

Elementary Ergonomics

2D and 3D

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www.dined.nl



body dimensions

body strength

reach (arms, hands)

□ flexibility (of the joints)

weight







Measuring, How?





Examples form?

Measurement form

Metingen		Percentiel		Percentiel						
	Meet- waarde (± 0,5 mm) (in mm)	DINED -Dutch adults mixed (20-60)	DINED -Dutch student s mixed	5		50	35			
ichaamslengte	1652,0	19,49	11,32	1						
Schouderhoogte staand	1360,0	22,66	13,07							
Ellebooghoogte staand	1022,0	20,05	16,38							
Onderbeenlengte zittend	432,0	21,77	12,01							
Bil-knieholtediepte	486,0	25,62	38,68		1					
Bil-voetlengte zittend	1046,0		36,99		2					
Schouderbreedte	374,0	1,84	2,34							
Heupbreedte zittend	457,0	97,67	>99,99	4						
Breedte over de ellebogen	520,0	83,06	99,73				1			
Armlengte zittend	719,0	49,6			7					
Hoofdomtrek	563,0	48,8	1		1					
Tailleomtrek	815.0	32.76	1		1					

TUDelft

Anatomy





Definitions in ASB

- 312. <u>Elbow Rest Height</u>. The height of the bottom of the tip of the elbow above the sitting surface.
- 318. <u>Elbow-Elbow Breadth</u>. The distance across the lateral surfaces of the elbows measured with the elbows flexed and resting lightly against the body.





Anthropometric Source Book Volume II: A Handbook of Anthropometric Data Edited by Staff of Anthropology Research Project Webb Associates Yellow Springs, Obio

and Space Administration

Anthropometric Source Book, 1978



Definitions in ASB

- 293. <u>Elbow Breadth (Humeral Breadth</u>). The distance between the medial and lateral epicondyles of the humerus measured with the flesh compressed.
- 297. <u>Elbow Breadth (Humeral Breadth)</u>, II. The previous measurement repeated on the opposite elbow. (Not pictured)
- 300. <u>Elbow Circumference, Flexed</u>. The circumference of the elbow measured over its tip and through its crotch with the arm bent 90°, the upper arm horizontal, and the fist clenched.
- 301. <u>Elbow Circumference</u>, Fully Bent. The distance around the maximum prominence of olecranon and the inside face of the elbow measured with the elbow fully flexed and the fingers touching the shoulder.
- 303. <u>Elbow Circumference, Relaxed</u>. The circumference of the elbow measured with the tape passing over the tip of the elbow.
- 309. Elbow Height. The height of radiale.





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More definitions



Op maat gemaakt Menselijke maten voor het ontwerpen en beoordelen van gebruiksgoederen	
J.F.M.*Molenbroek	

Faculteit van het Industrieel Ontwerpen Technische Universiteit Delft

MAAT	CODE	ASB	NEN	DELKI	DELSTI	GDVV	KIMA1	KIMA2	DMIL	DINED
acromion-muur afstand	124		4.4.01							
ambulantie	074					х				
armlengte binnenzijde	047	764							A08	
armlengte buitenzijde	046	773							A07	
bil-knicholte lengte	038	200	4.4.06	х	x	х	х	x	E06	16
bil-knieschijf lengte, zittend	039	194	4.4.07	х	х		х	х	E07	17
bil-voetlengte	098	191			х			х		18
bitragion boog	028	144	4.3.14						B05	
borstbreedte mesosternum	048	223	4.1.11							
borstbreedte, gemeten met meetlint	088								A10	
borstdiepte op tepelhoogte	069	236	4.1.09		x		x	х		03
borstomyang op tepelhoogte	051	230	4.4.09						A13	

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handbreedte zonder duim	de afstand tussen de ulnaire zijde van de pink en de radiale zijde van de wijsvinger, gemeten ter hoogte van de distale uiteinden van de middenhandbeentjes (metacarpale botstukken)	de te meten persoon houdt de onderarm horizontaal met de hand gestrekt	schuifmaat	018
handdikte	de maximale afstand tussen de handpalm en de handrug ter hoogte van het middelvingergewricht	de dikte wordt gemeten met gestrekte hand	passer	102



More definitions

TUDelft





More definitions



Child development, design implications and accident prevention





B-28 Popliteal height, seated [cm]

definition: The vertical distance from the footrest surface to the hollow of the knee.

- *method*: The child sits erect, thighs supported and feet resting on a platform adjusted for 90° knee flexion. The distance is measured from the footrest surface to the superior surface of the seat.
- device: Automated anthropometer.





User group characteristics

 tall/small
strong/weak
flexible/stiff
physical able/disabled









Thyssen Krupp, 2011







User evaluation 1:1 prototype





Niek Marks, 2011



Anthropometry

Based on the proposed posture different anthropometric sizes are identified.

A - Chest breadth

The chest breadth will influence the width of the total product and is based on "Anthropometric source book. Volume 2" (see Appendix 1.1). This data included multiple sample groups and the lowest P5 and highest p95 have been chosen to represents its boundaries.

Minimal P5: 217 mm Maximal P95: 392 mm

B - Axilla Height

The axilla height is crucial for the height of the final product. The found data is based on "Anthropometric source book. Volume 2" (see Appendix 1.2) This data included multiple sample groups and the lowest P5 and highest p95 have been chosen to represents its boundaries.



Niek Marks, 2011



Anthropometric measurement of the Chinese elderly living in the Beijing area Haitao Hua, Zhizhong Lia,, Jingbin Yana, Xiaofang Wanga, Hui Xiaob, Jiyang Duana, Li Zhenga aDepartment of Industrial Engineering, Tsinghua University, Beijing 100084, China bChina National Institute of Standardization, Zhichun Road, 4, Haidian District, Beijing 100088, China Paceived & March 2005: received in revised form 7 Nevember 2006: accepted 19

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Available online 12 February 2007

















Daan Janssen, 2011









Daan Janssen, 2011



Anthropometric tools

□ 1D anthropometry

2D anthropometry

□ 3D anthropometry

4D anthropometry (or 3D in time; dynamic)



www.dined.nl



Gives insight in correlation between 2 body dimensions

and insight in consequences for related product dimensions

□ but only in a 2D plane

requires individual measurement (rough data points)



Correlation



Correlations Woman (DELSTU)	1 Acromial height (standing)	5 Bideltoid breadth	7 Buttock- knee length (sitting)	8 Buttock- popliteal length	12 Chest depth	17 Eye height (sitting)	21 Forearm- hand length	22 Hand breadth	24 Hand length	27 Hip breadth (standing)
1 Acromial height C	1.000	0.374 **	0.732 **	0.651 **	0.218 *	0.628 **	0.822 **	0.235	0.561 **	0.483 **
(standing) N	89	89	89	87	89	89	50	50	89	89
5 Bideltoid C	0.374 **	1.000	0.536 **	0.350 **	0.432 **	0.394 **	0.337 *	0.166	0.325 **	0.545 **
breadth N	89	89	89	87	89	89	50	50	89	89
7 Buttock-knee C	0.732 **	0.536 **	1.000	0.899 **	0.428 **	0.370 **	0.657 **	0.092	0.540 **	0.633 **
length N	89	89	89	87	89	89	50	50	89	89
8 Buttock popliteal C	0.651 **	0.350 **	0.899 **	1.000	0.390 **	0.285 **	0.654 **	0.140	0.519 **	0.595 **
length N	87	87	87	87	87	87	48	48	87	87
12 Chest depth C	0.218 *	0.432 **	0.428 **	0.390 **	1.000	0.203	0.223	0.113	0.203	0.539 **
N	89	89	89	87	89	89	50	50	89	89
17 Eye height C	0.628 **	0.394 **	0.370 **	0.285 **	0.203	1.000	0.553 **	0.415 **	0.491 **	0.419 **
(sitting) N	89	89	89	87	89	89	50	50	89	89
21 Forearm-hand C	0.822 **	0.337 *	0.657 **	0.654 **	0.223	0.553 **	1.000	0.238	0.862 **	0.309 *
length N	50	50	50	48	50	50	50	50	50	50
22 Hand breadth C	0.235	0.166	0.092	0.140	0.113	0.415 **	0.238	1.000	0.430 **	0.223
N	50	50	50	48	50	50	50	50	50	50
24 Hand length C	0.561 **	0.325 **	0.540 **	0.519 **	0.203	0.491 **	0.862 **	0.430 **	1.000	0.329 **
N	89	89	89	87	89	89	50	50	89	89
27 Hip breadth C	0.483 **	0.545 **	0.633 **	0.595 **	0.539 **	0.419 **	0.309 *	0.223	0.329 **	1.000
(standing) N	89	89	89	87	89	89	50	50	89	89

Correlation overview paper SAE, 1998

Dependence between two variables or two data sets















Ellipse

How to use two-dimensional data

Ellipse

Ellipse is a tool to support the interpretation of two-dimensional data. The program allows you to display two-dimensional sample data as points in a scatter plot and find out what percentage of the sample data are contained in rectangles, called Blocks. Ellipse simultaneously shows the percentage of probability of the bivariate normal distribution contained in the Block. Ellipse also shows an ellipse containing a certain probability percentage of the bivariate normal distribution.

- More information about Ellipse
- Download Ellipse

Additional resources

 Op maat gemaakt Menselijke maten voor het gebruiken en beoordelen van gebruiks goederen by J.F.M. Molenbroek. TUD, 1994

Available data

Currently the TU Delft made two full datasets available that can be used for two-dimensional techniques. These will be available soon.

- GDVV 1982 Dutch elderly (360KB, Excel-document)
- Dutch students (229KB, Excel-document)

www.dined.nl







Four chair types (S, M, L, XL)

Examination furniture

Adjustable table height



Two important **product** dimensions:

□ Seat depth

□ Seat height



Two related **body** dimensions:

Buttock - popliteal length (sitting depth)

Popliteal height (lower leg length)

Examination furniture





Lower leg length (popliteal height)

Ellipse



From including one till all









Roller Coaster, Vekoma











User research: Mock-ups and subjects

Safety harness





User research: Mock-ups and subjects

Safety harness







- Digital Human Modeling ADAPS
- Ramsis
- 🗖 Jack
- Safework













www.dined.nl



laser scanning



Ceasar project

Sizechina



laser scanning





Sizechina



laser scanning





Sizechina



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laser scanning





Sizechina





Ears can not be scanned yet!







Photogrammetry



















Static scanner with human or product on rotating platform















Cross sections







Relevant websites

- www.dined.nl (anthropometry)
- http://store.sae.org/caesar (Caesar)
- www.sizechina.com (head sizes)
- http://wear.io.tudelft.nl (antro)
- www.io.tudelft.nl/rsi (rsi research)



Ellipse assignment

- Scatter plot breadth acr elbows & popliteal height
- Measure team members (sub population DELSTU)
- Place colour dots in Ellipse
- Design of office chair, include all team members
- Consider tolerance in usage (arm & leg angles)
- Draw minimum box armrest distance & seat height
- Arm rests 10 cm width, unlimited vertical adjustable



End of this presentation

Thank you for your attention

