King Saud University

College of Engineering

IE – 341: "Human Factors"

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Applied Anthropometry, Work-Space Design

Part II - Design of Work Surfaces

(Chapter 13)

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Lesson Overview

- Design of Work Surfaces
  - Horizontal Work Surface Area
  - Work-Surface Height
    - Seated
    - Standing

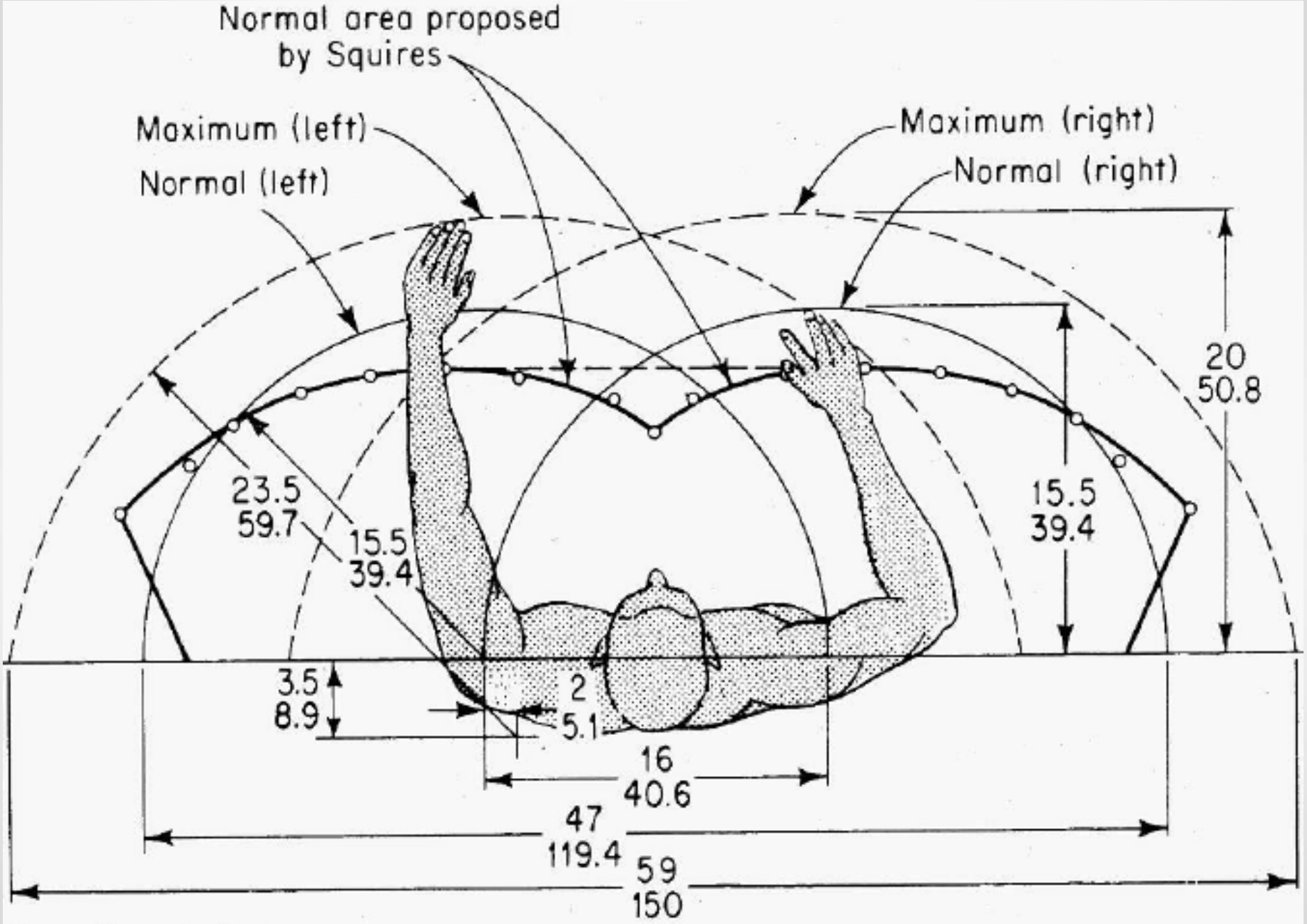
Design of Work Surfaces

- Important use of anthropometric data: work space

- **Work-space envelope** (Def^{n}): 3-D space within which individual works
  - Involves mostly space where hands can move
  - Within envelope, **design decisions** must be made about features of the workspace, e.g.
    - location and design of benches, desks, tables, and control panels
  - Discussed here samples of work surfaces: horizontal, vertical

Horizontal Work Surface Area

- This is area used by:
  - Seated worker
  - "Sit-stand" worker
- Area should allow for manual activities within "convenient" arm reach (what is convenient?)
- Research on horizontal work surface area:
  - Barnes (1963) and Farley (1955):
    - Shown in next slide (carefully examine dimensions)
    - **Normal Area**: area conveniently reached by forearm (while upper arm hangs in natural position)
    - **Maximum Area**: area reached by extending the arm from the shoulder
  - Squires (1956): suggests "**optimal area**": takes into account dynamic interaction of forearm movement as the elbow is also moving (also shown next slide)

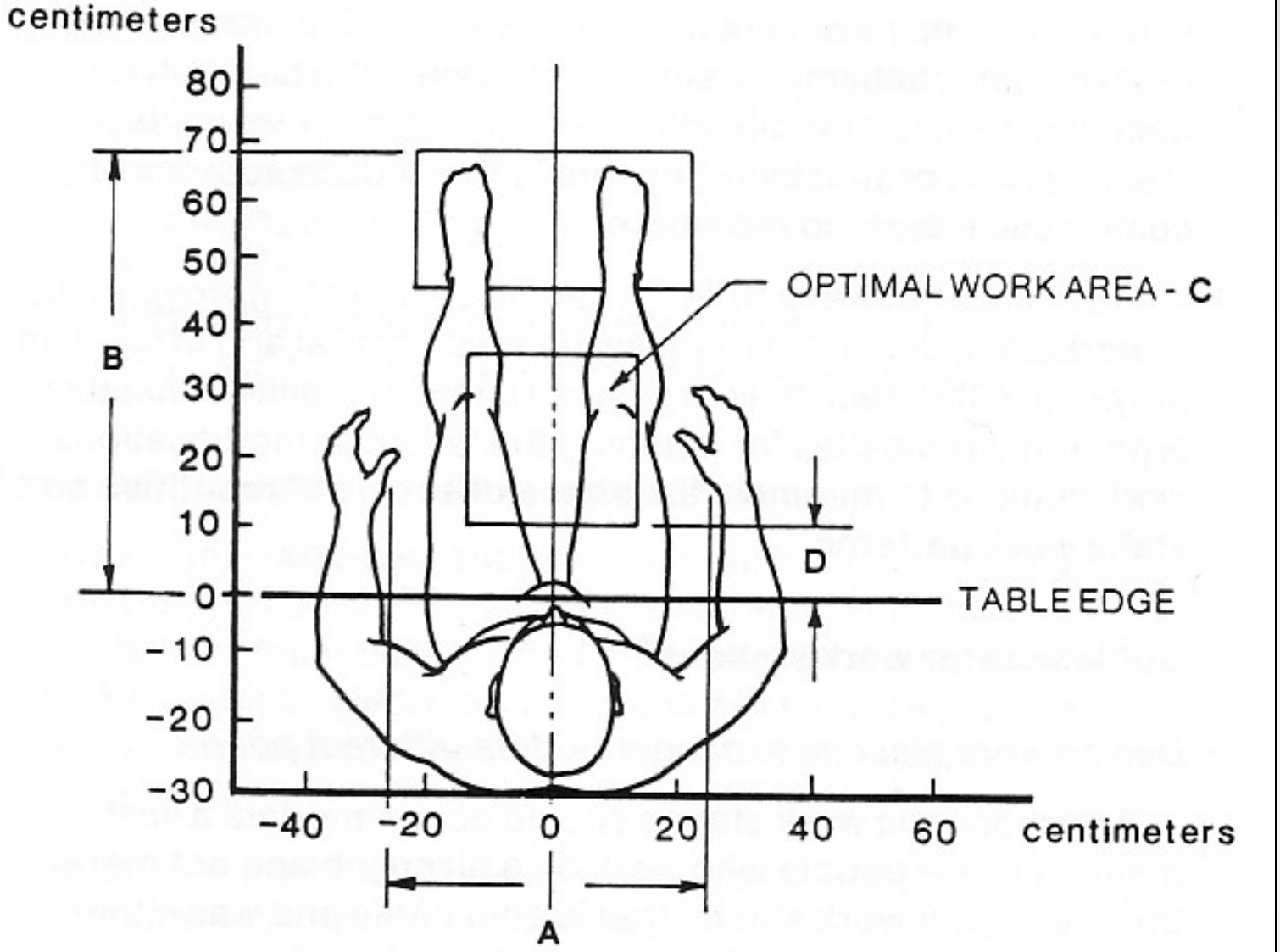


Top values - inches

Lower values - centimeters

Cont. Horizontal Work Surface Area

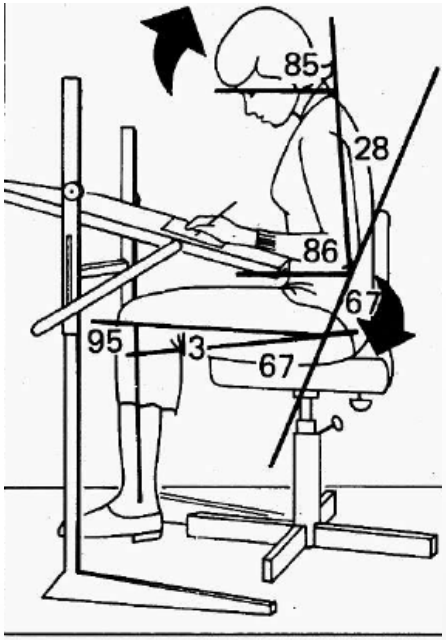
- Cont. Research on horiz. work surface area
  - Squires (optimal) area vs. Farley area (normal-max.)
    - Squires area more shallow but **covers more area**
    - Squires area requires less forearm extension ⇒ **minimal stress on elbow joint**
  - Ayoub (1973): suggests "optimal work" area:
    - approx. 25 * 25 cm (see next slide; note similarities)
    - located @ 10 cm from the table edge
    - body mid-line crossing at the middle of the area
    - Source [Pheasant textbook];



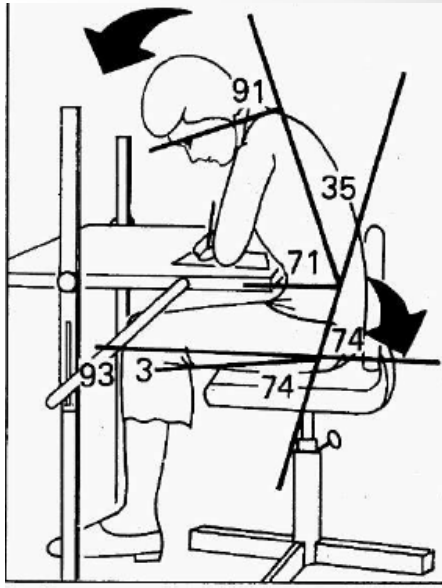
LEG ROOM:	1)	WIDTH (A)	MINIMUM OF 50 CM
	2)	DEPTH (B)	65 CM, IF LIMITED
OPTIMUM WORK AREA:	3)	(C)	APPROXIMATELY 25 X 25 CM
	4)	(D)	10 CM FROM EDGE OF WORK SURFACE

Cont. Horizontal Work Surface Area

- Cont. Research on horiz. work surface area
  - Bridger (1988): **slanted working surface** is better:
    - trunk: less motion –upright- (vs. horizontal)
    - neck: less bending
    - also less fatigue and discomfort
    - slant (here) = 15º
    - slant (other research): 12º and 24º
    - applications:
      - Visual tasks (e.g. reading)
      - Can you name any dis-advantages of slanted surfaces?



(b) Slanted surface



(a) Horizontal surface

Work-Surface Height

- Height of work surface:
  - Can cause backaches, neck aches, shoulder pains
  - Too low ⇒ back is bent over too much
  - Too high ⇒ shoulders raised over relaxed posture ⇒ discomfort in shoulder and neck

- **Work-surface height** vs. **working height**
  - Work-surface height:
    - height of upper surface of table, bench, desk, etc.
    - measured from the floor
    - for slanted surface: need height of front edge + angle
  - Working height
    - Depends on what operator is working on
    - e.g. writing paper ⇒ working ht. = work-surface ht.
    - e.g. writing on keyboard ⇒ working ht. = ht.: "asdfg…"
    - how about when washing vegetable in a sink?

Work-Surface Height: 1. Seated

- Seated Work-Surface: **Height & Arm Posture**
  - Work surface height is affected by:
    - Arm posture
    - Seat height
    - Thickness of the work surface (which affects …?)
    - Thickness of the thighs
  - As work-surface height ↓ ⇒
    - More relaxed posture of upper arms (@ working ht.)
    - Elbows are at 90º (with respect to working ht.)
    - Wrists are straight
    - Overall comfortable working (shoulders, spine, etc.)
    - Beneficial for repetitive tasks (e.g. typing, assembly)
  - Common desk work-surface heights
    - 76 cm (30 in)
    - Research: recommend reduction to 72 cm, 68.6 cm

Cont. Work-Surface Height: 1. Seated

- Seated Work-Surface:
  Height & Thigh Clearance
  - Thigh clearance:
    - Determined by dist. bet. seat & work surface bottom
      - Design here for max, min, average, adjustable?
    - Non-adjustable height work surface
      - ANSI: 26.2 in (66.5 cm) as min. ht. of bottom
    - Small users
      - raise seat so elbows are at 90º to work surface
      - ⇒ feet don't touch floor
      - ⇒ foot rest is needed to support feet
      - or use adjustable-height work surface
    - Adjustable-height work surface
      - ANSI: 51.3 – 66.5 cm for bottom of work surface

Cont. Work-Surface Height: 1. Seated

- General Principles for Seated Work Surfaces:
  1. Best to find work surfaces with **adjustable height** (e.g. adjustable computer tables)
  2. Best if work surface is such that elbow height = working height
  3. Work surface should provide enough clearance for people with thick thighs
  4. Recomm. seated work surface ht. for different tasks:

	Male		Female	
Type of task (seated)	**in**	**cm**	**in**	**cm**
Fine work (e.g., fine assembly)[1]	39.0–41.5	99–105	35.0–37.5	89–95
Precision work (e.g., mechanical assembly)[1]	35.0–37.0	89–94	32.5–34.5	82–87
Light assembly[1]	29.0–31.0	74–78	27.5–29.5	70–75
Coarse or medium work[1]	27.0–28.5	69–72	26.0–27.5	66–70
Reading and writing[2]	29.0–31.0	74–78	27.5–29.0	70–74
Range for typing desks[2]	23.5–27.5	60–70	23.5–27.5	60–70
Computer keyboard use[3]	23.0–28.0	58–71	23.0–28.0	58–71

Sources: [1] Ayoub, 1973; [2] Grandjean, 1988; [3] Human Factors Society, 1988.

Work-Surface Height: 2. Standing

- Factors governing standing work-surface ht
  - Elbow height
  - Type of work

- Type of work vs. elbow height (*next slide*):
  - **Light** and **heavy work**:
    work-surface height: **below** elbow height
  - **Precision work**:
    - work-surface height: **slightly above** elbow height
    - Reason: to support elbow while performing work
    - but recommended: sitting down for precision work
  - **Fixed** vs. **adjustable** standing work surface height
    - Fixed: designed for max. (i.e. tallest) users
    - Shorter users:
      - either use a platform to account for height difference
      - or use adjustable ht. (e.g. electric, manual, hydraulic)

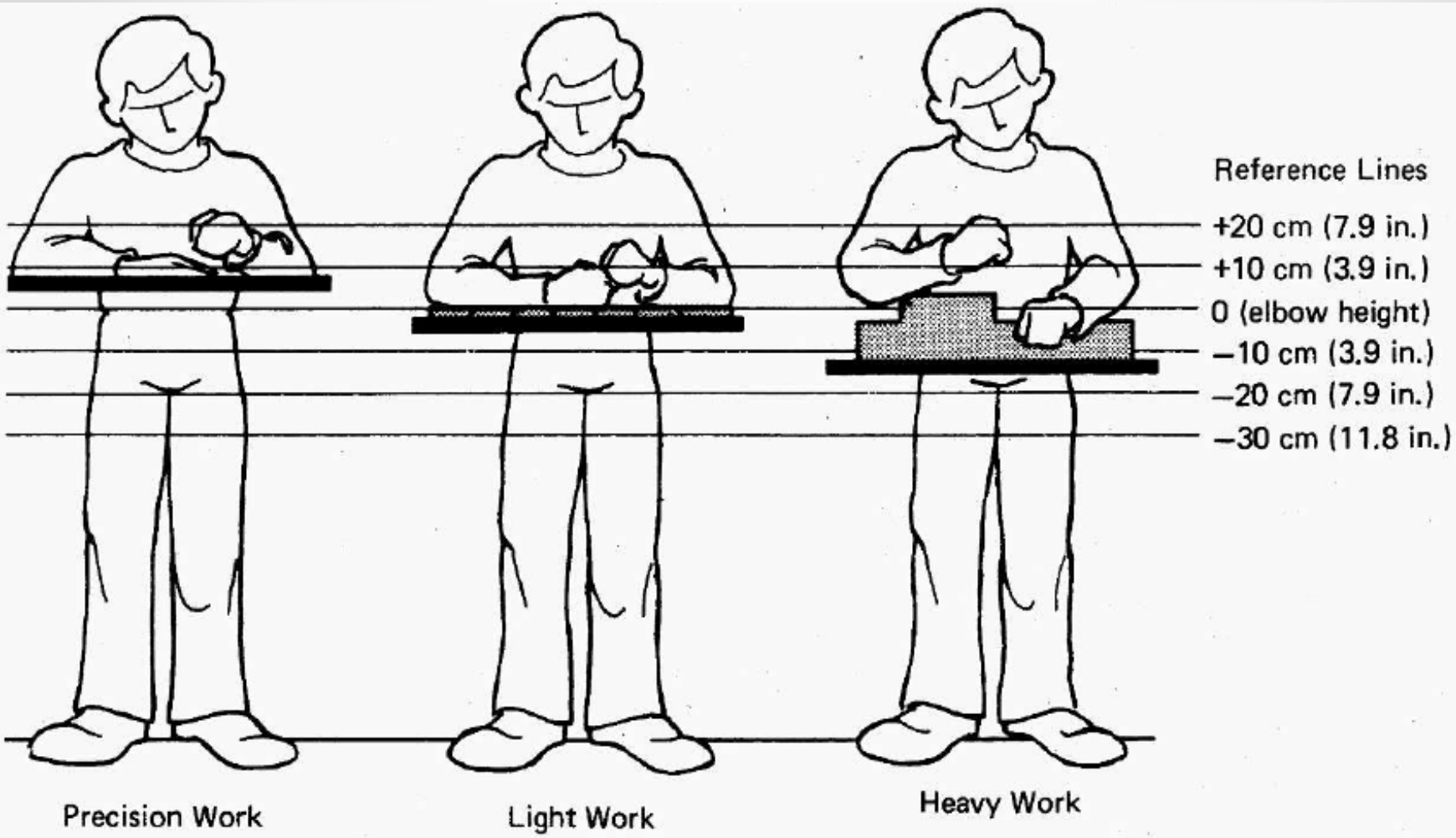


FIGURE 13-13
Relationship between elbow height (from floor) and recommended work-surface height for three types of work performed while standing. The zero horizontal reference line is the elbow height of the individual, and the other lines represent levels above and below. Average elbow height reported by Grandjean for Europeans is 105 cm (41.3 in) for males and 98 cm (38.6 in) for females. (*Adapted from Grandjean, 1988, Fig. 32.*)

Cont Work-Surface Height: 2. Standing

- Other recommendations:
  - Work height: too high ⇒ shoulders & upper limbs raised ⇒ fatigue, strain on shoulder muscles
  - Work height: too low ⇒ trunk, neck, head: inclined forward ⇒ stress on spine
  - Recommended hts. for different tasks: below for fixed vs. adjustable ht (and for male, female)

RECOMMENDED STANDING WORK-SURFACE HEIGHTS FOR THREE TYPES OF TASKS*

		Fixed height		Adjustable height	
Type of task (standing)	**Sex**	**in**	**cm**	**in**	**cm**
Precision work (with elbows supported)	Males	49.5	126	42.0–49.5	107–126
	Females	45.5	116	37.0–45.5	94–116
Light assembly work	Males	42.0	107	34.5–42.0	88–107
	Females	38.0	96	32.0–38.0	81–96
Heavy work	Males	39.0	99	31.5–39.0	80–99
	Females	35.0	89	29.0–35.0	74–89

* Assumes platform will be available to lift smaller users to proper level.