Human Activity Analysis

Customizing RULA Specifications

Glossary

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Preface

In the demanding global marketplace, ensuring that human fit, form, and function are comprehensively addressed is becoming an increasingly important aspect of design. Human Activity Analysis is based on a best-in-class human modeling system, which for many years has permitted detailed investigation into human-centered design issues in the context of a workplace before it physically exists. Human Activities Analysis specifically focuses on how a human will interact with objects in a working environment, as well as the effects of lifting, lowering, pushing, pulling and carrying on task performance.

Human Activity Analysis evaluates all elements of human performance from static posture analysis to complex task activities. Human Activity Analysis possesses a range of tools and methods that specifically analyze how a manikin will interact with objects in the virtual environment. The NIOSH 1981/1991 and Snook and Ciriello equations measure the effects of lifting/lowering, pushing/pulling, and carrying to fully optimize task performance. A designer can determine a number of task variables such as action limit, recommended weight limit, and maximum lifting/lowering weight. Benefits include accurately predicting human performance, ensuring conformance to health and safety standards and maximizing human comfort and safety.

Human Activity Analysis is part of the V5-based human modeling solution that also includes Human Builder, Human Posture Analysis, and Human Measurement Editor. Together, these tools provide designers with a comprehensive, quantitative and intuitive capability to design products that reflect the key skills as well as the limitations of the target audience.

Using this Guide

This book describes how to use Human Activity Analysis. Before you read it, you should be familiar with basic concepts such as document windows, standard tool bars, and view tool bars.

If you are new user, start with the tutorial in the Getting Started section.

The User Tasks section of the book provides procedures for using the features of Human Activity Analysis.

A Workbench Description section describes each functional icon or command in the workbenches.

The Glossary provides definitions of terms specific to Human Activity Analysis and related products.

Where to Find More Information

Prior to reading this book, we recommend that you read *Human Builder*. We also recommend that you read:

- *Human Measurements Editor*
- *Human Posture Analysis*
- *Conventions*

Conventions

Certain conventions are used in CATIA, ENOVIA & DELMIA documentation to help you recognize and understand important concepts and specifications.

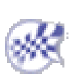
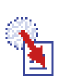
Graphic Conventions

The three categories of graphic conventions used are as follows:

- Graphic conventions structuring the tasks
- Graphic conventions indicating the configuration required
- Graphic conventions used in the table of contents

Graphic Conventions Structuring the Tasks

Graphic conventions structuring the tasks are denoted as follows:

This icon...	**Identifies...**
	estimated time to accomplish a task
	a target of a task
	the prerequisites
	the start of the scenario
	a tip
	a warning
	information
	basic concepts
	methodology
	reference information
	information regarding settings, customization, etc.
	the end of a task
	functionalities that are new or enhanced with this Release.
	allows you to switch back the full-window viewing mode.

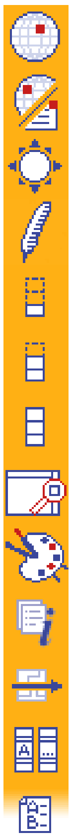
Graphic Conventions Indicating the Configuration Required

Graphic conventions indicating the configuration required are denoted as follows:

This icon...	Indicates functions that are...
P1	specific to the P1 configuration
P2	specific to the P2 configuration
P3	specific to the P3 configuration

Graphic Conventions Used in the Table of Contents

Graphic conventions used in the table of contents are denoted as follows:



This icon...	Gives access to...
	Site Map
	Split View mode
	What's New?
	Overview
	Getting Started
	Basic Tasks
	User Tasks or the Advanced Tasks
	Workbench Description
	Customizing
	Reference
	Methodology
	Glossary
	Index

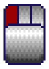
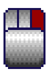
Text Conventions

The following text conventions are used:

- The titles of CATIA, ENOVIA and DELMIA documents *appear in this manner* throughout the text.
- **File** -> **New** identifies the commands to be used.
- Enhancements are identified by a blue-colored background on the text.

How to Use the Mouse

The use of the mouse differs according to the type of action you need to perform.

Use this mouse button...	**Whenever you read...**
	• Select (menus, commands, geometry in graphics area, ...) • Click (icons, dialog box buttons, tabs, selection of a location in the document window, ...) • Double-click • Shift-click • Ctrl-click • Check (check boxes) • Drag • Drag and drop (icons onto objects, objects onto objects)
	• Drag • Move
	• Right-click (to select contextual menu)

What's New?

New Functionality

Biomechanics Single Action Analysis

This new tool measures biomechanical data on a worker in a given pose. It calculates and gives information such as the lumbar spinal loads and the forces and moments on manikin joints.

Enhanced Functionalities

Catalog management

Additional manikin attributes can now be saved within catalogs and there is greater flexibility in the use of catalogs. The icons for catalog management in the Tools have changed.

Manikin Tools toolbar

For ease of use, this toolbar has been added. Previously these commands were accessed through the Human Builder workbench.

Removed Functionalities

The Load Library and Save in Library commands are removed. All existing libraries must be converted to catalogs.

Getting Started

This tutorial provides a "feel" of what Human Activity Analysis can do. It provides a step-by-step scenario showing you how to use key functions.

The tasks described in this section are:

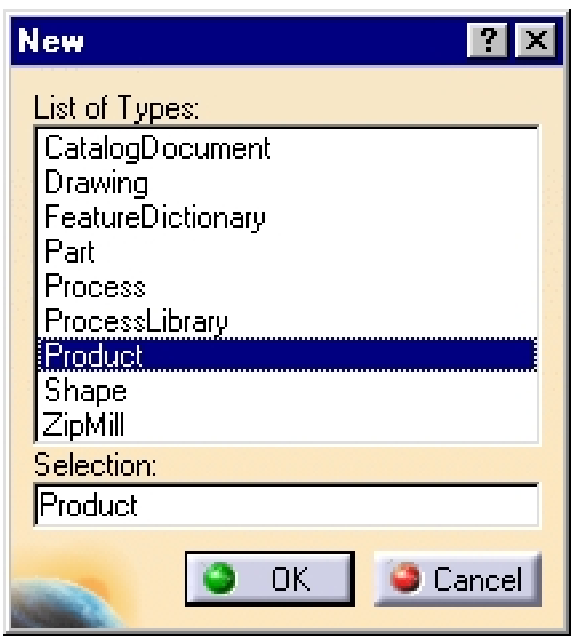
Accessing the Ergonomic Analysis Workbench

This procedure describes how to access the Ergonomic Analysis Workbench.

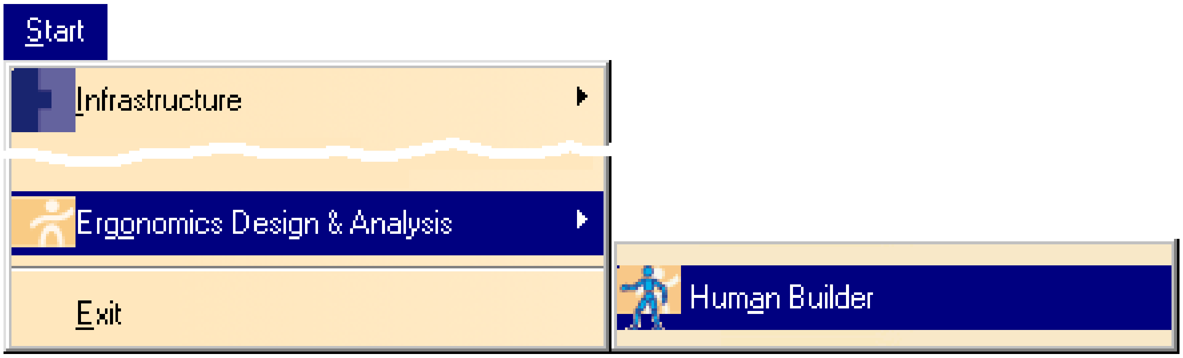
If you do not have an active product with a manikin, follow these steps to access the Ergonomic Analysis Workbench. If you do have an active product with a manikin, jump to step 5.

1. In the **File** menu, select **New**.

2. In the New dialog box, select Product, then click on **OK**.

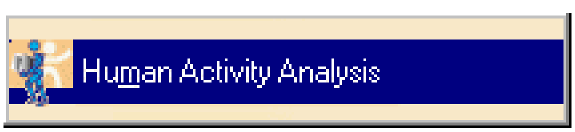


3. In the **Start** menu, select **Ergonomic Design & Analysis -> Human Builder**. A manikin can now be created in order to perform an ergonomic analysis.



4. In the **Insert** menu, select **Manikin**. A manikin is created. You can now change its posture to suit the task you want to analyze.

5. In the **Start** menu, select **Human Activity Analysis**. You are now ready to start an ergonomic analysis.



Select the type of analysis you want to perform from the Ergonomic Tools toolbar.

Analysis Introduction

This section gives some background information on the analysis of working postures in the workplace. It also describes the analyses types available in Human Activity Analysis.

The Ergonomic Analysis toolbar includes four types of analyses:

- RULA analysis
- Lift/Lower analysis
- Push/Pull analysis
- Carry analysis

Some analyses require you to record two postures (initial and final posture) while others use the current posture of the manikin as a base for the analysis.

As soon as the postures are set and recorded (if necessary) you can call each guideline individually and apply the analysis. The result of each analysis will appear at the bottom of the corresponding analysis window. Each dialog box allows you to specify the criterion required for that specific task such as duration and frequencies.

Note that all the analyses are real-time based. This means that if you modify the selected manikin's posture, the current analysis score will automatically be updated.

Note: You must select one manikin in the scene to be able to conduct the analysis.

RULA analysis

The RULA (Rapid Upper Limb Assessment) system was developed at the University of Nottingham's Institute for Occupational Ergonomics (Reference: Lynn McAtamney and E. Nigel Corlett, *RULA: A Survey Method for the Investigation of Work-related Upper Limb Disorders*). It was developed to investigate the exposure of individual workers to risks associated with work-related upper limb disorders.

Lift/Lower analysis

In the Lift/Lower Analysis, you can choose between three guidelines: NIOSH 1981, NIOSH 1991, and Snook and Ciriello. These three guidelines require the use of an initial and a final posture in order to complete the analysis. A brief description of each guideline follows.

NIOSH 1981

In 1981, NIOSH (National Institute for Occupational Safety and Health) published an algebraic equation for analyzing two-handed symmetrical lifts. The lifting is based on a two-handed symmetrical lift with no upper body twisting, and the distance between hands is less than 75 cm (30 inches). This analysis requires a good coupling between the load and the hands as well as between the shoes and the floor surface.

NIOSH 1991

The NIOSH 1991 equation also known as "the revised lifting equation" deals with two-handed manual lifting tasks. The equation handles a certain level of asymmetry. This analysis assumes an adequate coupling between the shoes and the floor surface.

Snook and Ciriello

The Snook and Ciriello lifting and lowering analysis tool is based on a study done by S. Snook and V. Ciriello. As with the NIOSH equations, this analysis is based on two input postures. The lifting is based on a two-handed symmetrical lift. The action (lifting or lowering) is determined by the displacement of the load in the scene.

There are three levels of lifting and lowering with approximately 30 inches between each.

- from floor to knuckle height
- from knuckle height to shoulder height
- from shoulder height to arm reach
- The horizontal distance is calculated from the chest to the mid-part of the hand grasp.

Push/Pull analysis

The Snook and Ciriello pushing/pulling analysis tool is based on a study done by S. Snook and V. Ciriello at Liberty Mutual Insurance Company. This analysis allows you to compare actual data for a "pushing/pulling" task to what is considered as a safe force to perform that task.

There are 3 steps defined for the vertical height of hands for the pushing task:

- from floor to 25 inches
- from floor to 35 inches
- from floor to 53 inches

There are six predefined distances for push:

- 7, 25, 50, 100, 150, and 200 foot push

The gender as well as the vertical height of hands are extracted from the selected manikin in the scene.

Carry analysis

The Snook and Ciriello carrying analysis tool is based on a study done by S. Snook and V. Ciriello at Liberty Mutual Insurance Company. This analysis allows you to compare actual data for a carrying task to what is considered as a maximum acceptable weight of carry to perform that task.

This analysis considers two vertical height distances of hands for the carrying task:

- For males: from floor to 31 inches, from floor to 44 inches
- For females: from floor to 28 inches, from floor to 41 inches

The manikin gender as well as the distance value for the hands are extracted from the selected manikin in the scene.

User Tasks

These are the tasks that a user performs using Human Activity Analysis.

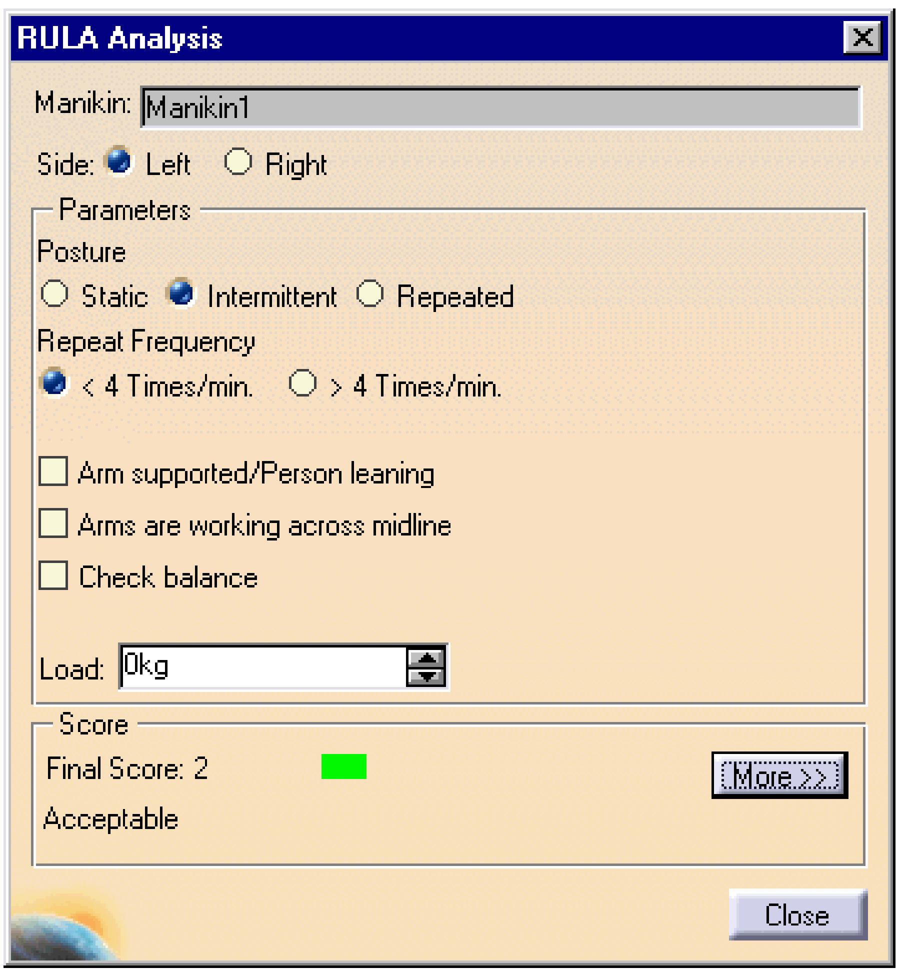
RULA Analysis

This task describes the RULA analysis procedure using the RULA Analysis dialog box.

For more information on RULA analysis, see the Analysis Introduction in the Getting Started section.

Select the **Launch RULA Analysis** icon from the Ergonomic Tools toolbar. The RULA Analysis dialog box appears. The fields to choose from are:

- Manikin: Displays the name of the selected manikin.
- Side: Select the side of the manikin that will be analyzed.
- Parameters - Specify settings that are not automatically set.
- Score - Displays the score obtained by the analysis.



Manikin:

This is a read-only field that displays the name of the selected manikin.

Side:

Use the two toggle buttons to select the side of the manikin that will be analyzed.

Parameters

Use the options in this zone to specify settings that cannot be set automatically.

Posture

Three types of postures are predetermined:

- Static
- Intermittent
- Repeated

Select the one that best describes the worker's situation.

Repeat Frequency

This parameter is used to determine the task frequency. Two choices are available:

- Less than 4 times per minute
- More than 4 times per minute

Shoulders are supported
Arms are working across midline
Check balance

Select one or more of these options to provide additional information that may affect the output of the RULA analysis.

Load

Use this field to specify the weight of the manipulated object. Click the arrows to increase or decrease the weight or use the keyboard to directly type a value into this field.

Score

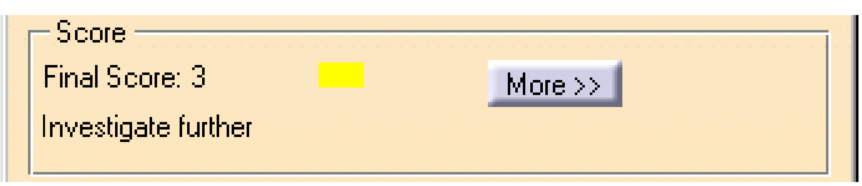
There are two modes for the score display: basic mode and advanced mode.

Basic mode

The data displayed in this mode is the final score accompanied by a colored zone. The color of this zone changes from green to red according to the final score.

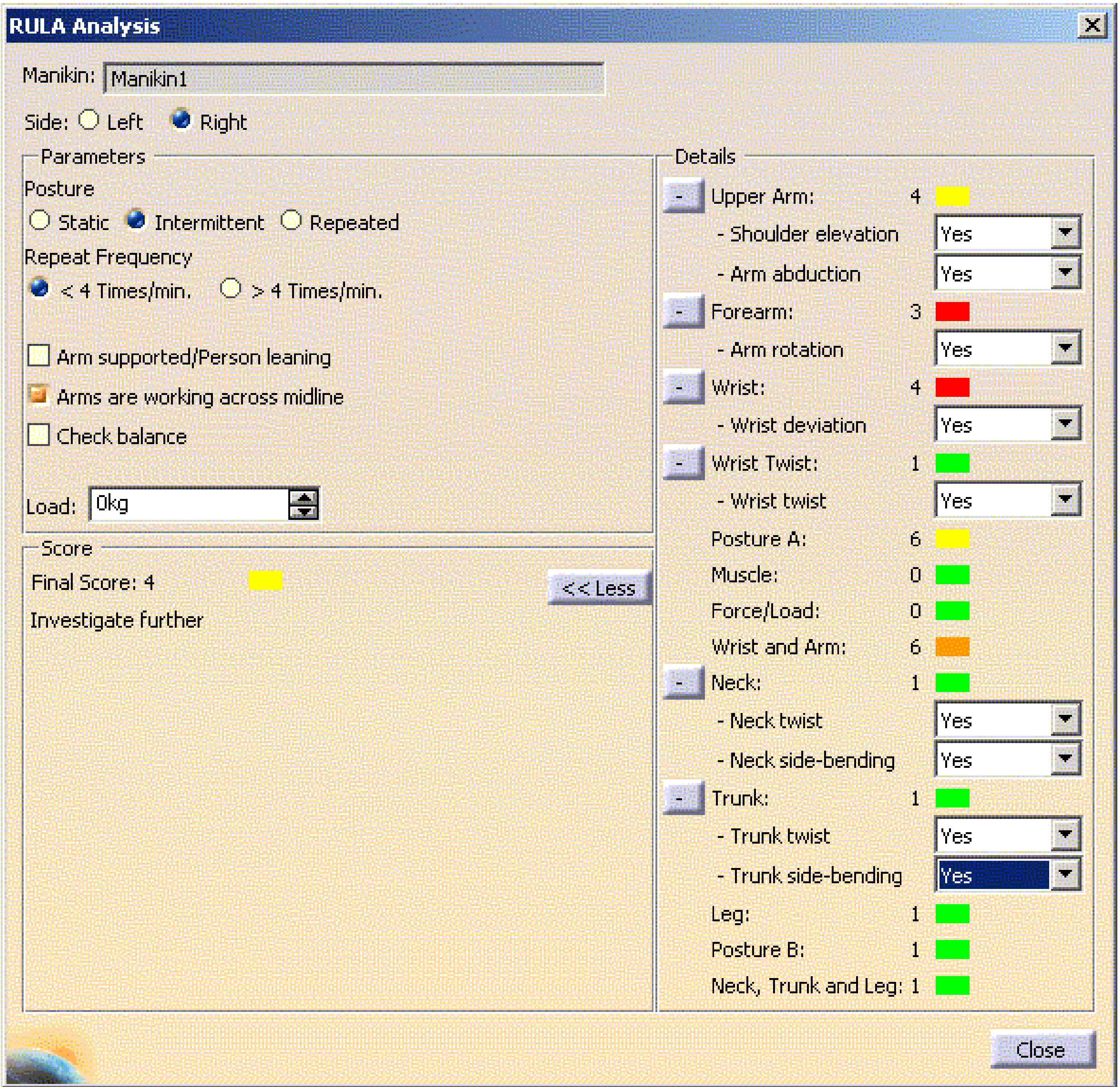
The RULA analysis examines the following risk factors: number of movements, static muscle work, force, working posture, and time worked without a break. All these factors combine to provide a final score that ranges from 1 to 7.

- 1 and 2: (Green) Indicates that the posture is acceptable if it is not maintained or repeated for long periods of time.
- 3 and 4: (Yellow) Indicates that further investigation is needed and changes may be required.
- 5 and 6: (Orange) Indicates that investigation and changes are required soon.
- 7: (Red) Indicates that investigation and changes are required immediately.
- Use the More>> button to switch from the basic mode to the advanced mode.



Advanced mode

The data displayed in the basic mode is also displayed in the advanced mode. The advanced mode, in addition, also displays the intermediate scores. Some of these scores are obtained by subjective values. In the basic mode, these values are automatically set to default; in the advanced mode you can change these values. The score will then be modified to reflect these new values.



Use the <<Less button to switch back to the basic mode.

Details section

The Details section that is displayed when you press the More>> button presents the score obtained for each section and used to calculate the final RULA score. The parameters of six of these segments can be edited:

Upper arm:	Shoulder elevation Arm abduction Arm rotation
Forearm:	Arm rotation
Wrist:	Wrist deviation
Wrist twist:	Wrist twist
Neck:	Neck twist Neck side-bending
Trunk:	Trunk twist Trunk side-bending

For each of the parameters, you have a choice of three options: Auto, Yes, and No.

Auto: (No or Yes): RULA is using the parameters defined in the RULA Parameters field (**Tools->Options->Ergonomics Design & Analysis)** to determine the state of a specific segment, i.e., Shoulder in elevation or not, Arm in abduction or not, etc.

Yes: By selecting Yes, you force RULA to consider that the segment is at the specified state (elevation, abduction, etc.) no matter what the posture of the selected manikin is.

No: By selecting No, you force RULA to consider that the segment is not at the specified state (elevation, abduction, etc.) no matter what the posture of the selected manikin is.

These intermediate scores, represented by a number and a color, are used to calculate the final RULA score. The following table indicates the score range for each segment as well as the associated color.

Segment	Score Range	Color associated to the score					
		1	2	3	4	5	6
Upper arm	1 to 6						
Forearm	1 to 3						
Wrist	1 to 4						
Wrist twist	1 to 2						
Neck	1 to 6						
Trunk	1 to 6						

For more information on the RULA method, please read the following page that explains the steps for manually carrying the RULA evaluation.

RULA Employee Assessment Worksheet

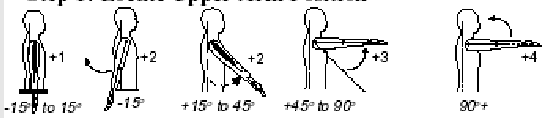
For more information about customization, please see Customizing RULA Specifications.

RULA Employee Assessment Worksheet

Complete this worksheet following the step-by-step procedure below. Keep a copy in the employee's personnel folder for future reference.

A. Arm & Wrist Analysis

Step 1: Locate Upper Arm Position

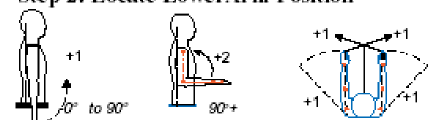


Step 1a: Adjust…

If shoulder is raised: +1;
If upper arm is abducted: +1;
If arm is supported or person is leaning: -1

Final Upper Arm Score =

Step 2: Locate LowerArm Position

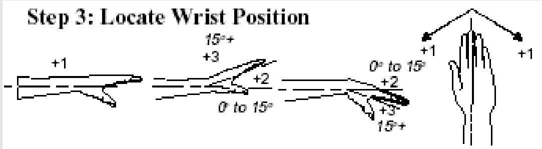


Step 2a: Adjust…

If arm is working across midline of the body: +1;
If arm out to side of body: +1

Final Lower Arm Score =

Step 3: Locate Wrist Position



Step 3a: Adjust…

If wrist is bent from the midline: +1

Final Wrist Score =

Step 4: Wrist Twist

If wrist is twisted in mid-range =1;
If twist at or near end of range = 2

Wrist Twist Score =

Step 5: Look-up Posture Score in Table A

Use values from steps 1,2,3 & 4 to locate Posture Score in table A

Posture Score A =

+

Step 6: Add Muscle Use Score

If posture mainly static (i.e. held for longer than 10 minutes) or;
If action repeatedly occurs 4 times per minute or more: +1

Muscle Use Score =

+

Step 7: Add Force/load Score

If load less than 2 kg (intermittent): +0;
If 2 kg to 10 kg (intermittent): +1;
If 2 kg to 10 kg (static or repeated): +2;
If more than 10 kg load or repeated or shocks: +3

Force/load Score =

=

Step 8: Find Row in Table C

The completed score from the Arm/wrist analysis is used to find the row on Table C

Final Wrist & Arm Score =

SCORES

Table ATable A

Upper Arm	Lower Arm	Wrist 1, Wrist Twist 1	Wrist 1, Wrist Twist 2	Wrist 2, Wrist Twist 1	Wrist 2, Wrist Twist 2	Wrist 3, Wrist Twist 1	Wrist 3, Wrist Twist 2	Wrist 4, Wrist Twist 1	Wrist 4, Wrist Twist 2
1	1	1	2	2	2	2	3	3	3
	2	2	2	2	2	3	3	3	3
	3	2	3	2	3	3	3	4	4
2	1	2	2	2	3	3	3	4	4
	2	2	2	2	3	3	3	4	4
	3	2	3	3	3	3	4	4	5
3	1	2	3	3	3	4	4	5	5
	2	2	3	3	3	4	4	5	5
	3	2	3	3	4	4	4	5	5
4	1	3	4	4	4	4	4	5	5
	2	3	4	4	4	4	4	5	5
	3	3	4	4	5	5	5	6	6
5	1	5	5	5	5	5	6	6	7
	2	5	6	6	6	6	7	7	7
	3	6	6	6	7	7	7	7	8
6	1	7	7	7	7	7	8	8	9
	2	7	8	8	8	8	9	9	9
	3	9	9	9	9	9	9	9	9

Table C

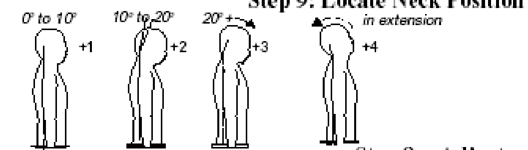
Final Score B (Neck, Trunk, Leg)

	1	2	3	4	5	6	7+
1	1	2	3	3	4	5	5
2	2	2	3	4	4	5	5
3	3	3	3	4	4	5	6
4	3	3	3	4	5	6	6
5	4	4	4	5	6	7	7
6	4	4	5	6	6	7	7
7	5	5	6	6	7	7	7
8+	5	5	6	7	7	7	7

Final Score

B. Neck, Trunk & Leg Analysis

Step 9: Locate Neck Position

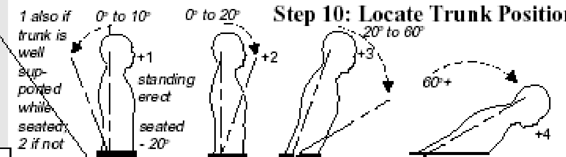


Step 9a: Adjust…

=Final Neck Score

If neck is twisted: +1; If neck is side-bending: +1

Step 10: Locate Trunk Position



Step 10a: Adjust…

= Final Trunk Score

If trunk is twisted: +1; If trunk is side-bending: +1

Step 11: Legs

If legs & feet supported and balanced: +1;
If not: +2

= Final Leg Score

Table B

Neck	Trunk 1, Legs 1	Trunk 1, Legs 2	Trunk 2, Legs 1	Trunk 2, Legs 2	Trunk 3, Legs 1	Trunk 3, Legs 2	Trunk 4, Legs 1	Trunk 4, Legs 2	Trunk 5, Legs 1	Trunk 5, Legs 2	Trunk 6, Legs 1	Trunk 6, Legs 2
1	1	2	1	2	2	3	3	4	4	4	4	4
2	1	2	2	2	3	4	4	5	5	5	5	5
3	2	2	2	3	3	4	4	5	5	5	6	6
4	2	3	2	3	3	4	4	5	5	6	6	6
5	3	4	4	4	4	5	5	6	6	6	6	6

Step 12: Look-up Posture Score in Table B

Use values from steps 9, 10 & 11 to locate Posture Score in Table B

= Posture B Score

+

Step 13: Add Muscle Use Score

If posture mainly static or;
If action 4/minute or more: +1

= Muscle Use Score

+

Step 14: Add Force/load Score

If load less than 2 kg (intermittent): +0;
If 2 kg to 10 kg (intermittent): +1;
If 2 kg to 10 kg (static or repeated): +2;
If more than 10 kg load or repeated or shocks: +3

= Force/load Score

=

Step 15: Find Column in Table C

The completed score from the Neck/Trunk & Leg analysis is used to find the column on Chart C

= Final Neck, Trunk & Leg Score

Subject: ____________________ Date: __/__/__

Company: ____________________ Department: ____________________ Scorer: ____________________

FINAL SCORE: 1 or 2 = Acceptable; 3 or 4 investigate further; 5 or 6 investigate further and change soon; 7 investigate and change immediately

Lift/Lower Analysis

This task describes the lift/lower analysis procedure using the Lift/Lower Analysis dialog box.

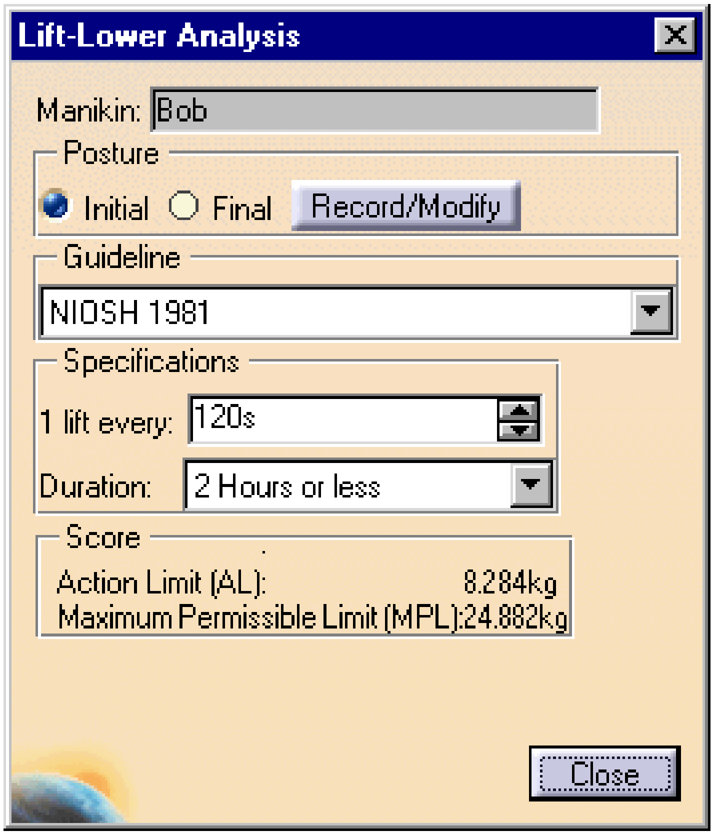
For more information on lift/lower analysis, see the Analysis Introduction in the Getting Started section.

Select the **Lift/Lower Analysis** icon from the Ergonomic Tools toolbar. The Lift/Lower Analysis dialog box appears. The fields to choose from are:

- Manikin: Displays the name of the selected manikin.
- Posture - Set the initial and final postures.
- Guideline - Choose the applicable guideline.
- Specifications - Choose or enter criterion corresponding to your selected guideline:
  - for NIOSH 1981
  - for NIOSH 1991
  - for Snook & Ciriello

The Specifications zone will change as different guidelines are chosen. Read the section related to each guideline for detailed information regarding individual specifications.

- Score - Displays the score obtained by the analysis.
  - for NIOSH 1981
  - for NIOSH 1991
  - for Snook & Ciriello



Manikin:

A read-only field displays the name of the selected manikin. Everything done during the analysis session will apply to this manikin.

Posture

This area of the dialog box has two functions:

- Display and choose postures (Initial and Final toggle buttons)
- Record or modify the selected posture (Record/Modify push button)

Initial and Final

Use these two toggle buttons to select which posture you want to record or modify. When the postures are recorded, use these buttons to switch back and forth between the two postures. The manikin in the scene displays the current posture selected.

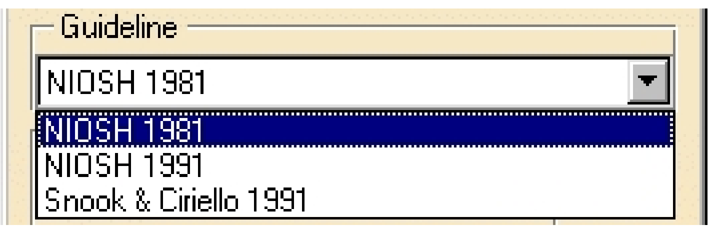
Record/Modify

Use this push button to record a posture. Use the Initial and Final buttons to select the posture to be recorded. If the manikin's current posture does not respect the lifting task definition, an error message will be displayed with the list of the missing or bad prerequisites.

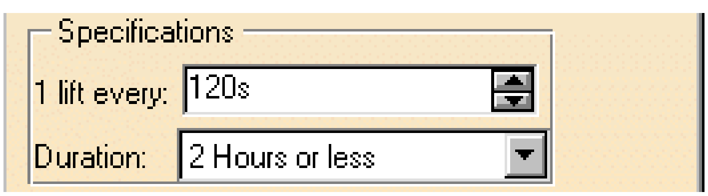
Guideline

From this list, select the guideline to perform the lift/lower analysis. The guidelines available are NOSH 1981, NIOSH 1991, and Snook & Ciriello.

The Specifications and Scores will change depending on which guideline is chosen.



Specifications (for NIOSH 1981)



1 lift every:

Use this specification to determine lift frequency. Click on the arrows to increase or decrease the value indicated in the text field or directly enter a new value using the keyboard.

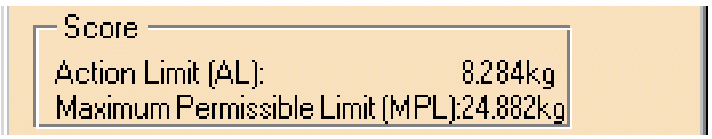
Duration:

Use this field to enter the duration of the work in hours per day.
The work is considered:

- occasional if the value is one hour or less
- continuous if the value is 8 hours

Score (for NIOSH 1981)

Immediately after the frequency and duration fields are completed, the results are displayed in the Score zone.



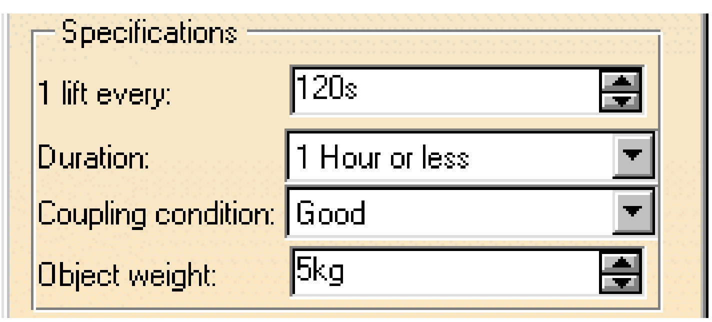
Action Limit (AL):

This value represents the weight below which the task could be considered as reasonably safe.

Maximum Permissable Limit (MPL):

This value represents a limit above which the lifting task is considered as hazardous and requires engineering controls.

Specifications (for NIOSH 1991)



1 lift every:

Use this specification to determine lift frequency. Click on the arrows to increase or decrease the value indicated in the text field or directly enter a new value using the keyboard.

Duration:

Use this field to enter the duration of the work in hours per day. The work is considered:

- occasional if the value is one hour or less
- continuous if the value is 8 hours

Coupling condition:

Use this function to quantify the quality of the hand-to-object. The coupling quality is classified as Good, Fair, and Poor.

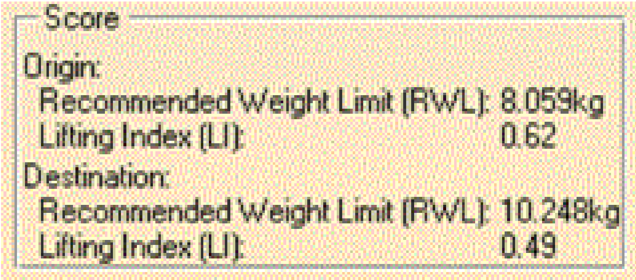
- Good - a comfortable grip in which the hand can easily wrap around the object
- Fair - a grip in which the hand can be flexed about 90 degrees.
- Poor - when the the object is hard to handle (irregular, bulky, sharp edges, etc.)

Object weight:

Use this field to enter the load weight. This value is used for the lifting index calculation.

Score (for NIOSH 1991)

Immediately after the frequency and duration fields are completed, the results are displayed in the Score zone.



Origin

This result is based on the initial posture of the manikin.

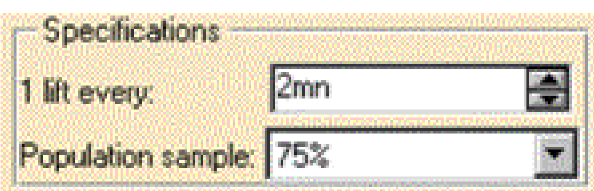
- Recommended Weight Limit:
  The RWL is the load weight that healthy workers can lift over a certain period of time without risk.
- Lifting Index:
  The LI provides a relative estimate of the level of physical stress.

Destination

This result is based on the final posture of the manikin.

- Recommended Weight Limit:
  The RWL is the load weight that healthy workers can lift without risk.
- Lifting Index:
  The LI provides a relative estimate of the level of physical stress.

Specifications (for Snook & Ciriello)



1 lift every:

Use this specification to determine lift frequency. Click on the arrows to increase or decrease the value indicated in the text field or directly enter a new value using the keyboard.

Population sample:

Three population percentiles are provided: 90th, 75th, and 50th. These percentiles represent the percentage of the population able to perform the task safely. The selected percentile takes the manikin gender into account.

Score (for Snook & Ciriello)

Immediately after the frequency and population sample fields are completed, the results are displayed in the Score zone.

Maximum Acceptable Weight:

The maximum acceptable weight is defined as the weight that the selected population can handle with reasonable safety.

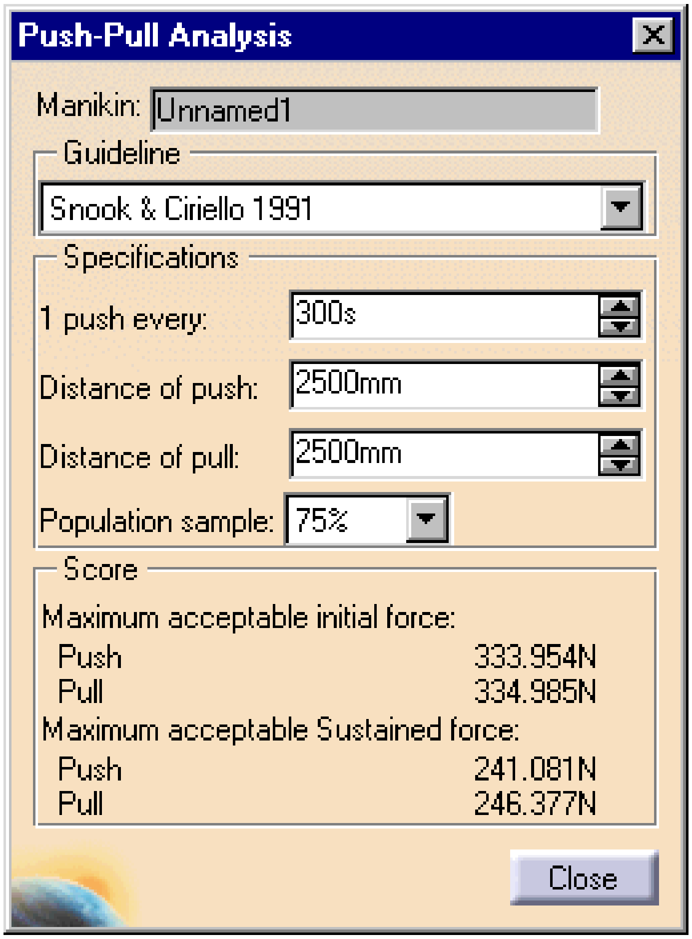
Push/Pull Analysis

This task describes how to execute a push/pull analysis using the Push/Pull Analysis dialog box.

For more information on Push/Pull analysis, see the Analysis Introduction in the Getting Started section.

Select the **Launch Push/Pull Analysis** icon from the Ergonomic Tools toolbar. The Push/Pull Analysis dialog box appears. The Push/Pull Analysis dialog box contains **only** the Snook & Ciriello guideline. This dialog box is divided into four parts:

- Manikin: Displays the name of the selected manikin.
- Guideline - Displays the current guideline.
- Specifications - Choose or enter analysis criterion.
- Score - Displays the score obtained by the analysis.



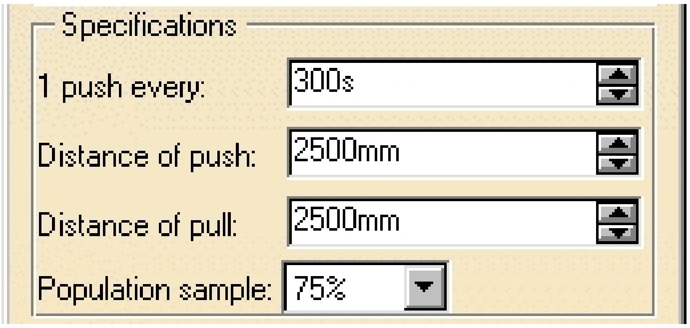
Manikin:

A read-only field displays the name of the selected manikin. Everything done during the analysis session will apply to this manikin.

Guideline

From this list, select the guideline to perform the Push/Pull analysis. In this analysis, only one guideline is available.

Specifications



1 push every:

Use this field to determine the push frequency. Click on the arrows to increase or decrease the value indicated in the text field or directly enter a new value using the keyboard.

Distance of push:

Use this field to specify the distance of the push. Click on the arrows to increase or decrease the value indicated in the text field or directly enter a new value using the keyboard.

Distance of pull:

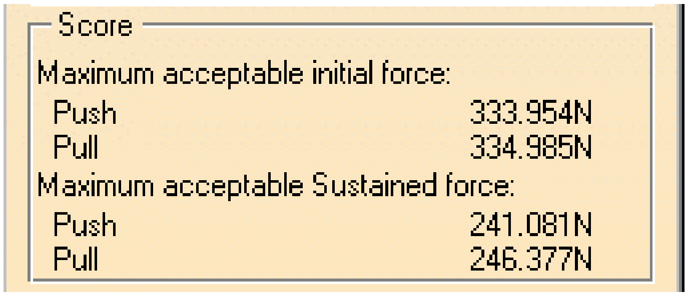
Use this field to specify the distance of the pull. Click on the arrows to increase or decrease the value indicated in the text field or directly enter a new value using the keyboard.

Population sample:

Three population percentiles are provided: 90th, 75th, and 50th. These percentiles represent the percentage of the population able to perform the task safely. The selected percentile takes the manikin gender into account.

Score

Immediately after the Specification fields are completed, the results are displayed in the Score zone.



The initial forces are required to initiate the object's motion. As the object begins to move, these forces will decline to a relatively constant level (sustained forces).

Maximum acceptable initial force:

This value expresses the force required to put an object into motion.

Maximum acceptable sustained force:

This value expresses the force required to keep the object in motion.

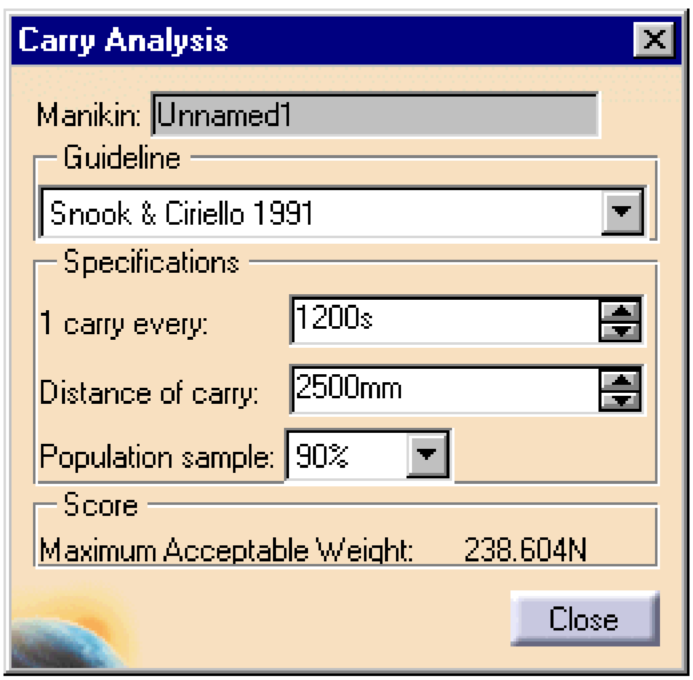
Carry Analysis

This task describes how to execute a carry analysis using the Carry Analysis dialog box.

For more information on Carry analysis, see the Analysis Introduction in the Getting Started section.

Select the **Launch Carry Analysis** icon from the Ergonomic Tools toolbar. The Carry Analysis dialog box appears. The Carry Analysis dialog box contains **only** the Snook & Ciriello guideline. This dialog box is divided into four parts:

- Manikin: Displays the name of the selected manikin.
- Guideline - Displays the current guideline.
- Specifications - Choose or enter analysis criterion.
- Score - Displays the score obtained by the analysis.

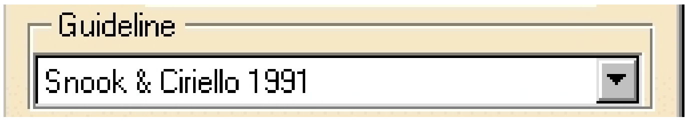


Manikin:

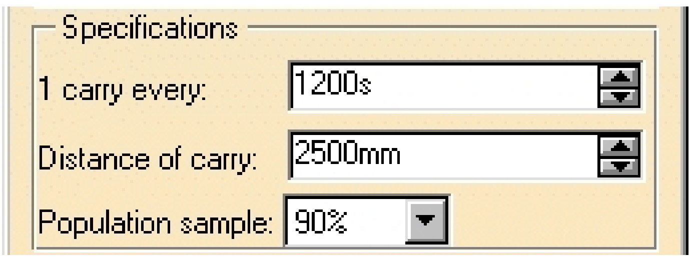
A read-only field displays the name of the selected manikin. Everything done during the analysis session will apply to this manikin.

Guideline

This list presents the guidelines available to perform Carry Analysis. Only one guideline is available.



Specifications



1 carry every:

Use this field to determine the carry frequency. Click on the arrows to increase or decrease the value indicated in the text field or directly enter a new value using the keyboard.

Distance of carry:

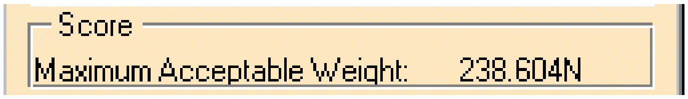
This specification is used to determine the distance the object will be carried. Click the arrows to increase or decrease the value indicated in the text field or directly enter a new value using the keyboard.

Population sample:

Three population percentiles are provided: 90th, 75th, and 50th. These percentiles represent the percentage of the population able to perform the task safely. The selected percentile takes the manikin gender into account.

Score

Immediately after the Specification fields are completed, the results are displayed in the Score zone.



Maximum Acceptable Weight:

The maximum acceptable weight is defined as the weight that the selected population can carry with reasonable safety.

Biomechanics Single Action Analysis

This procedure describes how to use the Biomechanics Single Action Analysis command.

This ergonomic tool measures biomechanical data on a worker in a given pose. From the current manikin posture, the Single Action Analysis tool calculates and outputs information such as the lumbar spinal loads (abdominal force, abdominal pressure, body movements) and the forces and moments on manikin joints. All the output incorporated in the model are based on research results and algorithms published by the scientific community.

The forces (loads) acting on the manikin's hands are taken into account in the biomechanical analysis; these forces represent the load of carry, push, lift/lower, or pull, depending on the scenario, and are available for the hands only. Both the **Load Properties** and the **Biomechanics Single Action Analysis** dialog boxes can be open at the same time. The last analysis is updated when the load is modified.

1. In the Ergonomics Tools toolbar, select the Biomechanics: Single Action Analysis command.
2. In the PPR tree or the 3D view, select a manikin for the analysis.

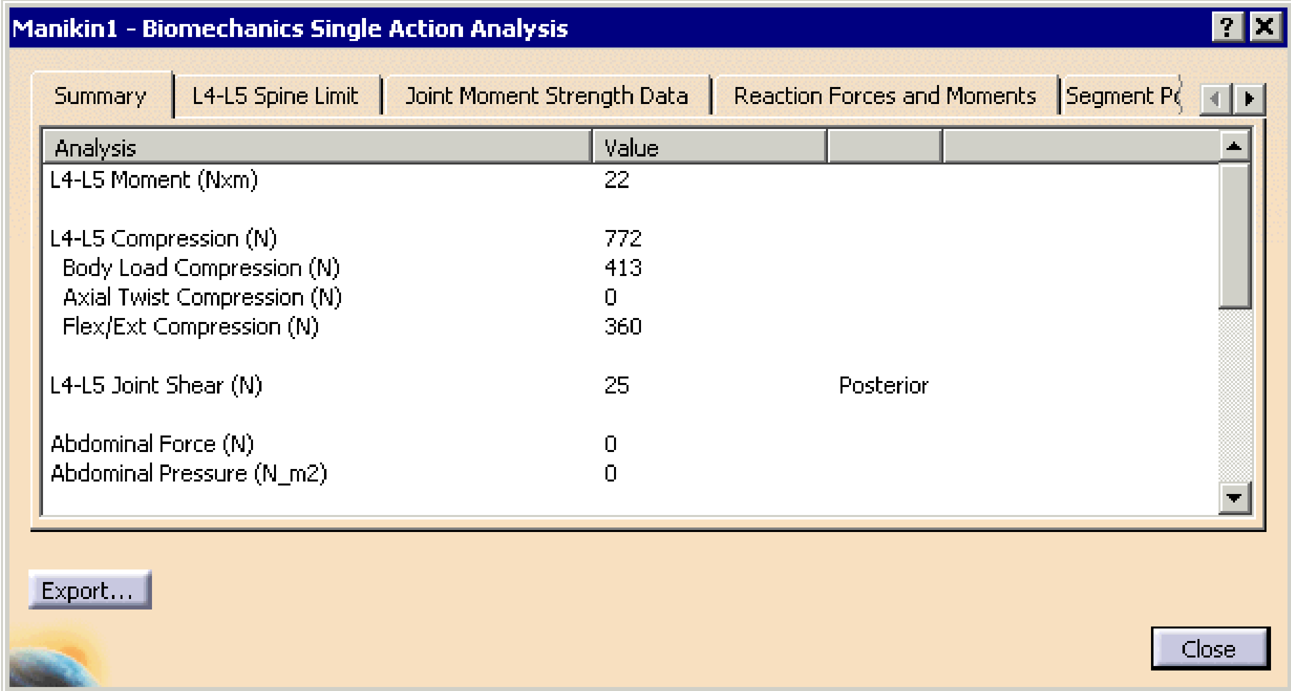
   The Biomechanics Single Action Analysis dialog box for that manikin appears, open to the default Summary tab.

   Read more about the:
   - Summary tab
   - L4-L5 Spine Limit tab
   - Joint Moment Strength Data tab
   - Reaction Forces and Moments tab
   - Segment Positions tab
   - Export button

These are the tabs and associated information in this dialog box:

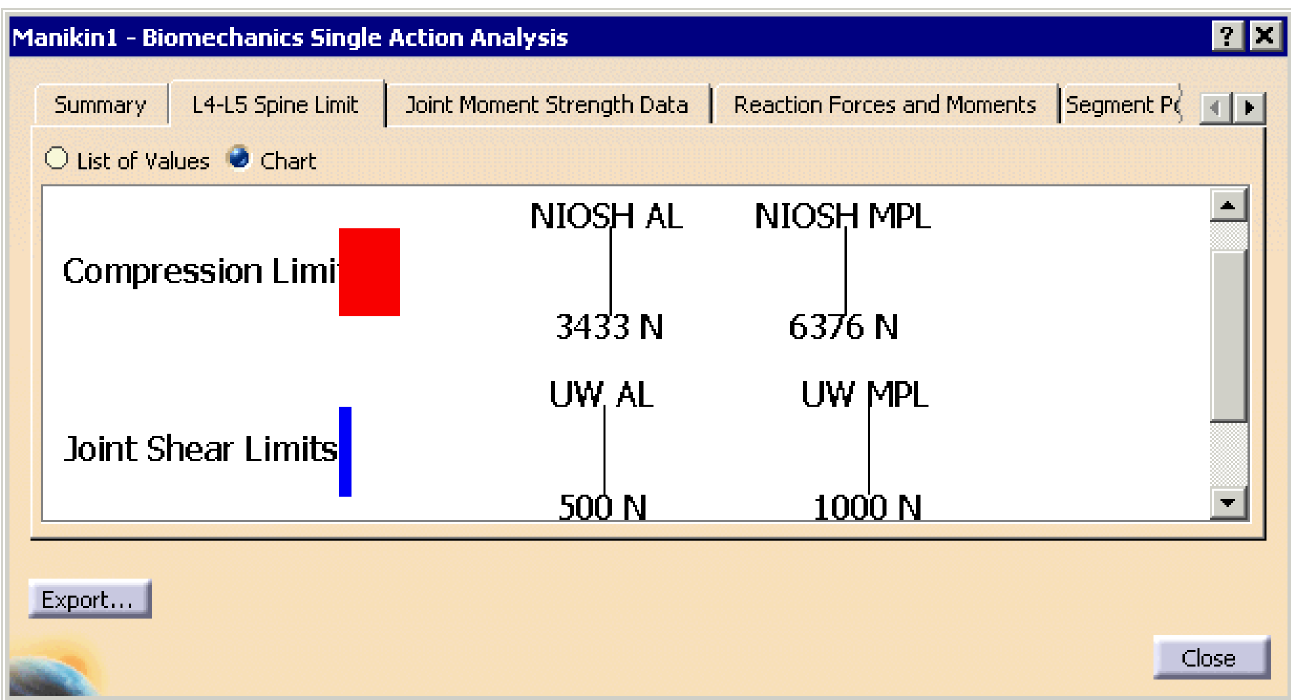
Summary tab

The Summary tab gives general biomechanics information such as:
- L4-L5 Moments
- L4-L5 Compression
- L4-L5 Joint Shear
- Abdominal Force and Pressure
- Ground Reaction



L4-L5 Spine Limit tab

The L4-L5 Spine Limit tab displays the evaluation of the posture and whether it exceeds the compression and joint shear limits recommended by NIOSH and the University of Waterloo. The information on this tab can be viewed as a list or as a chart, as shown below.

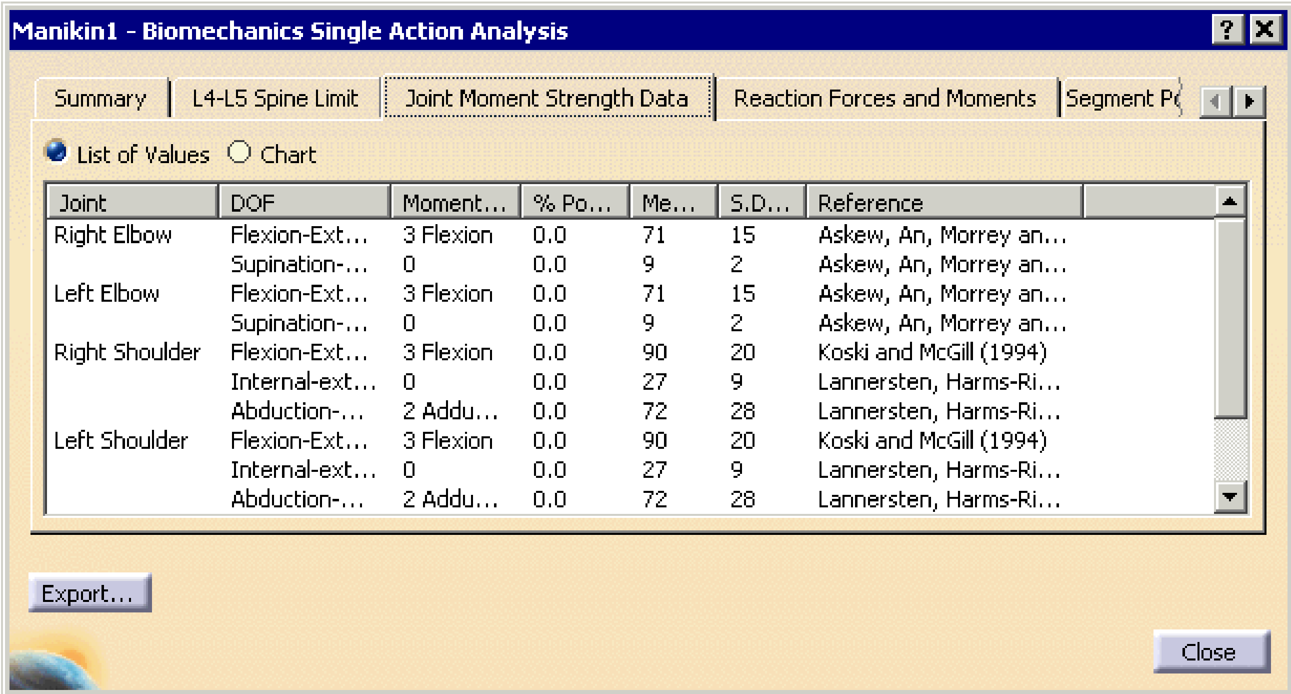


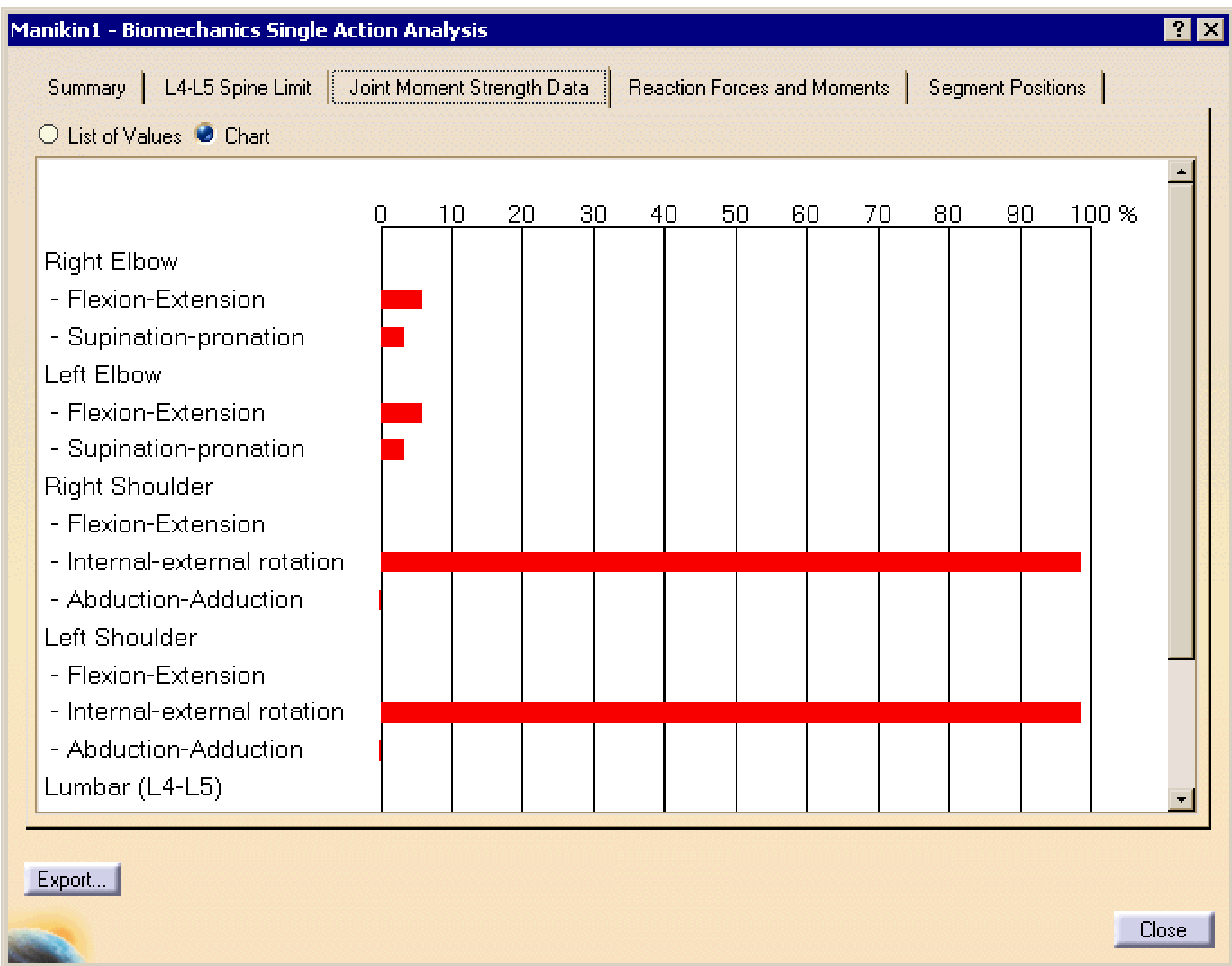
Joint Moment Strength Data tab

The Joint Moment Strength Data tab displays the evaluation of the percentage of a worker population that doesn't have the strength to perform a task based on strength studies such as those by Askew, An, Morrey and Chao (1987) for the elbow, Koski and McGill

(1994) for the shoulder, and Troup and Chapman (1969) for the lumbar.

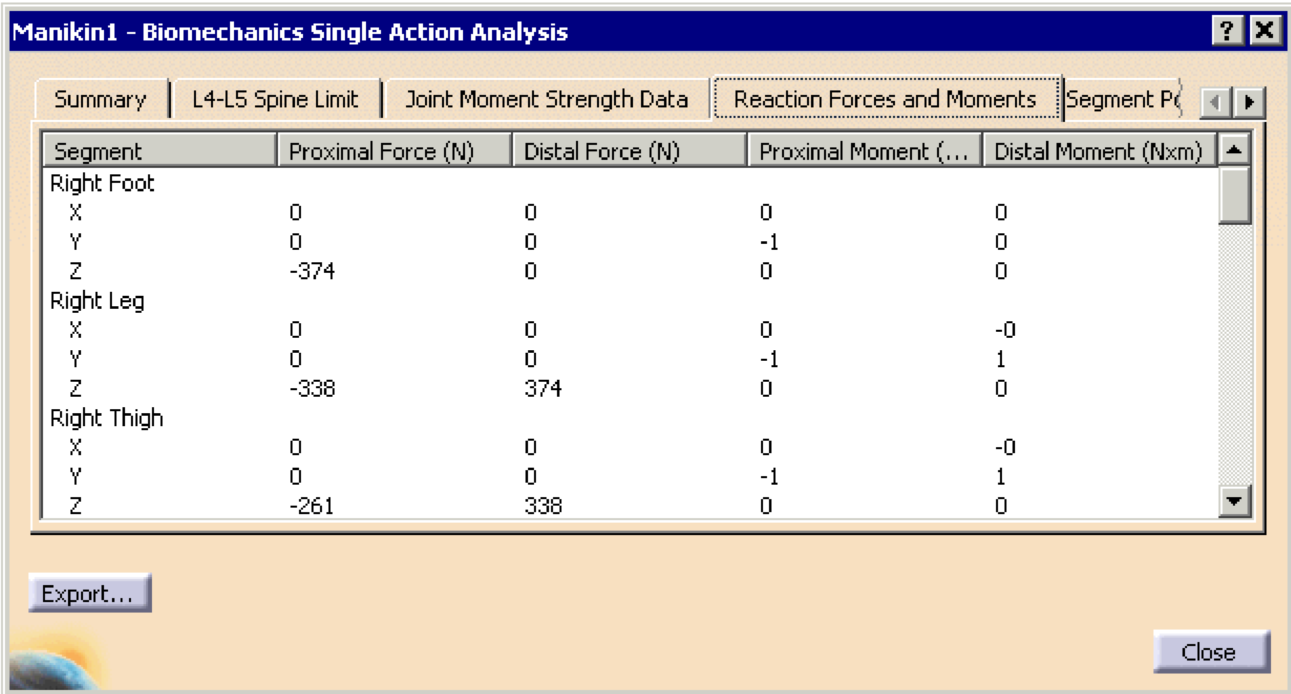
This information can be displayed as a chart or as a list, as shown below:





Reaction Forces and Moments tab

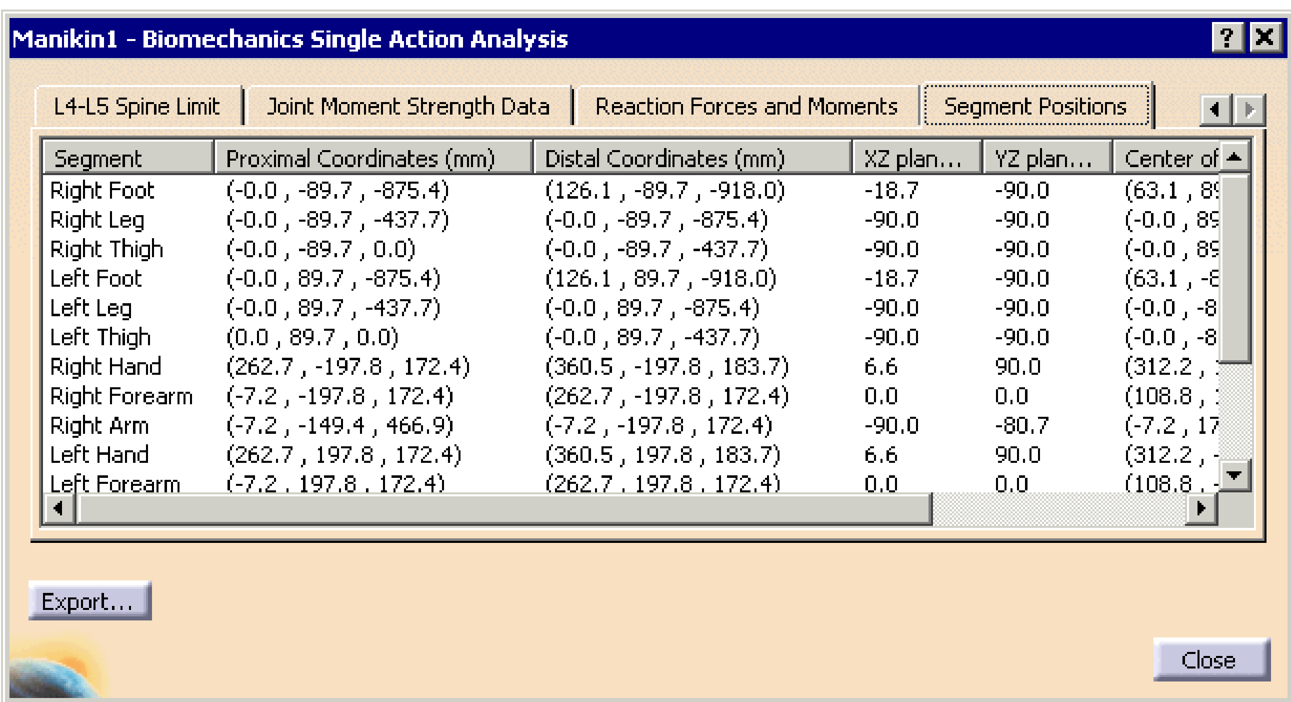
The Reaction Forces and Moments displays, in detail, the reaction forces (N) and orthopedic moments (Nm) proximal and distal segments.



Segment	Proximal Force (N)	Distal Force (N)	Proximal Moment (...	Distal Moment (Nxm)
Right Foot				
X	0	0	0	0
Y	0	0	-1	0
Z	-374	0	0	0
Right Leg				
X	0	0	0	-0
Y	0	0	-1	1
Z	-338	374	0	0
Right Thigh				
X	0	0	0	-0
Y	0	0	-1	1
Z	-261	338	0	0

Segment Positions tab

The Segment Positions tab displays information (position, angle, center of gravity, length) about the segments.

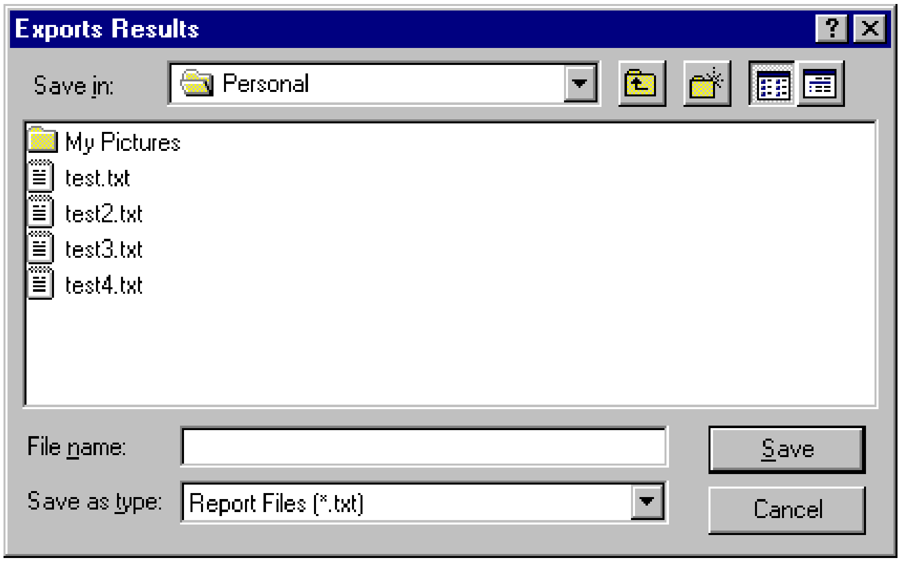


Segment	Proximal Coordinates (mm)	Distal Coordinates (mm)	XZ plan...	YZ plan...	Center of
Right Foot	(-0.0 , -89.7 , -875.4)	(126.1 , -89.7 , -918.0)	-18.7	-90.0	(63.1 , 89
Right Leg	(-0.0 , -89.7 , -437.7)	(-0.0 , -89.7 , -875.4)	-90.0	-90.0	(-0.0 , 89
Right Thigh	(-0.0 , -89.7 , 0.0)	(-0.0 , -89.7 , -437.7)	-90.0	-90.0	(-0.0 , 89
Left Foot	(-0.0 , 89.7 , -875.4)	(126.1 , 89.7 , -918.0)	-18.7	-90.0	(63.1 , -8
Left Leg	(-0.0 , 89.7 , -437.7)	(-0.0 , 89.7 , -875.4)	-90.0	-90.0	(-0.0 , -8
Left Thigh	(0.0 , 89.7 , 0.0)	(-0.0 , 89.7 , -437.7)	-90.0	-90.0	(-0.0 , -8
Right Hand	(262.7 , -197.8 , 172.4)	(360.5 , -197.8 , 183.7)	6.6	90.0	(312.2 ,
Right Forearm	(-7.2 , -197.8 , 172.4)	(262.7 , -197.8 , 172.4)	0.0	0.0	(108.8 ,
Right Arm	(-7.2 , -149.4 , 466.9)	(-7.2 , -197.8 , 172.4)	-90.0	-80.7	(-7.2 , 17
Left Hand	(262.7 , 197.8 , 172.4)	(360.5 , 197.8 , 183.7)	6.6	90.0	(312.2 , -
Left Forearm	(-7.2 , 197.8 , 172.4)	(262.7 , 197.8 , 172.4)	0.0	0.0	(108.8 , -

Export results

Use the **Export** button to save the biomechanical data in a text file. In the Export results dialog box, select the type of information you want to save and click on OK.

The biomechanical data is saved as a text file.



How to Do a Safe Save into ENOVIA LCA from CATIA V5

The objective of Safe Save is to prevent the user from building / editing data in CATIA V5 if they cannot be saved in ENOVIA LCA. Therefore, in interoperability mode, some CATIA V5 commands are grayed out / hidden in the Product Structure workbench.

Only commands subject to restrictions are listed below. And in some cases, rules are applied to restricted commands.

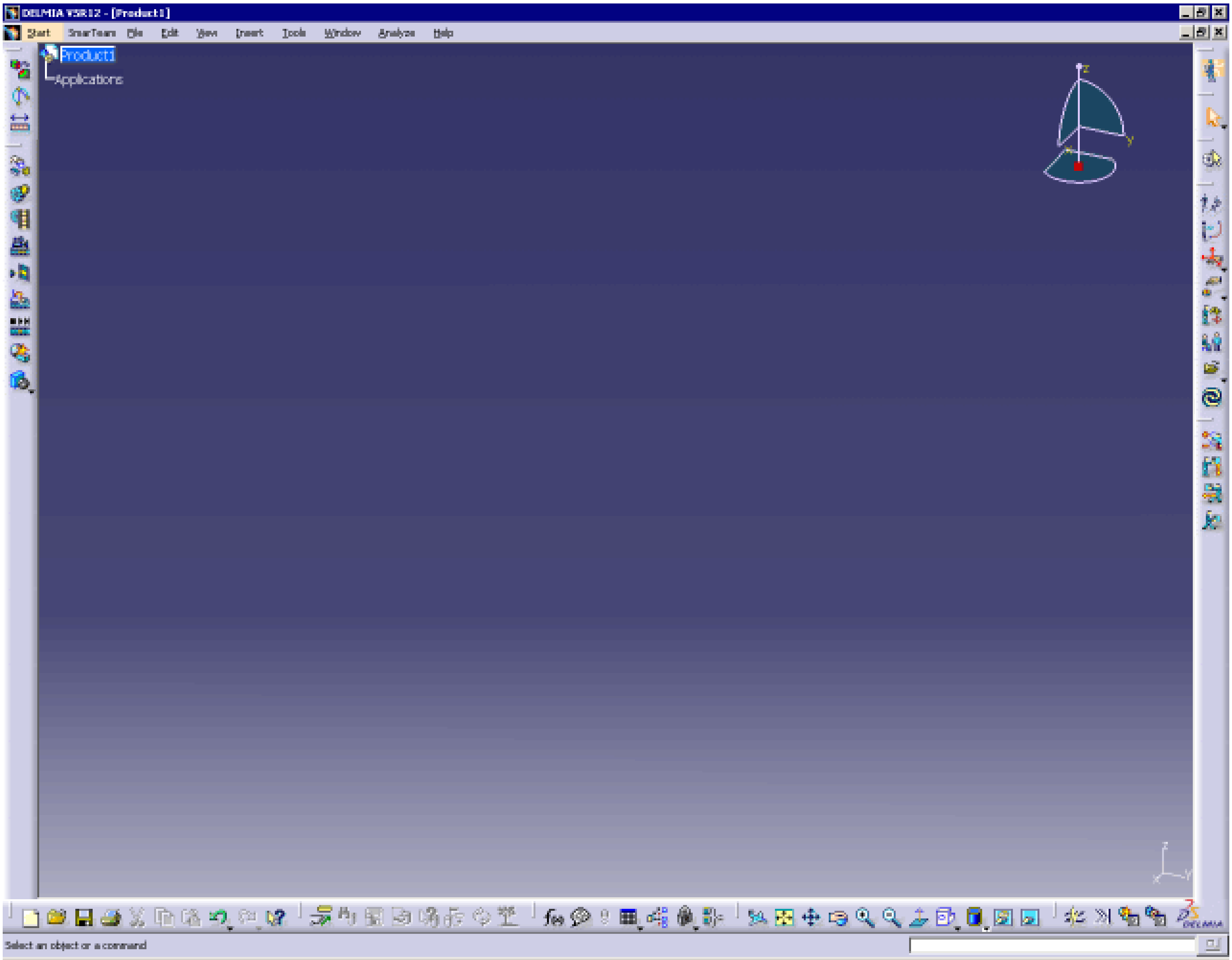
Workbench	Feature	Command	Accessibility in LCA mode	Warning / Comment	Save in LCA / Rules
HUMAN ACTIVITY	Manikin Simulation	Shuttle	NO (grayed out)		
		Simulation	NO (grayed out)		
		Generate Replay	NO (grayed out)		
		Generate Video	NO (grayed out)		
		Replay	NO (grayed out)		
		Track	NO (grayed out)		
		Play a Simulation	NO (grayed out)		

ANALYSIS		Distance and Band Analysis	YES	The result of this command cannot be saved.	NO
	Manikin Workspace Analysis	Arc Through Three Points	YES	The result of this command cannot be saved.	NO
		Measure Between	YES	The result of this command cannot be saved.	NO

Workbench Description

The Human Activity Analysis Version 5 application window looks like this.

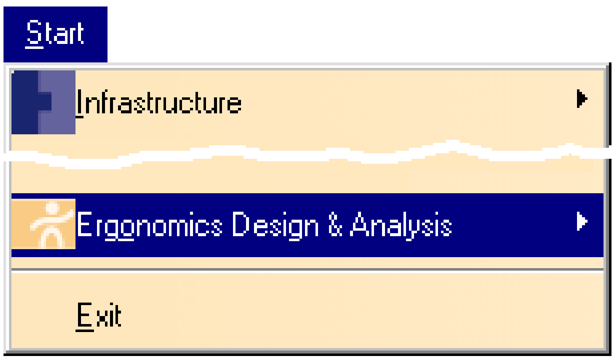
Click the hotspots to see the related documentation.



Human Activity Analysis Menu Bar

Start File Edit View Insert Tools Window Help

Start



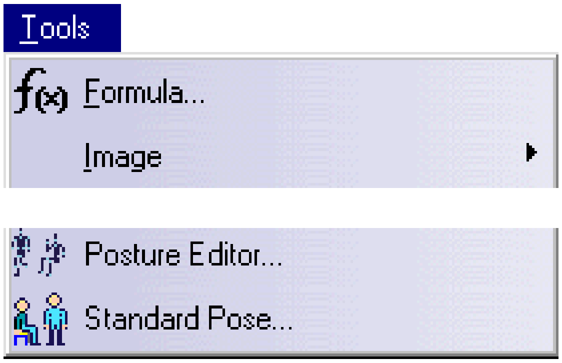
For	See
Human Activity Analysis 	Accessing the Ergonomic Analysis Workbench

File

For	See
New...	Accessing the Ergonomic Analysis Workbench

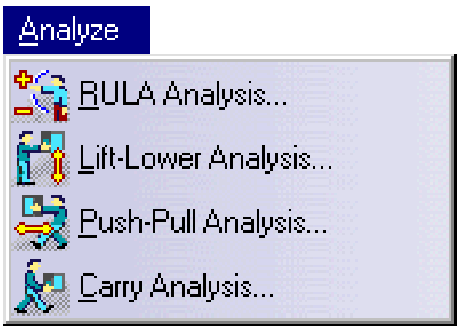
Tools

For	See
Posture Editor	Using the Posture Editor



Standard Pose	Applying Standard Poses

Analyze



For	See
RULA Analysis	RULA Analysis
Lift-Lower Analysis	Lift/Lower Analysis
Push-Pull Analysis	Push/Pull Analysis
Carry Analysis	Carry Analysis

Ergonomic Tools Toolbar

 See RULA Analysis

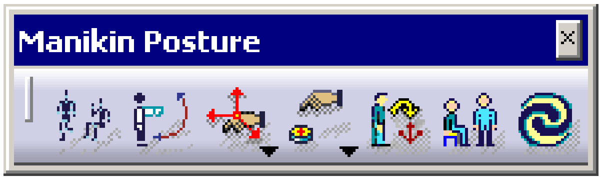
 See Lift/Lower Analysis

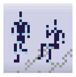
 See Push/Pull Analysis

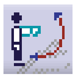
 See Carry Analysis

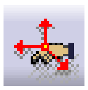
 See Biomechanics: Single Action Analysis

Manikin Posture Toolbar



 See Using the Posture Editor in the *Human Builder User Guide*.

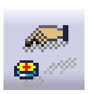
 See Using Forward Kinematics in the *Human Builder User Guide*.

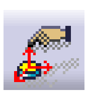
 See Using the Inverse Kinematics Segment Frame Mode and Worker Frame Mode in the *Human Builder User Guide*.

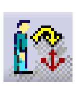
 See Redefining the Segment Offset for Inverse Kinematics in the *Human Builder User Guide*.

See Redefining the Segment Offset for Inverse Kinematics in the *Human Builder User Guide*

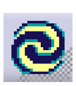
See Inverse Kinematics Behaviors in the *Human Builder User Guide*.

 See Interactive Positioning with the Reach Command in the *Human Builder User Guide*.

 See Interactive Positioning with the Reach Command in the *Human Builder User Guide*.

 See Using the Place Mode in the *Human Builder User Guide*.

 See Applying Standard Poses in the *Human Builder User Guide*.

 See Managing Multiple Constraints in the *Human Builder User Guide*.

Manikin Tools Toolbar

See Changing Manikin Display Attributes in the *Human Builder User Guide*.

See Inverse Kinematics Behaviors in the *Human Builder User Guide*.

See Assigning Descriptions (Memos) in the *Human Builder User Guide*.

See Using the Vision Function in the *Human Builder User Guide*.

See Using the Reach Envelope in the *Human Builder User Guide*.

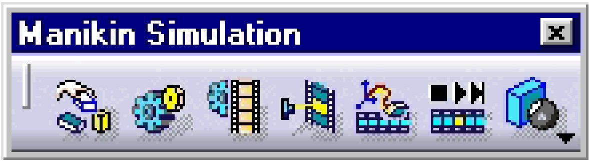
See Attaching an Object to a Manikin Segment in the *Human Builder User Guide*.

See Manikin Catalog Management in the *Human Builder User Guide*.

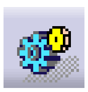
See Manikin Catalog Management in the *Human Builder User Guide*.

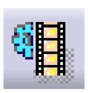
Manikin Simulation Toolbar

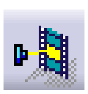
This toolbar contains the following tools:

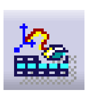


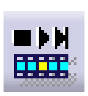
 See Using the Shuttle Command in the *Human Builder User Guide*.

 See Using the Simulation Command in the *Human Builder User Guide*.

 See Using the Compile Simulation Command in the *Human Builder User Guide*.

 See Using the Replay Command in the *Human Builder User Guide*.

 See Using the Track Command in the *Human Builder User Guide*.

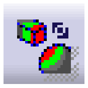
 See Using the Play Simulation Command in the *Human Builder User Guide*.

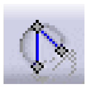
 See Using Global Collision Detection in the *Human Builder User Guide*.

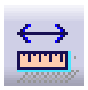
 See Using Global Collision Detection in the *Human Builder User Guide*.

 See Using Global Collision Detection in the *Human Builder User Guide*.

Manikin Workspace Analysis

 See Distance and Band Analysis in the *Human Builder User Guide*.

 See Arc Through 3 Points Analysis in the *Human Builder User Guide*.

 See Measure Between Analysis in the *Human Builder User Guide*.

Customizing RULA Specifications

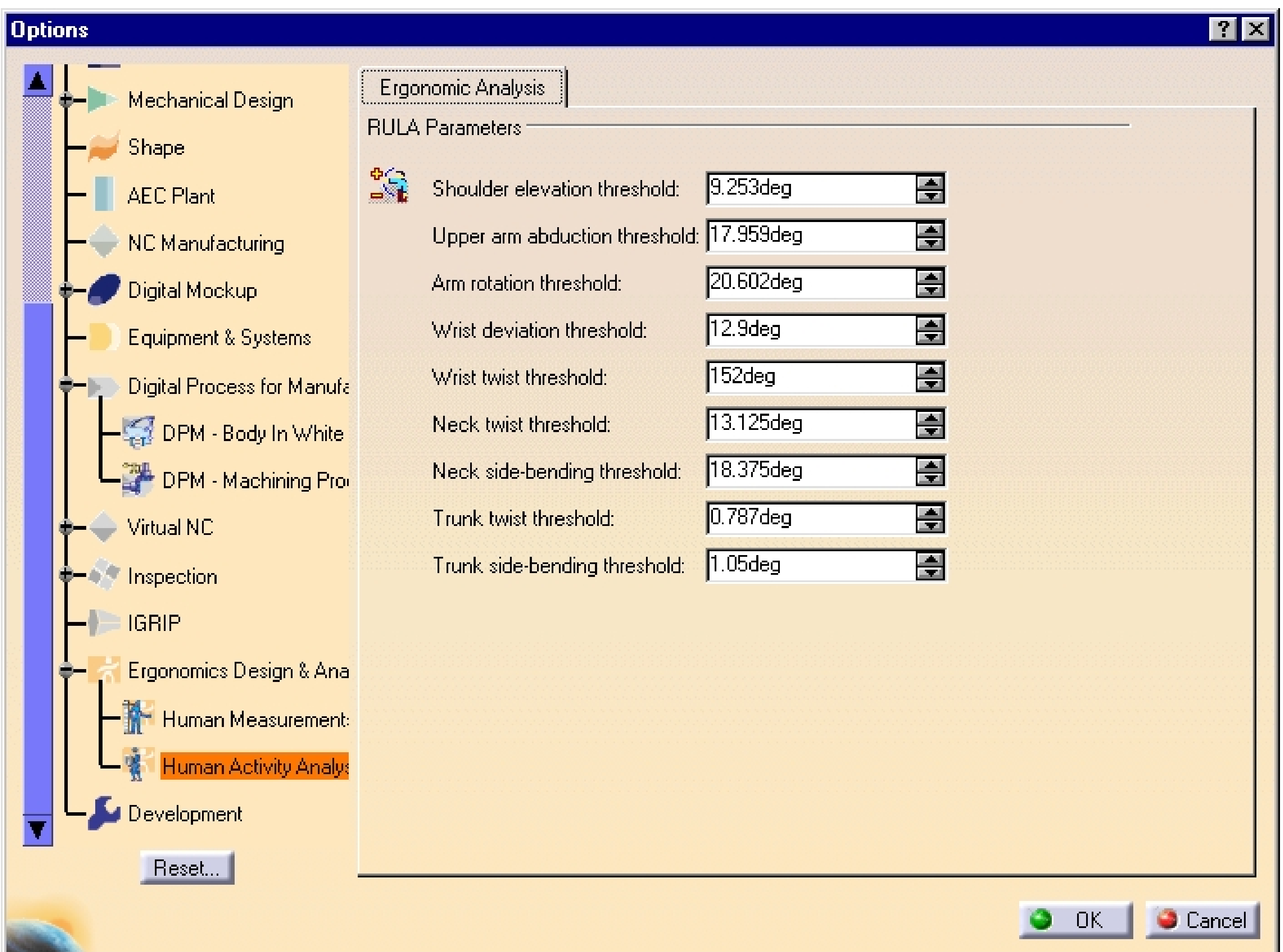
This task describes how to customize the specifications for the RULA (Rapid Upper Limb Assessment) Analysis.

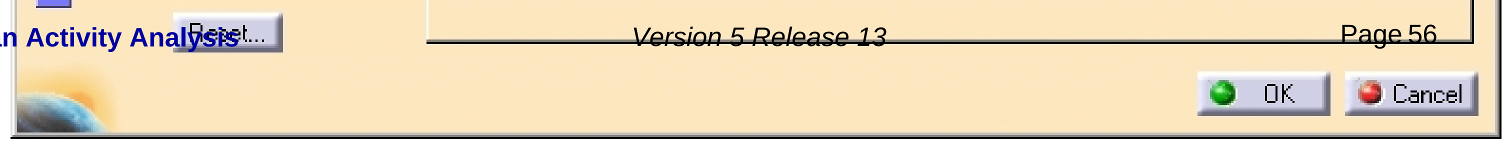
You can customize a total of nine parameters, thus influencing the result of the RULA analysis. These parameters define the threshold values for different degrees of freedom:

1. Shoulder elevation threshold
2. Upper arm abduction threshold
3. Arm rotation threshold
4. Wrist deviation threshold
5. Wrist twist threshold
6. Neck twist threshold
7. Neck side-bending threshold
8. Trunk twist threshold
9. Trunk side-bending threshold

To customize the RULA parameters, select **Tools -> Options** from the main menu. Go to the Ergonomics Design & Analysis section and select Human Activity Analysis.

The Ergonomic Analysis tab displays the default values of the different RULA parameters.





These nine parameters are used to transform the questions involved in the RULA process to angle comparisons. For example, during the calculation of the RULA result the question might be, *Is the neck bending to the side?* The question is subjective **unless a threshold is set**. For this particular case, the software compares the value of DOF 2 of the subject manikin's neck with the threshold defined in the RULA settings. If the value of that DOF is greater than 18.375 degrees, then RULA considers the neck to be bending.

If the user determines that 18.375 degrees (default threshold) is not an appropriate value for the neck, this value may be overridden. The new value entered by the user will then be used for the next RULA calculation, and the output will be affected accordingly.

Glossary

E M N R

E

ergonomics An applied science concerned with designing and arranging things people use so that the people and things interact most efficiently and safely.

M

maximum acceptable initial force The force required to put an object in motion.

maximum acceptable sustained force The force required to keep an object in motion.

maximum acceptable weight The weight that the selected population can carry with reasonable safety.

N

NIOSH National Institute for Occupational Safety and Health

R

RULA Rapid Upper Limb Assessment

RULA analysis Developed to investigate the exposure of individual workers to risks associated with work-related upper limb disorders.

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