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# **User's Manual for DESIGNTOOLS**

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**DesignTools** Laboratory Software for

*Methods, Standards, and Work Design* (11th ed.)  
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version 3.0  
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HOW TO USE THIS DOCUMENT  
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To view Readme.txt on screen in Notepad, maximize the Notepad window.

To print Readme.txt, open it in Notepad or another word processor, then use the Print command on the File menu.

For an instruction manual for Time Study program using Palm m105, read "Palm PC Instruction."

**PURPOSE of DesignTools**  
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**DesignTools** provides design tools for work measurement and workplace design for students using the 11th edition. This software also serves as a problem-solving tool for actual industrial designs.

There are many revisions and new modules in version 3.0.

- a module on cognitive workload
- a module on environmental design
- a time study module - downloadable to a Palm m105 (or higher model), data can then be uploaded to the existing time study form.
- new break-even analysis and value engineering tools.

Another module in **Ergosys** provides NIOSH Lifting Guideline Calculator which enables the user to calculate NIOSH lifting index (LI) of a job consisting of many small tasks. This feature is especially useful for users who frequently need to calculate LI since calculating LIs by hand is very time-consuming.

LIST of the MENU ITEMS

Ergonomics	- Workstation Dimension Guidelines	
	- NIOSH Lifting Guide Calculator	
	- CTD Checklist	
	- Environmental Design	- Noise - Illumination - Heat Stress
Quantitative Methods	- Exploratory Tools	- PARETO Chart - GANTT Chart
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Work Measurement	- Time Study	
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Applications of Standard Time	- Break-Even Analysis	
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## NIOSH Lifting Guide Calculator

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This NIOSH Lifting Guide Calculator provides individual RWL(Recommended Weight Limit) and LI(Lifting Index) for each sub-task as well as a CLI (Composite Lifting Index) for the entire job.

- 1) Select the type of measurement unit and the duration of work on the initial screen.
- 2) Enter in the second text box and click the 'Add Task' button on the left.
- 3) Edit any task (from default values), by highlighting the task in the third text box and clicking the 'Edit Task' button.
- 4) Check the 'Destination' checkbox to select data values for destination factors.
- 5) Edit various task factors according to the NIOSH lifting equation:

$$RWL = LC * HM * VM * DM * AM * FM * CM$$

where: LC = Load Constant = 51 lbs

HM = Horizontal Multiplier =  $10/H$

VM = Vertical Multiplier =  $1 - .0075|V-30|$

DM = Distance Multiplier =  $0.82 + 1.8/D$

AM = Asymmetry Multiplier =  $1 - 0.0032 * A$

FM = Frequency Multiplier (see Table 4-7)

CM = Coupling Multiplier (see Table 4-8)

H = Horizontal location of the load COG forward of the midpoint between the ankles,  $10 \leq H \leq 25$  inches

V = Vertical location of the load COG,  $0 \leq V \leq 70$

D = Vertical travel distance between the origin and destination of the lift,  $10 \leq D \leq 70$

A = Angle of asymmetry between the hands and feet (degrees),  $0 \leq A \leq 135$

note: all multipliers must be less than or equal to 1.00

- 6) Click 'Calculate Task' for the single task results.
- 7) After entering all data, return to the main screen and click the 'Calculate Job' to obtain the CLI for the entire job. If there is only one task, CLI is same as LI.

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## Workstation Dimension Guidelines

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This module provides anthropometric data for various workstation dimensions: Height, Arm Reach, Hand Tools, and Material Handling. The user may select one of four target population percentiles: 5<sup>th</sup> percentile female, 95<sup>th</sup> percentile female and male, or specific stature of operators. This module also provides various population data collected from many nations: North America, South/Central America, Latin America (Indian), Latin America (European), Eastern Europe, Africa, Japan, and so on. Graphical illustrations help the user easily understand the anthropometric features.

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## Environmental Design

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### 1. Noise

OSHA uses the concept of NOISE DOSE, with the exposure to any sound level above 80 dBA causing the listener to incur a partial dose. If the total daily exposure consists of several partial exposure to different noise levels, then the several partial doses are added to obtain a combined exposure:

$$D = 100 \times (C1/T1 + C2/T2 + \dots + Cn/Tn) \leq 100$$

where: D = Noise Dose

C = Time spent at specified noise level (hours)

T = Time permitted at specified noise level (hours) (see Table 6-6)

The noise dose can also be converted to an 8-hour time weighted average (TWA) sound level. This is the sound level that would produce a given noise dose if a worker were exposed to that sound level continuously over a 8-hour workday. The TWA is defined by:

$$TWA = 90 + 16.61 \times \log (D/100) \leftarrow 10 \text{ base}$$

Today, OSHA also requires a mandatory hearing conservation program, including exposure monitoring, audiometric testing, and training, for all employees who have occupational noise exposures equal to or exceeding TWA of 85 dB.

## 2. Illumination

Recognizing the complexity of extending the point source theory to real light sources and some of the uncertainties and constraints of Blackwell's (1959) laboratory settings, the IESNA (Illuminating Engineering Society of North America) adopted a much simpler approach for determining minimum levels of illumination. The first step is to identify the general type of activity to be performed and classify it into one of nine categories, A through I (see Table 6-2). For each category, there is a range of illuminances (low, middle, high). The appropriate value is selected by calculating a weighting factor (-1, 0, +1) based on three task characteristics that the user can select on the next frame of the screen.

## 3. Heat Stress

This module provides heat exposure limits and work-rest cycles based on the Wet Bulb Globe Temperature (WBGT), the metabolic load, and ACGIH/NIOSH guidelines. For outdoors with a solar load, the WBGT is defined as:

$$WBGT = 0.7 \text{ NWB} + 0.2 \text{ GT} + 0.1 \text{ DB}$$

and indoors or outdoors with no solar load, the WBGT is:

$$WBGT = 0.7 \text{ NWB} + 0.3 \text{ GT}$$

where: NWB = natural web bulb temperature (measure of evaporative cooling, using a thermometer with a wet wick and natural air movement)

GT = glove temperature (measure of radiative load, using a thermometer in a 6-in-diameter black copper sphere)

DB = dry bulb temperature (basic ambient temperature; thermometer shielded from radiation)

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### CTD Checklist

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The user should enter all the data if she/he wants to know the risk for incurring CTD for a particular task. There are four factors that affect the risk of CTD: Frequency, Posture, Force required, and Miscellaneous Factors. The user only needs to click corresponding items when calculating values of the Posture and Miscellaneous factors whereas she/he needs to type all the data when calculating values for the

Frequency and Force factors. Clicking "CALCULATE CTD INDEX" button shows the result after all the data has been entered.

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### PARETO Chart

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The PARETO chart identifies the most important or the most dangerous items as described in chapter 2 of the textbook. Up to 20 highest frequency ranked items from a maximum of 100 items are drawn in a chart using DesignTools. The input data set can be stored and retrieved as a 'pcd' file (i.e., the extension is \*.pcd). 'Sample.pcd' contains a sample data set for the user. The user can examine the chart by clicking the "Draw Pareto Chart" button or selecting it from the menu after inputting all the data.

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### GANTT Chart

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The GANTT chart shows the current status of a project. Up to 13 activities can be evaluated through this module. The project period can be up to 60 days (or 60 weeks or 60 months).

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### Flow Process Chart

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The Flow Process chart is used for evaluating the current job. A chart symbol will pop up next to the corresponding list box when the user selects an item from the box. The user can see what each symbol means by clicking the help menu. The input data set can be stored and retrieved as a dtm file (i.e., the extension is \*.dtm). Sample1.dtm contains a sample data set for the user. The user can compare the present work flow to the proposed design at the summary window.

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### Worker-Machine Relationship

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This module shows not only how many machines are assigned to a worker but also how much the total cost is based on the worker wages and machine costs. The chart shows the relationship between the worker(s) and the machine(s) when the basic data are entered. Clicking 'Show Results' button enables the user to see the chart with analytical results attached. If the cycle time is longer than 40 minutes, no chart will be plotted.

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### Line Balancing

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This module is to determine the ideal number of workers to be assigned to a production line (see Chapter 2 for details). There are two assumptions in the Line Balancing method:

- Operators are not able to move from one workstation to another to help maintain a uniform workload.
- The work elements that have been established are of such magnitude that further division would substantially decrease the efficiency of performing the work element.

The following procedure for solving an assembly line balancing problem is based on General Electric's Assembly Line Balancing:

1. determine the sequence of individual work elements.
2. find zoning restraints.
3. estimate the production rate, using the expression:

$$\text{Production per day} = \frac{\text{Working min/day}}{\text{Cycle time of system (min/unit)}}$$

4. create "Positional Weight Matrix" (see Figure 2-20 for an example)
5. assign an unassigned task having the highest positional weight to the current workstation after checking whether its predecessors are already assigned.

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 Time Study  
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This module consists of many categories which are required to calculate the standard time for a particular operation. However, in the most typical user scenario, the time study data will be uploaded from the Palm QuikTS program. Individual values or labels can be then modified by the user. This module has 4 windows.

== Main Window ==

The user can see a sample data set when opening one of the sample files (sample1 through sample3) with the extension of \*.tsd.

The pink-colored items such as Study Number, Number of Elements, Number of Cycles, and Time need to be entered before the observed data can be inserted.

Allowances can be changed by the user (default of 10 %).

Enter time data as decimals, for example, starting time as 9:00 or 9:00.50 (.50 means 0.5 minutes or 30 seconds). Units are hours and minutes in military time.

Speed rating can be used for rating individual elements or the overall study. The Westinghouse system can only be used for overall rating.

Snapback timing method is recommended when the user measures cycle times individually. Continuous timing method will be explained at the next window.

The user can now input the observation time data. Select Tools of the menu bar and click "Observation Data." An error message will show if any of the required data is missing.

== Observation Data Entry Window ==

The number of cells corresponding to the cycles and elements the user already typed are available for the data entry. The definitions of columns are described in the Help.

R columns are available only when the user selected Individual Rating.

W columns are available when the user selected Continuous Timing method.

NT columns are always calculated automatically when corresponding OT has been typed and <Tab> pressed (the user should check whether the NT cell is calculated correctly, especially at the end of data entry).

OT columns will be calculated automatically when the user inputs W columns.

The procedure for marking Foreign Elements or Outlier is as follows:

1. Place the cursor at the correct cell (usually OT cell).
2. Select "Cell Option" of the menu bar or click the right mouse button at non-clickable area (NT column is the best place to use).
3. There is no check mark when the background of the cell is white. Legends for the colors are summarized at the bottom of the screen.
4. Click again to clear the color mark of the cell.
5. The Foreign Element window is available if there is at least one Foreign Element (up to 7 foreign elements are allowed).
6. Outliers will not be included in the summary table.

== Foreign Element Window ==

The number of Foreign Elements is the same as the number of cells the user already marked as Foreign Elements.

== Summary Window ==

The definitions of items in 'TIME CHECK' frame are as follows:

Total Check Time: the time before and after collecting data = TEBS + TEAF

Effective Time = summation of all OTs

Ineffective Time = summation of all of Foreign Elements and Outliers

Total Recorded Time = Total Check Time + Effective Time + Ineffective Time

Unaccounted Time = Total Recorded Time - (Finishing Time - Starting Time)

Recording Error(%) = Unaccounted Time / (Finishing Time - Starting Time) × 100

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Standard Data  
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This module provides the user with standard time calculations for three machining operations: Drilling, Lathe, and Milling work. It is very straight- forward to enter data and iterate through the given equations. The user can find the equations in chapter 12 of the textbook and the symbols written in italics are exactly the same as the equations in the book.

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Work Sampling  
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The equations used in this module are explained in the Help window. This module provides a list of observation times which are generated randomly based on the selected days and time periods. The user can see the list through either print output or any type of wordprocessor because the list is saved as an ASCII file (extension \*.out).



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### Simple Reaction Time

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The simple reaction time experiment module is simply to show fastest possible response time to a given color. The user responds as fast as possible with any button when a stimulus appears. The user can set the number of trials from two(2) to one hundred (100). The experiment results will appear on a separate screen by clicking 'View Results' button on the left.

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### Choice Reaction Time

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The choice reaction time experiment module is to show effect of information loading on response time. The user tries to respond to the correct response button as fast as possible when a stimulus appears. The user can set the number of trials from two(2) to one hundred (100). The experiment results will appear on a separate screen by clicking 'View Results' button on the left.

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### Psychophysics

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The psychophysics experiment module is a line judgment paradigm to demonstrate just-noticeable differences. The user tries to determine which line is longer than the other and press or click the correct response button as fast as possible when two lines appear on the screen. The user can set the number of trials from two(2) to one hundred (100) and select the percent difference of line length between lines. The experiment results will appear on a separate screen by clicking 'View Results' button on the left.

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### Fitts Tapping Task

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The Fitts Tapping task experiment module is to demonstrate eye-hand coordination and information loading. The user can design an experimental condition via setting a size of click area and distance between the click areas. One trial has one hundred taps and the results show an average tap time of each trial. The user can set the number of trials from one(1) to one hundred (100) and select the size of areas and distance between them. The experiment results will appear on a separate screen by clicking 'View Results' button on the left.

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### Short-term Memory Span

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The Short-Term Memory Span experiment module is to demonstrate Miller's Rule and short-term memory span. A five-digit number is the shortest stimulus and a thirteen the longest. The user should determine the longest digit only, i.e., the minimum length is fixed. The interval between perceiving a stimulus and answering the memorized number can be set from 5 seconds to 60 seconds. The user should also decide the number of trials for each length. The total number of trials for the entire experiment will be:

Total Number of Trials = (Max Length - 4) \* (# of trials for each length)

The experiment results will appear on a separate screen by clicking 'View Results' button on the left.

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### Stroop Test

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The Stroop Test module is to demonstrate compatibility and interference issues.

There are four options in this test:

- Color-Words, No Interference
- Color-Words, Interference
- Color-Nonwords, No Interference
- Color-Nonwords, Interference

The user must respond to what the written word indicates. Under the Interference condition, the color of a stimulus doesn't match what the written word actually indicates. Under the Nonwords condition, letters of a stimulus are shuffled and don't give the user any meaning. Therefore, the user must identify which color the written word actually indicates before responding. The user can set the number of trials from ten(10) to one hundred (100). The experiment results will appear on a separate screen by clicking 'View Results' button on the left.

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### Visual Inspection

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The visual inspection module demonstrates an electronics inspection task. The user is given a mission to identify which resistor is correctly centered, i.e., whether the two lead lengths are same or not. There are three types of resistors, Large, Medium, and Small. The user can set the number of trials from ten(10) to one hundred (100). The experiment results will appear on a separate screen by clicking 'View Results' button on the left.

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### Break-Even Analysis

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The purpose of Break-Even Analysis is to compare two alternative methods, a new method with an old method. The new method, typically, has lower production costs but with the trade-off of higher implementation costs. The problem is to find the point in time or production output at which the new method breaks even with the old method in cost, i.e., is it worth implementing the new method? This Break-Even Analysis provides the best method with a graph. It also provides alternative optimal solution if one method is better in a particular interval and the other is better in a different interval.

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### Incentives

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This module has three options: Daywork Plan (no incentive), Standard Hour Plan (piecework beyond standard performance), and Variable Participation Plan (incentive rate is based on the user's input). The third option also enables the user to compare two different plans. The user can see a plot of worker's

wages and unit labor costs as the worker's performance increases. The graph shows the user the break-even point between the two plans.

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### Learning Curve

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This module provides two ways of calculating a learning curve: Two-Point method and Regression method. The average percent of learning is assumed to be the same throughout the entire work. The Two-Point method calculates a learning curve equation using two data points. The Regression method calculates a learning curve equation from input data using the least squares method. The user can store and retrieve the data during using the Regression method with file extension of \*.lcd. The user may want to know how many cycles are required to reach a certain standard time after the learning curve equation is obtained. Then she/he can change the standard time at the plot window and see how many cycles are necessary and how long it takes to reach that time by pressing <Enter> key.

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### Value Engineering

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Value Engineering is a semi-quantitative technique for finding the best determinative method. The user selects factors of interest, assigns appropriate weights (1 to 10 scale; 10 the best) and then rates each alternative (0 to 4; 4 the best) for each factor. The largest value determines the best method.