

Anthropometric Survey of Respirator Users

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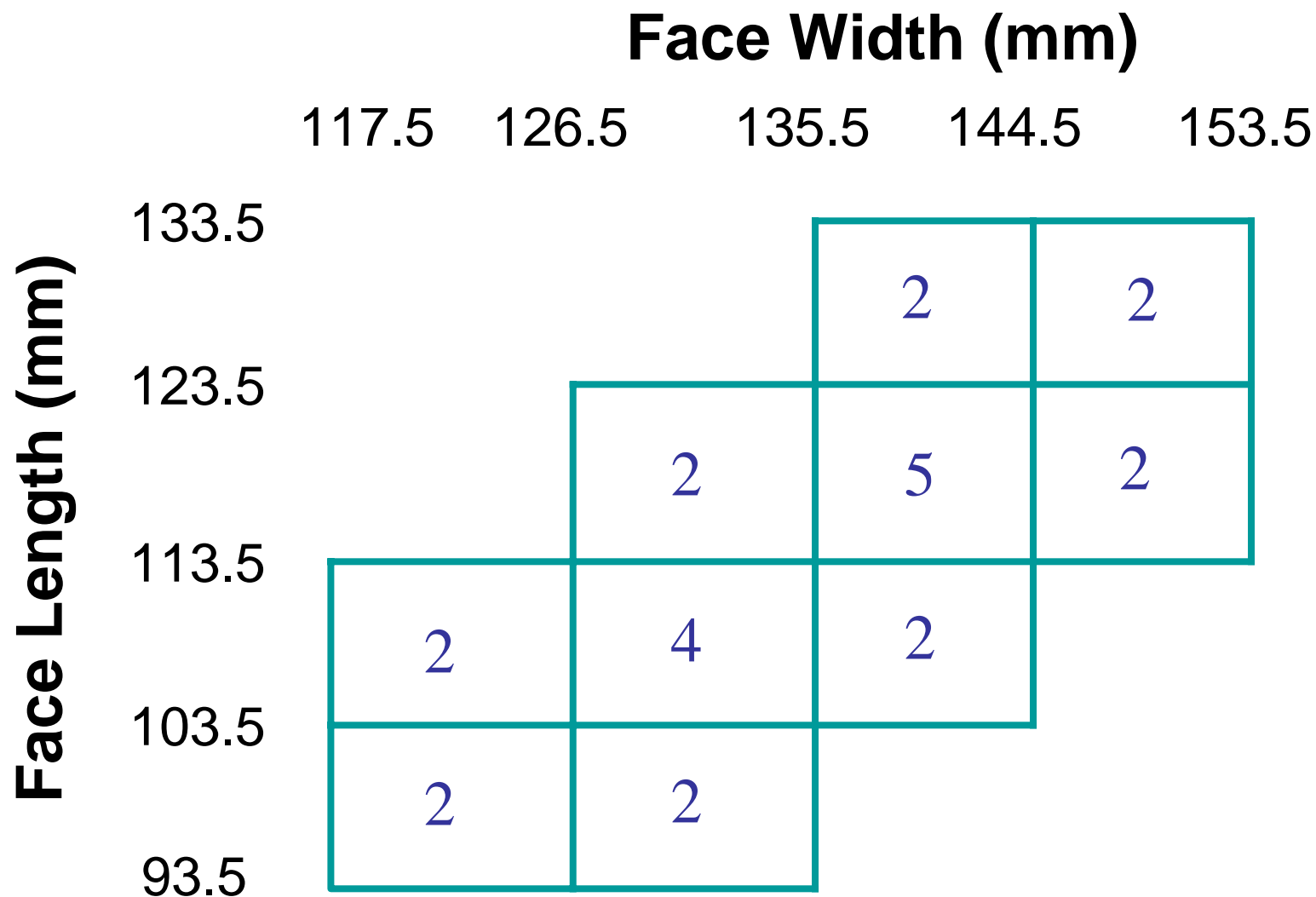
Goals

- **Conduct a large-scale anthropometric survey of respirator users**
- **Upgrade the LANL respirator fit test panels**

Background

- **Military data has been the normative basis for commercial respirator sizing**
- **Anthropometric panels of facial dimensions are often relied upon to provide sizing reference**
- **The current panels were developed based on 1967-68 US Air Force surveys**

LANL 25-Member Panel for Full-Facepiece Respirators



LANL 25-Member Panel for Half-Facepiece Respirators

		Lip Length (mm)			
		34.5	43.5	52.5	61.5
Face Length (mm)	133.5		2	2	
	123.5	1	5	3	
	113.5	3	4	1	
	103.5	2	2		
	93.5				

Background (Continued)

- These panels have played a prominent role in respirator fit test
- The facial anthropometry is assumed to be representative of U.S. adults
- Respirators designed to fit these panels are expected to accommodate 90-95% of the population

Background (Continued)

- Concern was raised about compatibility
- Los Alamos surveyed 200 males (1973)
- Bureau of Mines surveyed 48 male mine rescue workers (1978)
- NIOSH found that 16% of CAESAR subjects were rejected by LANL panel for full-facepiece respirators (2002)

Background (Continued)

- **Military data may not represent the great diversity in face size in civilian population**
- **The demographics of the U.S. population have changed over the last 30 years**

Race Distribution of 1967-1968 Air Force Survey Subjects and 2000 U.S. Population

Race	Air Force		2000 Census	
	Male (%)	Female (%)	Male (%)	Female (%)
White	98	91	71.6	71.4
African American	1	8	11.8	12.5
Hispanic	1	1	12.1	11.5
Asian/Pacific	-	-	3.7	3.9
American Indian	-	-	0.8	0.7

Objectives

- **Develop an anthropometric database detailing the face-size distributions of respirator users**
- **Compare the distributions of respirator users with those of Air Force pilots**
- **Determine if the LANL respirator fit test panels need to be revised**

Methods

- **A stratified sampling plan was used**
 - 2 gender strata: male and female
 - 3 age groups: 18-29, 30-44, and 45-66
 - 4 race/ethnic groups:
 - White, African American, Hispanics, and Others
- **Sample size was determined using the procedures outlined in ISO 15535**
$$n = (1.96 \times CV / a)^2 \times 1.534$$
$$= (1.96 \times 5.3 / 1)^2 \times 1.534 = 166$$

Targeted Sample Size by Sampling Cell

	Male				Female			
	Age Group				Age Group			
Race	18-29	30-44	45-65	Sum	18-29	30-44	45-65	Sum
White	166	166	166	498	166	166	166	498
African American	166	166	166	498	166	166	166	498
Hispanic	166	166	166	498	166	166	166	498
Others	166	166	166	498	166	166	166	498
Sum	664	664	664	1992	664	664	664	1992

Methods (Continued)

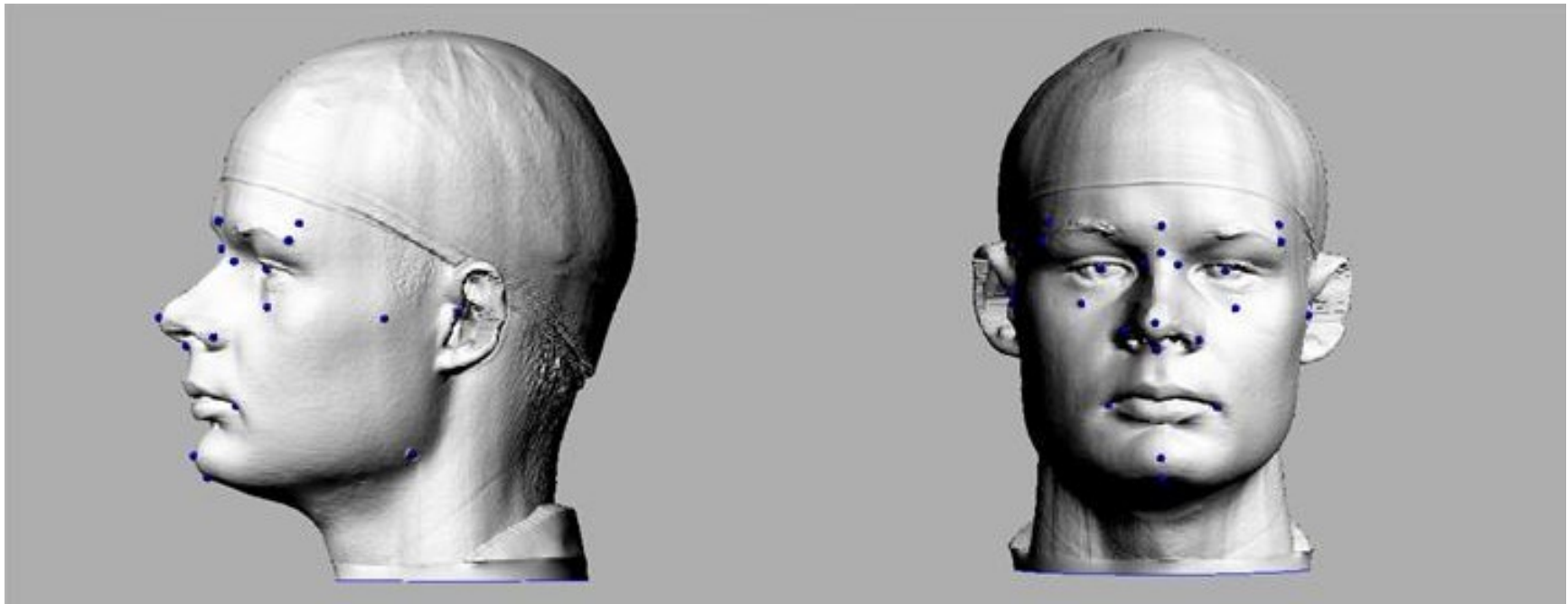
- Traditional measurement methods
- 3D laser scanner

Measurement List

Maximum Frontal Breadth
Menton Sellion Length
Minimum Frontal Breadth
Nasal Root Breadth
Neck Circumference
Nose Breadth
Nose Protrusion
Stature
Subnasale Sellion Length
Weight

Bigonial Breadth
Bitragion Coronal Arc
Bitragion Frontal Arc
Bitragion Subnasale Arc
Bitragion Chin Arc
Bizygomatic Breadth
Head Breadth
Head Length
Head Circumference
Interpupillary Breadth
Lip Length

3D Scan with Landmarks



Methods (Continued)

- **Nationwide data collection**
- **Manufacturing**
- **Construction**
- **Healthcare**
- **Fire department**
- **Law enforcement**

Results

- A total of 4026 subjects were measured using the traditional methods
- 1043 of them were scanned into the computer using a 3D head scanner
- Subjects aged 18-66 were included in the final sample (n=3998)

Final Sample by Sampling Cell

Race	Male				Female			
	Age Group			Total	Age Group			Total
	18-29	30-44	45-65		18-29	30-44	45-66	
White	271	611	485	1367	151	194	174	519
African American	101	255	278	634	51	213	325	589
Hispanic	155	182	75	412	53	36	37	126
Other	24	47	59	130	52	65	103	220
Total	551	1095	897	2543	307	508	639	1454

Final Sample (Scanned) by Sampling Cell

Race	Male				Female			
	Age Group			Total	Age Group			Total
	18-29	30-44	45-65		18-29	30-44	45-66	
White	77	169	128	374	97	52	14	163
African American	29	78	62	169	16	32	35	83
Hispanic	41	69	33	143	18	10	11	39
Other	6	21	11	38	12	4	14	30
Total	153	337	234	724	143	98	74	315

Final Sample by Geographic Region

State	N	%
California	229	5.7
Illinois	1564	39.1
Kentucky	93	2.3
New York	120	3.0
Ohio	751	18.8
Pennsylvania	29	0.7
Texas	857	21.4
Virginia	355	8.9
Total	3998	100.0

Final Sample by Occupation

Occupation	Male		Female		Total	
	N	%	N	%	N	%
Construction	594	23.4	47	3.2	641	16.0
Fire Fighting	775	30.5	74	5.1	849	21.2
Health Care	381	15.0	1100	75.7	1481	37.0
Law Enforcement	121	4.8	7	0.5	128	3.2
Manufacturing	429	16.9	60	4.1	489	12.2
Others	244	9.6	166	11.4	410	10.3
Total	2544	100.0	1474	100.0	3998	100.0

Weighting Factors

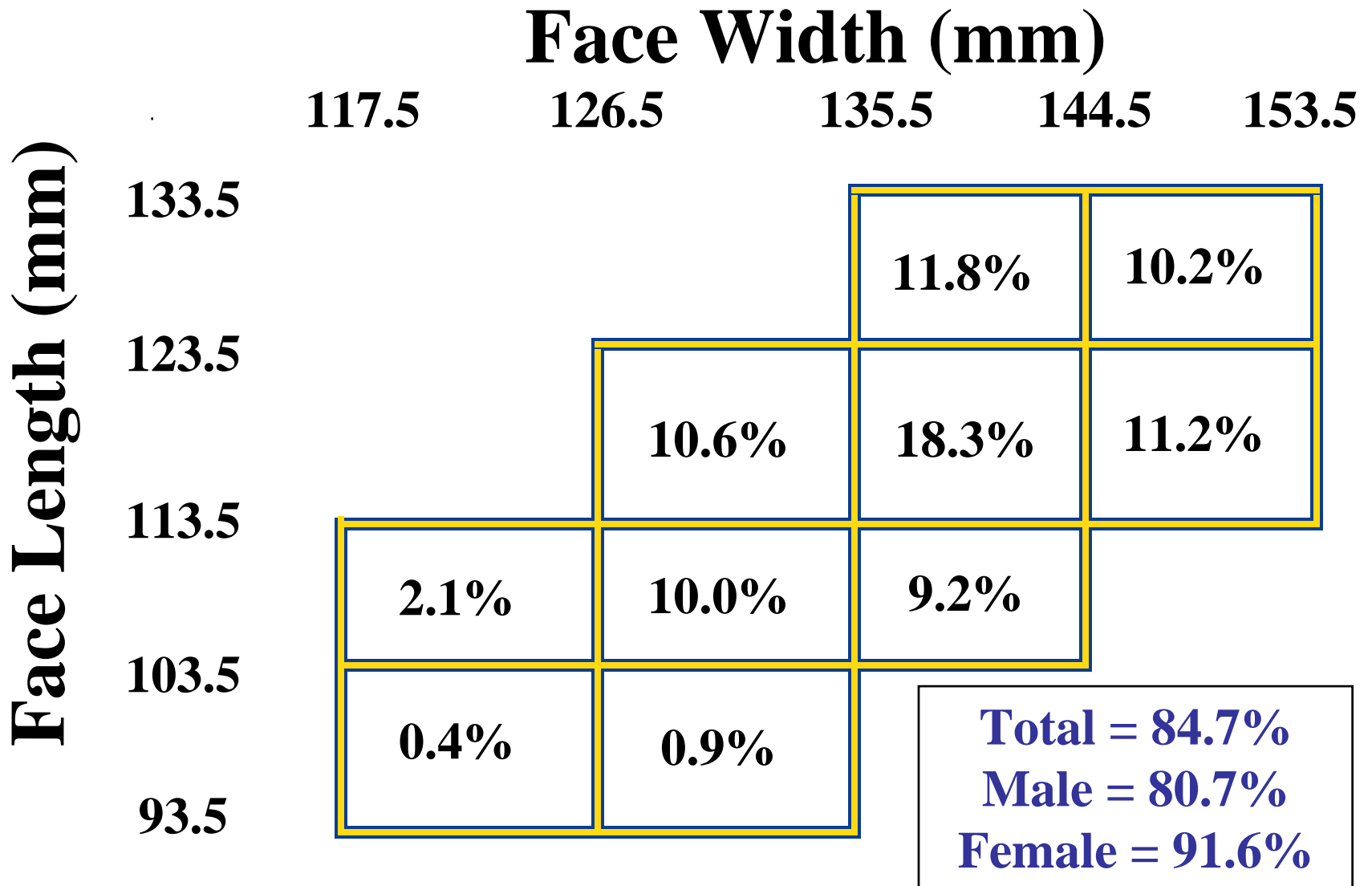
(Fraction of a Race/Age Group in U.S. Population Divided by the Fraction of the Same Group in the Sample)

Race	Male			Female		
	Age Group			Age Group		
	18-29	30-44	45-65	18-29	30-44	45-65
White	1.517	1.069	1.474	1.502	1.890	2.406
African American	0.836	0.425	0.312	1.000	0.324	0.162
Hispanic	0.809	0.691	0.934	1.124	1.822	1.150
Other	2.333	1.339	0.742	0.597	0.566	0.265

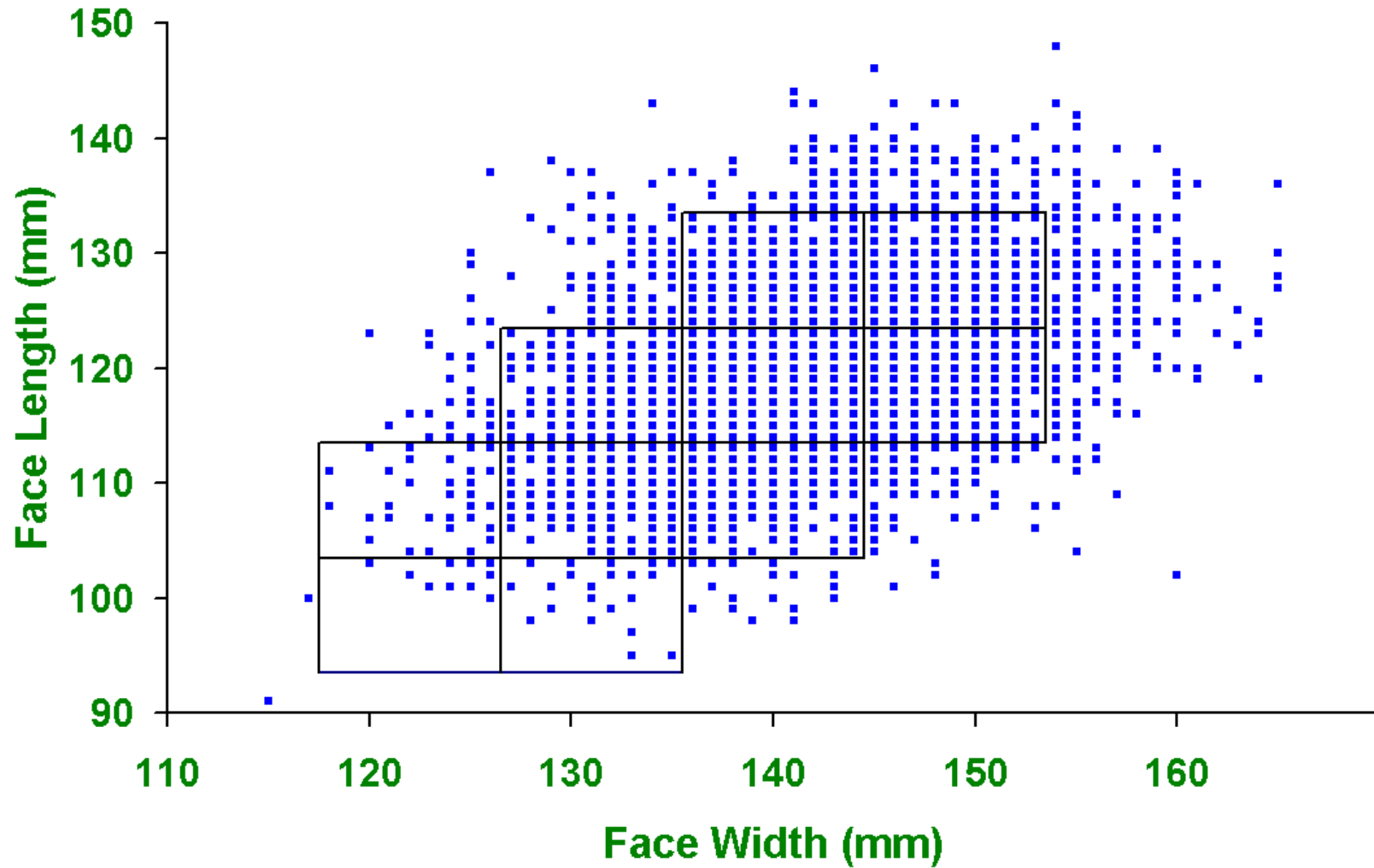
Summary Statistics for Key Dimensions

Facial Dimensions	Survey	Male		Female	
		Mean (mm)	SD	Mean (mm)	SD
Face Length	USAF	120.3	6.1	106.3	6.1
	NPPTL	122.7	7.1	113.4	6.1
Face Width	USAF	142.3	5.2	129.0	5.8
	NPPTL	143.5	6.9	135.0	6.5
Lip Length	USAF	52.3	3.8	43.8	4.2
	NPPTL	51.1	4.2	48.0	4.0

Fitting the NPPTL Data into the LANL Panel



Bivariate Distribution against the LANL Panel



Conclusions

- **An anthropometric database detailing the face-size distributions of the current U.S. workers was created**
- **The 1967-68 Air Force survey data is not reflective of the anthropometric distribution of the current U.S. workers**
- **New respirator fit test panels need to be developed**

Acknowledgement

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Thank You

Any questions?