HUMAN CENTERED DESIGN

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SUMMARY OF PREVIOUSLY COVERED PART OF HUMAN CENTERED DESIGN

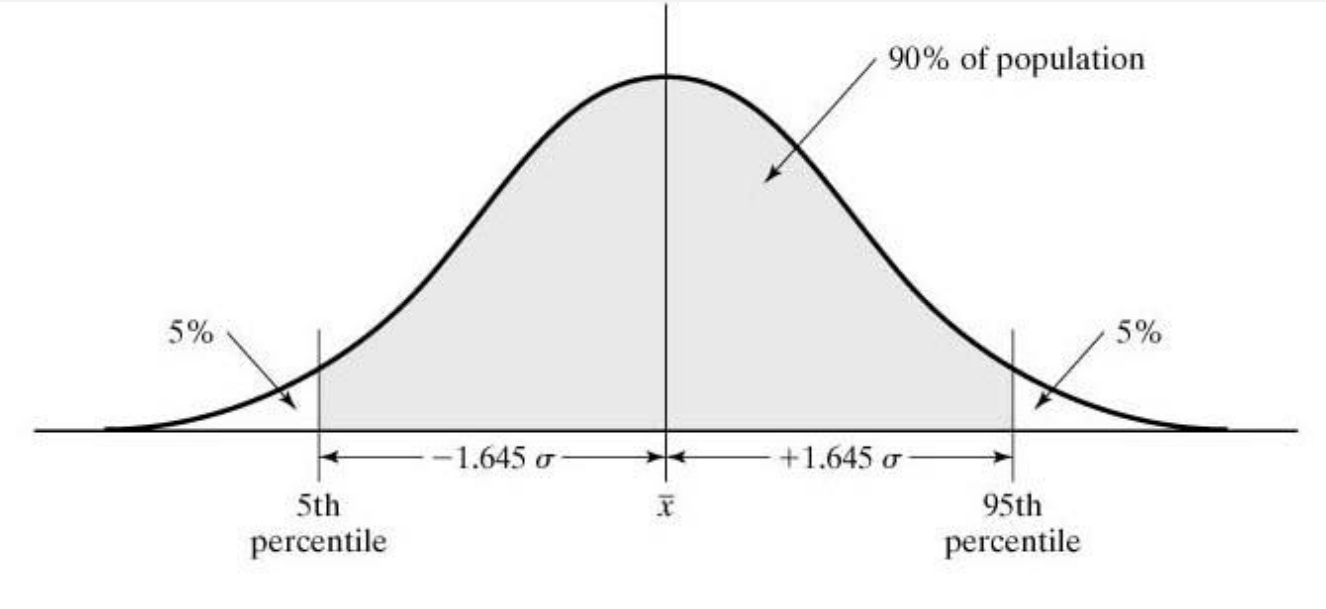
- Introduction to Human centered design
- Anthropometry
- Description of various dimensions of body

STATISTICS ESSENTIALS

- Anthropometric variables usually follow a normal distribution curve.
- Thus curve has a mean and standard deviation. (refer the mathematical formula to calculate mean and standard deviation from normal distribution curve)
- The more individuals that can be measured in an anthropometric survey, the more accurate the estimates will be. A statistic known as the standard error of the mean (se) is calculated to enable accuracy to be estimated.
- Se = sd/$\sqrt{n}$, where sd is standard deviation of the mean and n is the number of people measured in the survey.

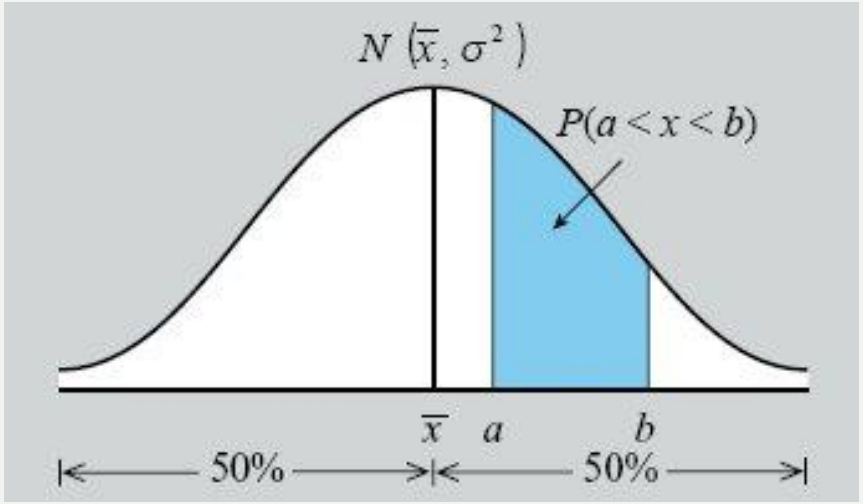
Normal Distribution in Anthropometry

Normal distribution for a given anthropometric variable of interest



Percentile limits on the variable

5^{th} and 95^{th} percentile points common



Properties of a Normal Distribution Curve

•The normal distribution is symmetric about the mean $\bar{x}$, ; 50% of the values lie above the mean (to the right), and 50% of the values lie below the mean (to the left). Because the mean divides the distribution in half, the mean is also the median. Because the maximum point on the graph occurs at the mean, the mean is also the mode of the distribution.

•100% of the distribution lies below the curve, the total area below the curve is 100% or 1.

•Approximately 68.3% of the distribution lies within one standard deviation of the mean; that is, the area below the curve between $\bar{x}-\sigma$ and $\bar{x}+\sigma$ is about 0.683.

•Approximately 95.4% of the distribution lies within two standard deviations of the mean; that is, the area below the curve between $\bar{x}-2\sigma$ and $\bar{x}+2\sigma$ is about 0.954.

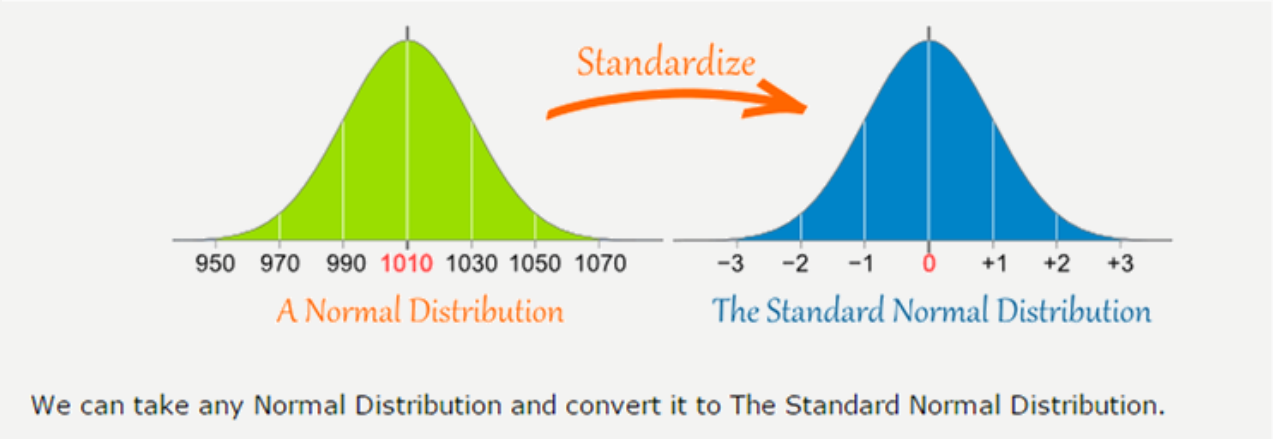
•The area below the curve between x = a and x = b is P(a < x < b), the probability that a given x-value will lie between a and b.

CALCULATING PERCENTILE VALUE OF THE BODY DIMENSION

- Any percentile may be calculated if mean and sd are known.
- The pth percentile of a variable X is given by,
- X_p = m+z SD
- Where z is the constant for the percentile concerned which we look up in the statistical table.
- For a convention purpose, Whenever a number is followed by another is square bracket, it refers to mean and standard deviation.

DIFFERENCE BETWEEN NORMAL DISTRIBUTION AND STANDARD NORMAL DISTRIBUTION CURVE

- Normal distribution can be fully described by its mean and standard deviation (SD).A normal distribution is called Standard Normal Distribution when its mean is zero and SD is equal to 1



Example: A survey of daily travel time had these results (in minutes):
26, 33, 65, 28, 34, 55, 25, 44, 50, 36, 26, 37, 43, 62, 35, 38, 45, 32, 28, 34

The **Mean is 38.8 minutes**, and the **Standard Deviation is 11.4 minutes**.

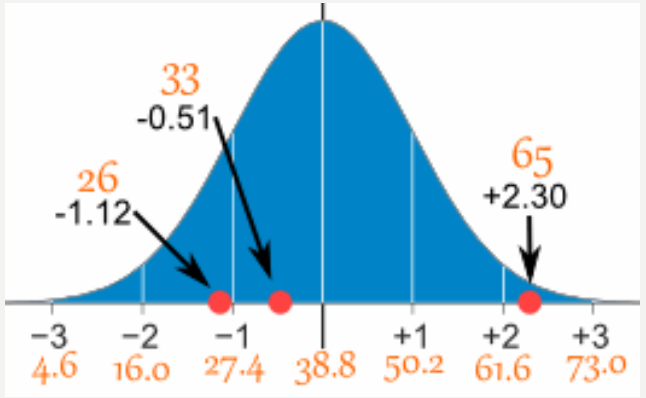
Convert the values to z-scores ("standard scores").
To convert **26**:
first subtract the mean: 26 - 38.8 = -12.8,
then divide by the Standard Deviation: -12.8/11.4 = -1.12
So **26** is **-1.12 Standard Deviations** from the Mean (This is Z score for plotting standard normal distribution curve)

Here are the first three conversions

- Original Value Calculation Standard Score (z-score)

26	(26-38.8) / 11.4	=	**-1.12**
33	(33-38.8) / 11.4	=	**-0.51**
65	(65-38.8) / 11.4	=	**+2.30**.....

- And here they are graphically:



- You can calculate the rest of the z-scores yourself!

Table of Probabilities Associated with Values of *z* in Normal Distribution

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
−.0	.5000	.4960	.4920	.4880	.4840	.4801	.4761	.4721	.4681	.4641
−.1	.4602	.4562	.4522	.4483	.4443	.4404	.4364	.4325	.4286	.4247
−.2	.4207	.4168	.4129	.4090	.4052	.4013	.3974	.3936	.3897	.3859
−.3	.3821	.3783	.3745	.3707	.3669	.3632	.3594	.3557	.3520	.3483
−.4	.3446	.3409	.3372	.3336	.3300	.3264	.3228	.3192	.3156	.3121
−.5	.3085	.3050	.3015	.2981	.2946	.2912	.2877	.2843	.2810	.2776
−.6	.2743	.2709	.2676	.2643	.2611	.2578	.2546	.2514	.2483	.2451
−.7	.2420	.2398	.2358	.2327	.2296	.2266	.2236	.2206	.2177	.2148
−.8	.2119	.2090	.2061	.2033	.2005	.1977	.1945	.1922	.1849	.1867
−.9	.1841	.1814	.1788	.1762	.1736	.1711	.1658	.1660	.1635	.1611
−1.0	.1587	.1562	.1539	.1515	.1492	.1469	.1446	.1423	.1401	.1379
−1.1	.1357	.1335	.1314	.1292	.1271	.1251	.1230	.1210	.1190	.1170
−1.2	.1151	.1131	.1112	.1093	.1075	.1056	.1038	.1020	.1003	.0985
−1.3	.0968	.0951	.0934	.0918	.0901	.0885	.0869	.0853	.0838	.0823
−1.4	.0808	.0793	.0778	.0764	.0749	.0735	.0721	.0708	.0694	.0681
−1.5	.0668	.0655	.0643	.0630	.0618	.0606	.0594	.0582	.0571	.0559
−1.6	.0540	.0537	.0526	.0516	.0505	.0495	.0485	.0475	.0465	.0455
−1.7	.0446	.0436	.0427	.0418	.0409	.0401	.0392	.0384	.0374	.0367
−1.8	.0359	.0251	.0344	.0336	.0329	.0322	.0314	.0307	.0301	.0294
−1.9	.0287	.0281	.0274	.0268	.0262	.0256	.0250	.0244	.0239	.0233-
−2.0	.0228	.0222	.0217	.0212	.0207	.0202	.0197	.0192	.0188	.0183
−2.1	.0179	.0174	.0170	.0166	.0162	.0158	.0154	.0150	.0146	.0143
−2.2	.0139	.0136	.0132	.0129	.0125	.0122	.0119	.0116	.0113	.0110
−2.3	.0107	.0104	.0102	.0099	.0096	.0094	.0091	.0089	.0087	.0084
−2.4	.0082	.0080	.0078	.0075	.0073	.0071	.0069	.0068	.0066	.064-
−2.5	.0062	.0060	.0059	.0057	.0055	.0054	.0052	.0051	.0049	.0048
−2.6	.0047	.0045	.0044	.0043	.0041	.0040	.0039	.0038	.0037	.0036
−2.7	.0035	.0034	.0033	.0032	.0031	.0030	.0029	.0028	.0027	.0026
−2.8	.0026	.0025	.0024	.0023	.0023	.0022	.0021	.0021	.0020	.0019

Source: from book "Introduction to Ergonomics" by R. S. bridger, CRC Press.

"Stature of men is 1740 [70] mm which means that stature of british men is normally distributed with a mean of 1740 mm and a std deviation of 70 mm.

Suppose we wish to calculate the 90th percentile of the stature of male adult indian population.
from the table we see that, for p = 90, z = 1.28
This means that 90th percentile is greater than the mean by 1.28 times the standard deviation
So, 90 percentile value = 1740 +70 *1.28 = 1830 mm.

Values of *z* for Selected Percentiles (*p*)

p	*z*	*p*	*z*
1	−2.33	99	2.33
2.5	−1.96	97.5	1.96
5	−1.64	95	1.64
10	−1.28	90	1.28
25	−0.67	75	0.67
50	0.00		
0.1	−3.09	99.9	3.09
0.01	−3.72	99.99	3.72
0.001	−4.26	99.999	4.26

https://books.google.co.in/books?id=0vAbDAAAQBAJ&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false

We have to estimate 5th percentile popliteal height of Indian males.
From table, we can find that

Mean = 415
Sd = 21

Constants Used to Estimate Population Proportions

Required Percentile	Area to Left of z	z Value (No. of Standard Deviations to Be Subtracted from the Mean)
0.5	0.0049	−2.58
1	0.0102	−2.32
2.5	0.0250	−1.96
3	0.0301	−1.88
5	0.0505	−1.64
10	0.1003	−1.28
15	0.1492	−1.04
20	0.2005	−0.84
25	0.2414	−0.67
75	0.7486	+0.67
80	0.7995	+0.84
85	0.8508	+1.04
90	0.8997	+1.28
95	0.9495	+1.64
97	0.9699	+1.88
97.5	0.9750	+1.96
99	0.9898	+2.32
99.5	0.9951	+2.58

Note: The total area under the normal curve is taken to be 1 (Appendix A).

Source: from book "Introduction to Ergonomics" by R. S. bridger, CRC Press.

QUESTIONS TO SOLVE

- Ninety fifth percentile value of a normal distribution variable is found by adding 1.64 standard deviations to mean. If the mean body mass of males is 82.1 kg and the standard deviation is 17.1 kg, what is the 95^{th} percentile body mass?

QUESTIONS TO SOLVE

- The 5th percentile of a normally distributed variable is found by subtracting 1.64 standard deviation from the mean. If the sitting height of females is 861 mm and standard deviation is 36 mm, what is the 5th percentile sitting height ?

STANDING HEIGHTS OF MALES AND FEMALES THROUGHOUT THE WORLD

	Males		Females	
Region	Centimeters	Inches	Centimeters	Inches
North America	179	70.5	165	65.0
Northern Europe	181	71.3	169	66.5
Central Europe	177	69.7	166	65.4
Southeastern Europe	173	68.1	162	63.8
India, North	167	65.7	154	60.6
India, South	162	63.8	150	59.1
Japan	172	67.7	159	62.6
Southeast Asia	163	64.2	153	60.2
Australia (European)	177	69.7	167	65.7
Africa, North	169	66.5	161	63.4
Africa, West	167	65.7	153	60.2

Work Systems and the Methods, Measurement, and Management of Work
by Mikell P. Groover, ISBN 0-13-140650-7.

ANTHROPOMETRIC DESIGN PRINCIPLES

- Design for extreme individuals
- Design for adjustability
- Design for the average user
- Design different sizes for different size users

THANK YOU ….

PLEASE READ ANTHROPOMETRY FROM RECOMMENDED REFERENCE BOOKS FOR A BETTER UNDERSTANDING OF NEXT LECTURE