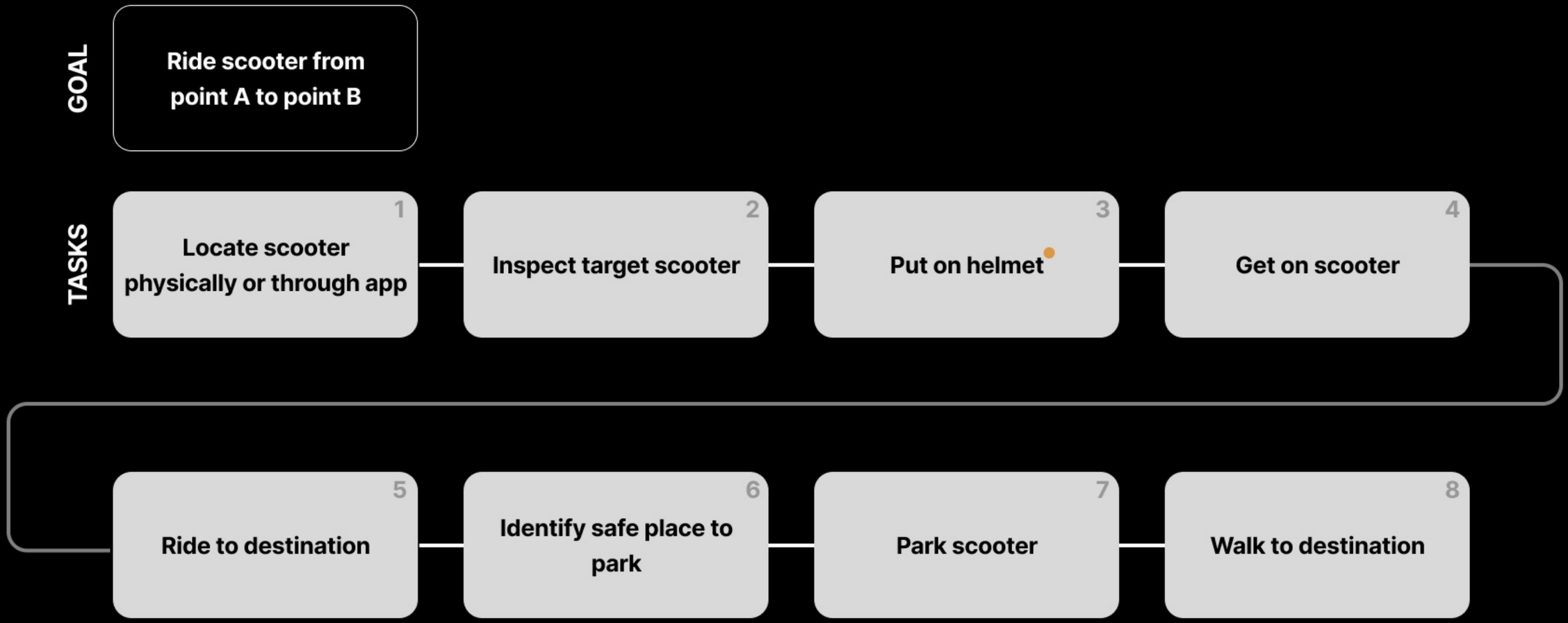
Ideal Male Specimen

Height - 175 cm

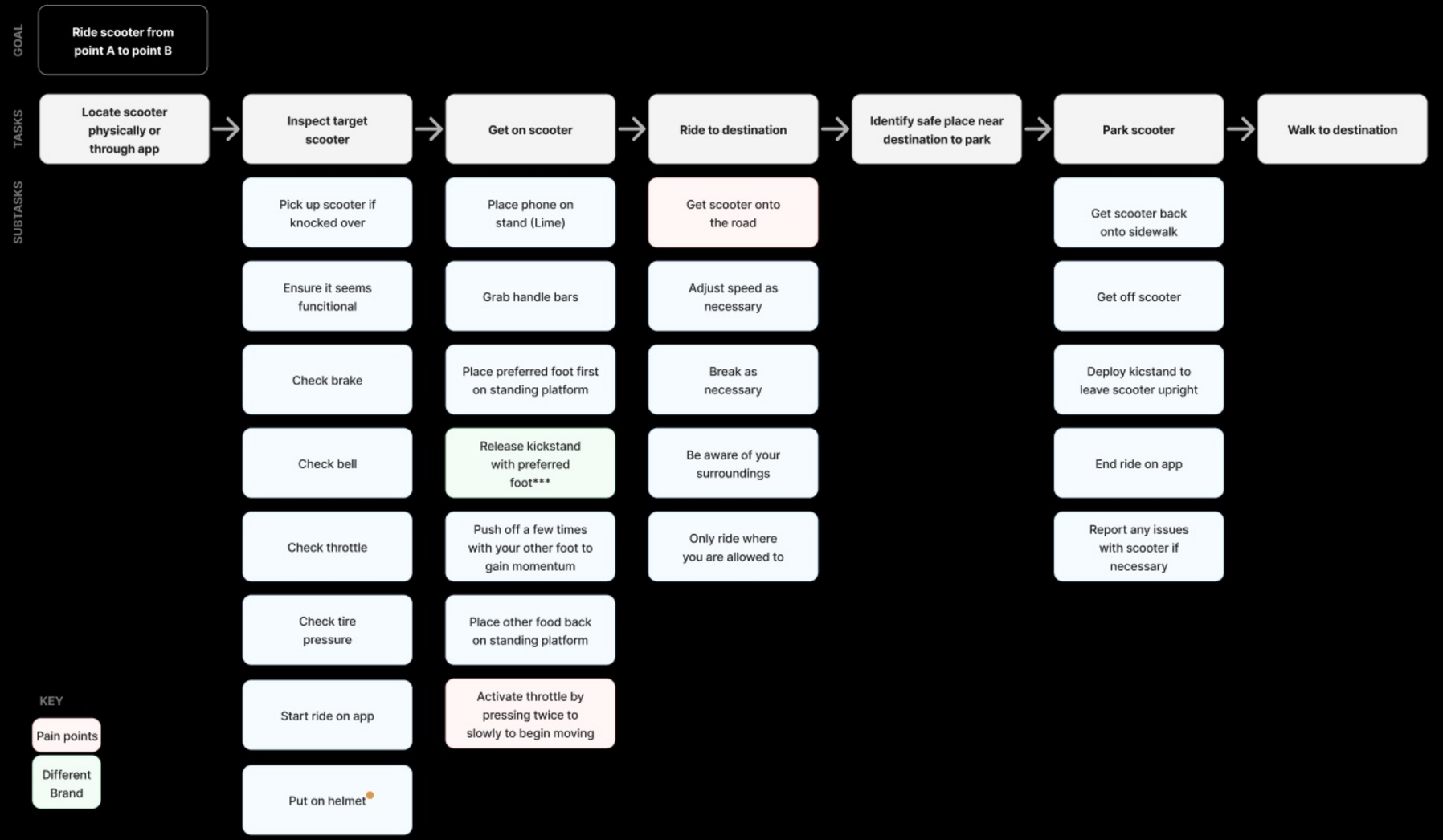
Ideal Female Specimen

Height - 157.5 cm (average is 161 cm)

TASK ANALYSIS - HIGH LEVEL VIEW



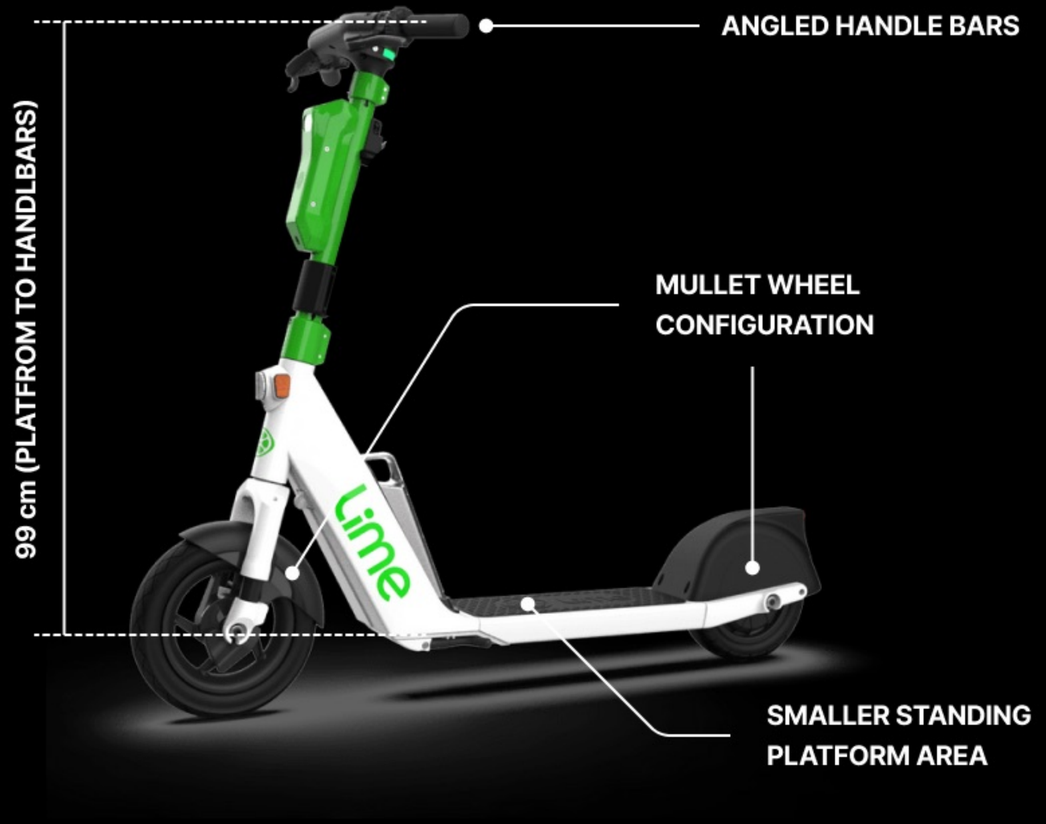
TASK ANALYSIS - DETAILED VIEW



PRODUCT DESCRIPTION

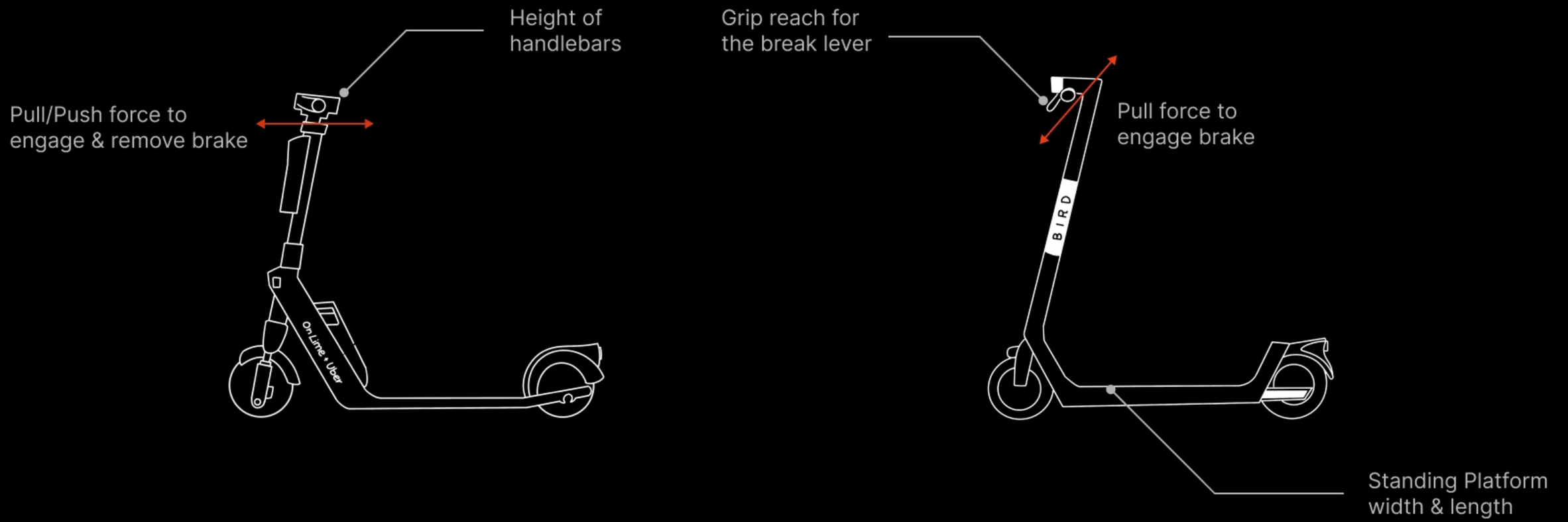
Bird Scooter Two

Lime Scooter



PRODUCT EVALUATION APPROACH

Review the design of Bird and Lime scooters



HANDLEBARS

Grip & Braking

Left Controls

Right Controls

11.5CM HANDLEBAR LENGTH

7.5 CM HANDLE BAR GRIP SPAN

6 KG REAR BRAKE PULL FORCE

BELL GRIP SPAN 5.5 CM

DIAMETER 4 CM

FRONT BRAKE 8 KG PULL FORCE

4.5 CM THROTTLE WIDTH

HANDLEBAR SPAN TOTAL 50 CM

DISTANCE BETWEEN HANDLEBAR 26 CM

Left Controls

Right Controls

11.5CM HANDLEBAR LENGTH

10 CM HANDLE BAR GRIP SPAN

5.5 KG REAR BRAKE PULL FORCE

DIAMETER 3.3 CM

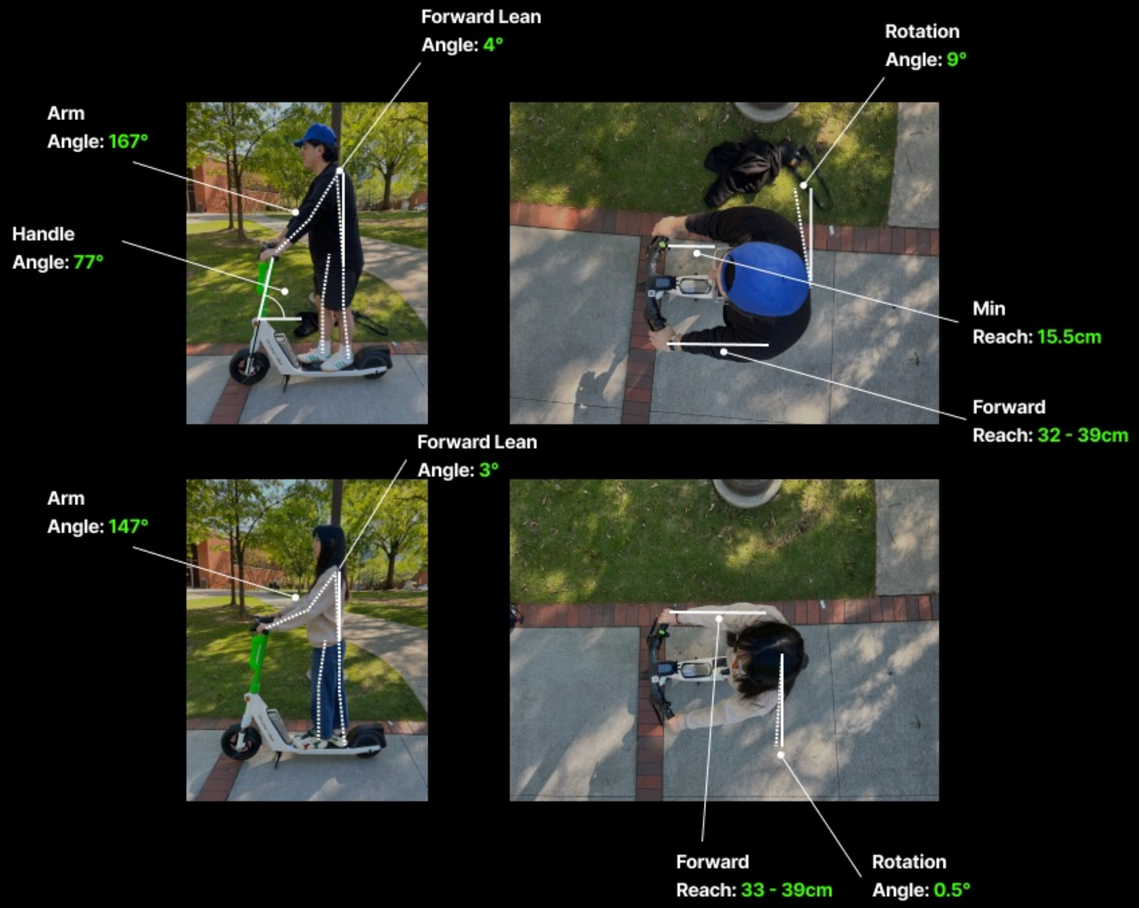
FRONT BRAKE 9 KG PULL FORCE

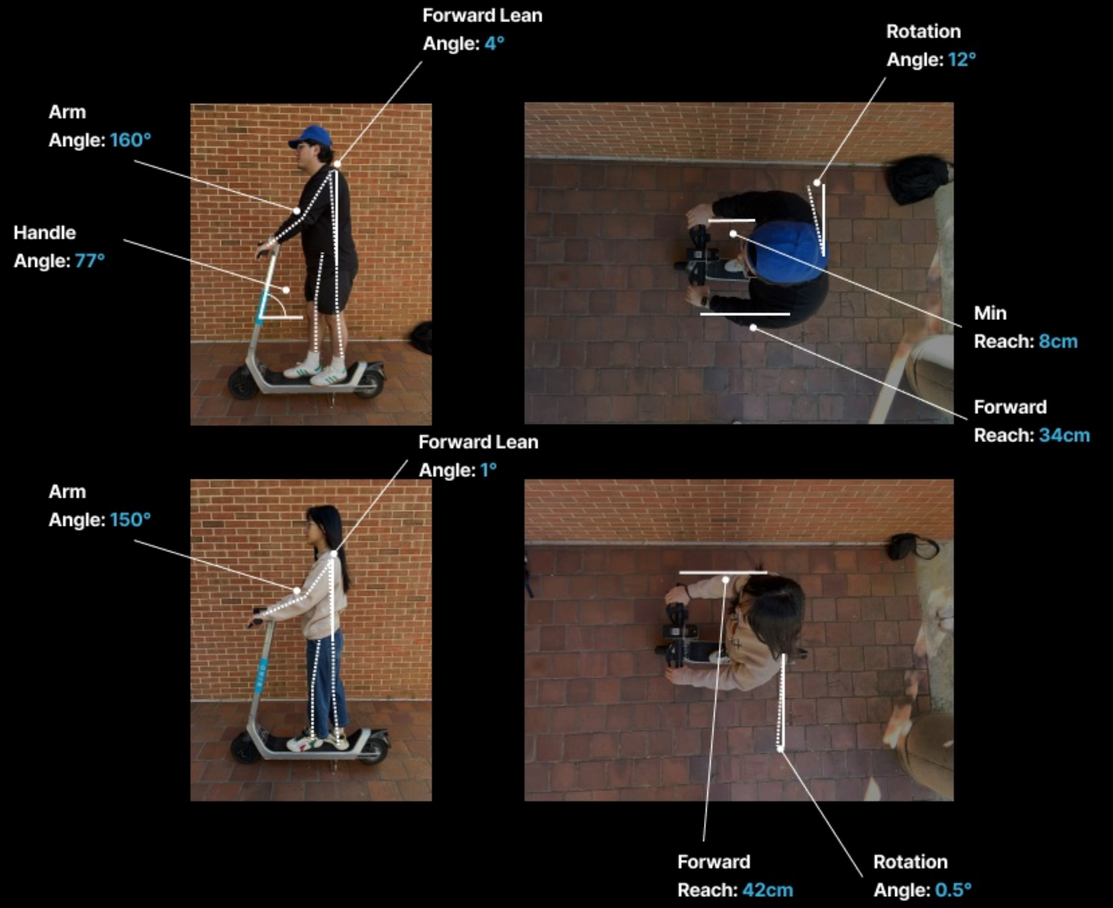
3 CM THROTTLE WIDTH

HANDLEBAR SPAN TOTAL 60 CM

DISTANCE BETWEEN HANDLEBAR 40 CM

HANDLEBARS


Forward Lean
Angle: 4°
Rotation
Angle: 9°
Arm
Angle: 167°
Handle
Angle: 77°
Min
Reach: 15.5cm
Forward
Reach: 32 - 39cm
Forward Lean
Angle: 3°
Arm
Angle: 147°
Forward
Reach: 33 - 39cm
Rotation
Angle: 0.5°


Forward Lean
Angle: 4°
Rotation
Angle: 12°
Arm
Angle: 160°
Handle
Angle: 77°
Min
Reach: 8cm
Forward
Reach: 34cm
Forward Lean
Angle: 1°
Arm
Angle: 150°
Forward
Reach: 42cm
Rotation
Angle: 0.5°

STANDING PLATFORM

DATA UTILIZED

	Scooter dimension (Bird / Lime)	Name of anthropometric measurement
Platform length	56 cm / 42 cm	Shoe length*factor
Platform width	15 cm / 16 cm	Shoe width*factor
Handlebar height	100 cm / 100 cm	Stature
Handlebar width	50 cm / 60 cm	Shoulder width
Handlebar reach	8 cm / 15.5 cm	Arm position
Handle Circumference	4cm / 3.3cm	Inside grip
Brake Distance	9cm / 11cm	Grip span
Brake Force	17.6 lbf / 11 lbf	Grip force
Kickstand Retraction	8.8 lbf / 12.2 lbf	Push force
Kickstand Extension	19.9 lbf / 19.9 lbf	Pull force

DATA UTILIZED

	Scooter dimension (Bird / Lime)	Name of anthropometric measurement
Platform length	56 cm / 42 cm	Shoe length*factor
Platform width	*15 cm / 16 cm*	*Shoe width*factor*
Handlebar height	*100 cm / 100 cm*	*Stature*
Handlebar width	50 cm / 60 cm	Shoulder width
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Handle Circumference	4cm / 3.3cm	Inside grip
Brake Distance	*9cm / 11cm*	*Grip span*
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Kickstand Extension	19.9 lbf / 19.9 lbf	Pull force

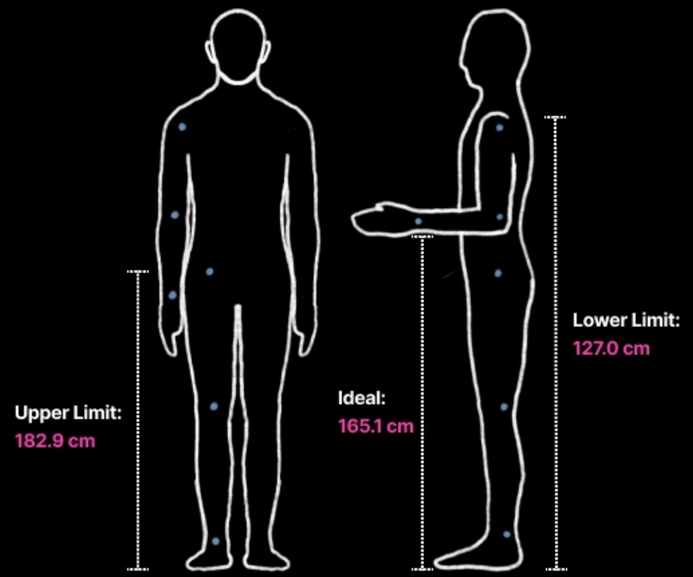
KEY ANTHROPOMETRICS

HANDLEBAR HEIGHT	———	STATURE | FUNCTIONAL REACH
BRAKE DISTANCE FROM HANDLE	———	GRIP SPAN
STANDING PLATFORM	———	FOOT WIDTH

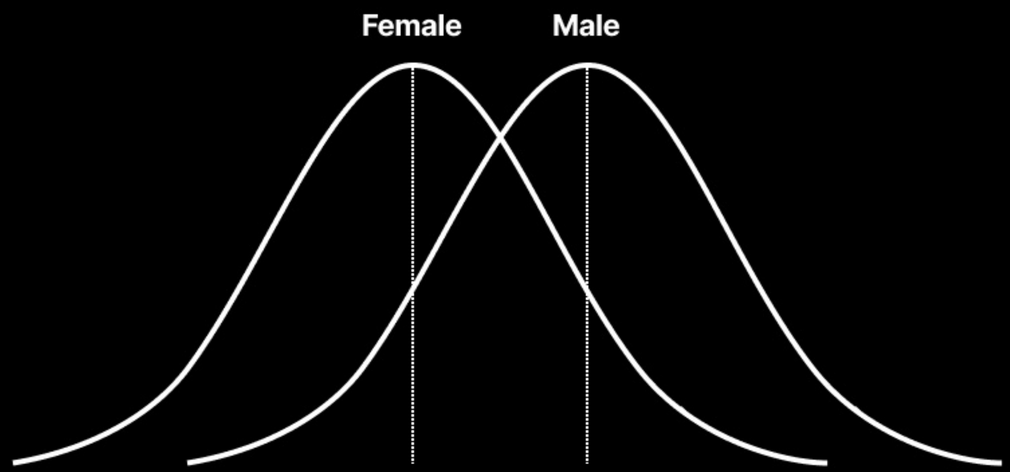
HANDLEBAR HEIGHT

Stature

Proportional Person



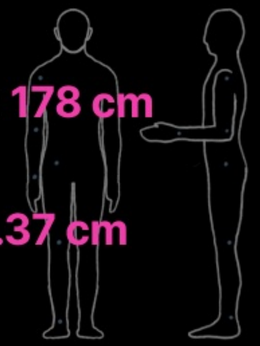
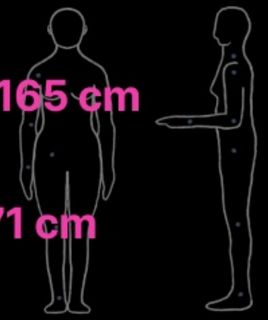
Male & Female Percentiles



Mean: 165 cm
Std: 7.71 cm

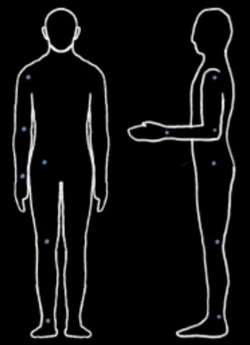
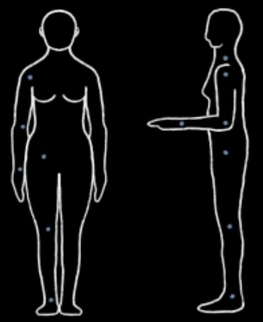
Mean: 178 cm
Std: 8.37 cm

HANDLEBAR HEIGHT

Stature	Bird			Lime		
	Upper Limit 182.9 cm	Ideal 165.1 cm	Lower Limit 127.0 cm	Upper Limit 182.9 cm	Ideal 165.1 cm	Lower Limit 127.0 cm
Male  **Mean:** 178 cm **Std:** 8.37 cm	72.09 %	6.16%	0.00%	72.09 %	6.16%	0.00%
Female  **Mean:** 165 cm **Std:** 7.71 cm	98.99 %	50.52%	0.00%	98.99 %	50.52%	0.00%

HANDLEBAR REACH

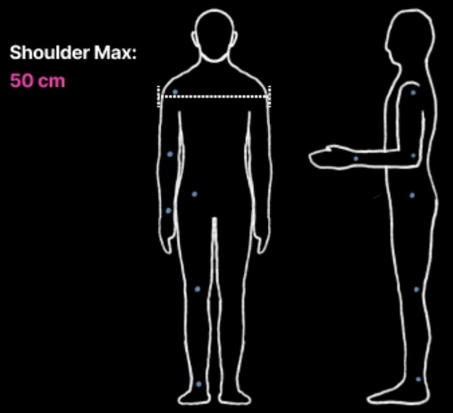
Functional Reach

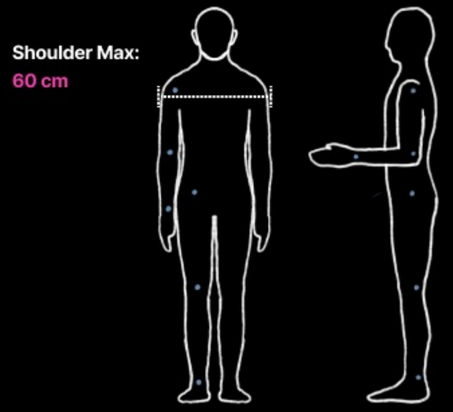
	Bird			Lime		
	Min Reach	Reach Arm Extended	Reach elbow 90º	Min Reach	Reach Arm Extended	Reach elbow 90º
Male **178 cm** 	**8 cm**	**54.1 cm**	**35.3 cm**	**15.5 cm**	**54.1 cm**	**35.3cm**
Female **162 cm** 	**8 cm**	**51.3 cm**	**32.1 cm**	**15.5 cm**	**51.3 cm**	**32.1 cm**

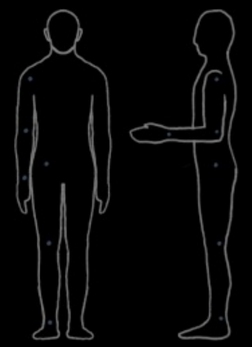
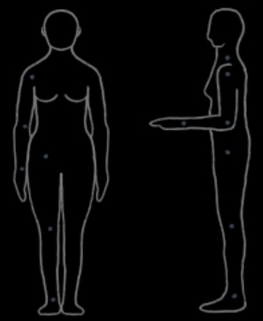
HANDLEBAR SPAN

Shoulder Breadth

Proportional Person

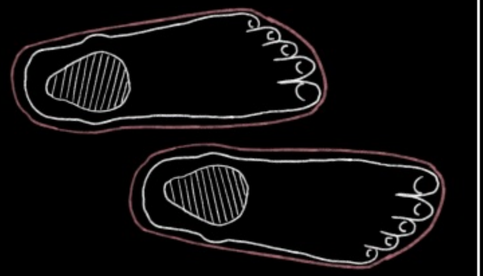
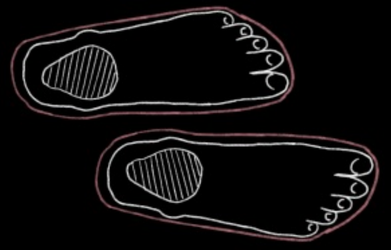




	Bird		Lime	
	Shoulder Max	Percentile	Shoulder Max	Percentile
Male 	**50 cm**	**30.9025%**	**60 cm**	**0.054%**
Female 	**50 cm**	**0.9869%**	**60 cm**	**0.00%**

PLATFORM LENGTH

Foot Size

	Bird - Platform Length: 56 cm	Lime - Platform Length: 42 cm	
	Foot length including shoe	Scooter stance length	Percentile
Male 	**32.8 cm**	**49.2 cm**	**95**
Female 	**30.8 cm**	**46.2 cm**	**95**

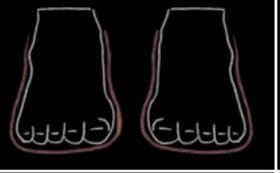
PLATFORM WIDTH

Foot Size

Foot Size	Bird				Lime			
	% Utilized Platform	Platform Width	Shoe Width	Percentile	% Utilized Platform	Platform Width	Shoe Width	Percentile
Male **Mean:** 10.4 cm **Std:** 0.801 cm 	80%	15 cm	12.0 cm	95%	75%	16 cm	12.0cm	95%
Female **Mean:** 9.36 cm **Std:** 0.748cm 	77%	15 cm	11.5 cm	99%	72%	16 cm	11.5 cm	99%

PLATFORM WIDTH

Feet Size

Feet Size	Bird				Lime			
	% Utilized Platform	Platform Width	Shoe Width*2	Percentile	% Utilized Platform	Platform Width	Shoe Width*2	Percentile
Male **Mean:** 20.8 cm **Std:** 1.7 cm 	160%	15 cm	24 cm	95%	150%	16 cm	24 cm	95%
Female **Mean:** 18.7 cm **Std:** 0.707 cm 	153%	15 cm	23 cm	99%	144%	16 cm	23 cm	99%

BRAKING ABILITY

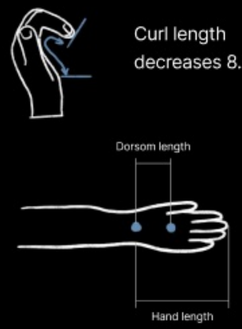
Grip Span

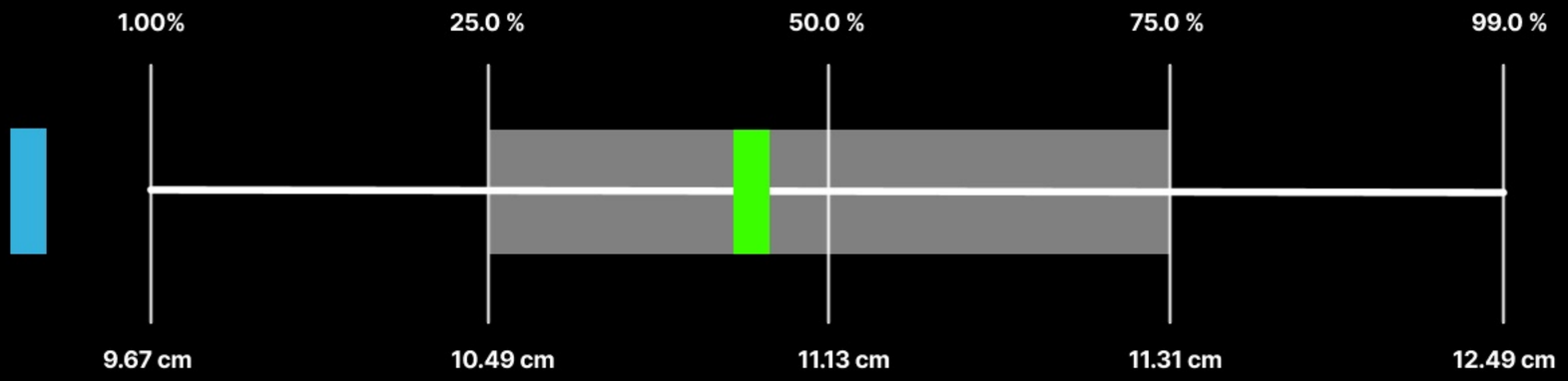
Grip Span= (hand length - dorsom length) * (1-hand curl)

Bird Brake Distance **9 cm**

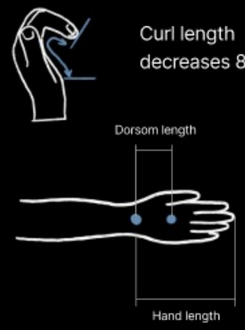
Lime Brake Distance **11 cm**

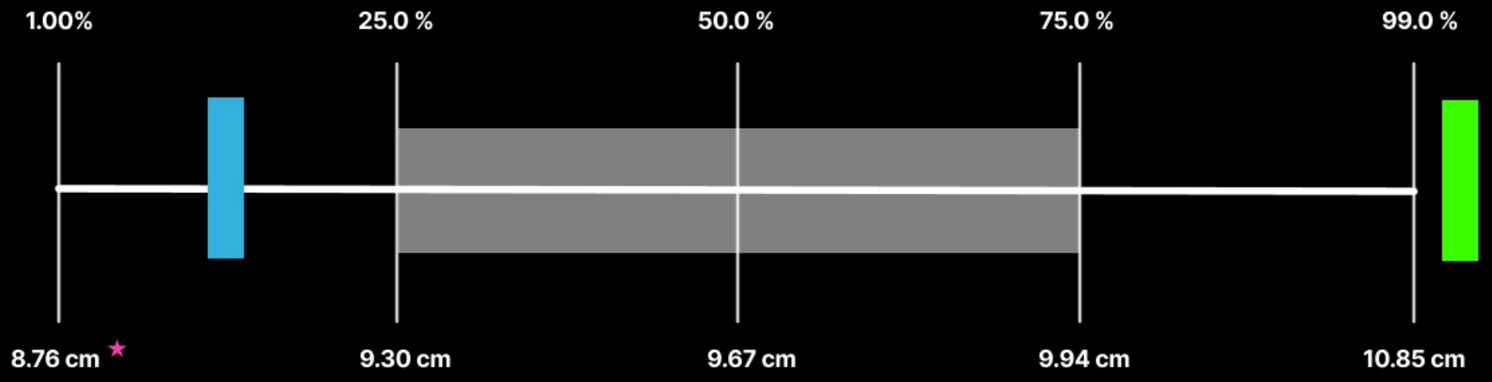
Male





Female





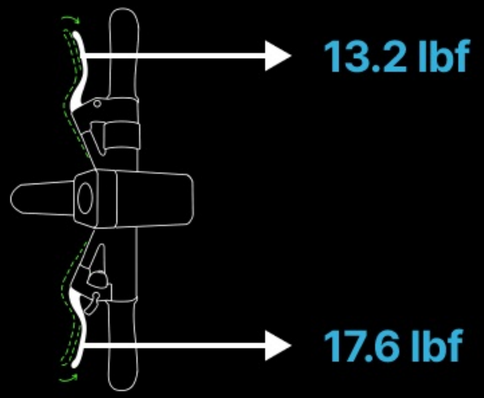
★ Calculated because possible error on Human Scale Handbook

BRAKING ABILITY

Grip Force

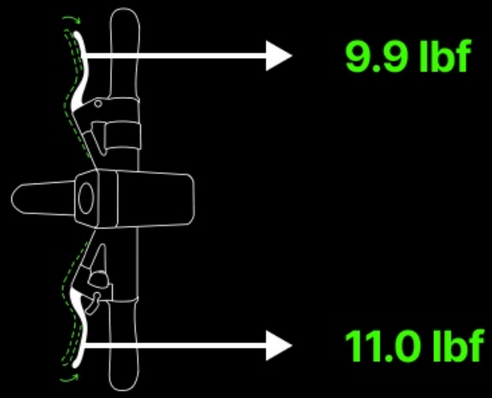
Bird

Brake Force



Lime

Brake Force



	2.5%	50%	98%
Male	86 lbf	94 lbf	147 lbf
Female	53 lbf	86 lbf	94 lbf

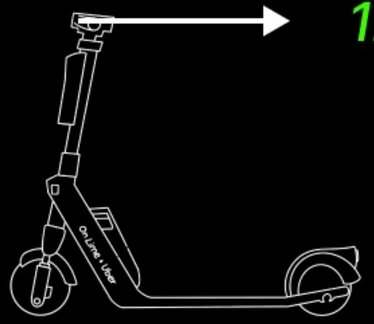
KICSTAND RETRACTION

Pulling Force

Bird

8.8 lbf

Lime



12.2 lbf

2.5 Percentile Male User —— **29 lbf**

2.5 Percentile Female User —— **16 lbf**

KICKSTAND EXTENSION

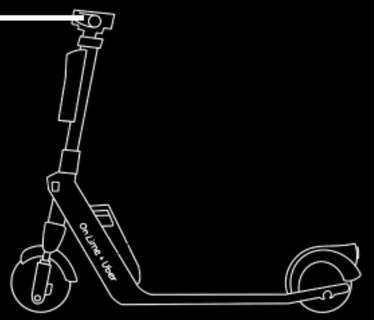
Pushing Force

Bird

19.9 lbf

Lime

19.9 lbf



2.5 Percentile Male User —— **34 lbf**

2.5 Percentile Female User —— **22 lbf**

DESIGN REQUIREMENTS

Must-Have

- **Increase handlebar height by 5cm** to accommodate a wider range of users comfortably and improve ergonomics
- **Wider standing platform** to securely accommodate both feet of users and improve stability and comfort
- **Shorter brake lever reach** to accommodate users with smaller hand sizes and finger lengths for effective and comfortable control over braking

Should-Have

- **Rethink battery placement on Lime scooters** to increase the available standing area lengthwise
- **Consider adjustable handlebar** stem height to further increase rider range and allow for an ideal height for more riders
- **Optimize the handlebar span to 60 cm for the Bird scooter** to ensure rider comfort for 30% of male Bird scooter riders

Nice to Have

- **Study the trade-offs between platform size** and portability to ensure an optimal balance between user comfort and scooter storage capabilities
- **Evaluate the potential impact of safety features** on scooter performance to find a balance between user safety and ride experience
- **Investigate the potential cost implications** of making the scooter more inclusive and accommodating for a wider range of users

SUGGESTION ONE

Wider Standing Platform

Key Anthropometry: Foot Size

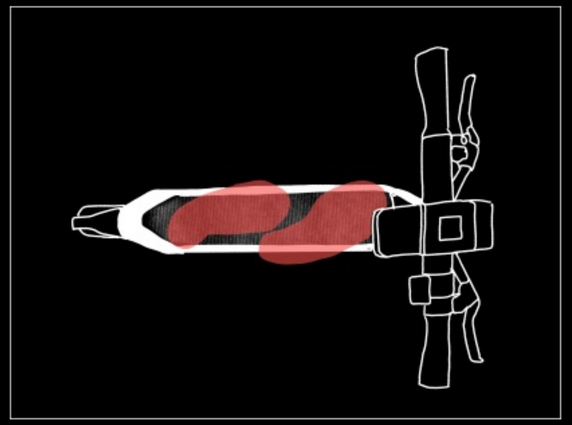
PLATFORM WIDTH

Foot Size

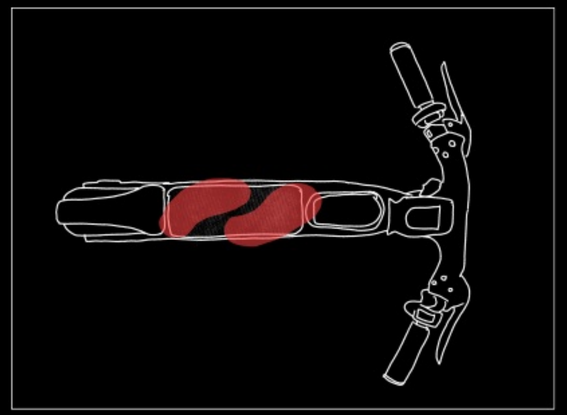
	Bird				Lime			
	% Utilized Platform	Platform Width	Shoe Width*2	Percentile	% Utilized Platform	Platform Width	Shoe Width*2	Percentile
Male **Mean:** 28.8 cm **Std:** 1.7 cm	160%	15 cm	24 cm	95%	150%	16 cm	24 cm	95%
Female **Mean:** 18.7 cm **Std:** 0.707 cm	153%	15 cm	23 cm	99%	144%	16 cm	23 cm	99%

SUGGESTION ONE

Wider Standing Platform

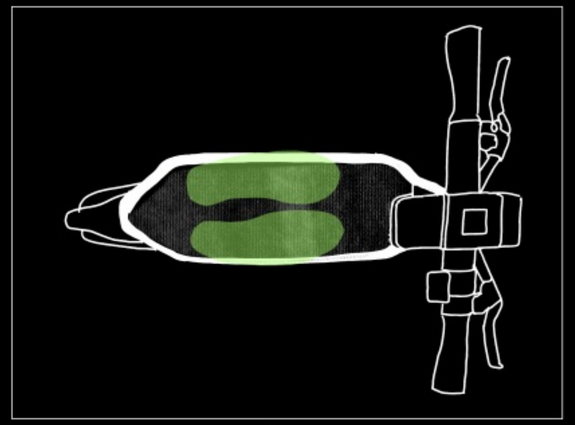


Bird

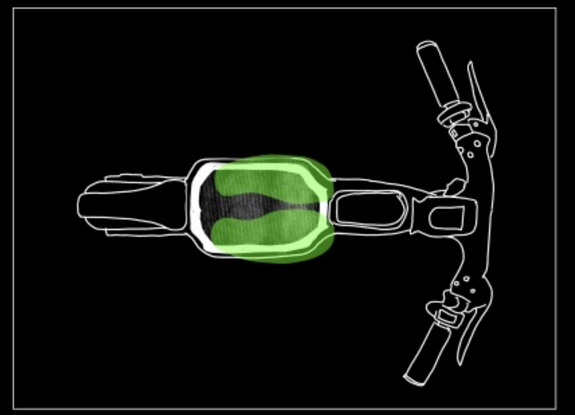


Lime

Key Anthropometry: Foot Size



Bird

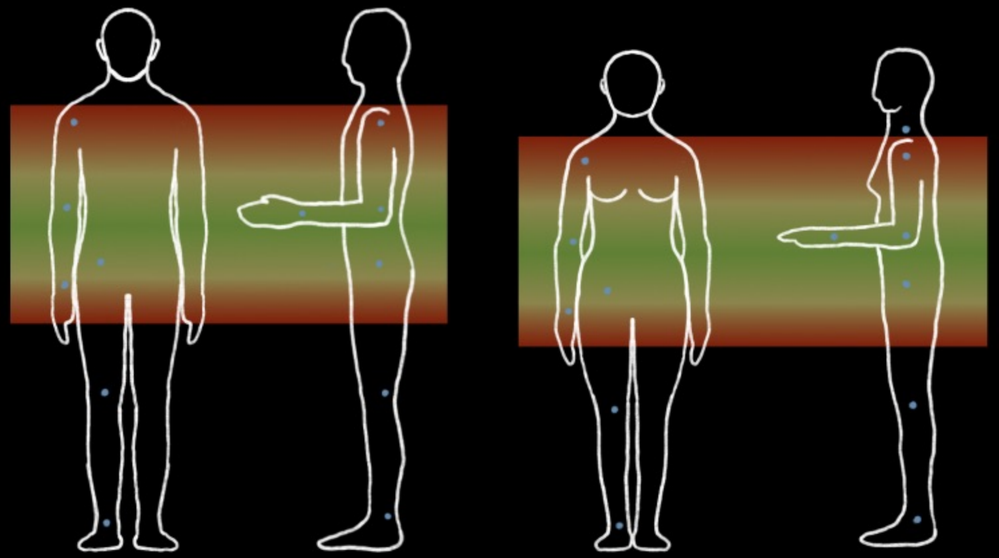


Lime

SUGGESTION TWO

Increase Handlebar Height by 5cm

Key Anthropometry: Stature



https://www.bloomberg.com/news/articles/2019-12-05/most-electric-scooter-riders-are-men-here-s-why

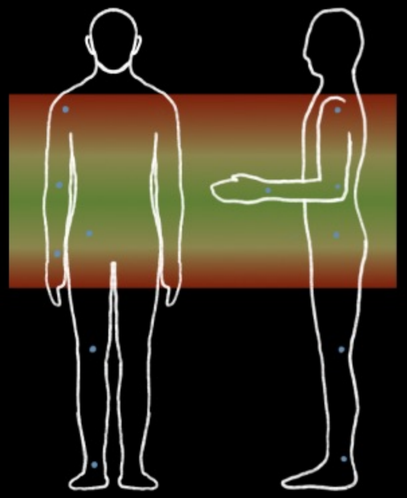
SUGGESTION TWO

Increase Handlebar Height by 5cm

Key Anthropometry: Stature

MALE

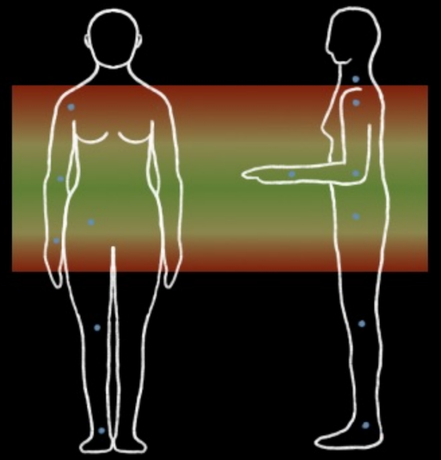
Average Stature: 178.0 cm
Stan Dev Stature: 8.37 cm



	Stature	Percentiles
Height Upper	182.9	72.09%
Height Lower	127	0.00%
Height Ideal	165.1	6.16%
+5 Upper	192	95.28%
+5 Lower	131	0.00%
+5 Ideal	172	23.67%
Pop. Increase		14,936,529
Pop. Decrease		0
Net Population		14,936,529

FEMALE

Average Stature: 165.0 cm
Stan Dev Stature: 7.71 cm



	Stature	Percentiles
Height Upper	182.9	98.99%
Height Lower	127	0.00%
Height Ideal	165.1	50.52%
+5 Upper	192	99.98%
+5 Lower	131	0.00%
+5 Ideal	172	81.80%
Pop. Increase		637,243
Pop. Decrease		-322
Net Population		636,921

https://www.bloomberg.com/news/articles/2019-12-05/most-electric-scooter-riders-are-men-here-s-why

SUGGESTION TWO

Increase Handlebar Height by 5cm

By increasing the height of the handlebars, we can create a more comfortable and controlled experience for **15,573,450** male & female scooter riders.

https://www.bloomberg.com/news/articles/2019-12-05/most-electric-scooter-riders-are-men-here-s-why

SUGGESTION THREE

Shorter Brake Lever Reach

Current Brake Distance

Bird	Lime
9 cm	11 cm

Men

Grip Span (cm)	Percentile
9.48	2.5
10.49	50
11.86	97.5

Women

Grip Span (cm)	Percentile
8.76	2.5
9.48	50
9.76	97.5

Key Anthropometry: Grip Span

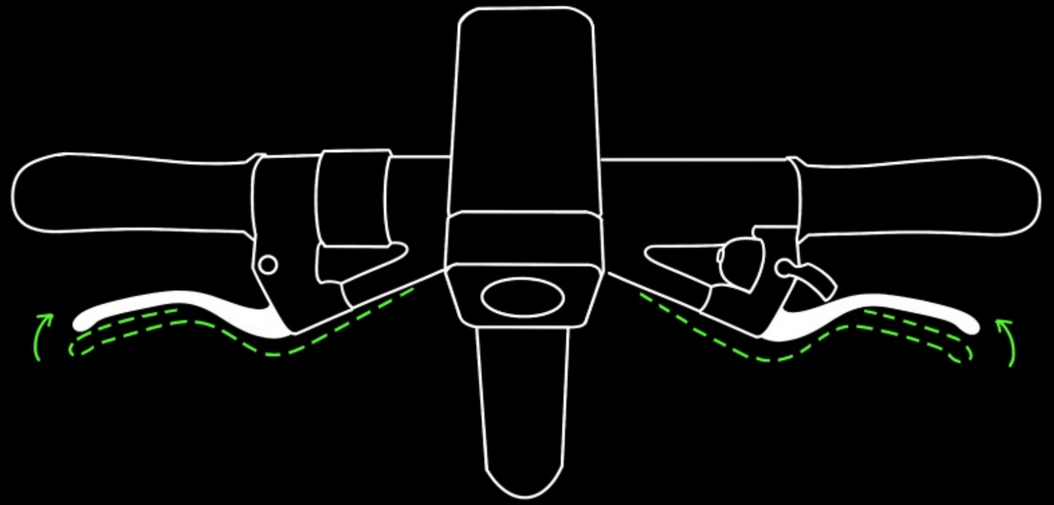
Grip Span= (hand length - dorsom length) * (1-hand curl)

SUGGESTION THREE

Shorter Brake Lever Reach

Key Anthropometry:

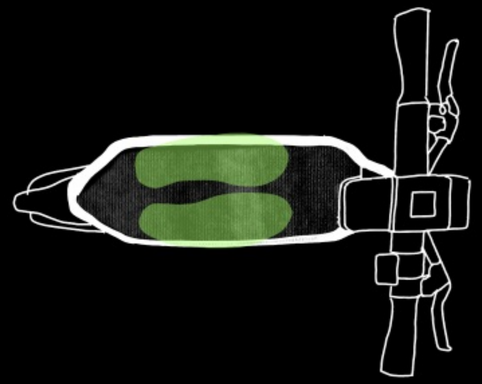
Grip Span= (hand length - dorsom length) * (1-hand curl)



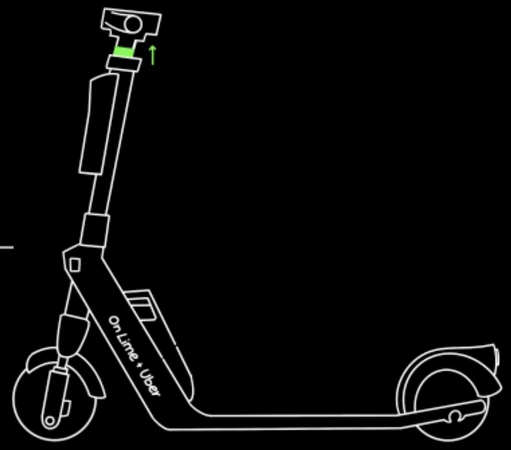
CONCLUSION

Three Design Suggestions Were Made

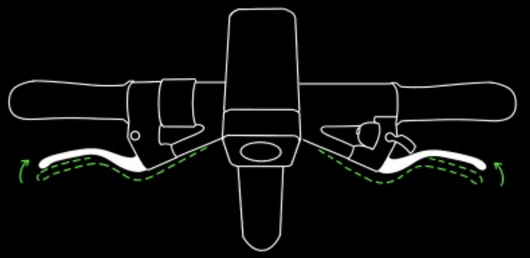
Wider Standing Platform



Increase Handlebar Height by 5cm



Shorter Brake Lever Reach



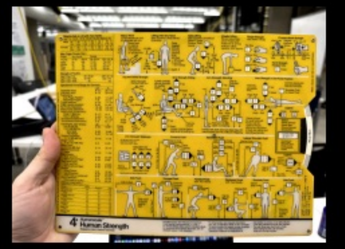
WHAT WE HAVE LEARNED

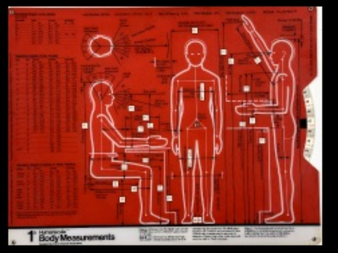
- **Anthropometric data plays a critical role in understanding the diverse physical dimensions of users** and designing products that cater to wide range of users comfortably.

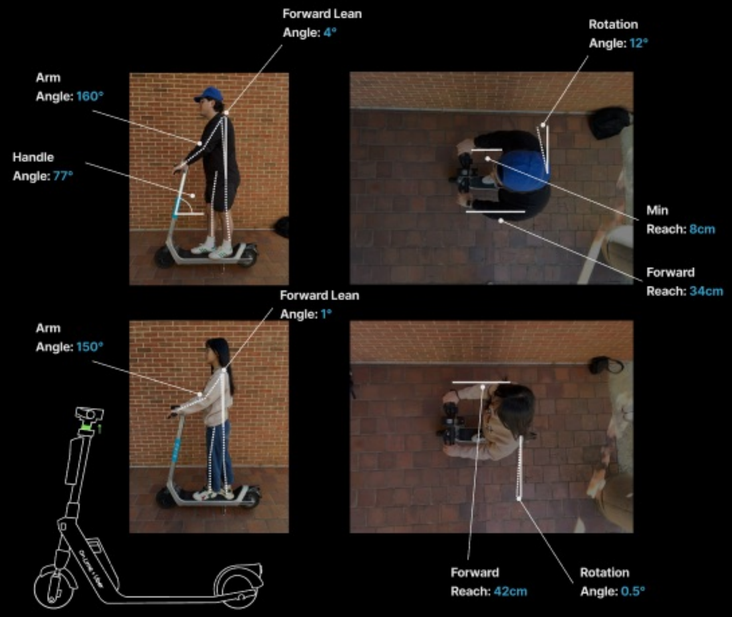
- **Applying anthropometric data from sources like CAESAR and Human-scale databases** helps identify key dimensions that impact the user experience and ergonomics of products, such as electric scooters.

- **Analyzing and comparing the measurements of real-world products with existing anthropometric data** can reveal shortcomings and areas for improvement in design.

- Designing with an anthropometric approach contributes to **more inclusive, accessible,** and **user-friendly products.**







THANK YOU

Questions?