INDUSTRIAL ENGINEERING

Lesson 7
Ergonomics

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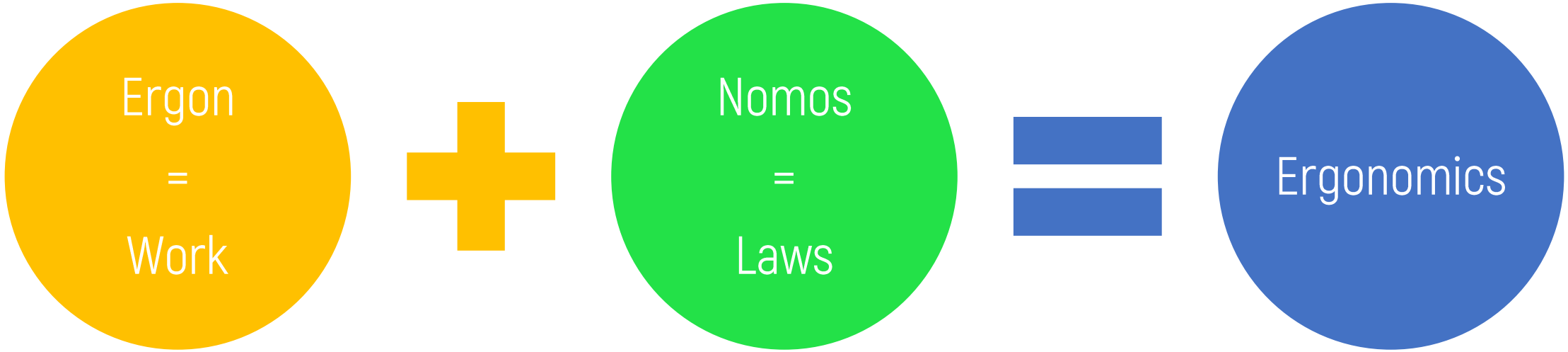
Synopsis

In this chapter, the concept of ergonomics comprising ergonomics for cognitive and physical tasks will be discussed. Subsequently, anthropometry, occupational biomechanics, and work safety will be explained.

Expected Outcome

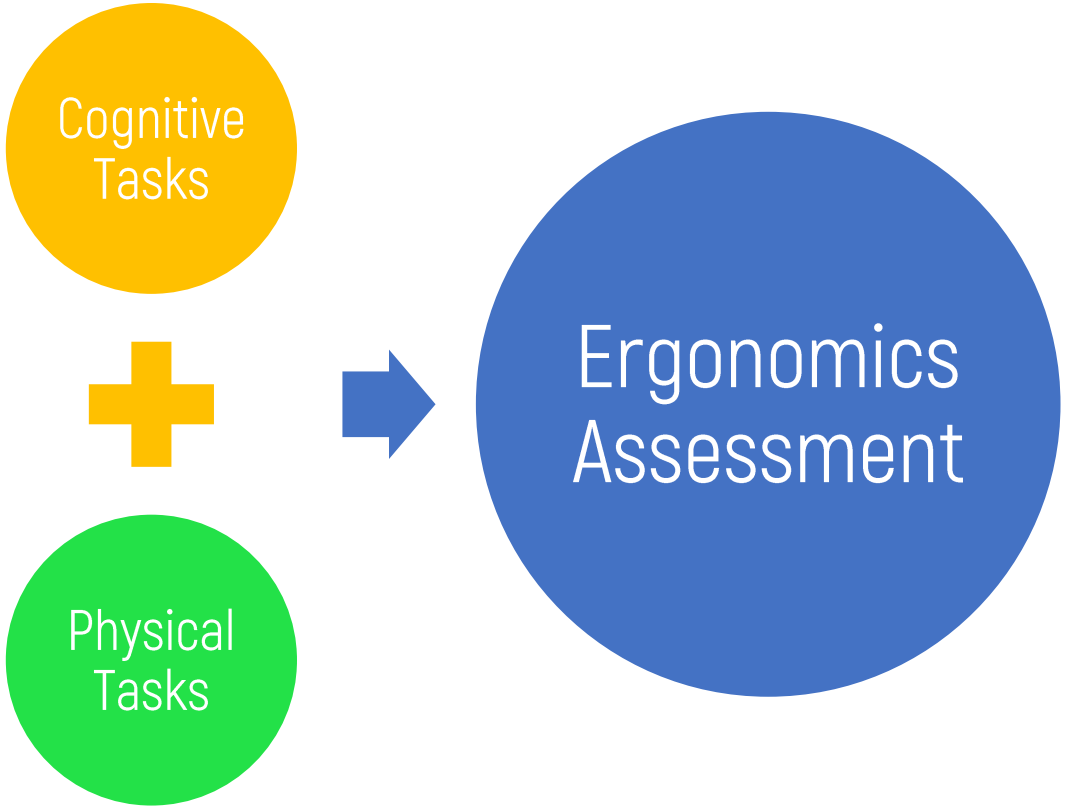
1. Understand the general concepts of ergonomics.
2. Apply the concept of ergonomics in improving cognitive tasks.
3. Apply the concept of ergonomics in improving physical tasks.
4. Explain the concept of anthropometry and occupational biomechanics.
5. Understand the concept of work safety.



Ergonomics

Designing the work to fit the worker, instead of fitting the worker to the work.

Ergonomics Assessment

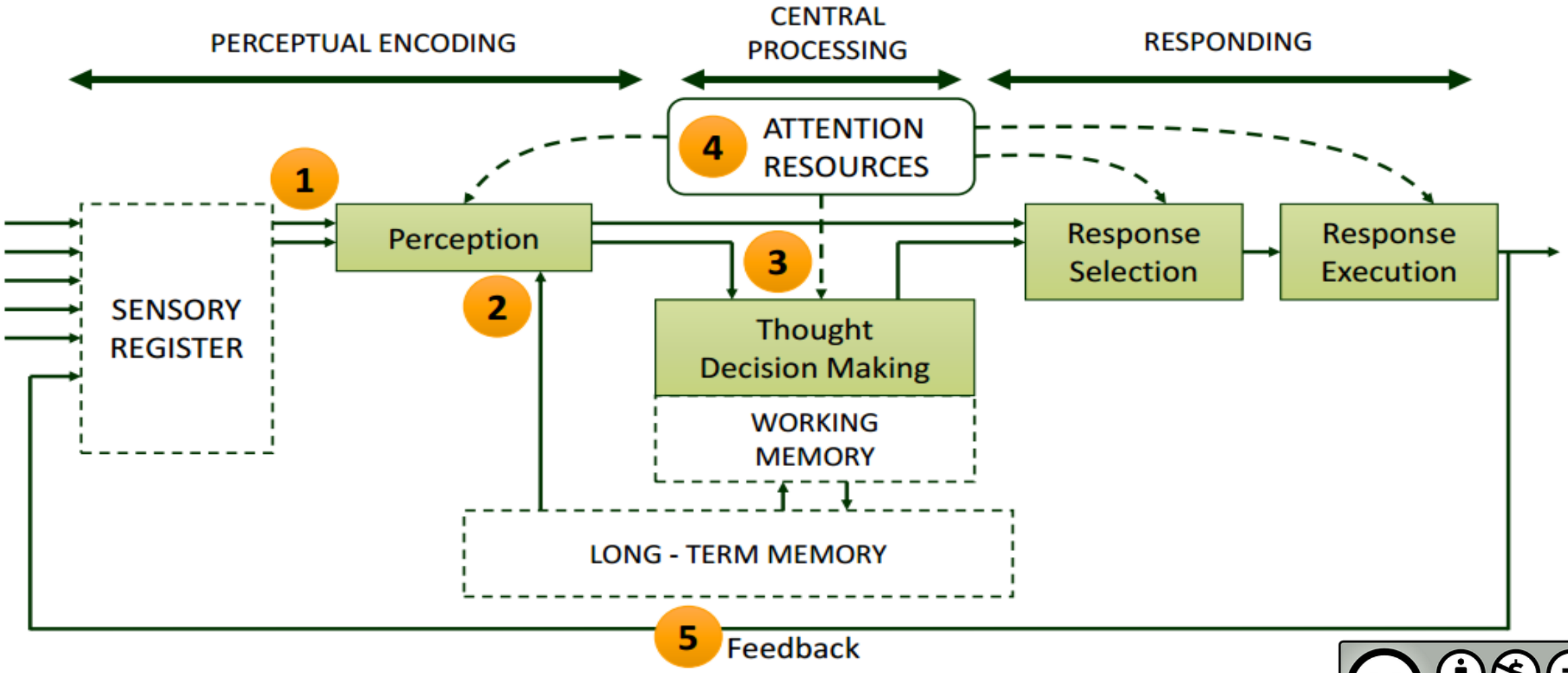


To ensure that workstation is ergonomically designed to minimize injury & increase productivity.

Cognitive Tasks

Refer to the tasks that require a lot of cognitive activities from the user.

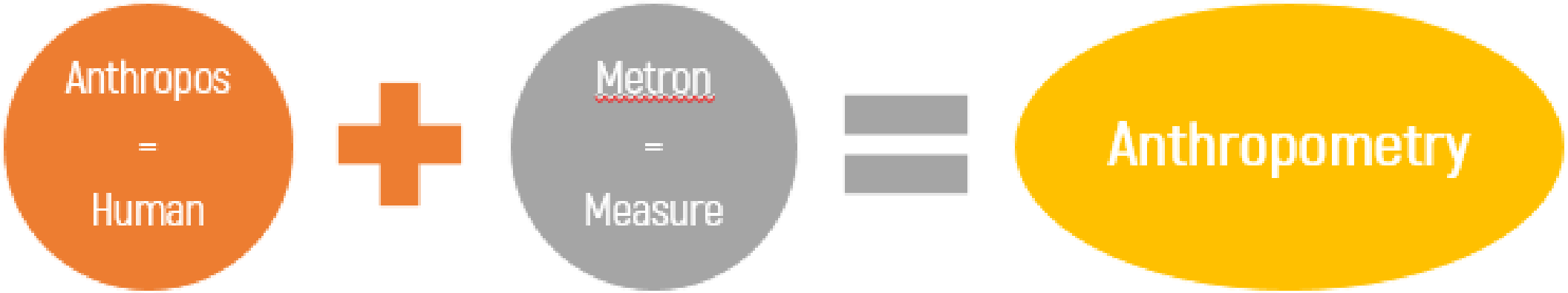
Human Information Processing Model



Source: http://dewihardiningtyas.lecture.ub.ac.id/

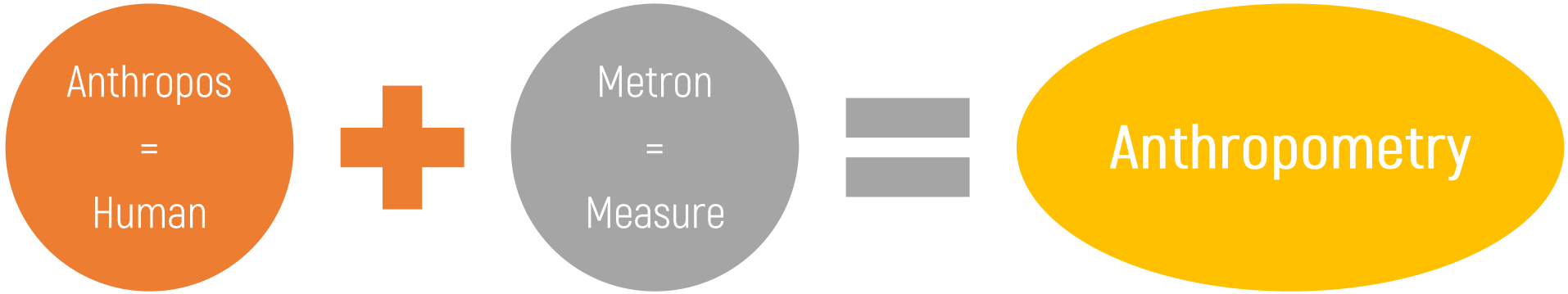
Evolution of the iOS Home Screens

https://www.pinterest.com



Anthropometry

Deals with the measurement of human body.

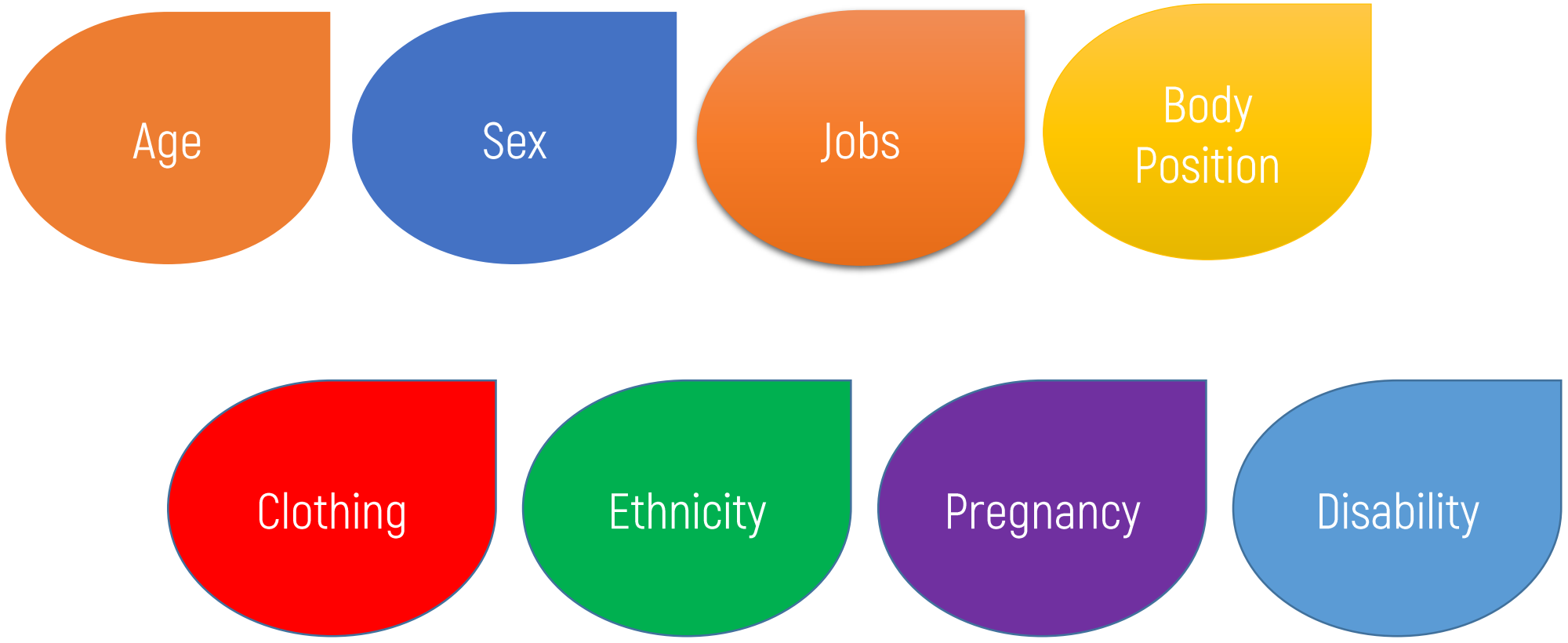


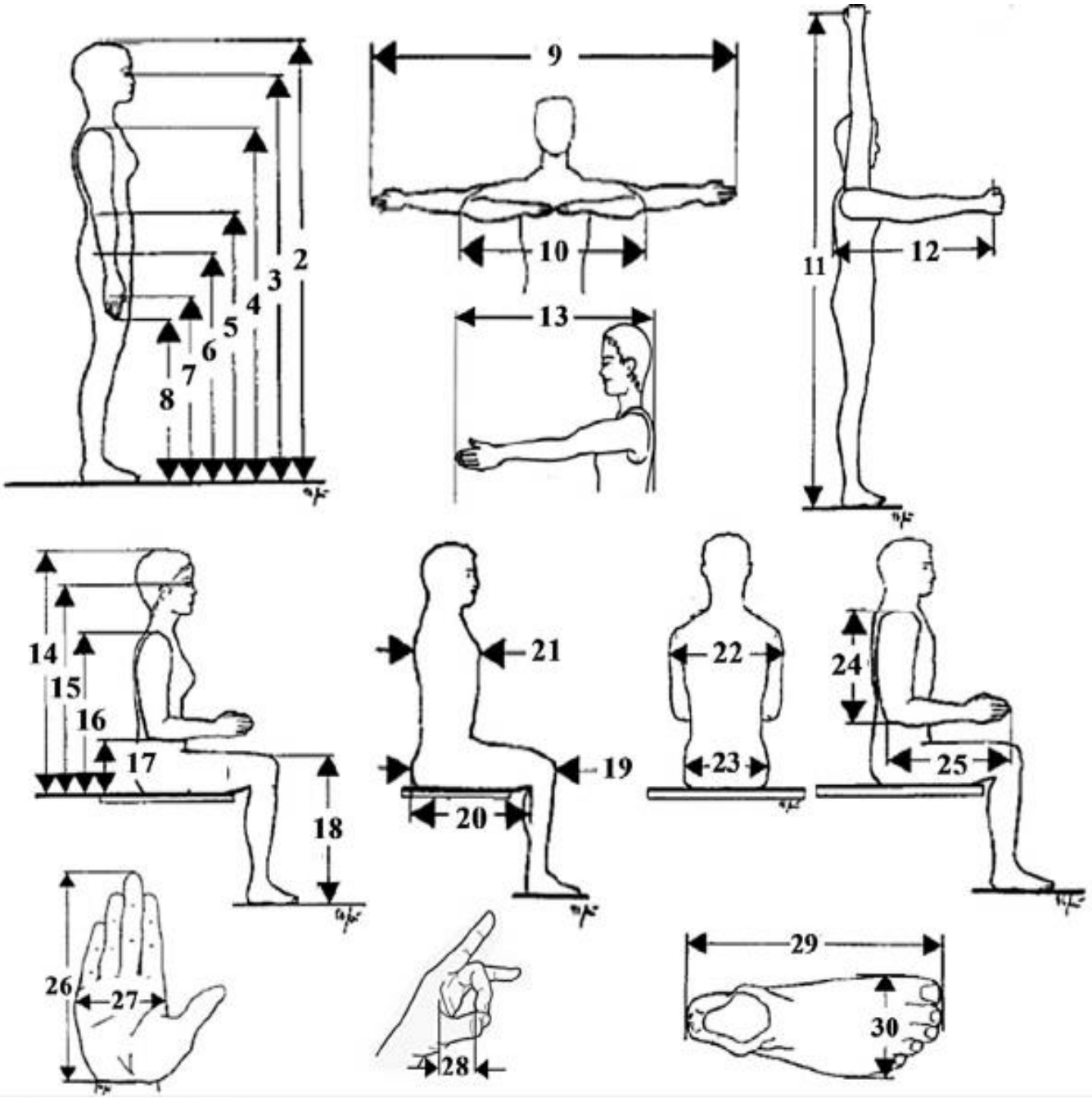
Anthropometry

It is empirical in nature to measure physical dimensions of human body quantitatively

(Chaffin, 1984)

Factors Affecting Anthropometry Data





1	Weight (kg)
2	Stature
3	Eye height
4	Shoulder height
5	Elbow height
6	Waist height
7	Knuckle height
8	Fingertip height
9	Arm span
10	Elbow span
11	Vertical grip reach
12	Forward Grip Reach
13	Forward fingertip reach
14	Sitting height
15	Sitting eye height
16	Sitting shoulder height
17	Sitting elbow height
18	Knee height
19	Buttock-knee length
20	Buttock popliteal length
21	Cest (Bust) depth
22	Shoulder breadth
23	Hip breadth
24	Upper-arm length
25	Forearm hand length
26	Hand Length
27	Hand breadth
28	Grip diameter (inside)
29	Foot length
30	Foot breadth

Body Dimensions (Kroemer, 1997)

Developing Anthropometry Data

Step 1: Determine frequency distribution of each anthropometry data.

Step 2: Calculate mean & standard deviation of each data.

$$Mean = \bar{X} = \frac{\sum_{i=1}^{n} X}{n}$$

$$SD = \sqrt{\frac{\sum_{i=1}^{n} (X_i - \bar{X})}{n-1}}$$

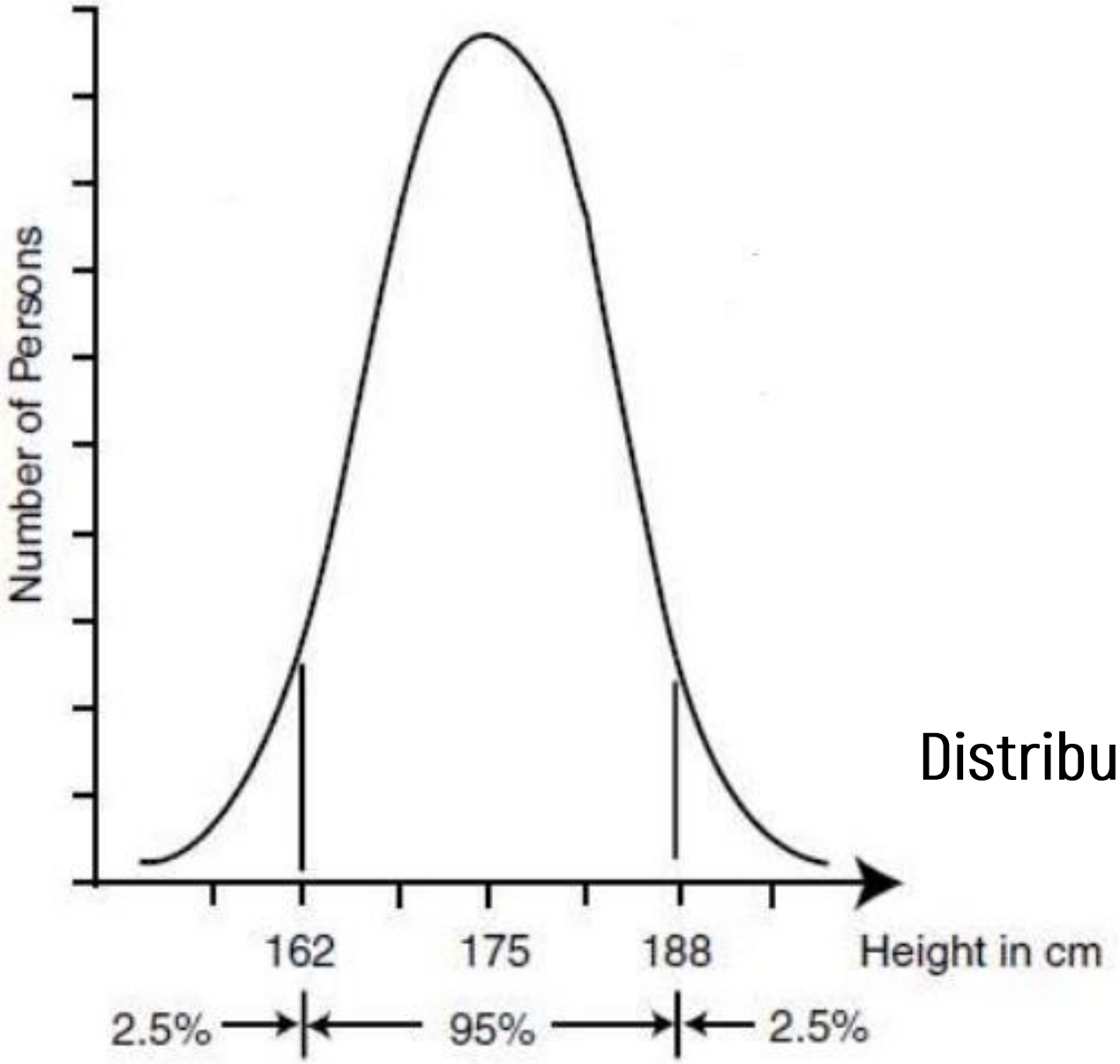
Developing Anthropometry Data

Step 3: Calculate lower & upper percentiles of each anthropometry data.

Percentile <50th : lower percentile

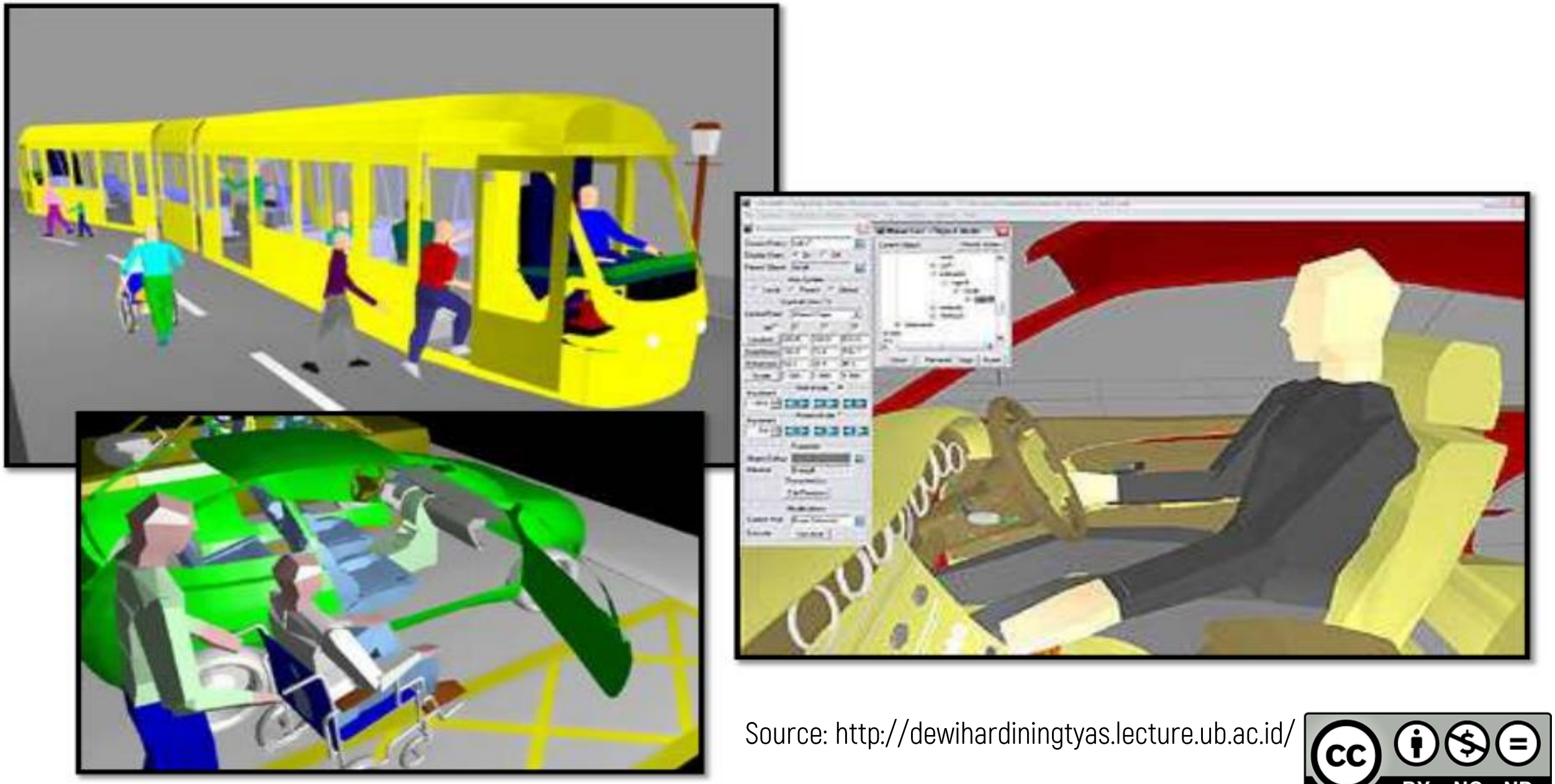
✓ Percentile >50th : upper percentile

Percentile	Factor	Tabulation
1st	-2.32	X – 2.32SD
2.5th	-1.95	X – 1.95SD
5th	-1.64	X – 1.64SD
10th	-1.28	X – 1.28SD
50th	0	X
90th	1.28	X + 1.28SD
95th	1.64	X + 1.64SD
97.5th	1.95	X + 1.95SD
99th	2.32	X + 2.32SD



Distribution of stature of Americans

Source: http://dewihardiningtyas.lecture.ub.ac.id/



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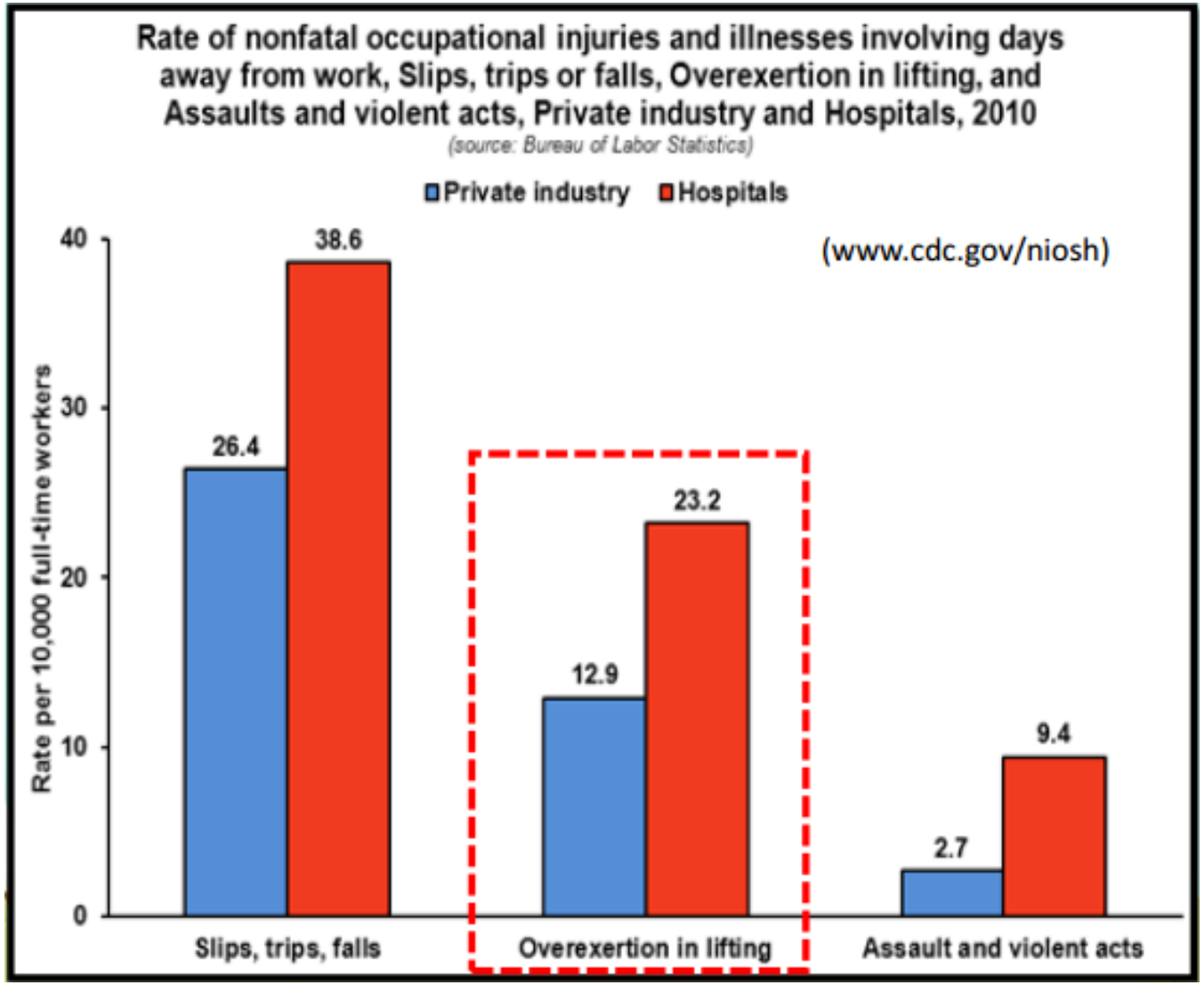
Why Occupational Biomechanics is Important?



Most common musculoskeletal problems:

- ✓Low back pain (LBP).
- ✓Upper-extremity.
- ✓Cumulative Trauma Disorder (CTD).

Most common pain areas…

Source: http://www.painawaydevices.com

Moore-Garg Strain Index

Used to evaluate jobs for risk of work-related musculoskeletal disorders (WRMSDs) of the distal upper extremities (hand, wrist, & elbow).

Moore-Garg Strain Index

Strain index (SI) = (intensity of exertion multiplier) x (duration of exertion multiplier) x (exertions per minute multiplier) x (posture multiplier) x (speed of work multiplier) x (duration per day multiplier)

TABLE 23 Rating Criteria for Strain Index

Rating	Intensity of Exertion	Duration of Exertion (% of Cycle)	Efforts/Minute	Hand–Wrist Posture	Speed of Work	Duration per Day (h)
1	Light	<10	<4	Very good	Very slow	≥1
2	Somewhat hard	10–29	4–8	Good	Slow	1–2
3	Hard	30–49	9–14	Fair	Fair	2–4
4	Very hard	50–79	15–19	Bad	Fast	2–8
5	Near maximal	≤80	≤20	Very bad	Very fast	≤8

Adapted from Moore and Garg 1995.

TABLE 24 Multiplier Table for Strain Index

Rating	Intensity of Exertion	Duration of Exertion (% of Cycle)	Efforts/Minute	Hand–Wrist Posture	Speed of Work	Duration per Day (h)
1	1	0.5	0.5	1.0	1.0	0.25
2	3	1.0	1.0	1.0	1.0	0.50
3	6	1.5	1.5	1.5	1.0	0.75
4	9	2.0	2.0	2.0	1.5	1.00
5	13	3.0[a]	3.0	3.0	2.0	1.50

Adapted from Moore and Garg 1995.
[a]If duration of exertion is 100%, then the efforts/minute multiplier should be set to 3.0.

SI < 3 → Safe
SI = 3-5 → Uncertain
SI = 5-7 → Some Risk
SI > 7 → Hazardous

Recommended Levels of Illumination (foot-candles/ft-c)

500 and up

Exacting Tasks
(electronic and watch assembly, dentistry)

100–200

Small Details
(engraving, detail drafting)

75–100

Normal Visual
(office, classroom, machining)

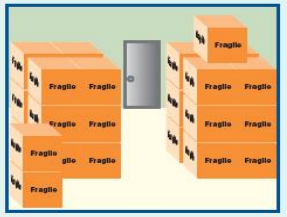
50–75

Assembly Tasks
(parts assembly)

25–50

General Interiors
(conference, rest rooms, restaurants)

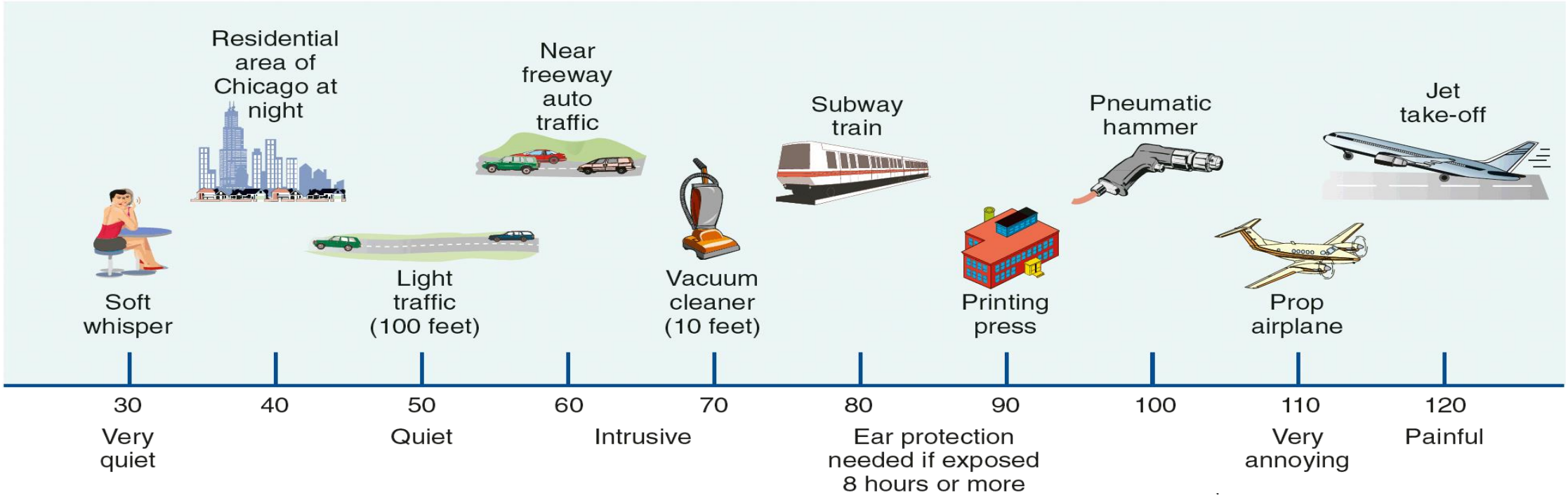
10–25



Large Objects
(warehouses, hallways)

Source: Heizer & Render (2014)

Decibel (dB) Level for Various Sounds

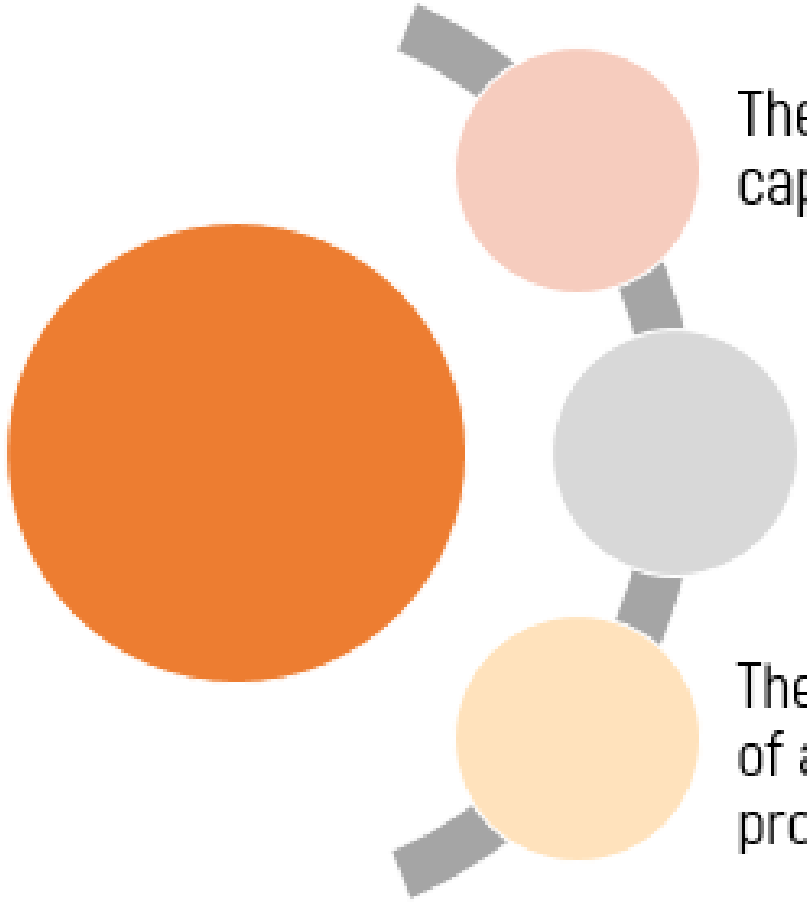


Source: Heizer & Render (2014)

Occupational safety & health

It deals with all aspects of health & safety & focuses on prevention of hazards.

Main Focus of OSH



The maintenance & promotion of workers' health & working capacity

The improvement of working environment to be conducive

The development of health & safety culture at work, & promotion of a positive social climate, smooth operation, and enhance productivity of the undertakings

Domino Theory (Heinrich, 1931)

Major Injury

Minor Injury

No Injury

The Heinrich 300-29-1 Model

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