Chapter II. Task Design – Excerpts from the Chapter

Guidelines

Measuring Grip Forces

To use Tables II.2 through II.4, it is necessary to measure the grip force requirements of the task. To do this:

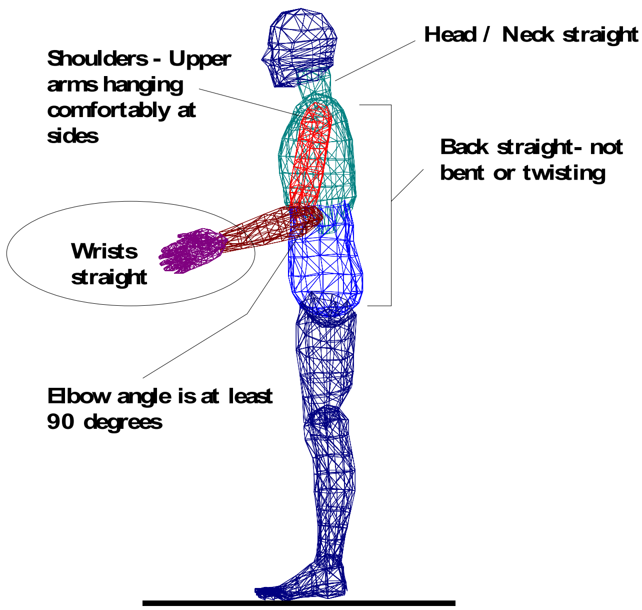
- Use the weight of the object being handled as the grip force measure. If the object being lifted weighs 10 lb, assume a 10 lb grip force. Please note that grip forces can significantly exceed the actual weight of the object handled, depending on factors such as the type of gloves being worn, etc.
- The grip force can be estimated by having workers exert what they feel is the grip force against a hand dynamometer. The worker should be using the same grip type, gloves, and arm/wrist posture as would be encountered when performing the actual grip. The measure should be taken immediately following the actual task, so the worker's memory of the exertion is fresh. Repeated measures should be used to insure reliability.
- Actual measurements of force can be achieved using calibrated strain gauges under certain circumstances (e.g., measuring force required to use cutting tool). Muscular activity at the hand(s) can be performed using EMG techniques, although this is a more complex methodology.
- The Borg Scale (Borg, 1980) asks the performer of a task to numerically rate the physical demand of the task on the following scale:

10	Very, very strong (close to maximum)
9	
8	
7	Very strong
6	
5	Strong (heavy)
4	Somewhat strong
3	Moderate
2	Weak
1	Very Weak
0.5	Very, very weak (just noticeable)
0	Nothing at all

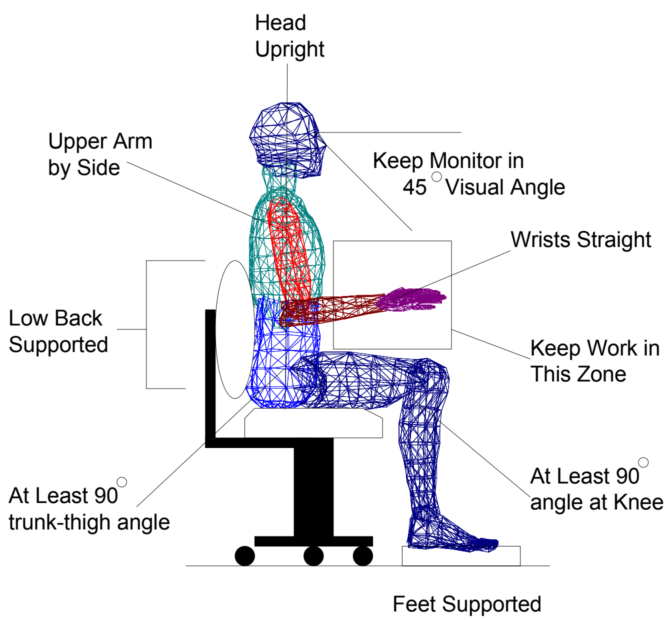
Chapter II. Task Design – Excerpts from the Chapter

II.B.3. Postures, cont.

Figure II.1. Components of the Neutral Posture. **A.** Standing Neutral Posture. **B.** Seated Neutral Posture.



A. The Standing Neutral Posture



B. The Seated Neutral Posture

Chapter II. Task Design – Excerpts from the Chapter

II.B.3. Postures, cont.

Figure II.6. Awkward Postures of the Neck – Neck flexion, extension, rotation, and lateral flexion.

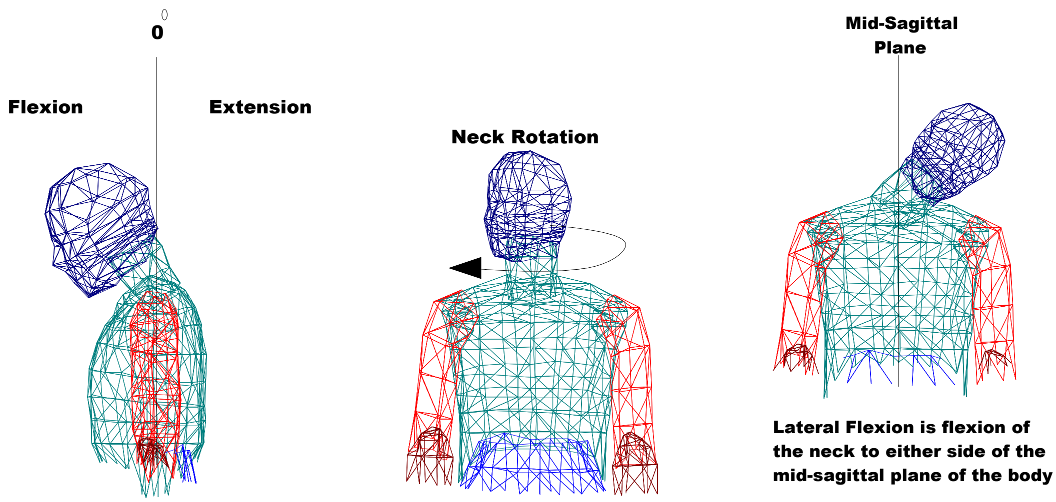
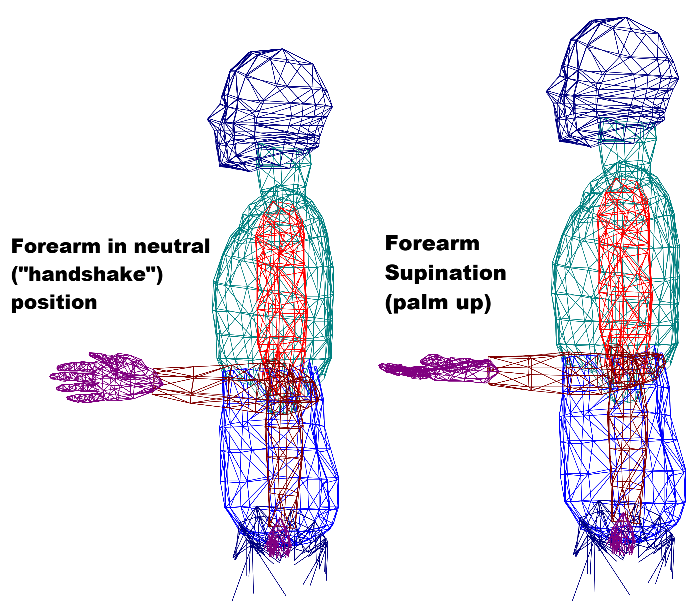


Figure II.7. Awkward Postures of the Elbow (Forearm) – Forearm in neutral (handshake) position, forearm supinated (palm up). Not shown is forearm pronation (palm down).



Chapter II. Task Design – Excerpts from the Chapter

Awkward Postures - How Much is Too Much?

Table II.8. Guidelines and Rankings for Extreme Postures of the Upper Extremities

Body Part	Posture	Maximum Movement Should Not Exceed (in degrees) ...	Ranking of Postural Discomfort *
Neck (3) **	Flexion Extension Rotation Lateral Bending	20 0 20 20	5 5 5 4
Shoulder (1)	Flexion Extension Abduction	30 – 45 *** 0 30 – 45 ***	1 1 1
Elbow (2)	Flexion Pronation Supination	<45, >120 30 30	4 4 2
Wrist (2)	Flexion Extension Ulnar Deviation Radial Deviation General	15 10 10 0 Deviations less than 25% of total Range of Motion (ROM) do not significantly increase discomfort during repetitive exertions. (Carey and Gallwey, 2000)	3 2 5 5
Fingers	Flexion	25 – 52 (Maximum movement should not exceed this range if posture needs to be maintained for extended period)	NA

* Highest ranking (perceived most stressful posture) is 1, least stressful is 5

** Numbers indicate body part ranking in terms of postural discomfort (i.e., Shoulder ranked as highest discomfort, neck ranked as least discomfort).

*** Postural discomfort measured at shoulder flexion > 45 degrees. Shoulder flexion or abduction of 30° can impede muscle blood flow (Viikari—Juntura, 1999), although flexion at the elbow will reduce the impingement.

Chapter II. Task Design – Excerpts from the Chapter

Guidelines **Table II.11.** Guidelines to Minimize Repetition

Task or Industry	Guideline
Appropriate Use of Automation / Mechanization	• Use powered tools versus manual tools. • Provide mechanized assists such as case erectors, case sealers, and/or tape dispensers to reduce motion requirements (and grip force requirements).
Training	• Unnecessary motions sometimes get built into work behaviors (e.g., flip part to inspect when inspection is not required). • An unskilled (inadequately trained) worker often performs more motions than the skilled worker (e.g., the untrained typist makes more mistakes, hence more motions, than the skilled typist).
Keyboard Work (Office or Industrial)	• Use macro keys on keyboards to avoid multiple keystrokes. • Training Issue: Be certain that users know the many "shortcut keys" used in software packages/ programs. • Select the appropriate input device (keys, mouse, etc.) That will minimize motion requirements. • Provide adequate space for the mouse. • Clean the mouse on a regular basis. • Properly scale the movement of the screen cursor to the movement of the mouse in the work area. • If a lengthy e-mail response is anticipated, call the person instead of typing out the lengthy response. • If a lengthy document is being "read" on-screen, consider printing out the document for reading. This minimizes keying requirements (scrolling, etc.) and it is typically easier to read hard copy versus on-screen material. • Use scanning technology or optical character recognition (OCR) to reduce keying requirements. • Interconnect computers to eliminate the need to retype materials.

Chapter II. Task Design – Excerpts from the Chapter

Guidelines Cont.

Table II.11 (cont.). Guidelines to Minimize Repetition

Task or Industry	Guideline
Product Design / Assembly Work	• Provide fixtures to support objects being worked on (eliminate static handling) • Deliver materials so that they do not have to be rehandled or re-oriented prior to performing the task. If possible, product should not have a top/bottom/ front/back.
General	• Design the overall job such that a variety of motions and postures are used (keeping in mind that neutral postures are a goal). This can be accomplished through job rotation or job enlargement. • Avoid concentrating stresses on a specific body part. For example, switching sides at a conveyor may allow the arms to "switch off" in terms of motion requirements • Design jobs so that either hand can be used (minimize precision motions requiring use of dominant hand). • Take motions away from an overly-stressed body part. For example, use a foot control to replace hand motions. • Determine the minimum number/ percentage of parts requiring manual inspection.

Chapter II. Task Design – Excerpts from the Chapter

II D1. Selecting the Appropriate Manual Materials Handling (MMH) Analysis Tool

Discussion

Four general MMH evaluation tools are presented in the following sections. The tools are the NIOSH (1991) lifting equation, biomechanical models, psychophysical capacity tabular data, and physiological data collection. Section II F presents information regarding measurement of energy/endurance requirements of jobs (physiological assessment).

Table II.19 was designed to assist in the analysis of MMH jobs in the following areas:

- provide a guide for collecting the necessary data
- select the appropriate evaluation tool based on the task characteristics and data collected.

Using the Table

MMH task variables are gathered as the first step in the evaluation of the MMH task. Based on the data gathered, Table II.19 is used to determine the most appropriate evaluation tool(s) based on the task characteristics. For example, suppose you are evaluating a MMH task with the following characteristics:

- MMH Type = 2 hand lift performed in a standing posture,
- Frequency of lift = 4 lifts per minute,
- Worker twists during the handling motion,
- Worker is required to wear gloves that may adversely impact handling capacity,
- In the summer, the worker is exposed to ambient temperatures exceeding 90 degrees F when performing the task.

Chapter II. Task Design – Excerpts from the Chapter

II D1. Selecting the Appropriate Manual Materials Handling (MMH) Analysis Tool, cont.

Using the Table, Cont.

Going to Table II.19, the frequency of lift eliminates the biomechanical model (BIO MODEL column) as an appropriate **single** analysis tool. The presence of heat stress conditions indicates that, of the four evaluation tools, psychophysical capacity data (PSYCHO column) represents the single evaluation tool that best "fits" the task variables (were heat stress not an issue, the NIOSH equation (NIOSH column) and psychophysical capacity data would be equally applicable). Note that assessment of the endurance requirements of the job (PHYSIO column) is also appropriate, although it would not directly address the impact of gloves and twisting motions on worker capacities.

Note that in many situations the use of **multiple tools** will be appropriate. For those situations, you are encouraged to use all of the appropriate tools and use the most conservative value as your design guideline.

Chapter II. Task Design – Excerpts from the Chapter

Table II.19. Criteria to Determine the Most Appropriate MMH Analysis Tool(s). "X" in cell indicates analysis tool may be appropriate.

MMH TYPE	"IF" CONDITION	NIOSH	BIO MODEL	PSYCHO	PHYSIO
2 Hand Lift or Lower	F < 1 lift / 5 minutes	X	X	X	
	F > 1 lift / 5 minutes	X		X	X
	F > 9 lifts / minute	X			X
	Twisting Occurs	X	X (3D)	X	
	Handle Design is an Issue	X		X	
	Limited Headroom During Lift			X	
	Work Duration > 8 hours			X	
	Load Placement Clearance is an Issue	X		X	
	Load Asymmetry is an Issue	X	X (3D)	X	
	Exposure to Heat Stress			X	X
	Length of Object > 26 inches		X (3D)		
1 Hand Lifts	Posture = Standing		X	X	
	Posture = Kneeling or Seated			X	
1 or 2 Hand Carry	Note: Carry is Operationally Defined as Horizontal Movement of Load ≥ 7 feet			X	
1 or 2 Hand Push/Pull	Distance < 7 feet and F < 1 Push/Pull / 5 minutes		X	X	
	Distance ≥ 7 feet and F ≥ 1 Push/Pull / 5 minutes			X	X
	Push/Pull Task Requires Significant Sustained Forces (e.g., slide box along floor)			X	
Lift/Lower in Non-Standard Postures	Kneeling, Sitting, or Lying			X	

NOTE: Under BIO MODEL, 3D indicates that a 3-dimensional biomechanical model is required for the task condition.

Chapter II. Task Design – Excerpts from the Chapter

II E1a. Mechanization

Guidelines

Mechanization should be considered when:

- large forces are required
- repetitive motions are required
- a standard product size is being handled
- a relatively constant handling pattern is required

Example

Using robots, hoists, lift tables, drum/barrel dumpers, conveyors, etc., can serve to minimize MMH.

Why Do Mechanical Assists Go Un-Used?

It is unfortunately not uncommon to see a company spend significant sums of money to install a mechanical assist, only to see the assist go un-used by the workers. Understanding why this happens is the first step towards preventing it from happening.

- The end user was not involved in the decision-making process. Involvement of the workers should be considered mandatory in the development/selection of any mechanical assist where the use of the assist is volitional on the part of the workers.
- The mechanical assist slows down the worker. If the mechanical assist is adversely impacting the productivity of the worker, the probability that the assist will be used is greatly decreased. To address this, the selection of the assist should keep in mind the criticality of production to the worker. The impact of the assist on productivity should be documented (sometimes, the decrease in productivity is a perception rather than a reality). If the mechanical assist has a definable negative impact on the existing production standards, the company needs to consider modifying standards to reflect this.
- It should be remembered that the MMH analysis tools presented previously have, as their design criteria, accommodating 90% of the population. Based on this, there may be a significant segment of the workforce who correctly feels that they can handle the job-required weight/force safely.

II E1. **Mechanization, Cont.**

Guidelines, Cont.

Why do Mechanical Assists Go Un-Used? (cont.)

Table II.45 presents an implementation strategy for companies to consider during the introduction of any mechanical assist into the workplace. In addition to the steps outlined in Table II.45, it should be emphasized that the underlying reason for non-use of mechanical assists is that use is often made **voluntary**. To increase use of mechanical assists:

- Companies should write the use of mechanical assists into the job performance standard, so that the mechanical assist device is no different than (e.g.) the use of a hand tool with a product-specified torque.
- Non-use of a mechanical assist should have an enforcement element associated with it. Minimally, a worker injured on the job who is not using the mechanical assist should be subject to some form of discipline.

Cautionary Note Regarding Mechanization

It is typically assumed that mechanization means the elimination of or significant reduction in physical demands associated with the job. However, this needs to be validated prior to introduction. For example, Juul-Kristensen, et al. (2002) compared the physical workload associated with a manual and mechanical poultry deboning operation and found the differences to be only marginal. Chaffin, et al. (1989) found that push/pull forces associated with hoists and similar mechanical assists are significant.

II E1. **Mechanization, Cont.**

Guidelines, Cont.

Table II.45. An implementation strategy for the introduction of mechanical assists in the workplace (adapted from Lawson and Potiki, 1994)

Implementation Step	**Definition**
1	Consult with workers to identify problems with the existing way the task is done, and provide information about the mechanical assist options available
2	Conduct a thorough assessment of the task for which the mechanical assist will be used.
3	Get advice about mechanical assist types and options from a manufacturer/supplier.
4	Try out the new assist before purchasing.
5	Train all users in the proper use of the mechanical assist.
6	Obtain worker feedback regarding the utility of the mechanical assist. Make modifications based on the feedback.
7	Include use of the mechanical assist in all specifications for the job/task (i.e., Use of the mechanical assist is no different than using a wrench of a specified torque. It is simply **how** the job is performed). Develop a procedure for the proper use of the mechanical assist.

Chapter II. Task Design – Excerpts from the Chapter

II E3b. **Minimize Twisting, cont.**

Guidelines, cont.

Figure II.16. Recommended Locations of Materials to Minimize Twisting