King Saud University

College of Engineering

IE – 341: "Human Factors Engineering"

Spring – 2025 (2nd Sem. 1446H)

Manual Materials Handling

(Chapter 8)

part 2 – Case Studies

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Lesson Overview

Part 1:

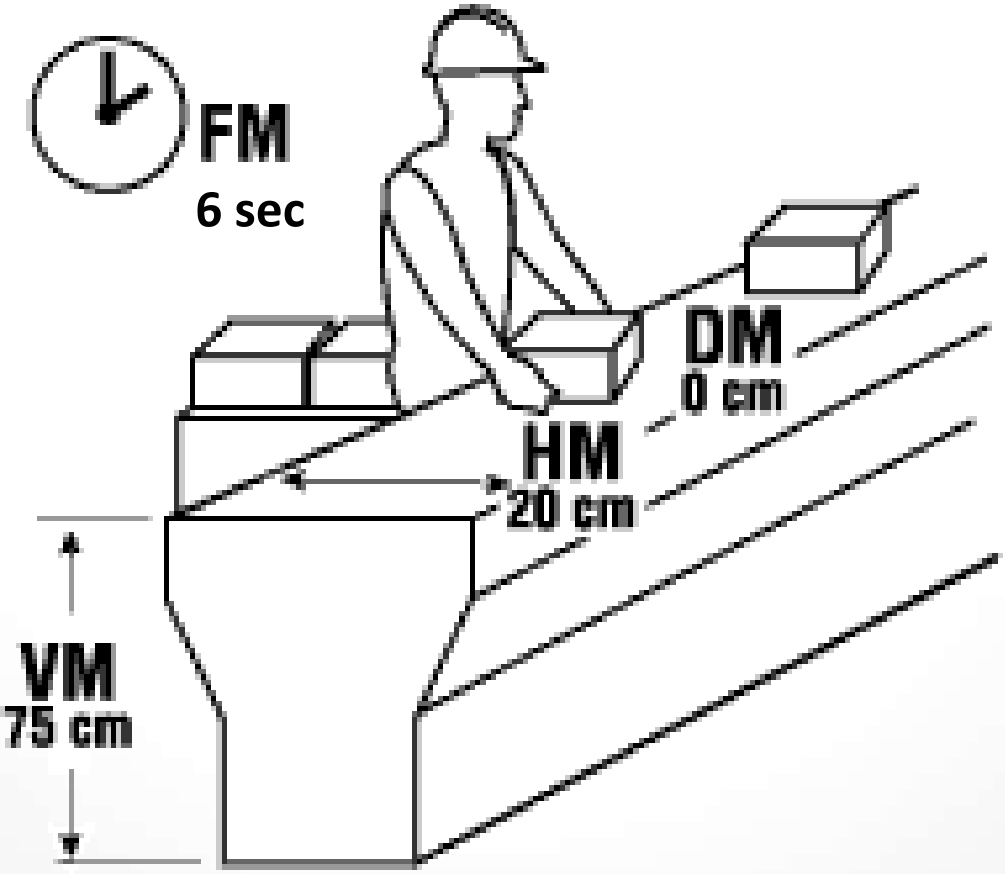
- What is MMH?
- MMH Activities
- MMH Effect on Health
- NIOSH Lifting Equation
- Multiplier Values
- Lifting Index

Part 2 (this part):

- Case Studies
  - Case 1: Effect of Frequency Factor on RWL
  - Case 2: Effect of Horizontal Distance on RWL
  - Case 3: Effect of Vertical Distance on RWL

Case 1: Effect of Frequency Factor on RWL

Problem Statement: Analyze the following work task. A worker lifts 10-kg boxes from the conveyor to the cart, ten times every minute for two hours.

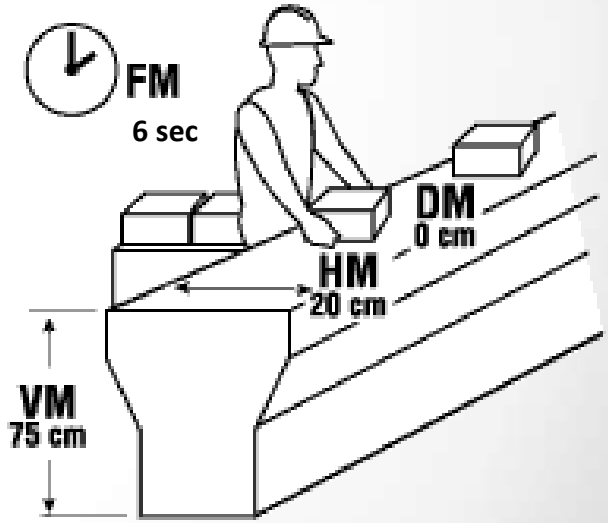


Case 1: Effect of Frequency Factor on RWL

Solution: First, calculate the recommended weight limit (RWL) for the task

1. Determine the weight of the load.
   Weight = 10 kg
2. Assess the six components of lifting task.

H (Horizontal Distance)	20 cm
V (Vertical Distance)	75 cm
D (Lifting/ carrying Distance)	0 cm
A (Angle)	90°
F (Frequency)	6 sec
C (Coupling/quality of grip)	fair



Case 1: Effect of Frequency Factor on RWL

3. Select appropriate multiplier factors for each lifting component from the appropriate tables

HM	(25/H)
VM	1– (.003|V-75|)
DM	.82 + (4.5/D)
AM	1– (.0032A)

F = Time Between Lifts	FM		
	Lifting While Standing (V ≥ 75 cm)		
	≤ 1 hr.	>1 & ≤ 2 hr.	>2 & ≤ 8 hr.
≥5 min	1.00	0.95	0.85
2 min	0.97	0.92	0.81
1 min	0.94	0.88	0.75
30 sec	0.91	0.84	0.65
15 sec	0.84	0.72	0.45
10 sec	0.75	0.50	0.27
6 sec	0.45	0.26	0.13

C = Grasp	CM Factor:	
	Standing	Stooping
Good (handles)	1.00	1.00
Fair	1.00	0.95
Poor	0.90	0.90

H (Horizontal Distance)	20 cm	**HM**	**1**
V (Vertical Distance)	75 cm	**VM**	**1**
D (Lifting/carrying Distance)	0 cm	**DM**	**1**
A (Angle)	90°	**AM**	**0.71**
F (Frequency)	6 sec	**FM**	**0.26**
C (Coupling/quality of grip)	fair	**CM**	**1**

Case 1: Effect of Frequency Factor on RWL

4. Determine the Recommended Weight Limit for the task:

$$\mathbf{RWL} = 23\ \text{kg} * 1 * 1 * 1 * 0.71 * 0.26 * 1$$
$$= \mathbf{4.25\ kg}$$

5. Compare weight of the load against determined weight limit for the task:
   - weight of load: L (10 kg) **>** RWL (4.25 kg)
   - **LI** (lifting index) = L / RWL = 10 / 4.25 = **2.35** (i.e. 2 < LI ≤= 3 ⇒ lifting is "**highly risky**")

6. Conclusion: **Task is Dangerous (not safe)**

Case 1: Effect of Frequency Factor on RWL

- Check results using NIOSH Lifting Eqn Calculator:

Inputs

Measurement System: Metric

	Origin	Destination
Horizontal Location	20	20
Vertical Location	75	75
Travel Distance	0	0
Angle of Asymmetry	0	90
Coupling	Fair	Fair
Frequency	10	10
Avg. Load	10	10
Max Load	10	10
Duration	Moderate (1-2 hours)	Moderate (1-2 hours)

Calculate

Clear | Print | Save

Results

	Origin	Destination
Recommended Weight Limit (RWL)	5.98 kg	4.25 kg
Frequency Ind. RWL (FIRWL)	23.00 kg	16.33 kg
Lifting Index (LI)	1.67	2.35
Frequency Ind. Lifting Index (FILI)	0.43	0.61

	Origin	Dest.
HM	1.00	1.00
VM	1.00	1.00
DM	1.00	1.00
AM	1.00	0.71
CM	1.00	1.00
FM	0.26	0.26

About the NIOSH Lifting Equation

The NIOSH Lifting Equation is a tool used by occupational health and safety professionals to assess the manual material handling risks associated with

Case 1: Effect of Frequency Factor on RWL

7. Recommendations:

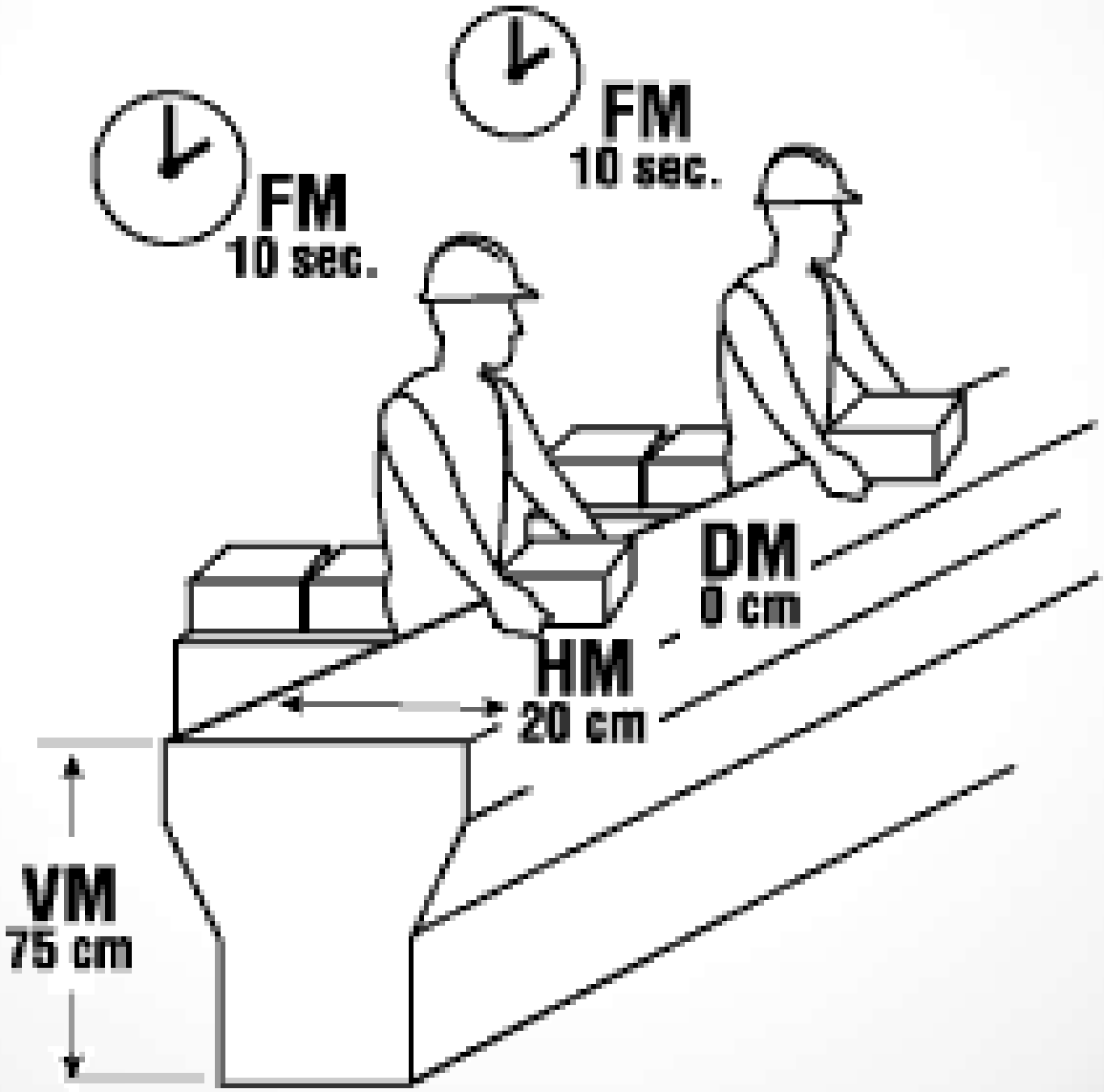
- Assess which component(s) contribute(s) most to the risk
  - the critical factor is FM ⇒ it is required to reconsider the frequency of lifting and/or duration of task

- Shorten the frequency of lifting by:
  a. reducing the frequency of incoming boxes (i.e. increasing F) and/or
  b. shortening the time of the task to 1 hour, and/or
  c. assigning additional workers to task

F = Time Between Lifts	FM Lifting While Standing (V ≥ 75 cm)		
	≤ 1 hr.	>1 & ≤ 2 hr.	>2 & ≤ 8 hr.
≥5 min	1.00	0.95	0.85
2 min	0.97	0.92	0.81
1 min	0.94	0.88	0.75
30 sec	0.91	0.84	0.65
15 sec	0.84	0.72	0.45
10 sec	0.75	0.50	0.27
6 sec	0.45	0.26	0.13

Case 1: Effect of Frequency Factor on RWL

7. Recommendations (Cont.):



Case 1: Effect of Frequency Factor on RWL

8. Redesign the Task

- Assess the six components in the redesigned task
- Determine new RWL:

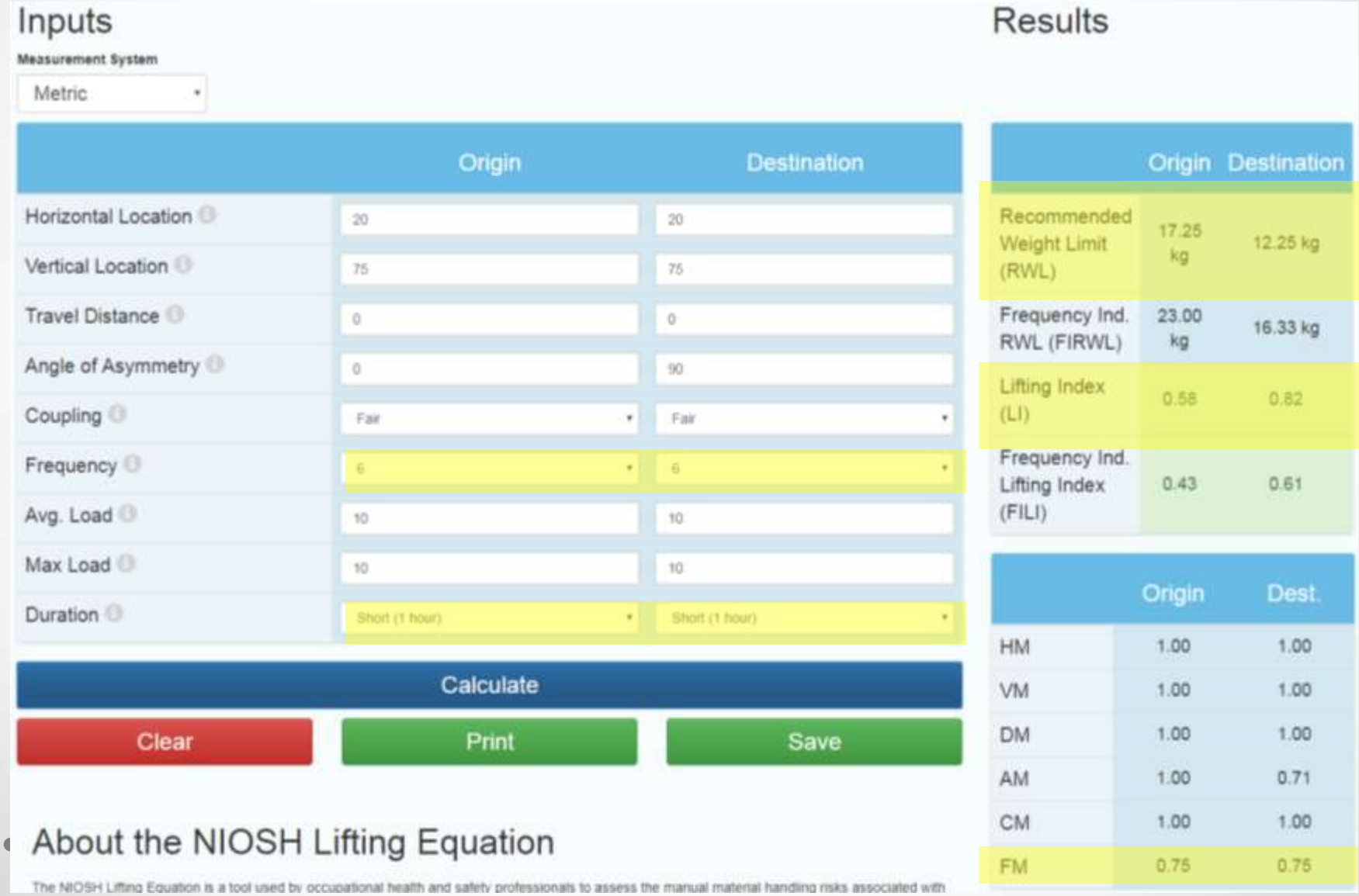
$$\text{RWL} = 23\ \text{kg} * 1 * 1 * 1 * 0.71 * 0.75 * 1$$
$$= \mathbf{12.25\ kg}$$

- Compare weight of the box against determined weight limit for redesigned task:
  - weight of load (10 kg): now **<** RWL (12.25 kg)
  - Also, new **LI** = L / RWL = 10 / 12.25 = **0.82** (i.e. LI < 1)

- Conclusion:
  most **workers can perform the task safely** (why *most*?)

Case 1: Effect of Frequency Factor on RWL

- Check results using NIOSH Lifting Eqn Calculator:



Inputs

Measurement System: Metric

	Origin	Destination
Horizontal Location	20	20
Vertical Location	75	75
Travel Distance	0	0
Angle of Asymmetry	0	90
Coupling	Fair	Fair
Frequency	6	6
Avg. Load	10	10
Max Load	10	10
Duration	Short (1 hour)	Short (1 hour)

Calculate

Clear | Print | Save

Results

	Origin	Destination
Recommended Weight Limit (RWL)	17.25 kg	12.25 kg
Frequency Ind. RWL (FIRWL)	23.00 kg	16.33 kg
Lifting Index (LI)	0.58	0.82
Frequency Ind. Lifting Index (FILI)	0.43	0.61

	Origin	Dest.
HM	1.00	1.00
VM	1.00	1.00
DM	1.00	1.00
AM	1.00	0.71
CM	1.00	1.00
FM	0.75	0.75

About the NIOSH Lifting Equation

The NIOSH Lifting Equation is a tool used by occupational health and safety professionals to assess the manual material handling risks associated with

Case 1: Effect of Frequency Factor on RWL

- NIOSH Lifting Eqn Calculator printable results:

Name: sherbo
Company: KSU - IE Dept.
Job: Effect of Frequency Factor on RWL

NIOSH Lifting Equation Calculator

	Origin	Destination
Horizontal Location	20	20
Vertical Location	75	75
Travel Distance	0	0
Angle of Asymmetry	0	90
Coupling	Fair	Fair
Frequency	6	6
Avg. Load	10	10
Max Load	10	10
Duration	Short (1 hour)	Short (1 hour)

	Origin	Destination
RWL	17.25 kg	12.25 kg
FIRWL	23.00 kg	16.33 kg
LI	0.58	0.82
FILI	0.43	0.61

	Origin	Dest.
HM	1.00	1.00
VM	1.00	1.00
DM	1.00	1.00
AM	1.00	0.71
CM	1.00	1.00
FM	0.75	0.75

LIFTING ANALYSIS WORKSHEET

DEPARTMENT _____ JOB DESCRIPTION

JOB TITLE _____ _____

ANALYST'S NAME _____ _____

DATE

STEP 1. Measure and record task variables

Object Weight (kg)		Hand Location				Vertical Distance	Asymmetric Angle (deg.)		Frequency Rate	Duration	Object Coupling
		Origin		Dest			Origin	Destination	lifts/min	Hrs	
L(AVG)	L(MAX)	H	V	H	V	D	A	A	F		C
10	10	20	75	20	75	0	0	90	6	1	Fair

STEP 2. Determine the multipliers and compute the RWLs

RWL = LC x HM x VM x DM x AM x FM x CM

ORIGIN	RWL =	23	x	1.0	x	1.0	x	1.0	x	1.0	x	0.75	x	1.0	=	17.25 kg
DEST.	RWL =	23	x	1.0	x	1.0	x	1.0	x	0.71	x	0.75	x	1.0	=	12.25 kg

STEP 3. Compute the LIFTING INDEX

ORIGIN LIFT INDEX $\frac{\text{OBJECT WEIGHT}}{\text{RWL}} = \frac{10\text{ kg}}{17.25\text{ kg}} =$ 0.58

DESTINATION LIFT INDEX $\frac{\text{OBJECT WEIGHT}}{\text{RWL}} = \frac{10\text{ kg}}{12.25\text{ kg}} =$ 0.82

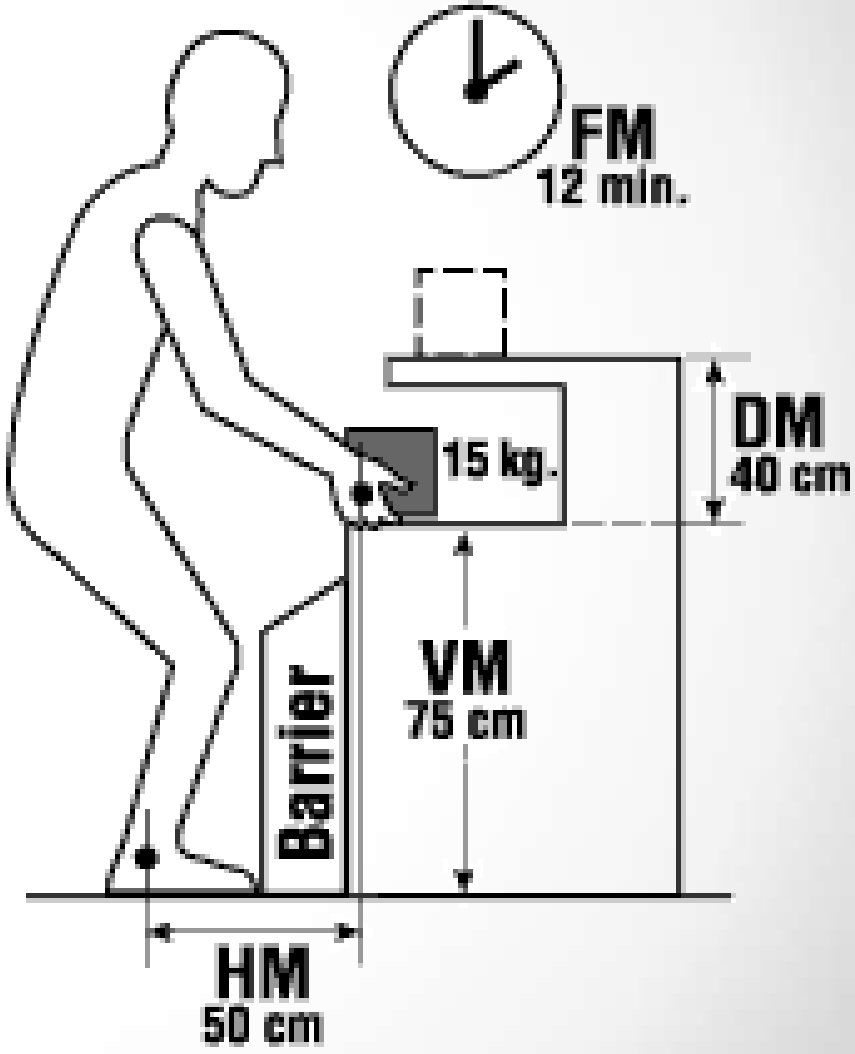
Case 2: Effect of Horizontal Dist. on RWL

Problem Statement:

Analyze the following work task.

A worker lifts 15-kg boxes from the table to the shelf, five times an hour.

Notice that there is a barrier between the worker and the box.

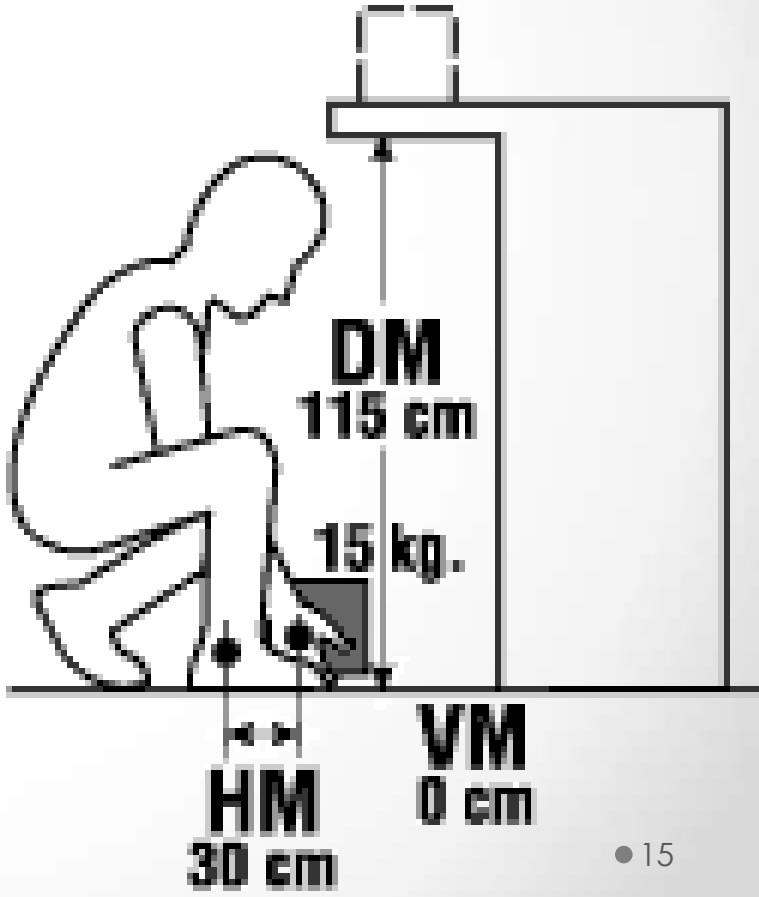


Case 3: Effect of Vertical Distance on RWL

Problem Statement:

Analyze the following work task.

A worker lifts a 15-kg load of loosely-piled pieces of metal from the floor to the table, five times an hour.



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2. ***Applications Manual for the Revised NIOSH Lifting Equation***. Thomas R. Walters, Vern Putz-Anderson, Arun Garg. US Department of Health and Human Services: Public Health Services. Cincinnati, OH, 1994.
3. ***OSHA Technical Manual. Section VII: Chapter 1: Back Disorders and Injuries***. Online at:

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4. ***Applications Manual For the Revised NIOSH Lifting Equation***. Centers for Disease Control & Prevention. Thomas R. Waters, Ph.D., Vern Putz-Anderson, Ph.D., Arun Garg, Ph.D. Centers for Disease Control & Prevention. Publication date: 01/01/1994. Online at:

   https://wonder.cdc.gov/wonder/prevguid/p0000427/p0000427.asp#head005001002000000

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5. ***A Step-by-Step Guide to Using the NIOSH Lifting Equation for Single Tasks.*** Mark Middlesworth. *Ergonomics Plus.* Online at: http://ergo-plus.com/niosh-lifting-equation-single-task/