Citation: **Ahmed Moustafa (2024), Anthropometry of the Hand and Product Design, International Design Journal, Vol. 14 No. 6, (November 2024) pp 21-19 DOI: 10.21608/idj.2024.378407**

Anthropometry of the Hand and Product Design

Dr. Ahmed Waheed Moustafa
Professor, Department of Metal Products and Jewelry, Faculty of Applied Arts, Helwan Unicersity, ahmedwms@hotmail.com

Abstract:

Statement of the problem: Given the importance of the hand in many tasks requiring the manipulation of objects, the information gathered in this study may help in the development of a human hand model that is simple and straightforward to use for all product designers. A set of key anthropometric characteristics that are pertinent to the creation and design of human digital models have been suggested by recent research. Nevertheless, there is a severe absence of the dimensions of available data that allow designers to operate as effectively and efficiently as possible. Designing consumer goods for commercial usage has been incredibly slow when it comes to user anthropometry research. **Objective**: The purpose of this study is to define, characterize, and illustrate hand measurements and their implications and associations for product design. In order to facilitate a better knowledge of hand dimensions and their relationships, the study has also examined the anatomy and structure of the human hand for employing real key measurements and Parameters. Therefore, an widespread study has been dedicated to anthropometric data collection methods covering traditional and most sophisticated techniques. For convenience and preference, it also creates a link between user and product sizes. Furthermore, it draws implications for design that are particular to user groups, generalizes these implications for a range of goods, and illustrates these implications throughout the product development cycle. **Methodology**: The study employed both analytical descriptive and deductive approach in order to developing a product design criterion based on and implementing hand anthropometry. **Results**: A summary of all the variables linking hand anthropometry to product design and potential future developments in this area concludes the study. Product designers should be able to readily match product interfaces with human capabilities and competencies thanks to the data sets offered and comparisons made.

Keywords:

Hand Anthropometry, Hand Anatomy, Product Design, Photogrammetry, 3D Body Scanning

References:

1. Albin, T. & Molenbroek, J. (2023). ***Introduction to the Special Issue, Anthropometry in Design***. Ergonomics in Design. [Source]
2. Ashdown, S. P. (2020). Full body 3-D scanners. Anthropometry in Anthropometry, ***Apparel Sizing and Design (Second Edition)***, The Textile Institute Book Series, Pages 145-168
3. Bartol, K., Bojanić, D., Petković, T., & Pribanić, T. (2021). ***A review of body measurement using 3D scanning***. Ieee Access. [Source]
4. Bridger, Robert, (2018), ***Introduction to human factors and ergonomics***, Fourth edition, Boca Raton, Taylor & Francis, CRC Press.
5. Bruno, F., Barbieri, L., & Muzzupappa, M. (2020). ***A Mixed Reality system for the ergonomic assessment of industrial workstations***. International Journal on Interactive Design and Manufacturing (IJIDeM), 14(3), 805-812. [Source]
6. Capsi-Morales, P., Grioli, G., Piazza, C., Bicchi, A., & Catalano, M. G. (2020). ***Exploring the role of palm concavity and adaptability in soft synergistic robotic hands***. IEEE Robotics and Automation Letters, 5(3), 4703-4710. [Source]
7. Chow, L. (2022). ***Finite element model for design of pressure therapy gloves for hypertrophic scars***. [Source]
8. Cotes, J. E. (2020). ***Body Size and Anthropometric Measurements***, Wiley Research, https://doi.org/10.1002/9781118597309.ch4
9. Cross, N. (2021). ***Engineering design methods: strategies for product design***. [Source]
10. Daruis, D. D. I., Khamis, N. K., & Deros, B. M. (2021). ***The hand–the basic anthropometry.*** Human Factors and Ergonomics Journal (HFEJ), Vol. 6(2): 49 – 55
11. Dimitrijevic, M., Lalovic, D., & Milovanov, D. (2021). ***Correlation of different anthropometric methods and bioelectric impedance in assessing body fat percentage of professional male athletes.*** Experimental and Applied Biomedical Research (EABR). [Source]
12. Disabilities Administration (2012) ***Adaptive Equipment Maintenance Protocols***, Developed by Developmental Adaptive Equipment Task Force. Department of Disability Services, DC.
13. Dunai, L., Novak, M., & García Espert, C. (2020). ***Human hand anatomy-based prosthetic hand***. Sensors. [Source]
14. Fang Yu, Lei Zeng, Ding Pan, Xinlei Sui & Juyu Tang, (2020) ***evaluating the accuracy of hand models obtained from two 3D scanning techniques***, Scientific RepoRtS, 10:11875, https://doi.org/10.1038/s41598-

020-68457-6
15. Ferrari, R., Lachs, L., Pygas, D. R., Humanes, A., Sommer, B., Figueira, W. F., ... & Guest, J. R. (2021). ***Photogrammetry as a tool to improve ecosystem restoration***. Trends in Ecology & Evolution, 36(12), 1093-1101. [Source]
16. Fulton, P. V., Löhlein, S., Paredes-Acuña, N., Berberich, N., & Cheng, G. (2021). ***Wrist exoskeleton design for pronation and supination using mirrored movement control***. In 20th International Conference on Advanced Robotics (ICAR) pp. 575-580. [Source]
17. Gupta, Deepti. (2020). ***New directions in the field of anthropometry, sizing and clothing fit, in Anthropometry, Apparel Sizing and Design*** (Second Edition), The Textile Institute Book Series, Pages 3-27
18. Hajaghazadeh, M., Taghizadeh, M., Mohebbi, I., & Khalkhali, H. (2022). ***Hand anthropometric dimensions and strengths in workers: A comparison of three occupations***. Human Factors and Ergonomics in Manufacturing & Service Industries, 32(5), 373-388. [Source]
19. Joanna Szkudlarek, Bartłomiej Zagrodny, Sandra Zarychta, and Xiaoxue Zhao (2023), 3D ***Hand Scanning Methodology for Determining Protective Glove Dimensional Allowances***, Int J Environ Res Public Health. 2023 Feb; 20(3): 2645. doi: 10.3390/ijerph20032645
20. John D. Lee, Christopher D. Wickens, Yili Liu, Linda Ng Boyle (2017), ***Designing for People: An Introduction to Human Factors Engineering***, 3rd Edition, Create Space Charleston, SC, ISBN-10: 1539808009.
21. John-John Cabibihan & Aya Gaballa. (2021). ***Indirect Hand Anthropometric Measurements using 3D Scanning Devices***. IEEE Dataport. https://dx.doi.org/10.21227/7gca-j353
22. Joyce Sabari, Dimitre G. Stefanov, Judy Chan, Joyce Starr (2019), ***Adapted Feeding Utensils for People With Parkinson's-Related or Essential Tremor,*** American Journal of Occupational Therapy 73(2):7302205120p1, DOI: 10.5014/ajot.2019.030759
23. Kaewdok, T., Sirisawasd, S., Norkaew, S., & Taptagaporn, S. (2020). ***Application of anthropometric data for elderly-friendly home and facility design in Thailand***. International Journal of Industrial Ergonomics, 80, 103037. [Source]
24. Kamariotou, V., Kamariotou, M., & Kitsios, F. (2021). ***Strategic planning for virtual exhibitions and visitors' experience: A multidisciplinary approach for museums in the digital ag***e. Digital Applications in Archaeology and Cultural Heritage, 21, e00183. [Source]
25. Kashef, S. R., Amini, S., & Akbarzadeh, A. (2020). ***Robotic hand: A review on linkage-driven finger mechanisms of prosthetic hands and evaluation of the performance criteria. Mechanism and Machine*** Theory. [Source]
26. Kelkanlo, R., Kouhnavard, B., & Falaki, S. H. (2020). ***Investigating Hand Anthropometric Dimensions-A Case Study on Office Personnel and Car Mechanics***. International Journal of Occupational Hygiene, 12(3), 180-191. [Source]
27. Kivell, T. L., Ostrofsky, K. R., Richmond, B. G., & Drapeau, M. S. (2020). ***Metacarpals and manual phalanges***. Hominin Postcranial Remains from Sterkfontein, South Africa, 1936-1995, 106. [Source]
28. Laffranchi, M., Boccardo, N., Traverso, S., Lombardi, L., Canepa, M., Lince, A., ... & De Michieli, L. (2020). Th***e Hannes hand prosthesis replicates the key biological properties of the human hand***. Science robotics, 5(46), eabb0467. [Source]
29. Linsey Griffin, Susan Sokolowski, Heajoo Lee, Robin Carufel (2019), ***Methods and Tools for 3D Measurement of Hands and Feet***, In book: Advances in Interdisciplinary Practice in Industrial Design, DOI: 10.1007/978-3-319-94601-6_7
30. Ma, L. & Niu, J. (2021). Three-Dimensional (3D) ***Anthropometry and its Applications In Product Design***. Handbook of human factors and ergonomics. [Source]
31. Malhotra, S., Yadav, J., & Chopra, A. (2023, May). ***Precision Anthropometric Insights for User-Centric Mobile Phone Design***. In International Conference on Business and Technology (pp. 192-203). Cham: Springer Nature Switzerland.
32. Mandahawi, Nabeel, Sheik Imrhan, Salman Al-Shobaki, B.Sarder (2008) ***Hand anthropometry survey for the Jordanian population***, International Journal of Industrial Ergonomics, Vol 38(11), Pages 966-976, https://doi.org/10.1016/j.ergon.2008.01.010
33. Martin, P. (2023). T***he Seven Measures of the World***. [Source]
34. Matthew S. Rogers, Alan B. Barr, Boontariga Kasemsontitum & David M. Rempel (2008). ***A three-dimensional anthropometric solid model of the hand based on landmark measurements***, Ergonomics Vol. 51, No. 4, 511–526, DOI:10.1080/00140130701710994
35. Mocini, E., Cammarota, C., Frigerio, F., Muzzioli, L., Piciocchi, C., Lacalaprice, D., ... & Pinto, A. (2023). ***Digital anthropometry: A systematic review on precision, reliability and accuracy of most popular existing technologies. Nutrients,*** 15(2), 302. [Source]
36. Mohd Javaid, Abid Haleem, Ravi Pratap Singh,Rajiv Suman (2021), ***Industrial perspectives of 3D scanning: Features, roles and it's analytical application***, Sensors International, Sensors International, Volume 2, 2021,https://doi.org/10.1016/j.sintl.2021.100114
37. Morgan, J. & Liker, J. K. (2020). ***The Toyota product development system: integrating people, process, and technology***. [Source]
38. Moustafa A. W. (2016) "***Anthropometry of the Egyptian female hand with relevance to control design***", 4th International Conference of the Faculty of Applied Arts, Helwan University, Cairo (28-29 February,

2016)
39. N. N. Kaashki, X. Dai, T. Gyarmathy, P. Hu, B. Iancu and A. Munteanu, "***Automatic and Fast Extraction of 3D Hand Measurements using a Deep Neural Network***," 2022 IEEE International Instrumentation and Measurement Technology Conference (I2MTC), Ottawa, ON, Canada, 2022, pp. 1-6, doi: 10.1109/I2MTC48687.2022.9806686.
40. Nickerson, B. S., McLester, C. N., McLester, J. R., & Kliszczewicz, B. M. (2020). ***Relative accuracy of anthropometric-based body fat equations in males and females with varying BMI classifications***. Clinical nutrition ESPEN, 35, 136-140. [Source]
41. Padilla, C. J., Ferreyro, F. A., & Arnold, W. D. (2021). ***Anthropometry as a readily accessible health assessment of older adults***. Experimental Gerontology. [Source]
42. Pal, A., Patel, T., & Khro, K. (2024). ***A comparative study of the effectiveness of photogrammetric versus manual anthropometric measurements***. Work. [Source]
43. Parvez, M. S., Shahriar, M. M., Tasnim, N., & Hoque, A. S. M. (2022). ***An anthropometry survey of Bangladeshi university students***. Journal of Industrial and Production Engineering, 39(2), 89-108. [Source]
44. Patrick, V. M. & Hollenbeck, C. R. (2021). ***Designing for all: Consumer response to inclusive design***. Journal of consumer psychology. [Source]
45. Pepe, M. & Domenica, C. (2020). ***Techniques, tools, platforms and algorithms in close range photogrammetry in building 3D model and 2D representation of objects and complex architectures***. Computer-Aided Design and Applications. [Source]
46. Reiman, A., Kaivo-oja, J., Parviainen, E., Takala, E. P., & Lauraeus, T. (2021). ***Human factors and ergonomics in manufacturing in the industry 4.0*** context–A scoping review. Technology in Society, 65, 101572. [Source]
47. Rincón-Becerra, O. & García-Acosta, G. (2020). ***Estimation of anthropometric hand measurements using the ratio scaling method for the design of sewn gloves***. Dyna. [Source]
48. Rosu, D., Enache, I. S., Muntean, R. I., & Stefanica, V. (2024). ***Effects of Kin Ball Initiation: Pre-and Post-Pandemic Impact on Palmar Muscle Strength, Endurance, and Coordination in Non-Athlete Participants***. Sports. [Source]
49. Rumbo-Rodríguez, L., Sánchez-SanSegundo, M., Ferrer-Cascales, R., García-D'Urso, N., Hurtado-Sánchez, J. A., & Zaragoza-Martí, A. (2021). ***Comparison of body scanner and manual anthropometric measurements of body shape: a systematic review***. International journal of environmental research and public health, 18(12), 6213. [Source]
50. Saaludin, N., Saad, A., & Mason, C. (2022). ***Reliability and ethical issues in conducting anthropometric research using 3D scanner technology***. In Digital Manufacturing Technology for Sustainable Anthropometric Apparel (pp. 71-95). Woodhead Publishing. [Source]
51. Seifert, E. A. (2020). ***Comparison and Validation of Traditional and Three-Dimensional Anthropometric Methods for Measuring the Hand through Reliability, Precision, and Visual Analysis***. [Source]
52. Shahriar, M. M., Parvez, M. S., & Lutfi, M. (2020). ***A survey of hand anthropometry of Bangladeshi agricultural farm workers***. International Journal of Industrial Ergonomics, 78, 102978. [Source]
53. Shan, D., Geng, J., Shu, M., & Fouhey, D. F. (2020). ***Understanding human hands in contact at internet scale***. In Proceedings of the IEEE/CVF conference on computer vision and pattern recognition (pp. 9869-9878). [Source]
54. Shan, G. (2023). ***Exploring the intersection of equipment design and human physical ability: Leveraging biomechanics, ergonomics/ anthropometry, and wearable technology for enhancing human***, Advanced Design Research. [Source]
55. Sheik N. Imrhana; M. D. Sarderb; Nabeel Mandahawic (2009). ***Hand anthropometry in Bangladeshis living in America and comparisons with other populations***, Ergonomics Volume 52(8) pp987-998, DOI:10.1080/00140130902792478
56. Smith, B., McCarthy, C., Dechenaud, M. E., Wong, M. C., Shepherd, J., & Heymsfield, S. B. (2022). ***Anthropometric evaluation of a 3D scanning mobile application***. Obesity, 30(6), 1181-1188. [Source]
57. Stark, E., Haffner, O., & Kučera, E. (2022). ***Low-cost method for 3D body measurement based on photogrammetry using smartphone. Electronics***. [Source]
58. Taifa, I. W., Desai, D. A., & Bulsara, N. M. (2021). ***The development of an ergonomically designed product through an integrated product team approach***. International Journal of Occupational Safety and Ergonomics. [Source]
59. Thanas M. Greiner (1991) ***Hand Anthropometry of U.S. Army Personnel***, Anthropology Branch, Behavioral Sciences Division, Soldier Science Directorate, U.S. Army Natick Research, Development & Engineering Center, Natick, REPORT NUMBER MA 01760-5020
60. Thelwell, M., Chiu, C. Y., Bullas, A., Hart, J., Wheat, J., & Choppin, S. (2020). ***How shape-based anthropometry can complement traditional anthropometric techniques: a cross-sectional study***. Scientific Reports, 10(1), 12125. [Source]
61. Thomas M. Greiner (1991), ***Hand Anthropometry OF U.S. Army Personnel***, Anthropology Branch, Behavioral Sciences Division Soldier Science Directorate, U.S. Army Natick Research, Development & Engineering Center, Natick, Report Number MA 01760-5020
62. Tuong Nguyen Van, Natasa Naprstkova (2024) ***Accuracy of Photogrammetric Models for 3D printed Wrist-hand Orthoses***, Manufacturing Technology, Vol. 24 (3), Doi: 10.21062/mft.2024.048

63. Uriel, J., Ruescas, A., Iranzo, S., Ballester, A., Parrilla, E., Remón, A., & Alemany, S. (2022). ***A methodology to obtain anthropometric measurements from 4D scans***. In Proceedings of the 7th International Digital Human Modeling Symposium (Vol. 7, No. 1). University of Iowa. [Source]
64. Vijayan, V., Connolly, J. P., Condell, J., McKelvey, N., & Gardiner, P. (2021). ***Review of wearable devices and data collection considerations for connected health.*** Sensors, 21(16), 5589. [Source]
65. Wang, L., Lee, T. J., Bavendiek, J., & Eckstein, L. (2021). ***A data-driven approach towards the full anthropometric measurements prediction via Generalized Regression*** Neural Networks. Applied Soft Computing. [Source]
66. Wen, J., Wang, J., Xu, Q., Wei, Y., Zhang, L., Ou, J., & Tong, M. (2020). ***Hand anthropometry and its relation to grip/pinch strength in children aged 5 to 13 years***. Journal of International Medical Research, 48(12), 0300060520970768. [Source]
67. Yang, Y., Zhou, H., Song, Y., & Vink, P. (2021). ***Identify dominant dimensions of 3D hand shapes using statistical shape model and deep neural network***. Applied Ergonomics. [source].

Paper History:

Paper received June 17, 2024, Accepted August 27, 2024, Published on line November 1, 2024

