



Strategies and Challenges in Applying Anthropometric Data in Design

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Anthrotech

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A little about me

- With Anthrotech since 1983
 - Before personal computers!
- Conducted large anthropometric surveys for government and private industry
- Conducted anthropometric fit tests of protective equipment, clothing, products
- Worked on ISO standards since 1999
 - ISO 7250 dimensions and definitions
 - ISO 15535 requirements for anthropometric databases

What data should I use?

- Getting data for the right people
- NIOSH has occupational data sets
 - Firefighters
 - Law enforcement
 - Meat processors
 - Farm tractor operators
 - Truck drivers
- Commercial set – school bus drivers
- Global variation



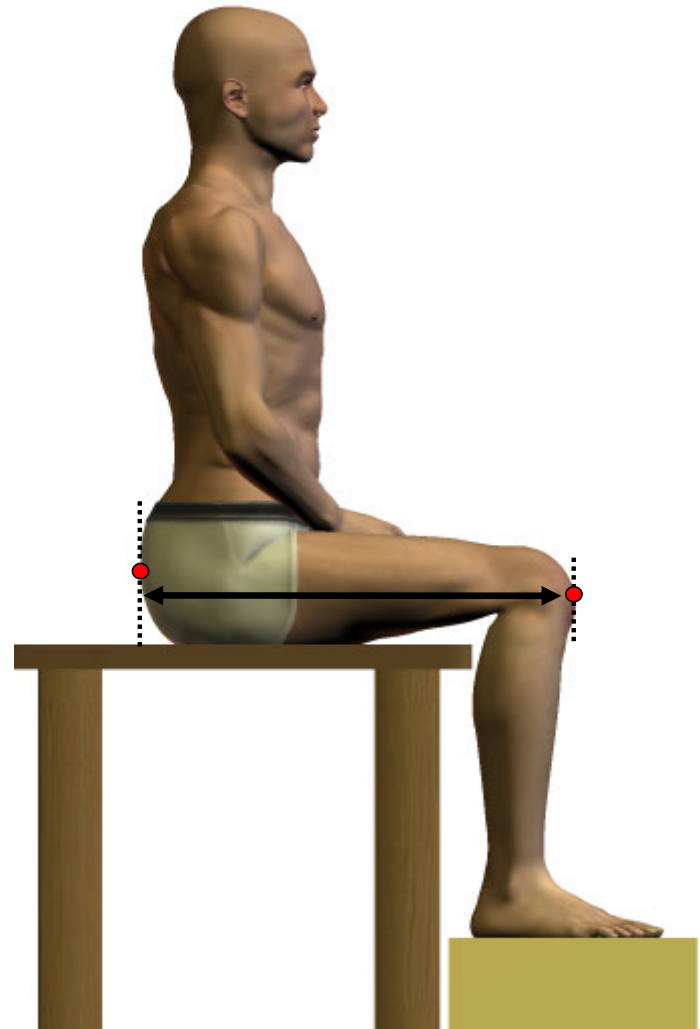
What happens if anthro data are not used?



What happens if anthro data are not used?

- Or used incorrectly...





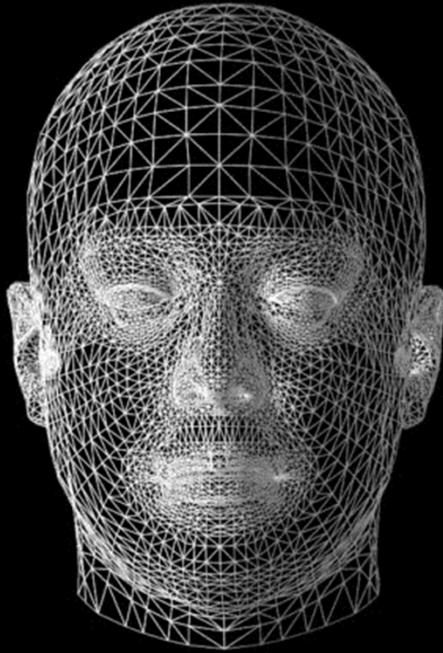
Establishing the design target

- Previously, percentiles widely used
- More recently, accommodation envelope
 - Multidimensional set
 - PCA analysis
- How to pick design points
 - Small, medium, large?
- Keep in mind critical dimensions (what bad happens....?)
 - Ejection seats, but also
 - Chemical protection
 - COVID protection

3D Scans and/or tape and caliper

- Scans allow extraction of surface contours, volumes
- 3D scan outcomes
 - Head forms (vs. face forms)
 - Dress (body) forms
- How are data analyzed? Summarized? PCA min/max?

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Final thoughts....

- Demographic differences in the US
 - Avoid disaccommodating certain groups; sexes – racial/ethnic groups
 - Analyze separately
- Digital human models useful in the design process

Anthropometry in Manufacturing

About Me

- Graduated from the University of Windsor 2017
- Graduated from Fanshawe College Advanced Ergonomics Program in 2018
- Started working with Sandalwood Engineering and Ergonomics in 2018
- Obtained CPE Certification Exam in 2021

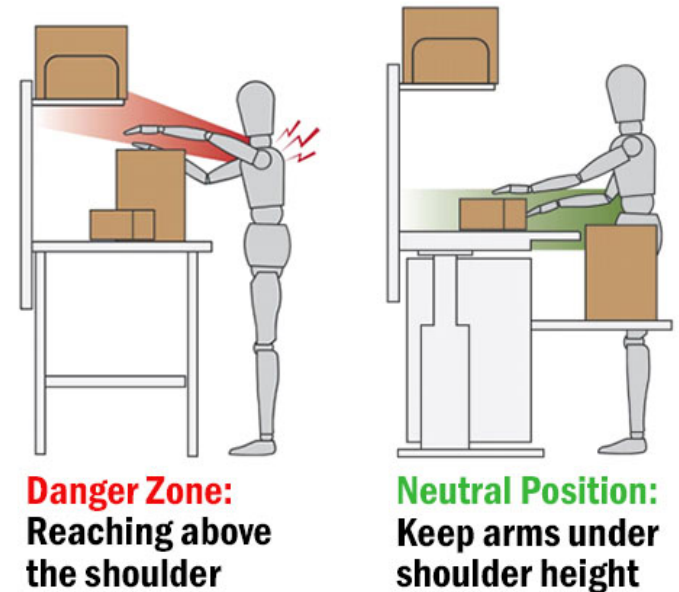


Why do we need to utilize Accurate anthropometric data?

- **“Anthropometric design of workstations facilitates the sustainable development of the workplace”** – Vargas et al.
- By incorporating the right anthropometric data workstation design can be focused on the correct user base.
- This in turn can affect both risk of injury and productivity...
 - When a workstation is designed to accommodate the working population the number of superfluous movements or those that could be awkward for the worker (working above shoulder) can be significantly reduced.
 - A reduction in extra or awkward movements can reduce the amount of time required to complete a task and increase throughput.

The Design Process

- In designing a manufacturing work system, the designer should not only attempt to maximize worker productivity, but also try to improve worker satisfaction and minimize safety hazards. It is possible to achieve such a desirable goal through proper application of ergonomics principles and anthropometric data.
- Using anthropometric data inadequate posture from an improperly designed workstation causes static muscle efforts eventually resulting in acute localized muscle fatigue, and consequently in decreased performance and productivity, and in enhanced possibility of operator related health hazards.



Common Applications of Anthropometry

One of the most common uses of anthropometrics in manufacturing is to establish “work zones”.

Work zones are best used to provide guidance for a human centered work areas.

An understanding of two components is required to establish these working zones

1. The population of those who will be completing the work
2. The nature of the work required to be completed

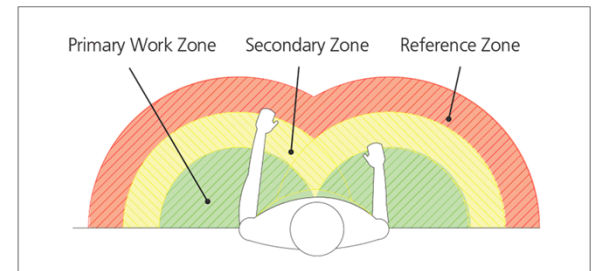


Figure 1: Workzones

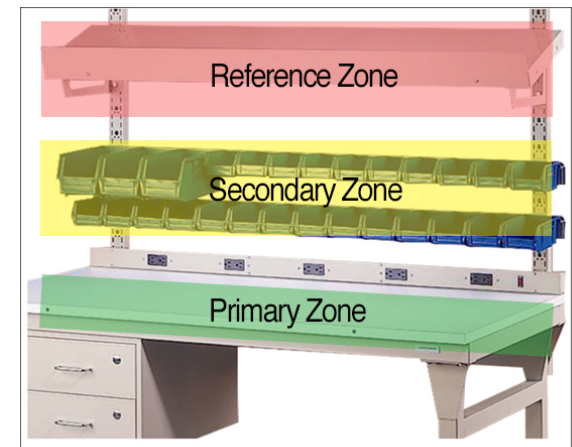
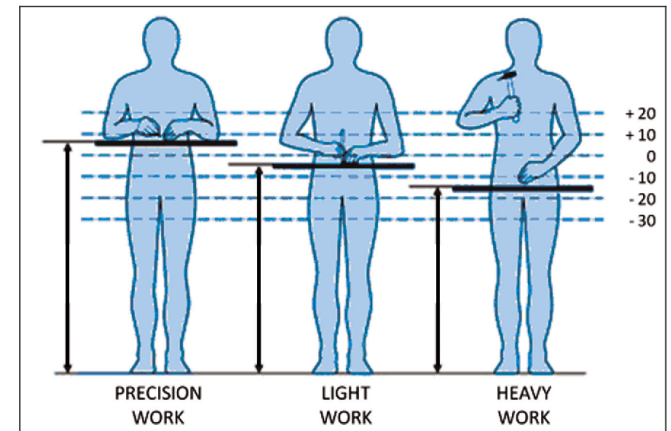


Figure 3: Example workzones

Understanding the “Type of Work”

- Many different “types of work” exist within the manufacturing space and being able to identify which type is required by the worker will help to narrow down the appropriate working zone.
 - Precision work – including fine detail work or small component assembly should occur at or slightly above elbow height
 - Heavy work – including hammering or pushing down with force should occur nearer the height of the waist to allow for leverage
- Anthropometric Data by itself is not enough information for safe workstation design



Applying Anthropometric Data

- If generic anthropometric data is used to derive a working zone and applied during the design of a workstation there are potential points of failure for a human centered design of a workstation.
- By combining an accurate or representative anthropometric data base with an understanding of the work being completed the effectiveness of the design or station update can improve more than the risk of injury to a worker but also productivity.

Data sources

- <https://wwwn.cdc.gov/nchs/nhanes/continuousnhanes/default.aspx?cycle=2017-2020>
- Das, B. (1987). An ergonomic approach to designing a manufacturing work system. *International Journal of Industrial Ergonomics*, 1(3), 231–240. [https://doi.org/10.1016/0169-8141\(87\)90017-5](https://doi.org/10.1016/0169-8141(87)90017-5)
- *Eliminating extreme movements in the warehouse: Cisco-Eagle*. Warehousing Insights | Material Handling Systems. (2020, June 18). Retrieved August 30, 2022, from <https://www.cisco-eagle.com/blog/2020/06/18/workstation-ergonomics-eliminating-extreme-movements/>
- Pynn, C. (2022, August 12). *3-zones for good workstation ergonomics - workplace modular systems*. Workplace Modular Systems LLC. Retrieved August 30, 2022, from <https://workplacenh.com/2017/02/13/organize-a-3-zone-workstation/>
- Realyvásquez-Vargas, A., Arredondo-Soto, K. C., Blanco-Fernandez, J., Sandoval-Quintanilla, J. D., Jiménez-Macías, E., & García-Alcaraz, J. L. (2020). Work standardization and anthropometric workstation design as an integrated approach to sustainable workplaces in the manufacturing industry. *Sustainability*, 12(9), 3728. <https://doi.org/10.3390/su12093728>
- *Working Zones based on Work Type*. Alfagro Tohum kaliteli tohum. (n.d.). Retrieved August 30, 2022, from <http://alfagrotohum.com.tr/eid.asp?iid=301881945&cid=65>