



CATIA V5 Training
Foins

Student Notes:

Human Modeling

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About this course

Objectives of the course

Upon completion of this course you will learn how to

- Use Human Model technology in order to leverage your ergonomics analysis.
- Position and manipulate the manikin within a V5 Scene.
- Evaluate the comfort, the reach, clearance, and the vision of your target population.

Targeted audience

Designers, Engineers, Human factors specialists, Any Health specialists, V5 Users.

Prerequisites

Students attending this course must have knowledge of V5 Digital Mock-up.



16 hours

Student Notes:

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Student Notes:

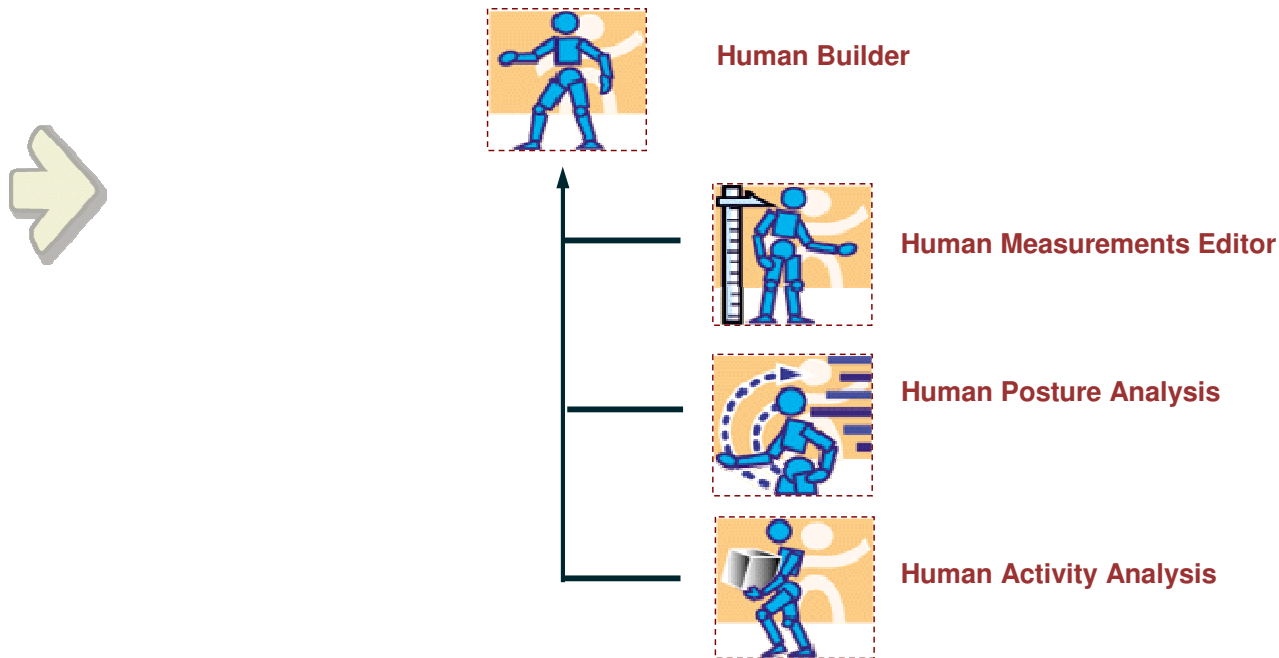
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Product Overview

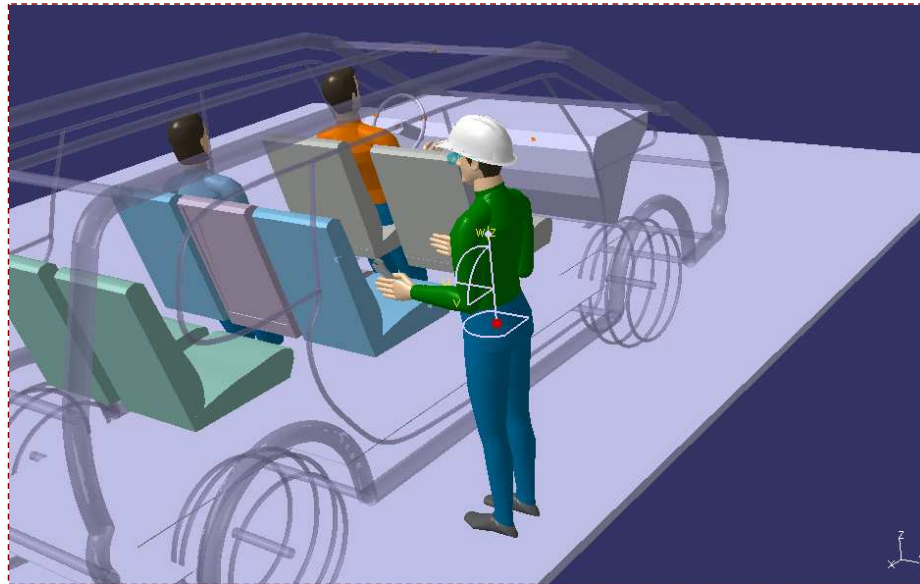
The V5 Human product is a scalable solution that is 100% embedded inside the V5 Architecture. The solution is divided into 4 interacting components: The main product (HB) and 3 add on. With these tools, the user is able to perform sooner and in a more efficient manner the different level of ergonomics assessment.

Let's explore together this solution and these products (workbenches) in more details.



Student Notes:

Human Builder (1/2)

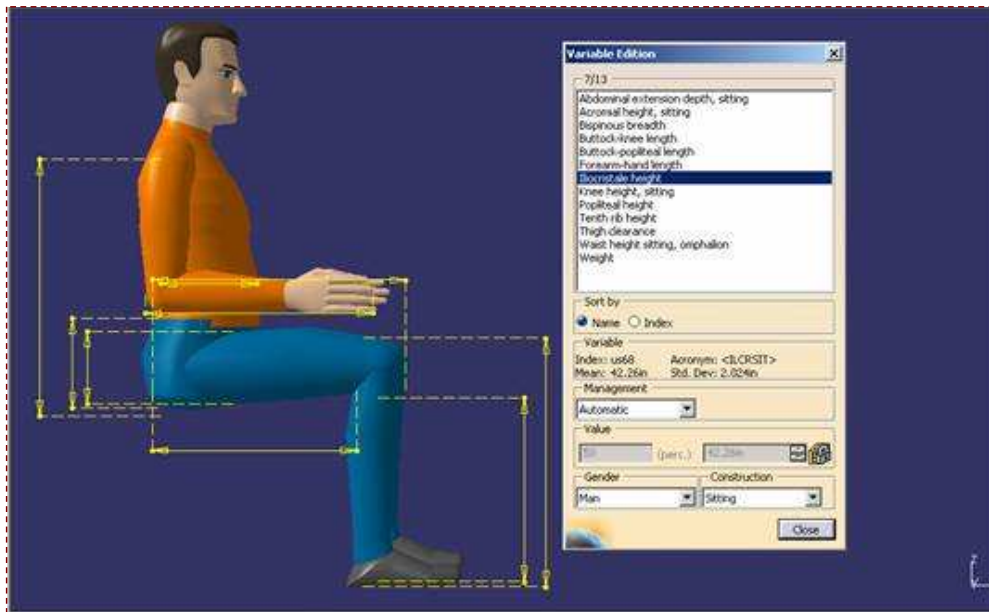


- **Human Builder is based on a best-in-class human modeling system which, for many years, has permitted detailed investigation into human-centered design issues in the context of a workplace before it physically exists.**
- **Human Builder provides very accurate simulation of humans and their interactions with products to ensure they will operate naturally in a workplace tailored to their tasks.**
- **The Human Builder product specifically focuses on creating and manipulating digital humans for 'first level' human-product interaction analysis.**

Human Builder (2/2)

- Human Builder consists of a number of advanced tools for creating, manipulating and analyzing how manikins (based on the 5th, 50th and 95th percentile value) can interact with a product. The manikins can then be used to assess the suitability of a product for form, fit and function. The manikins can be intuitively created and manipulated in conjunction with the digital mockup to check features such as reach and vision. A simple-to-use interface ensures that first-level human factors studies can be undertaken by non-human factors specialists.
- Tools contained within the Human Builder product include manikin generation, gender specification, percentile specification, direct Kinematics and Inverse Kinematics manipulation techniques, animation generation, Constraint, Simulation, Replay, Reach envelope, Attach-Detach, Coloring, Monocular, binocular and ambinoocular vision, as well as vision output cones.

Human Measurement Editor (1/2)

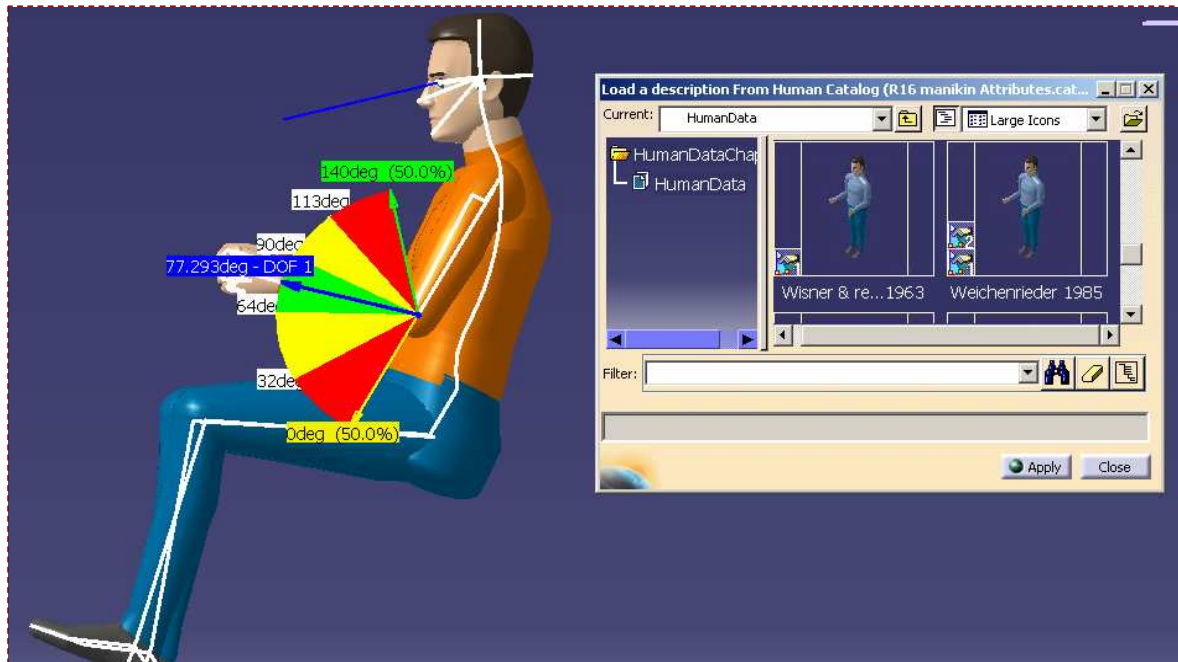


- Human Measurements Editor is based on a best-in-class human modeling system for the calculation of anthropometric correct manikins. This product allows any users (even non specialist) to generate specific manikins of specific dimensions in order to represent the target population. Two approaches can be explored: generating a specific manikin to represent one specific individual, or create a series of manikins that reflect all together a defined percentage of a population.

Human Measurement Editor (2/2)

- ❏ The Human Measurements Editor specifically focuses on creating detailed digital humans for advanced human factors analysis and global target audience accommodation.
- ❏ In addition to six default manikins, Human Measurements Editor users can create any human being from any population anywhere in the world. Users can amend all 103 anthropometrics variables on the manikin or manipulate a smaller number of 'critical' variables and ask the Human Measurements Editor to determine the rest. These variables can be altered manually by inputting desired measurements in percentile value, unit measurement, or by an intuitive 'click and drag' graphical user interface.
- ❏ The Human Measurements Editor also has the capacity to define the mean and standard deviation of all anthropometry variables. Using a unique multi-normal technique, the Human Measurements Editor ensures that resultant manikins do exist in the target population. In addition, it is possible to specify the percentage of the population to be accommodated in the design using the boundary manikin technique.

Human Posture Analysis (1/2)



- Human Posture Analysis offers the ability to evaluate (quantitatively) the posture of manikins. Human Posture Analysis focuses on how human posture can affect task performance by analyzing local and global postures, preferred angles, and comfort. It also allows the users to create manikins with limited range of motion either created by the age, an handicap or rigid equipment (ex heavy clothing).

Human Posture Analysis (2/2)

- **Human Posture Analysis permits users to quantitatively and qualitatively analyze all aspects of manikin posture. Whole body and localized postures can be examined, scored, iterated, and optimized to determine operator comfort and performance throughout the complete range of task motion in accordance with published comfort databases.**
- **User-friendly dialog boxes provide postural information for all segments of the manikin. Color-coding techniques ensure that problem areas can be quickly identified and iterated to optimize posture. Human Posture Analysis allows users to create specific comfort and strength libraries to meet the needs of individual applications**

Human Activity Analysis (1/2)



- In the demanding global marketplace, ensuring that human fit, form, and function are comprehensively addressed is becoming an increasingly important aspect of design.
- 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.
- This tool allows to validate if the tasks performed by the manikins are respecting the ergonomics standards currently recognized by the market.

Human Activity Analysis (2/2)

- ❏ **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 (Known as Snook table) 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.**
- ❏ **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.**

Introduction to Human Tools

In this lesson you will learn the general Human Concepts:

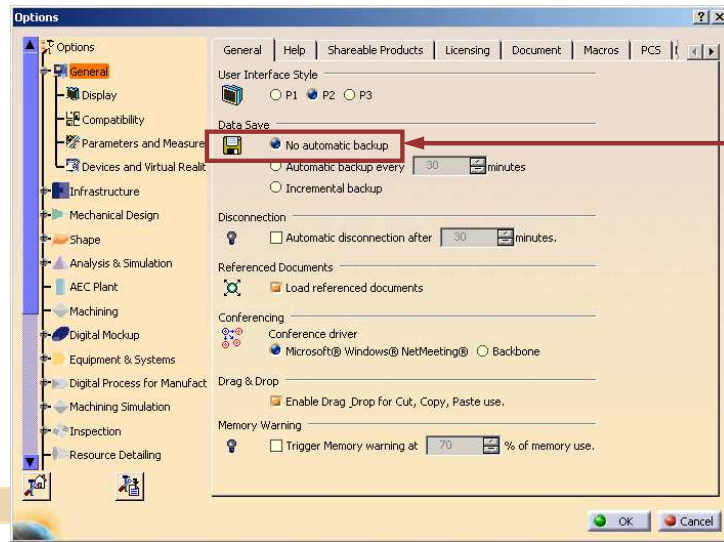
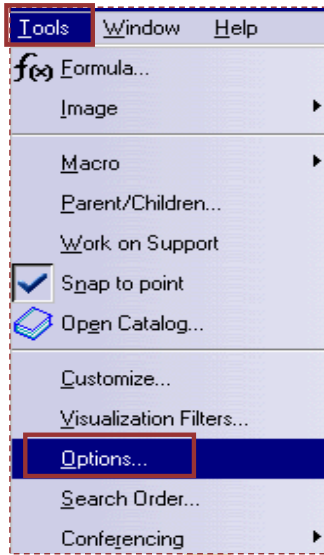


- **General Settings**
- **Useful Keyboard shortcuts**

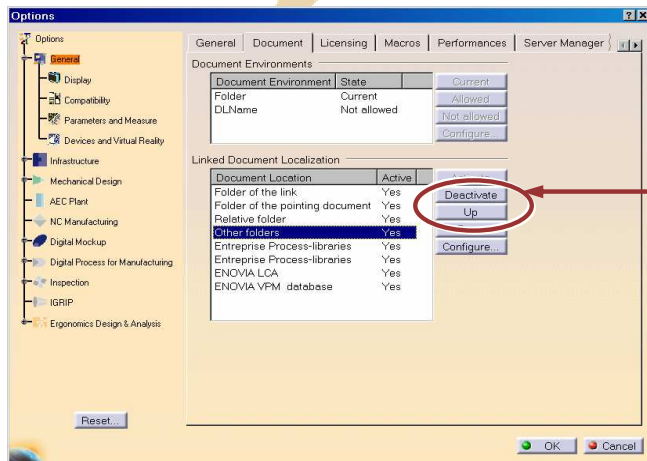


Specific settings for Human Modeling will be seen before each Workbench

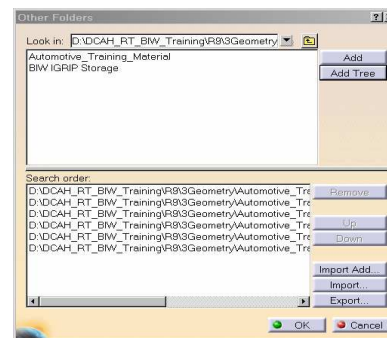
General Settings (1/3)



1
Remove automatic saving



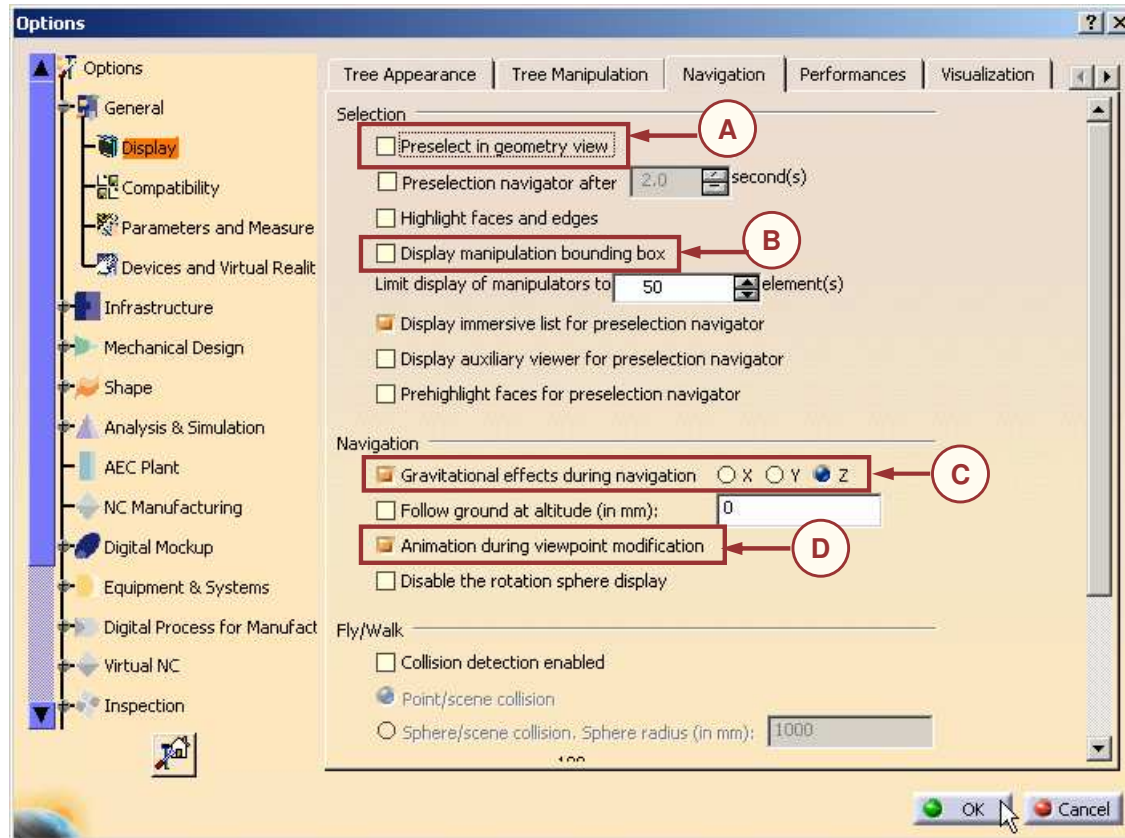
2
Define path for document



3
Add the path

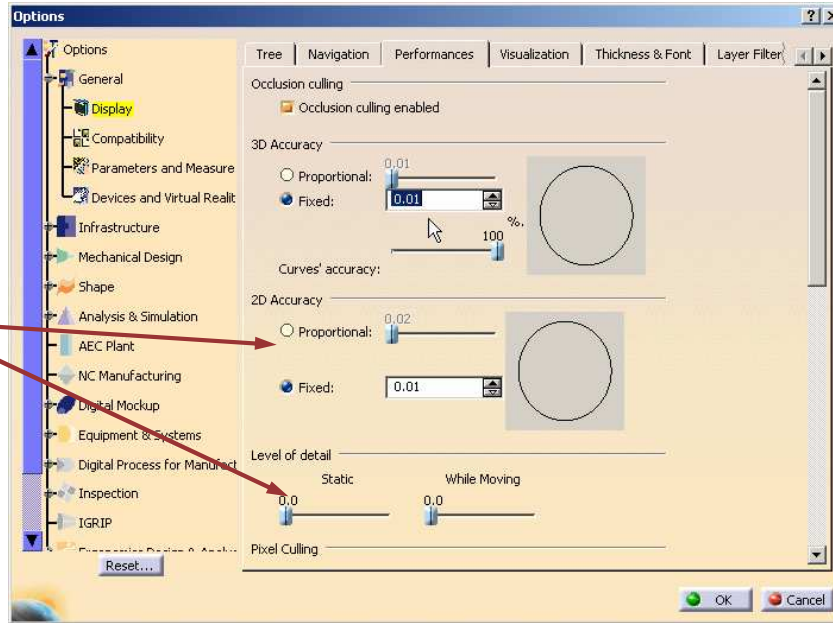
General Settings (2/3)

- A. Pre select on geometry view
- B. Manipulation Box
- C. Gravitational effect Z
- D. Animation

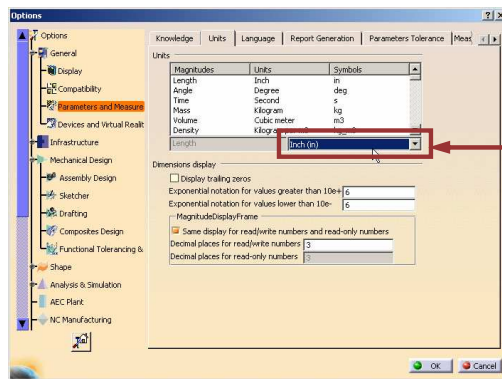


General Settings (3/3)

A. Set the level of accuracy and performance



B. Setup the Units



Useful Keyboard Shortcuts

Escape10.....	Exit the current dialog box (when there is one)	Down arrow.....	Relocate the graph 1/10th (one tenth) of a page to the bottom
F1.....	Get contextual online help	Left arrow.....	Relocate the graph 1/10th (one tenth) of a page to the left
Shift + F1.....	Get help on toolbar icons	Right arrow.....	Relocate the graph 1/10th (one tenth) of a page to the right
Shift + F2.....	Toggle the specification tree overview on and off	Ctrl + Tab.....	Swap active document windows
F3.....	Toggle specification tree display on and off	Alt + Enter.....	Run the Properties... command
Alt + F8.....	Run macros	Ctrl + C.....	Run the Copy command
Shift + F3.....	Activate the graph is the model is active and inversely	Ctrl + F.....	Run the Search... command
Home.....	Display the top of the graph	Ctrl + G.....	Run the Selection Sets... command
End.....	Display the bottom of the graph	Ctrl + N.....	Run the New... command
Page Up.....	Relocate the graph one page up	Ctrl + O.....	Run the Open... command
Page Down.....	Relocate the graph one page down	Ctrl + P.....	Run the Print... command
Ctrl + Page Up....	Zoom In the graph	Ctrl + S.....	Run the Save... command
Ctrl + Page Down	Zoom Out the graph	Ctrl + V.....	Run the Paste command
Up arrow.....	Relocate the graph 1/10th (one tenth) of a page to the top	Ctrl + X.....	Run the Cut command

Manikin inside a 3D Context

You will become familiar with the manipulation of the manikin :

- *Introduction of the Human Activity Analysis workbench*
- *Defining the Settings*
- *Human Builder Toolbars*
- *Manipulating Manikins*
- *Kinematics*
- *Creating links between manikins and geometry*
- *Using Catalog*
- *Analyzing Vision*
- *Creating a Reach Envelope and a Swept volume*
- *Analyzing clash*
- *Performing simulation*

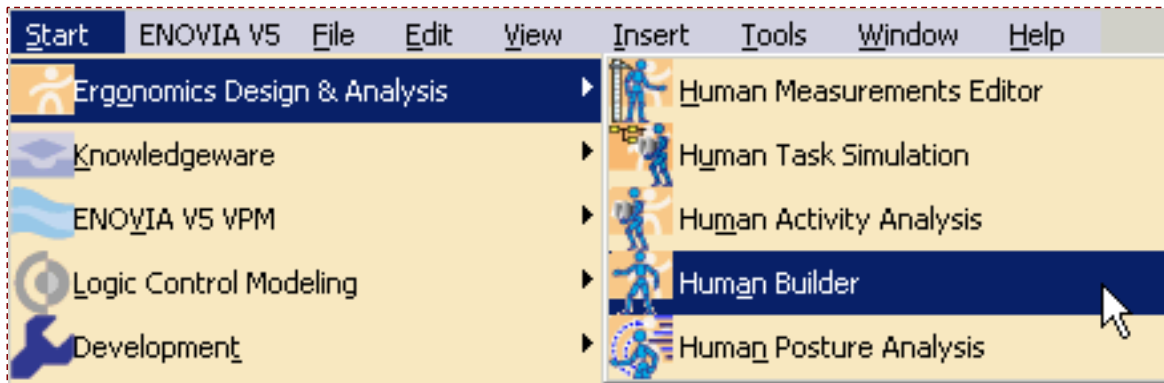


Specific settings for Human Modeling will be seen before each Workbench

Accessing the Human Builder Workbench

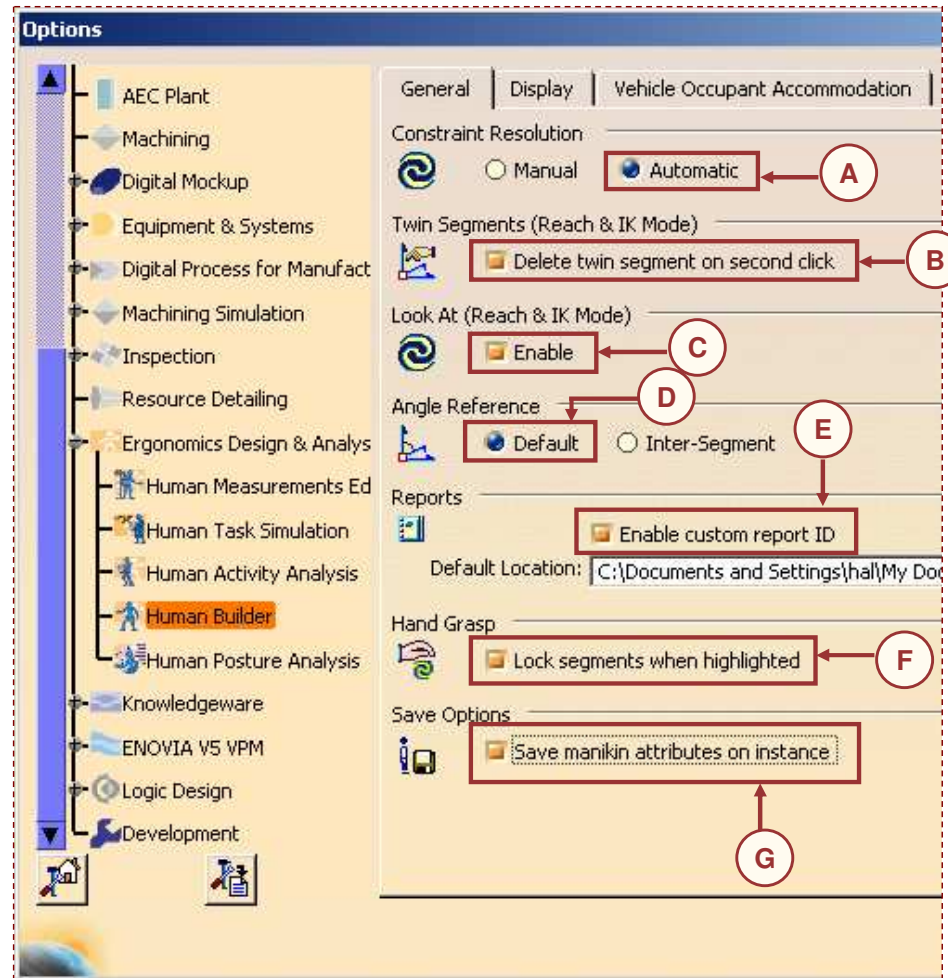
This workbench focuses on creating and manipulating manikins for 'first level' human-product interaction analysis. Based on the 5th, 50th and 95th percentile value of a manikin, you can analyze the interaction with a product.

You can access the workbench from Start > Ergonomics Design & Analysis > Human Builder



Human Builder - Settings

- A. Define if you want the constraint to be update automatically
- B. Activate the twin segment activation
- C. Activate the look at function
- D. Define the reference of the angle of a segment
- E. Enable the Report ID
- F. Define if you want to lock the grasping motion of the selected fingers when selected
- G. Define if you want to save manikin specific attributes on instance or also on the reference



Human Builder Toolbars (1/2)

These are the toolbars and icons for  Human Builder



Inserts a new manikin



Inserts a new load



Inserts a new Report



Inserts a new offset



Changes the display of a manikin



IK Behaviors



Adds a description to a manikin object



Open Vision Window



Computes a Reach envelope



Attach/Detach



Load manikin's attributes from a catalog



Save manikin's attributes in a catalog

Student Notes:

Human Builder Toolbars (2/2)



Posture Editor



Forward Kinematics



Inverse Kinematics Worker Frame Mode



Reach (position only)



Place Mode



Standard Pose



Hand spherical posture



Hand cylindrical posture



Hand pinch posture



Execute auto grasp



Contact Constraint



Coincidence Constraint



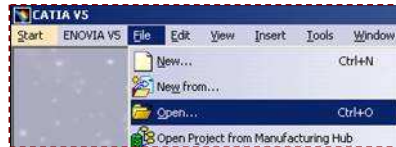
Fix Constraint



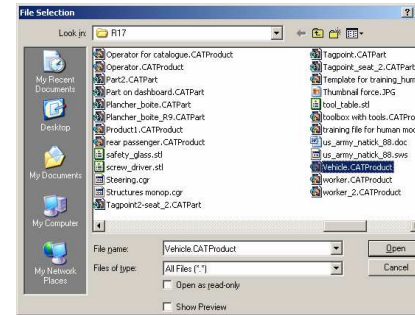
Fix On Constraint

Preparation of a 3D Scenario

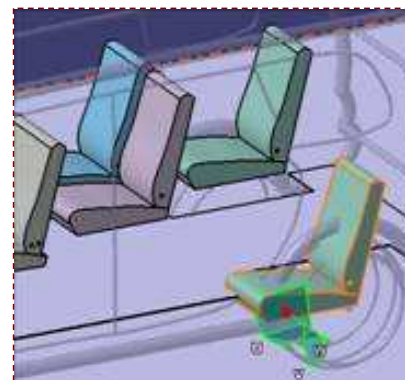
1. By selecting File/Open in the main menu, Open the desired CATProduct in the file selection dialog box.



2. To Insert an existing component select the parent product in the specification tree, right click and select insert an existing component



3. To move a part inside a CATProduct, you have to double click on the parent product to be able to move the child.



Moving and Manipulating Manikins (1/4)

Integrating a new Manikin

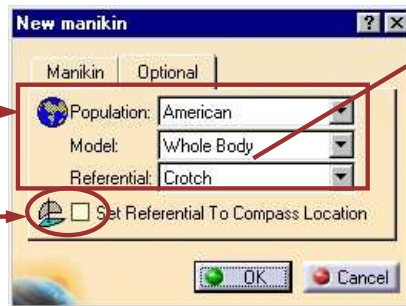
1. Insert a manikin using the following icon



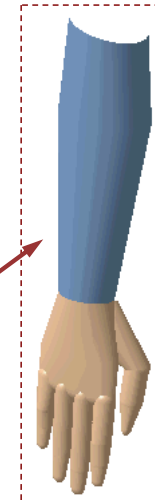
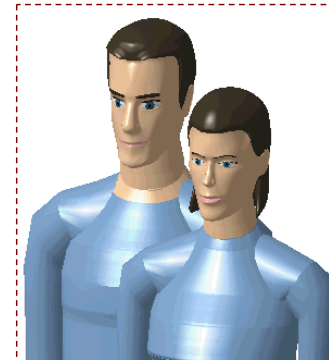
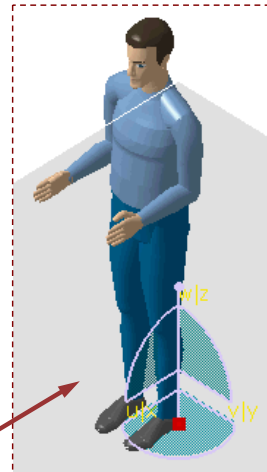
2. Select Details
Father product
Name
Gender
Percentile



3. Select the Option
Population
Model
Referential



4. Drag the compass at the destination prior to insert the manikin.



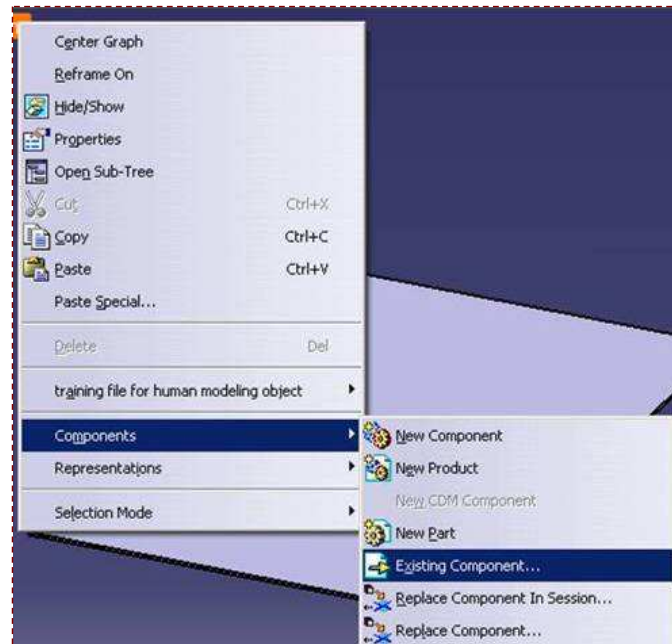
Moving and Manipulating Manikins (2/4)

Integrating an existing Manikins

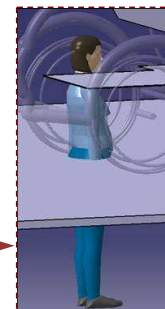
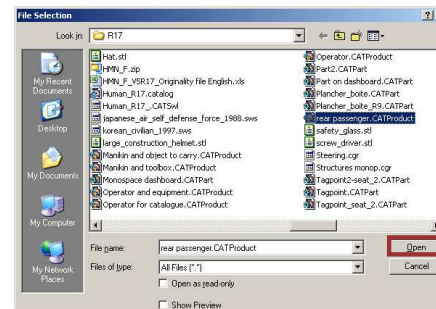
- 1. Insert in the current V5 Scene a manikin that already exist in a file.



A manikin is always inside a CATproduct file



- 2. Select a file that contains a manikin and click Open.

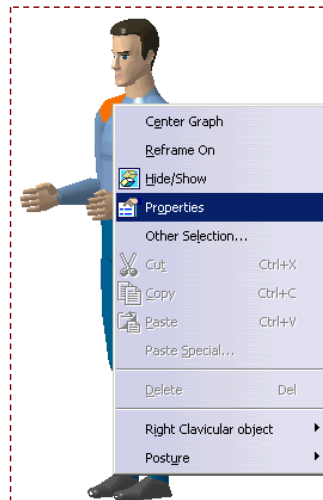
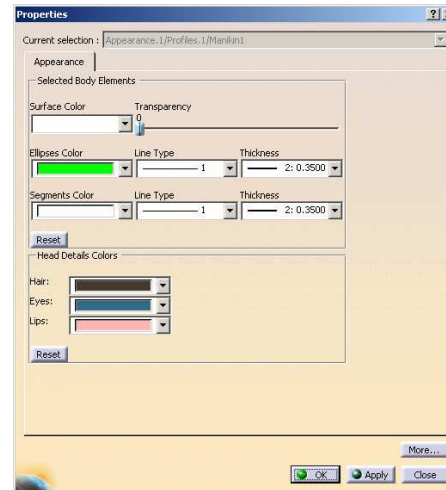
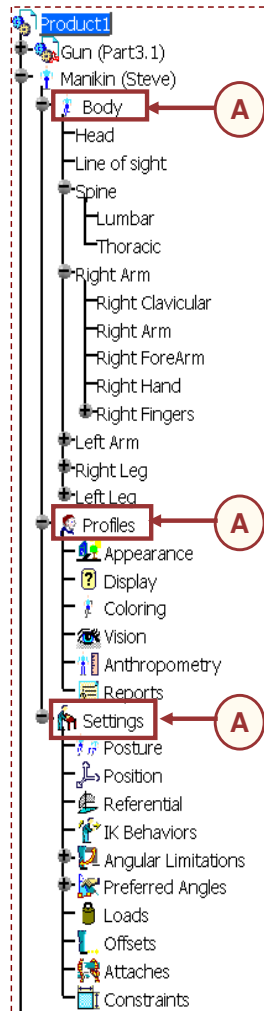


Moving and Manipulating Manikins (3/4)

Changing the Manikin's Properties

- A. The manikin tree is divided in three sections.
- B. Under the Profiles or for any specific segment, you can change the properties of the manikin.
- C. Using the contextual menu, you can have access to the Properties of segment.

Manikin Tree Organization



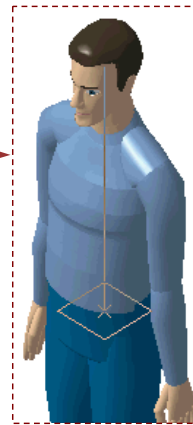
Moving and Manipulating Manikins (4/4)

There are many ways to Move (change position) the Manikin in the scene: At the Creation, Compass, Place Mode and Manipulation Box.

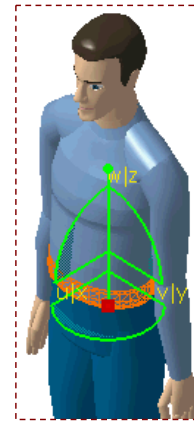
1. When creating a manikin, it's possible to define the exact location using the referential.



2. Once created, the compass is the primary mode to move the manikin. Drag the compass on the manikin, select the manikin in the specification tree and change its position.



Once snapped on the manikin, use the green edges or arcs to move the manikin

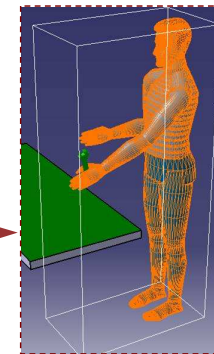


3. The place mode function allows also to position the manikin on a specific location. (the Z only directly aligns the z-coordinate of the manikin's referential with the object selected)



Drag the compass on a surface and select the manikin

4. Finally, if activated in the tools > options, the manipulation box is a rapid way to move the manikin. Unfortunately, it does not supported the rotation since you can only use the edges.

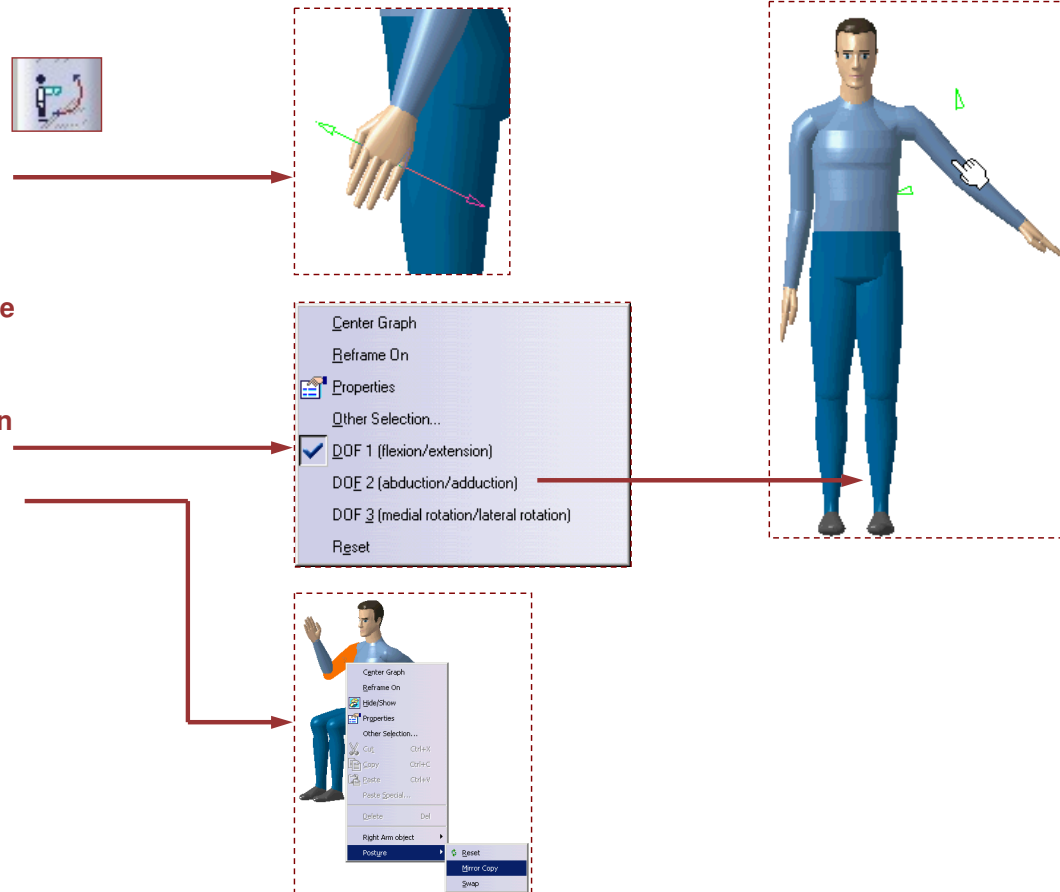


Kinematics (1/7)

Forward Kinematics

There are mainly two types of manipulation for the manikin. The first is the forward kinematics where the segment is controlled directly

1. Select the segment of the manikin and activate the forward kinematics icon.
2. With the left mouse button, drag the selected segment so that the mouse cursor follows the arrow. By default, the movement exerted will be done according to DOF1 (Degree of Freedom 1).
3. Change the DOF by clicking on the right mouse button .
4. Once the desired posture has been obtained you can select the segment and use the right click button
Reset
Mirror copy
Swap copy



Kinematics (2/7)

Forward Kinematics

For the forward kinematics, the Posture Editor panel allows accurate manipulation.

1. Select the segment of the manikin and activate the Posture Editor function. Segment can also be selected inside the panel.
2. With the cursor, slide the button in order to change the posture. You can also input a specific value.



The reference of the angle can be modified in the option (p19). You can use zero (as considered fully extended (No flexion) or 180 degrees fully extended

3. Change the DOF directly in the DOF field.
4. Change the point of view automatically and display the angular limitation directly on the segment.
5. Change the side.
6. Change the direction of the movement.
7. Change the posture automatically to 5 default posture. Check for the referential point selected when created the manikin

Posture Editor (Manikin1)

Segments

- Forearm
- Full Spine (Lumbar+Thoracic)
- Head
- Leg
- Line of sight
- Lumbar
- Thigh
- Thoracic
- Toes

Hand filter
 Hand Only Hand and Fingers Side: [Dropdown] 5

Degree of Freedom
 [Dropdown] DOF0 3

Value --- Default
 [Slider] % [0deg] 2

Motion: [Flexion] 6
 Enable Coupling

Display
 Angular Limitations
 Animate Viewpoint 4

Predefined Postures
 [Initial] 7
 Stand
 Sit
 Span
 Kneel

Kinematics (3/7)

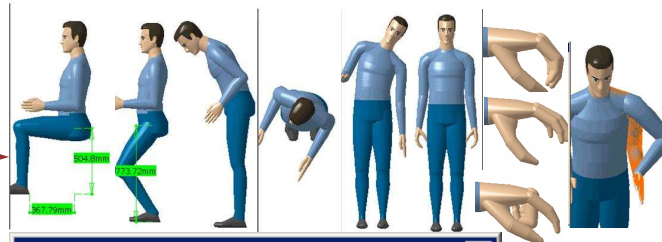
Standard Pose

For the forward kinematics, the Standard pose allows to move the manikin with some Inverse kinematics components.

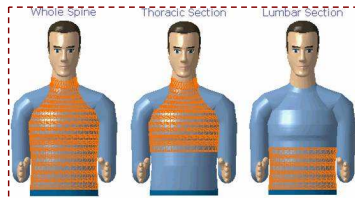
1. Select the Standard Pose function and click on the manikin.



2. There are several tab that allows to move several part or segment of the manikin.



3. For the stoop, specific portion of the spine can be selected.



4. Temporary constraint (IK mode) can be activate in order to maintains segment location while changing the posture of the manikin.

5. Activate the view point mode so the best point of view is displayed.

Standard Pose (Manikin1)

Sit | Squat | Stoop | Twist | Lean | Hand Grasp | Adjust Elbow

Translation

942.457mm

69.867mm

5 → Display

4 → Animate Viewpoint

Constraints

Keep eye direction

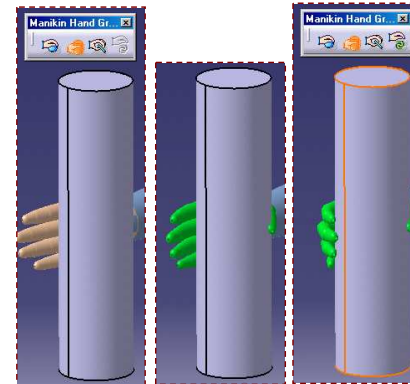
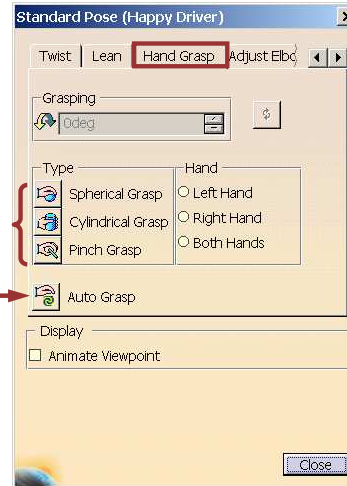
Keep hand(s) position/orientation Right

Close

Kinematics (4/7)

Standard Pose – Auto Grasp

- 1 Select the Standard Pose function and click on the manikin
- 2 Select the Hand Grasp tab
- 3 Select the desired type of grasp and click on the manikin's hand
- 4 Select the object and click on the Auto Grasp icon
- 5 You can maintain the auto grasp activated and use the reach and IK in sequence. In the tools options, you can activate a feature that would lock the selected segment.
This is useful once the hand is closed and you want to modify the grasp except for the selected fingers
- 6 It's possible to use a separated toolbar for auto grasp.
By using View > Toolbar > Manikin Hand Grasp



Kinematics (5/7)

Inverse Kinematics

When using Inverse kinematics of the manikin, there are three mode mainly use in order to move the manikin, Reach, IK mode and the Constraint: Reach

1. The reach mode is easily accessible by clicking the Reach icons.

2. There are two modes of reach

Position only



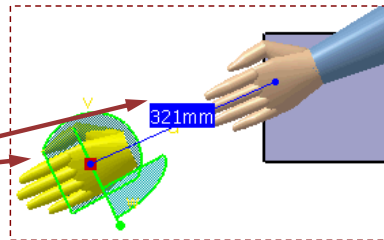
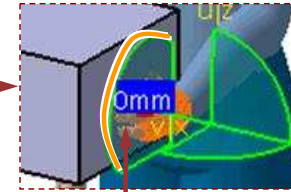
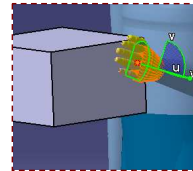
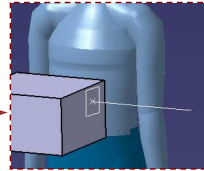
Position & orientation



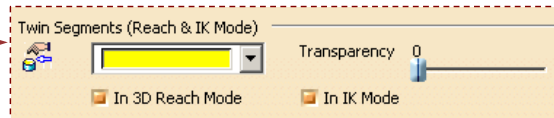
3. Select the segment you wish to use for the reach and click on a target (a white compass appears automatically). Use the arc of the compass to fine tune the posture.

4. If the object is out of reach, the twin segment will display and the missing value will be shown.

5. In the tools > Option > Human Builder > Display, the option of the display for the twin segment can be modified.



When using the position & orientation reach, most of the time you need to readjust the orientation using this specific arc of the compass.



The reach can be used for every segment of the manikin. Also you can use CTRL button to select multiple segment.

Kinematics (6/7)

Inverse Kinematics

When using Inverse kinematics of the manikin, there are three mode mainly use in order to move the manikin, Reach, IK mode and the constraint: Inverse Kinematics IK Mode

1. The reach mode is easily accessible by clicking the IK Mode icon.

2. There are two modes of Inverse Kinematics Mode:

Segment frame



The compass is aligned with the segment

Worker Frame

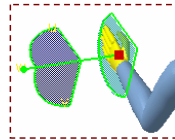
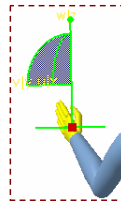


The compass is aligned with the hip of the manikin

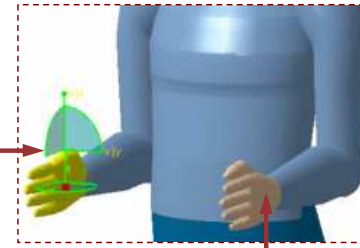
Using the 3D mouse

3. Select a kinematics chain and the compass will snap the its end-effectors (See 7 control points in the note below).

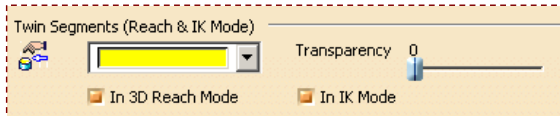
4. Use the compass to position the hand at the desired position.



For example select the arm and the hand twins (Yellow) will be highlight with the compass. A temporary constraint will be create end the hand will try to match the position and the orientation of the Twin



When using the position & orientation reach, most of the time you need to readjust the orientation using this specific arc of the compass.



5. In the tools > Option > Human Builder > Display, the option of the display for the twin segment can be modified.



The IK mode can be used only by seven control points on the manikin (2 Hands, 2 Feet, Hip, Neck and line of sight)

Kinematics (7/7)

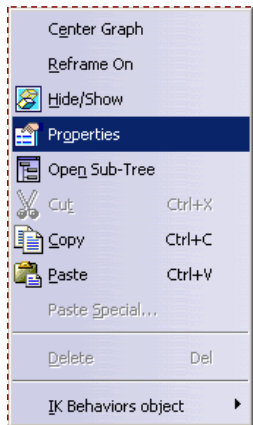
When using the IK function of the manikin (Reach, IK mode or the constraint) the IK behavior allows to change the way the manikin reacted

1. Call the IK Behavior using the following Icon:



3. Check several combination, start by using the IK Mode, select both leg (Activate Feet twins) and then select the hand and drag the hand twin

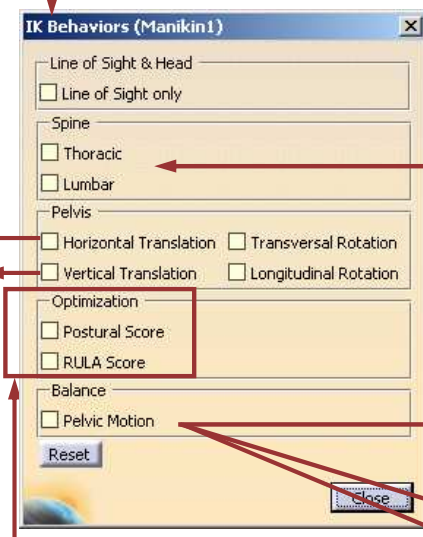
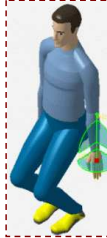
2. In the specification tree, you also get the Properties of the IK behavior.



5.



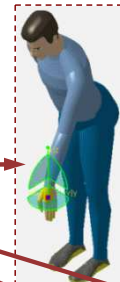
5.



4. The Spine section allows to involved Or Not some trunk component when using the IK. If not activated, only the arm kinematics segment will be used



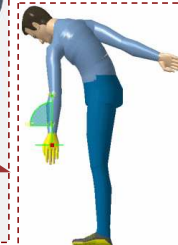
6.



6.



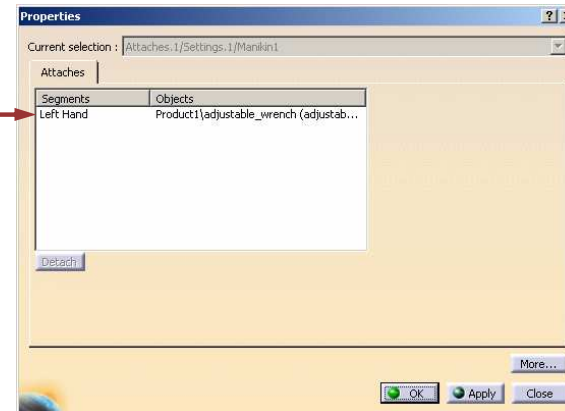
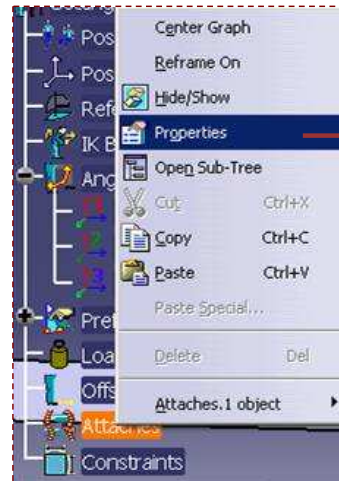
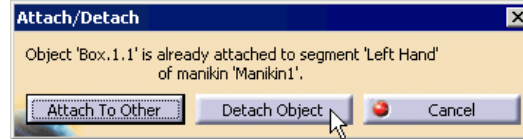
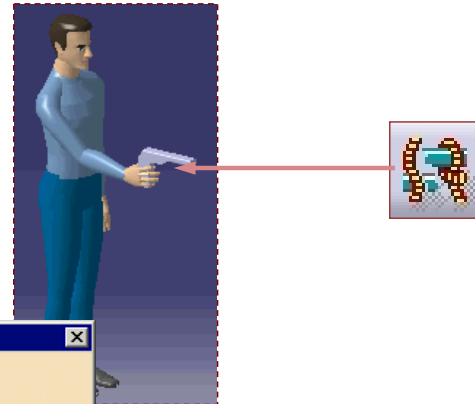
6.



7. The Optimization section Help to automatically find better postures according to criteria such as the Postural Angles (Scores) or the Rapid Upper Limb Assessment (RULA)

Creating Links between Manikins and Geometry (1/4)

1. Once integrated in the file, any object can be attached to any manikin's segment. Select in sequence; the Attach icon, the object and then the segment.
2. If the object is already attached to a segment, a warning message will ask if the user want to attach to other object or simply detach it.
3. At any time, the status of objects attached to the manikin can be verified by clicking on the properties of the attaches Node in the specification tree.

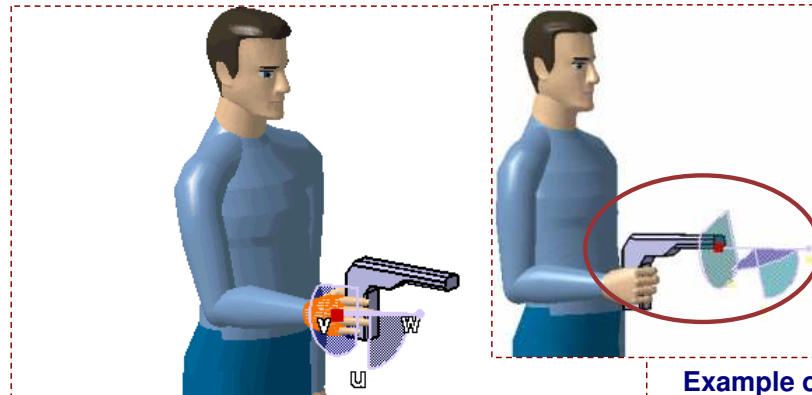


If the segment is moved and the object is attached to this segment, the object will follow. However, if the object is moved, the segment does not follow.

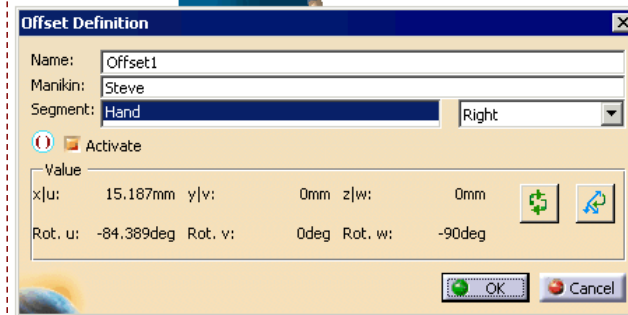
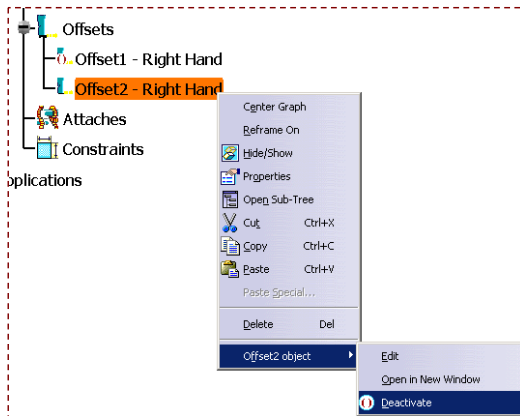
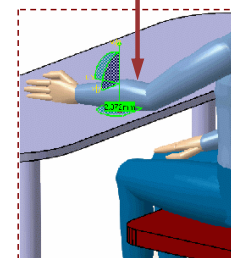
Creating Links between Manikins and Geometry (2/4)

The Offset command is used to redefine the behavior of the Reach Mode. Reach Mode default behavior is used to make the end point of the selected segment reach the compass location. The offset command, therefore, allows you to transfer that 'end point' to a different point in 3D space.

1. Select the icon, and click on the hand that has an attached object :
2. In the panel , input the coordinates of the offset OR position directly the compass at the desired offset using the red box of the compass (Example move the compass to tip of the tool) and then click OK
3. You can create several offset of the manikin on the same tool or on different tool he will use. Only one at the time can be used (activated)



Example of offset for the forearm and the reach function



Creating Links between Manikins and Geometry (3/4)

When using Inverse kinematics of the manikin, the two first mode presented previously are temporary. If you deactivate the function, the constraint are removed. It's possible to make these constraint more persistent: Constraint

1. There are four different type of constraint:

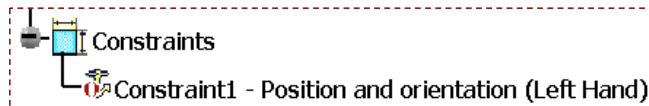
Coincidence  → Allow to have the selected segment that coincide with a line or a plan.

Contact  → Allow to have the selected segment in contact with a line, a plan or a point.

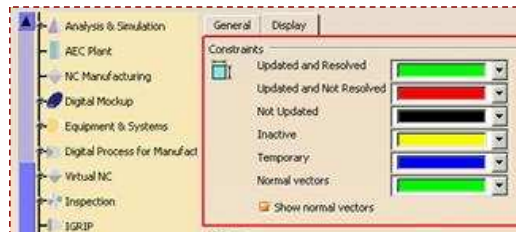
Fix  → Allow to have the selected segment at a Specific location in the space.

Fix on  → Allow to have the selected segment at a specific location in relation with a selected object.

2. In order to create a constraint, simply select the type of constraint, select the segment and select the object or the components of the object (Point, line or plane).



3. In the tools / Options, the display of the constraint can be modify according to its status.



Creating Links between Manikins and Geometry (4/4)

4. In the Specification tree, each constraint are accessible, using the contextual menu, you can get the properties or change the status directly.

In the tools > Option > Human > Builder > Display, select if you want to have the constraint updated automatically when moving an object OR only after you click on the update button.

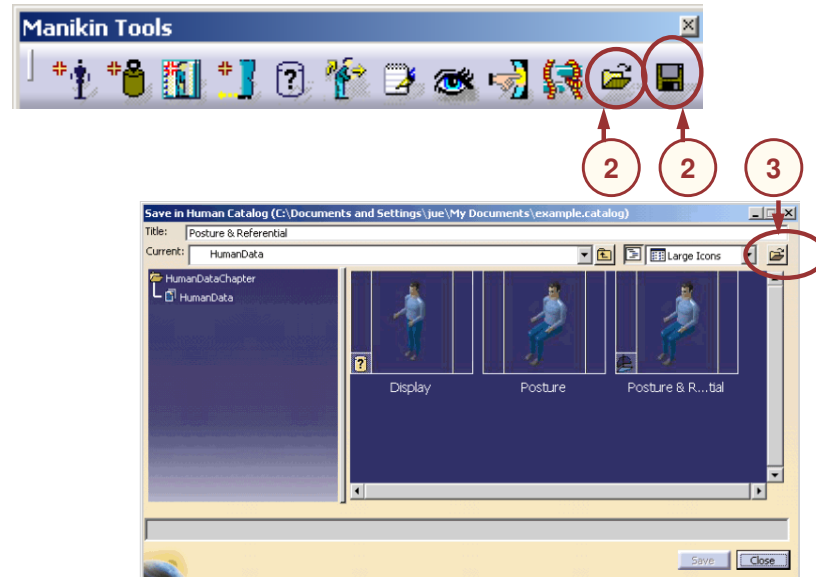
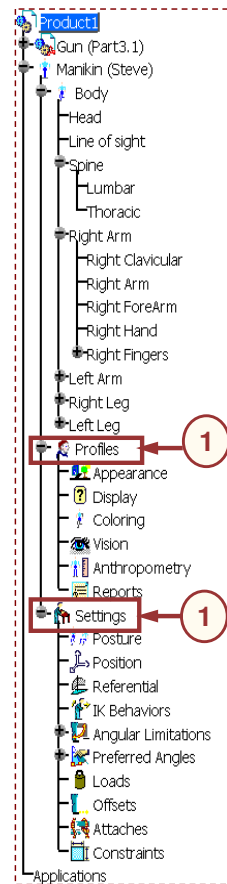


Using Catalog (1/2)

Manikin tree organization

1. 1) From the Specification tree, select the attributes to be saved.
 - 2) Select the save manikin's attributes in catalog.
 - 3) Select the desired catalog or creates a new one with the Browser icon.
 - 4) Enter a title for the manikin attributes that are about to be saved. Click on Save. The catalog browser is updated, displaying the new posture/set of attributes that have been saved.
2. The attributes saved inside the catalog can also be apply on the manikin with the icon load manikin's attributes from a catalog.

Manikin Tree Organization

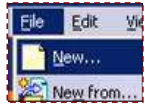


You need to be specific on what attributes has to be saved and for which segment. If the manikin node is selected, the attribute for every segment will be stored. The reverse process is identical.

Using Catalog (2/2)

Create a catalog

1

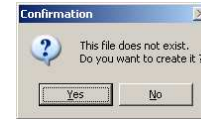


OR

2

When you use the function 'Save Manikin's attributes in a catalog' click on 'Browse another catalog', select the desired location and type a new name for a catalog. This will create a new catalog.

A catalog is a structure composed of the following items:



3

Chapter : This item is a method for categorizing the sub-items contained within

4

Family : This item is a set of components

5

Part Family : This item is a set of components referring to a .CATPart document. Part Families are assigned different sets of parameters values that are managed by a design table.

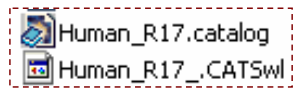
6

Component : This item is a reference to an external document or entity and is described by keywords.

7

Keyword : This item is an attribute describing chapter and family content. Keywords are user-defined.

DESIGNATION	TYPE	DIAMETER	LENGTH
1 FHC M03-05	FHC	3mm	5mm
2 FHC M04-05	FHC	4mm	5mm
3 FHC M05-08	FHC	5mm	8mm
4 HC CU M03-05	HC CU	3mm	5mm
5 HC CU M04-05	HC CU	4mm	5mm
6 HC CU M05-05	HC CU	5mm	5mm



For every catalog, there is a .catalog file and a .CATSwl file. Those two files must always be together because the CATSwl contains all the attributes data.

Analyzing Vision (1/2)

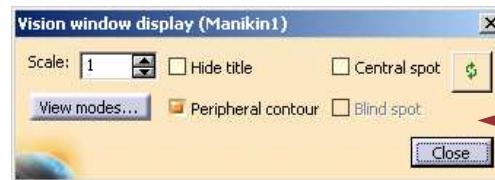
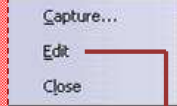
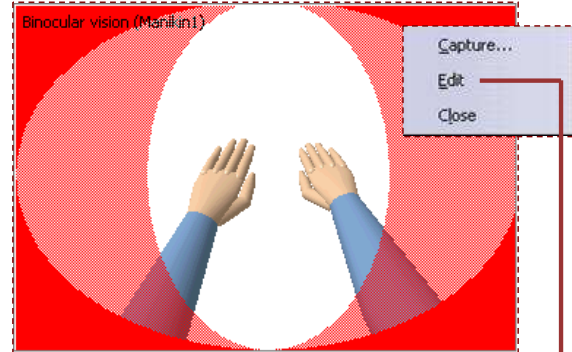
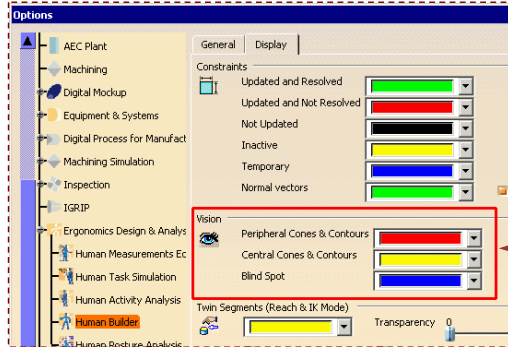
1. The vision is available either by double clicking on the vision node in the specification tree



or selecting the Vision icon.

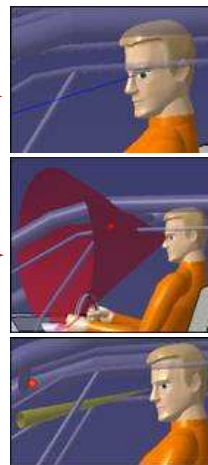
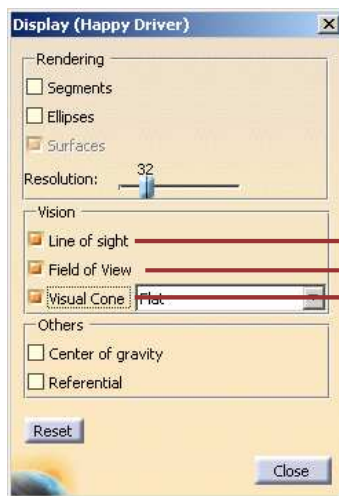
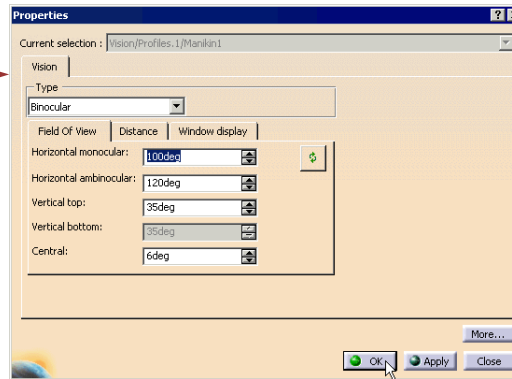
2. Once the vision window is open, you can edit using the contextual menu by right clicking on the window.

3. In the option, all color of the vision display can be modified



Analyzing Vision (2/2)

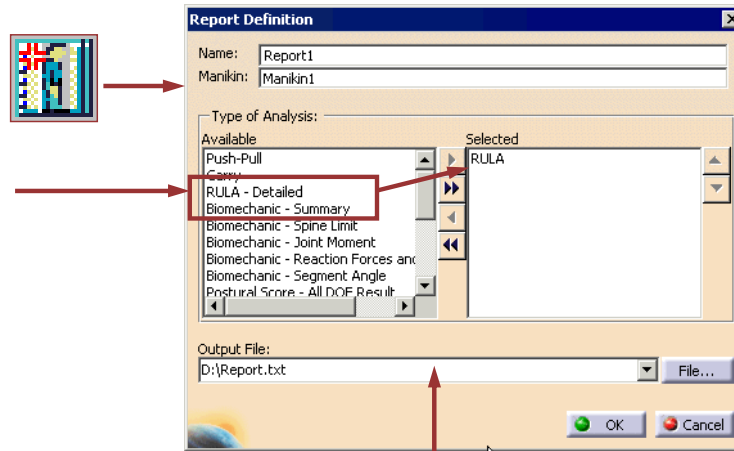
- 4. In the properties of the vision, all parameters can be adjusted
- 5. By changing the display of the manikin, the line of sight can be accessible and used as a normal segment



Report Definition

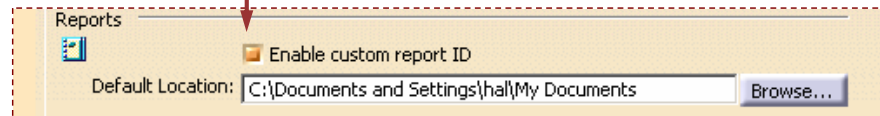
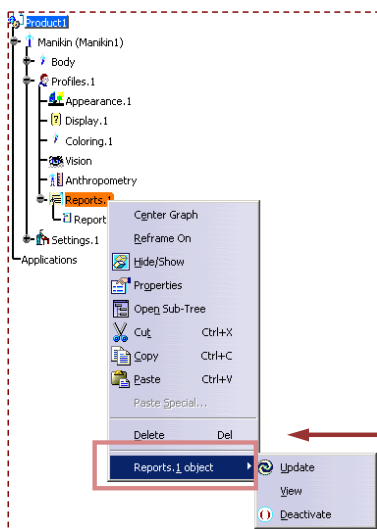
Ergonomics analysis, constraints result and vision can be efficiently shared using the Report function

1. Click on the report icon and select the manikin. A new report will be added in the specification tree:
2. Using the contextual menu or by double clicking on the report, select the analysis that needed to be reported.
3. The report can also be updated using the updated button.
4. In the specification tree, the contextual menu allows also to deactivate the report



5. Select the path for the output and the format (suggested HTML)

6. In tools > Option > Human > Builder > General, the naming function can be activated so a name can be added every time a report is refreshed



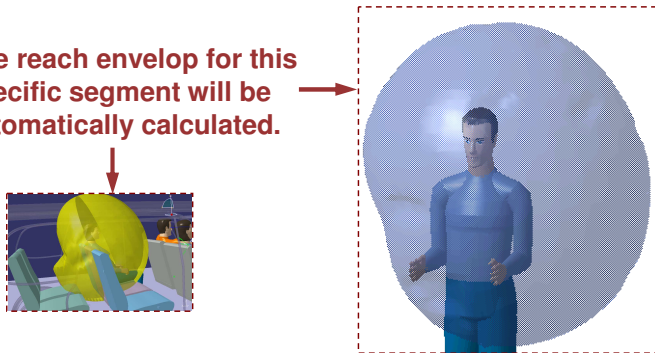
Creating a Reach Envelope and a Swept Volume

The Reach Envelope function evaluates the manikin's arm reachability and the Swept volume icon generates the volume that is occupied by the manikin's segments movement.

1. Select a segment of the hand and activate the reach envelop function.



2. The reach envelop for this specific segment will be automatically calculated.

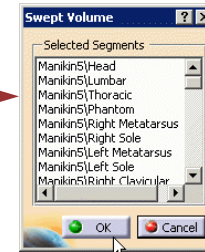


The reach envelop does not include the movement of the trunk (no matter the option of the IK behaviors but it does take into consideration the angular limitations)

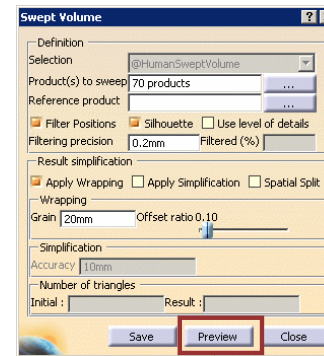
3. A similar function can be also analyzed fir the segment: Swept volume



4. Select the segment you want to include in the analysis.



5. Move the manikin using any functionalities available (from FK, IK simulation, etc.) Then click on stop recording swept volume button



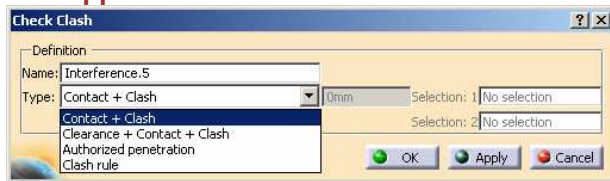
6. Check the preview.
7. Both analysis can be exported and insert in the scene.

Analyzing Clash (1/3)

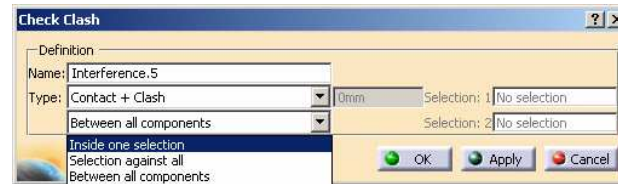
The clash analysis analyzes interactions between products and determines the existing clash.



- 1 Select the item you want to monitor for collisions.
- 3 The Check Clash dialog box appears.



- 2 Select the Clash icon
- 4 Depending of the scenario, chose the appropriate type of clash you want to determine.



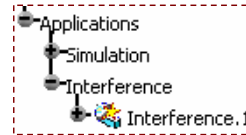
- Contact + Clash** Checks whether two items occupy the same space and whether they are in contact.
- Clearance + Contact + Clash** In addition to checking whether the two products or resources occupy the same space zone, and whether they are in contact, this option checks whether they occupy a clearance zone around each other.
- Authorized Penetration** Checks whether an item penetrates another object beyond a user-specified amount.
- Clash Rule** Allows you to use Knowledgeware capabilities for clash.

- Inside One Selection** Checks for collisions per specifications set in the Type pull-down menu. This is the default setting.
- Between All Components** Checks for collisions per specifications set in the Type pull-down menu for a selected product or resource.
- Selection Against All** Checks for collisions per specifications set in the Type pull-down menu that are caused by a selected product or resource.
- Between Two Selections** Checks for collisions per specifications set in the Type pull-down menu occurring between two selected products or resources.

Analyzing Clash (2/3)

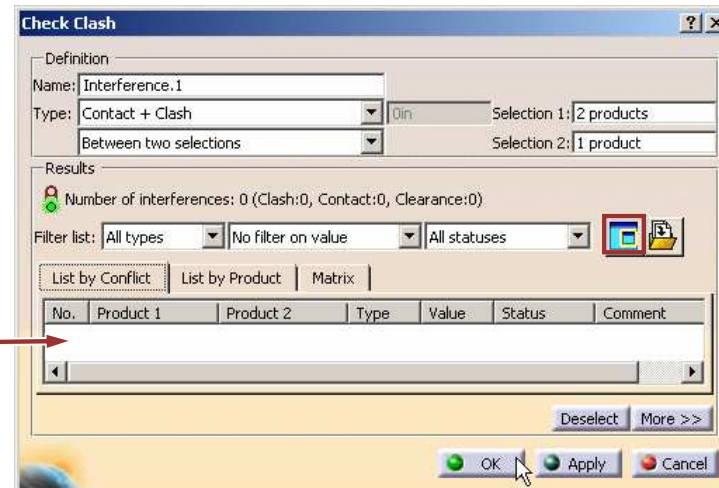
5 If an object is already attached to the manikin, this object will be considered as a sub element of the manikin. Therefore, it's possible to detect the collision between the tool handle by the manikin and another object.

6 Clash analysis data is stored in the Product tree within the Application node



7 You can review clash results, by clicking the Results Window button.

8 If there are clashes, they will be listed in the Check Clash dialog box.



Analyzing Clash (3/3)

The clash detection activates or deactivates automatic clash detection in a simulation

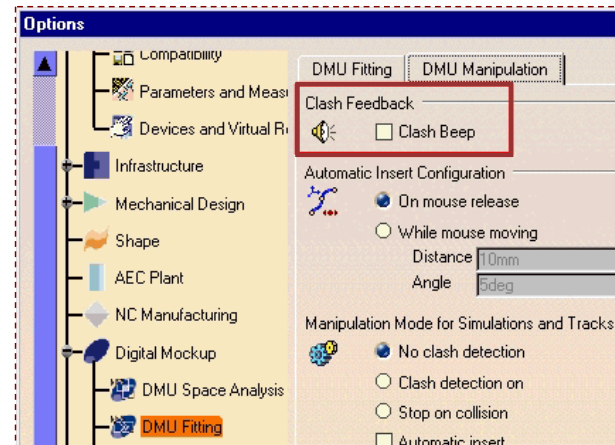
- 1 The elements involved in the collision will be highlighted in the 3D viewer by activating the Clash detection (ON).



- 2 The elements involved in the collision will be highlighted in the 3D viewer and manikin motion will stop by activating the settings Stop on collision (see next icon).



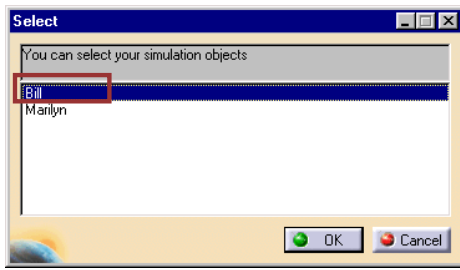
- 3 To set an audible feedback, select the Tools > Options > DMU Fitting from the main menu. Under the DMU Manipulation tab, activate or de-activate the Clash Feedback as shown.



Performing a Simulation (1/2)

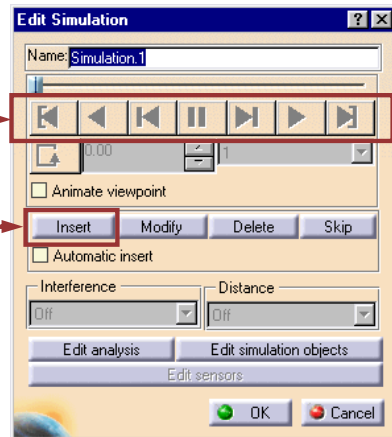
Movement of the manikin can be saved using two different functions: **Simulation OR Track**

1. Select the Simulation Icon and pick in the list the object that you want simulation.

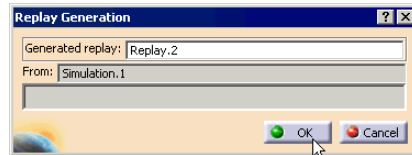


Double click the items and use the keys to run the simulation

2. Move the manikin using the Forward kinematics and click Insert for every desired frame and click Ok when completed.



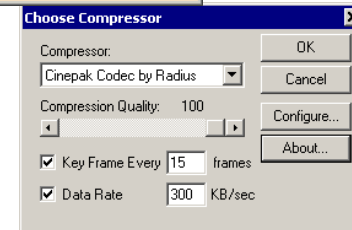
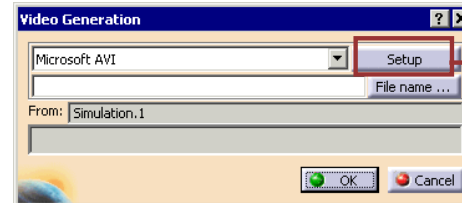
3. In the specification tree, a new node will be created called Simulation.



4. Generate a Replay. The replay will appear in the Specification tree.



5. Real Video can be generated for the manikin: Need to select the simulated object: Manikin



A simulation can be done for an object (Inserted inside a shuttle). Run the simulation of the object and put a constraints between the hand an the object.

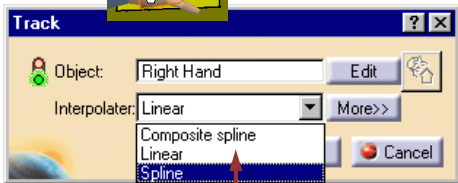
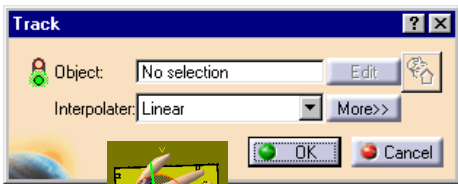
Performing a Simulation (2/2)

Movement of the manikin can be saved using two different functions: Simulation OR Track

1. Select the track icon.



2. Pick one of the seven control points of the manikin: 2 Hands, 2 Feet, Hip, Neck and line of sight.

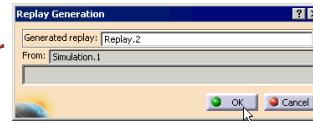


Select the type of interpolation between the frame.

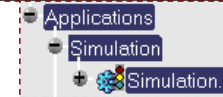
3. Using the compass, move the segment and record each frame and click OK.



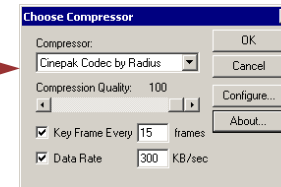
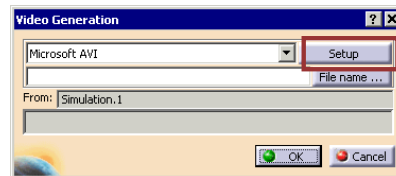
4. Generate a Replay. The replay will appear in the Specification tree.



Double click the items and use the keys to run the simulation.



5. Real Video can be generated for the manikin: Need to select the simulated object: Manikin



A simulation can be done for an object (Inserted inside a shuttle). Run the simulation of the object and put a constraints between the hand an the object.

Manikin's Body Dimension



You will become familiar with the anthropometry of the manikin :

- *Introduction of the Human Activity Analysis workbench*
- *Editing the accommodation*
- *Changing the anthropometrics variables*
- *Creating boundary manikins*

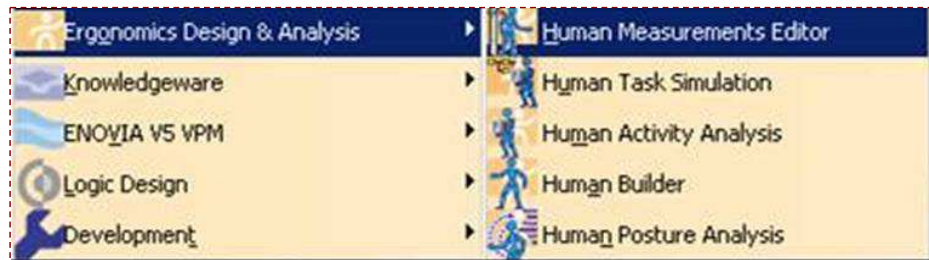


Accessing the Human Measurement Editor Workbench

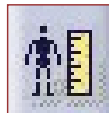
In this workbench, there are six default population of manikins, but you can manually create specific manikins according to your data. The 103 anthropometrics variables on the manikin can be modified or a smaller number of 'critical' variables can be manipulated. In that case, the Editor will determine the rest of the value according to the predefined correlation.

Accessing the workbench

1. From the main top menu.



2. By clicking on the following icon

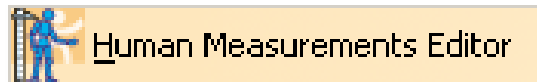


3. By double clicking on the anthropometry in the specification tree.



Human Measurements Editor - Accessing the Workbench

This is the toolbar for



Returns to the previous workbench



Interpolation



Switches Gender



Display



Population



Descriptions



Applies a Posture



Load manikin's attributes from a catalog



Displays the variable list



Save manikin's attributes in catalog



Filter



Reset

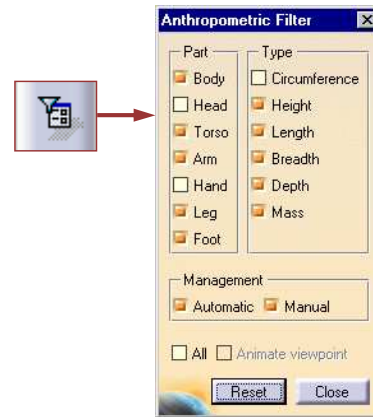
Editing the Accommodation

This concept consists to the definition of the percentage of accommodation of the target population. This function is mainly used when you want to do not want to accommodate the entire population. The cost of a design is more important when you try to accommodate the tallest and the smallest at the same time.

1. In this workbench, you can change the gender, the population directly using the following icon.

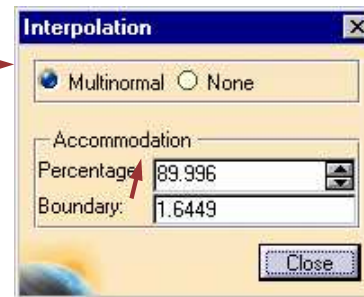
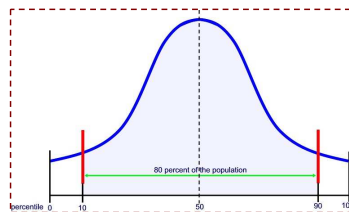


2. Use the Filter, Posture and View panel in order to select different anthropometrics variables



A best compromise would allow you to accommodate most of the population at the minimum cost. Usually an accommodation rate between 80 and 90% represent a good compromise.

3. Once you have identified the critical variable, the first thing to do when you want to generate non-standard manikins is to select the type of interpolation and the percentage of accommodation. Pick Multinormal and 90 %.

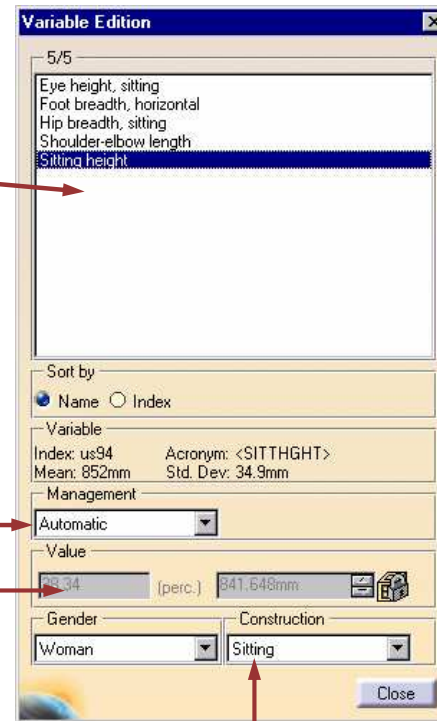
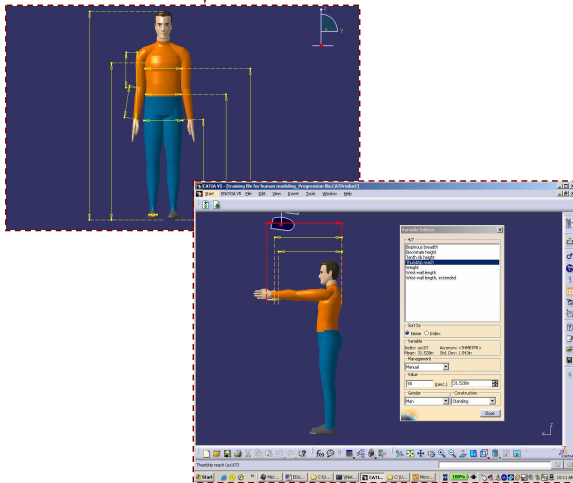


Changing the Anthropometric Variables

This concept consists change the value of different anthropometrics variables within the limits of the target population. This function is mainly used you do not want to work with standard manikins. A 50th manikin might have different arm length and this later might be crucial for your work station.

1. In the following widow, you can select and double-click on any critical variables.

or select the edit variable icon.



After changing the type of management to manual you can input the value you want

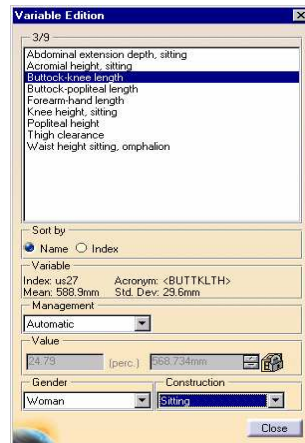
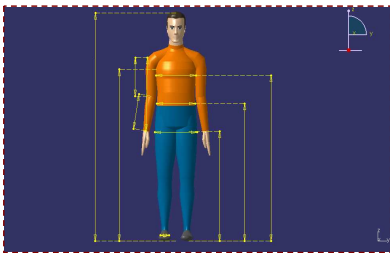
Of course, the software will change all the others values to the most probable. It will also indicates the limits of the variable.

This is the posture used to input the data, it better to reflect the posture used in the scene

Creating Boundary Manikins (1/2)

This concept consists to generate extreme manikins for a specific number of variables and for a specific percentage of the target population. This function is mainly used when the standard manikin (5,50 and 95th) are not enough for your analysis.

1. Identify the critical variable for your workstation.



3. Organize the variable in order to define the less correlated variable using a matrix.

	Buttock knee-length	Eye height-sitting	Knee height-sitting	Thumb tip reach
Buttock knee-length	1.0	0.343	0.844	0.786
Eye height-sitting	0.343	1.0	0.415	0.358
Knee height-sitting	0.844	0.415	1.0	0.838
Thumb tip reach	0.786	0.358	0.838	1.0
Mean	0.658	0.372	0.699	0.661
Order	Variable 2	Variable 1	Variable 4	Variable 3

2. The generation of boundary manikin considers the mean, the standard deviation and correlation between each variable. This information is available in the SWS file within the online documentation.

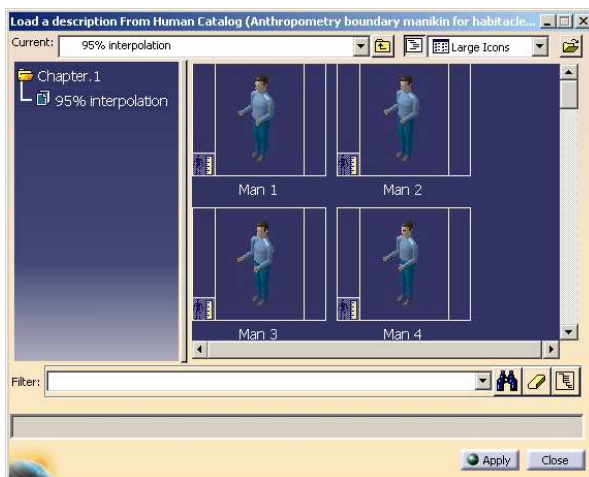
```
MEAN_STDEV M
us100      177.0      6.0
MEAN_STDEV F
US100      164.0      6.0
CORR M
us2        us125      0.772
us2        us127      0.470
us63       us77        0.288
us63       us81        0.309
us63       us82        0.288
CORR F
us2        us125      0.744
us2        us127      0.386
us63       us77        0.231
us63       us81        0.320
us63       us82        0.313
END
```

Creating Boundary Manikins (2/2)

1. Check the minimum and the maximum value for each variable.
2. Always by following the sequence, you will generate all the minimum and maximum value of each critical variable.
3. Each time you have complete a sequence, the result is boundary manikin that you can save into a catalog.



Variable 1	min : 52.304								
Variable 2	min : 73.129		max						
Variable 3	min : 55.874		max		min	max			
Variable 4	Min : 73.426	Max : 81.386	Min	max	min	max	min	Max	
Manikin	1	2	3	4	5	6	7	8	



Posture Evaluation



You will become familiar with the analysis of the manikin's postural information

- *Introduction of the Human Activity Analysis workbench*
- *Editing the range of motion*
- *Displaying the postural score*
- *Gathering and analyzing the results*

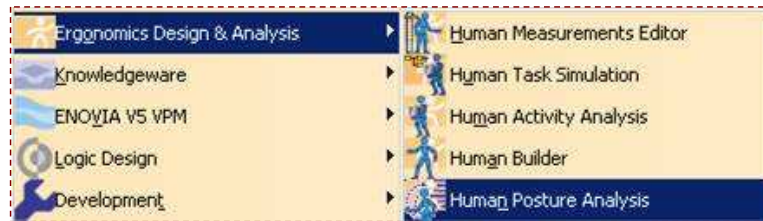


Accessing the Human Posture Analysis Workbench

This workbench allows you to analyze local and global postures, preferred angles and comfort. The color code and score provides postural information for all segments of the manikin and also permits to optimize the posture. According to scientific documentations, a catalog of preferred angles or angular limitations can be created for special population or predefined scenario.

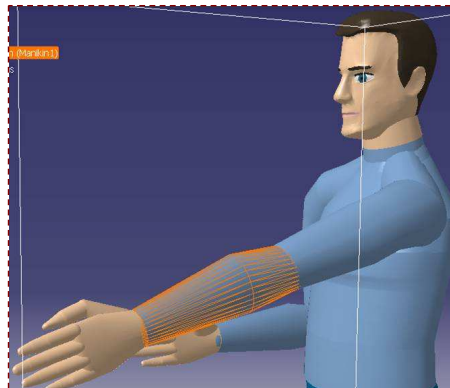
Accessing the workbench

1. From the Main Top Menu



OR

2. Double clicking directly on a manikin's segment



Human Posture Analysis Toolbars

These are the toolbars and icons for



Edits the angular limitations and the preferred angles



Optimizes the angular limitations according to the best preferred angles



Sets the angular limitations according to a percentage between 0 and 100



Locks the active DOF



Removes the angular limitations



Reset angular limitations



Customized Joint



Opens the Postural Score Panel



Finds the posture which maximizes the postural score

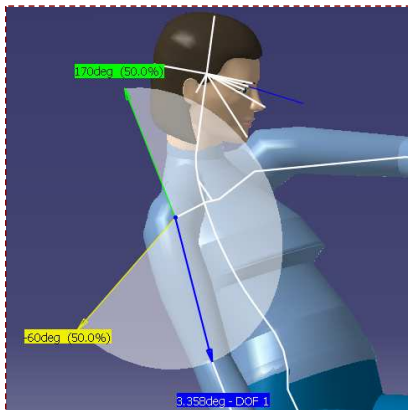
Editing the Range of Motion (1/4)

Angular limitations and Preferred angles

Those functions allows you to define inside a specific range of motion the best zone to conduct a designed task. The criteria of the zone can be: Comfort, force, etc. This function is mainly used when you want to evaluate the posture of various manikins inside a workstation. To realize a unique task, the posture of the manikins might be different according to their dimensions. In this case, their comfort will be different as well as their energy, etc.

This function is mainly used when you want to evaluate the posture of various manikins inside a workstation. To realize a unique task, the posture of the manikins might be different according to their dimensions. In this case, their comfort will be different as well.

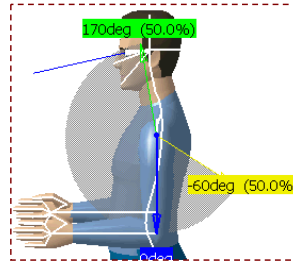
- 1 Using the following Icon, the range of motion (Angular limitations) and the criteria zone (Preferred angles) can be modified according to your specific scenario or manikin's characteristics



Editing the Range of Motion (2/4)

Angular Limitations allows you to set restrictions on the upper and lower limits of movement (in degrees) on a particular DOF of the manikin.

- 2 Edit the limit (Angular limitation) by double clicking on them directly OR with the contextual menu and select Edit

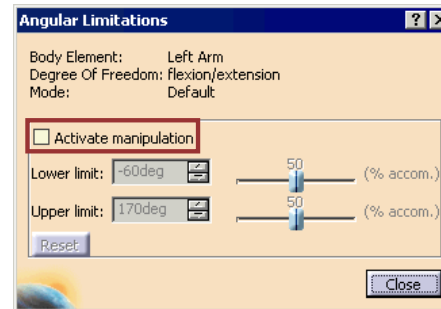


OR



- 3 To modify the angular limitations, you have to Select 'Activate manipulation' and change the limit

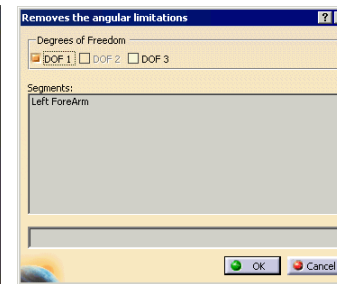
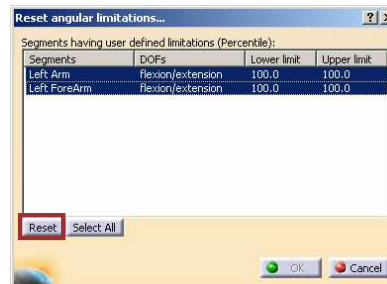
- 4 Save the angular limitation in a catalog using this icon.



The default range of motion is displayed in this panel (50% of the population). The bigger the range of motion smaller is the accommodation (only the elite are really flexible)

- 5 To reset the angular limitations, open the dialog box and select the angular limitation you want to reset.

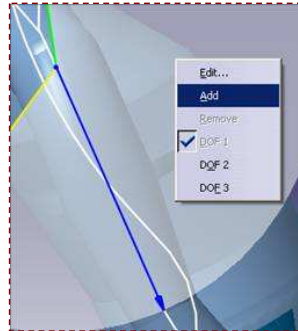
- 6 Using the following icon, you can remove all angular limitation on selected segments



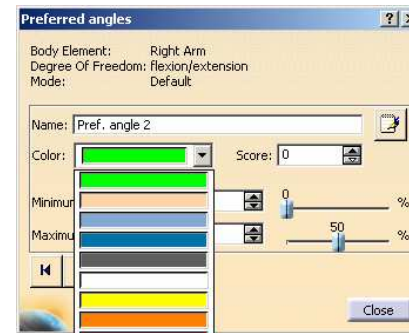
Editing the Range of Motion (3/4)

Preferred Angles allows you to create or edit preferred angles within the whole manikin range of motion. For example, it can refer to areas where the manikin would be comfortable, stronger or be in a safe posture.

7 You can add or remove preferred angles for each DOF of the articulation



8 In the Preferred Angles dialog box, the characteristics of each preferred angles must be detailed according to the scenario



9 You can save those preferred angles in a catalog by selecting the Preferred angles node in the specification tree.

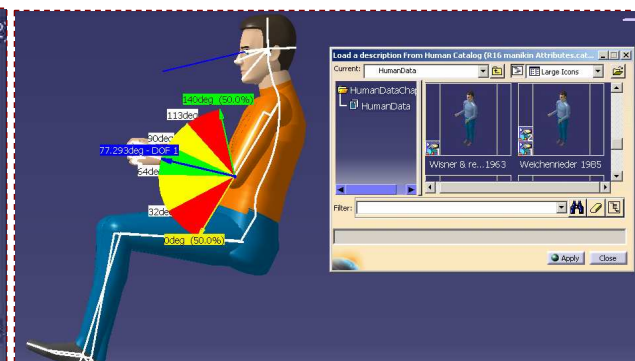
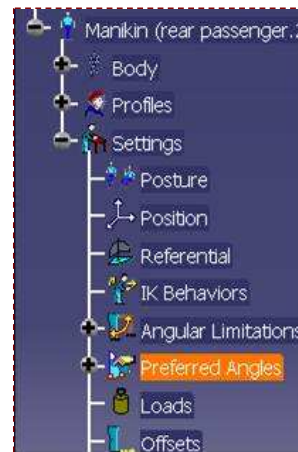
10 You can also limit or optimized the range of motion according to the preferred angles.



Or simply lock completely the mobility of a joint.



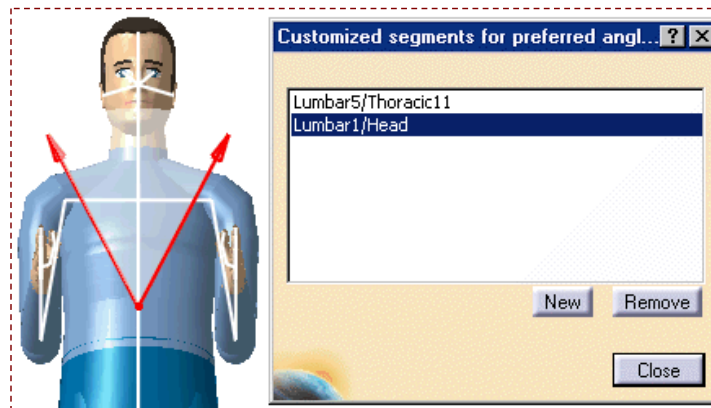
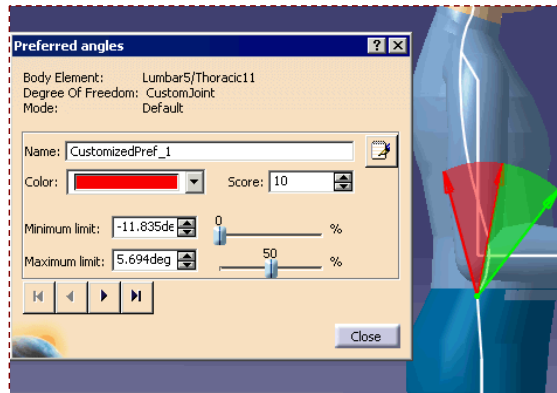
By selecting the segment and (ctrl key) on the preferred angles node in the Specification tree, you can do a Mirror Copy of those preferred angles.



Editing the Range of Motion (4/4)

The Customize joint function groups segments on the upper body (including the spine and the head). This creates a new segment for the Postural Score analysis. This will give more flexibility for analyzing the posture of the trunk. It allows you to create virtual segments of the pelvis, trunk, neck and head on which you will be able to edit preferred angles with a score.

- 11 Using the customized joint function, you can create virtual joint with a set of upper body segments (including the spine and the head). These virtual Segments can be created for any Degree of Freedom (DOF). Then, you will be allowed to specify standard Preferred Angles with a score.



Options:

- Select Whole Spine to score all vertebrae as a single element.
- Select Each Vertebrae to score each vertebra individually.
- Select Whole Hand to regroup each finger into a global element.
- Select Each Fingers to score each finger individually.

Displaying the Postural Score (1/3)

The Postural Score Analysis feature is used to evaluate the manikin's posture. Once the preferred angles have been specified or loaded from a library, you can evaluate the posture using the postural score function.

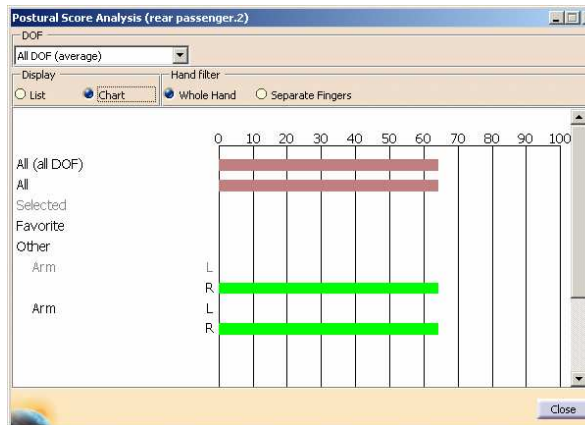
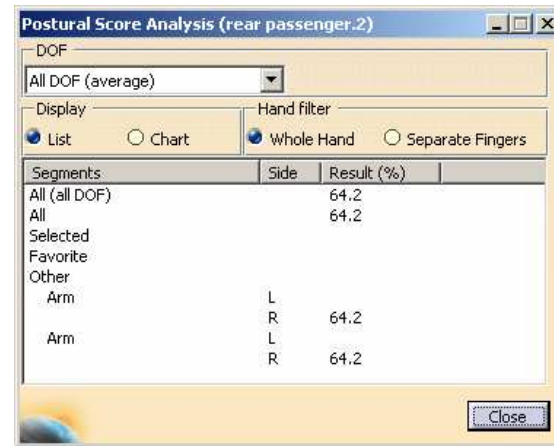
By opening the postural score panel, the Postural Score Analysis dialog box is displayed with the Display List as the default



The following information is displayed according to the selected Display type:

- **Global Score** – this item is the total posture score for all segments combined.
- **Current Score** – this item is the average score of all items in the current list.
- **Selected Score** – this item is the posture score for all selected items on the multi-list.
- **Favorites** – this item is customizable and displays all preferred angles, even if they have never been edited.

If you choose the List display, scores will be displayed as percentages in list form. If you choose the Chart display, scores will be displayed in chart form.



Displaying the Postural Score (2/3)

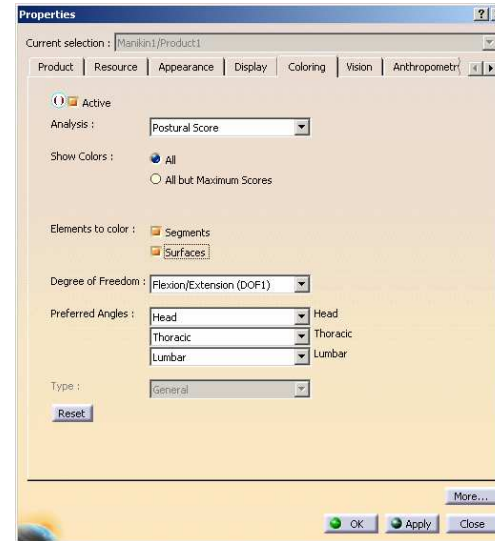
Use the Segment coloring to display color on the manikin's segment according to the score of the preferred angle

Under the manikin's properties it's possible to change the coloring options

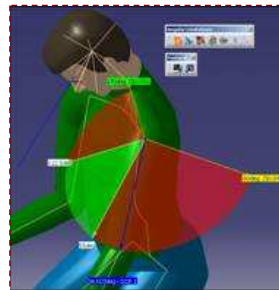
- ☐ **Active:** check if you want to activate the coloring.
- ☐ **All:** activates the coloring.
- ☐ **All but Maximum Scores:** activates the coloring on all segments except those with scores at their maximum.

This feature can be used, for instance, to display colors only if the manikin goes out of its zone according to the score.

- ☐ **Element to color:** These check boxes are used to select the parts that will change color.
- ☐ **Degree of Freedom:** This combo is used to choose the degree of freedom to activate.



By activating the coloring, you can get highlights for the worst case.



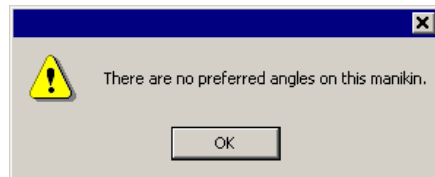
Displaying the Postural Score (3/3)

The function Find the Posture which maximizes the Postural Score changes the position of the body so as to maximize the global postural score of the manikin.

By using this icon, you can find the posture which maximizes the postural score that you have edited before



Only the edited preferred angles are saved in a catalog. For this reason, it's possible to load different preferred angles on the same manikin. You can keep the previous preferred angles if it's according to different segment or DOF.



The score that is assigned on a zone is the only indicator of a preferred angle. Specific Color, name is not an indicator of preferred angles.

Student Notes:

Gathering and Analyzing the Results

This concept consist in gathering all different types of results into a single document. Analyzing the posture using a unique database might minimize the accuracy of your analysis. This approach allows to gather different results in order to obtain a more objective analysis.

Here different manikin (standard, boundary)

Here different analysis database

A	B	C	D	E	F	G	H	I	J	K	L	M	N	
Design phas	Population	Manikin number	Name	Target posture (Comfort)					Clearence					
Vehicle: ggg				Weichenreider adapted by customers	Human scale	Wiesner & Rebiffe	Weichenreider	hpoint position	Steering wheel	Air bag	Seat pan_popleat al	Thigh VS Seat pan angle	Head Clearance	
Comments:														
SAFEWORK files: /raid1/home/enovia1/data/				General Working.sw										
	SAE	1	95th male	94.4	85.7	33.3	85.7	240	42.5	569.57	108	Not available	105.49	
			50 th male	56.6	82.9	75	78.9	195.6	502	65.34	94.9	Not available	not required	
			2	5th female	58.3	82.9	50	71.4	51.6	Not required	360.8	33.5	Not available	not required
				2D template P										
	Malaysian (libname##) Male		3 min,min,min	50	82.9	50	67.9		OK					
			4 Min,min,max	64.3	80	33.3	64.3		OK					
			5 Min,max,min	66.7	85.7	75	85.7							
			6 Min,max,ma	80.6	85.7	75	85.7							
			7 Max,min,mir	63.9	85.7	50	78.6							
			8 Max,min,me	98.3	85.7	83.3	92.9							
			9 Max,max,m	83.3	85.7	91.7	85.7							
		10	Max,max,m	88.9	85.7	83.3	78.6							

Here different population

Standard Ergonomic Analysis



You will become familiar with the use of standard ergonomic analysis

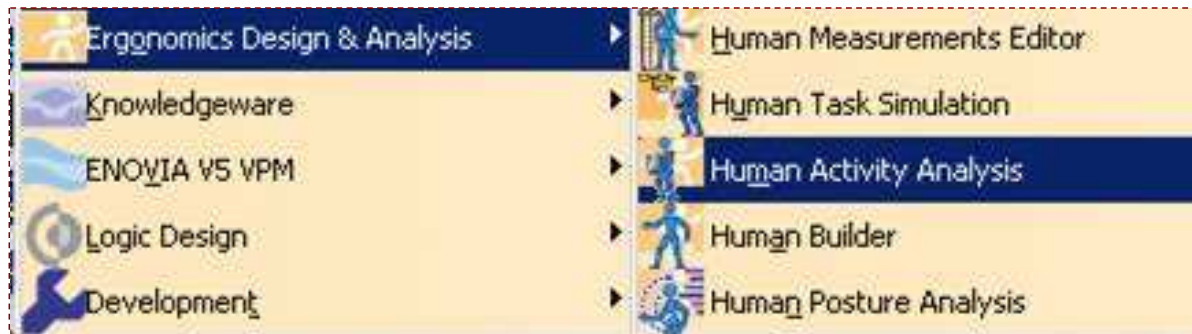
- *Introduction of each workbench*
- *RULA ergonomic analysis*
- *Lift /lower ergonomic analysis*
- *Push/pull ergonomic analysis*
- *Carry analysis*
- *3D Biomechanics*



Accessing the Human Activity Analysis Workbench

This workbench allows investigation between the manikin and the working environment. All the analysis (RULA, lifting, lowering, pushing, pulling and carrying) are based on scientific ergonomics analysis. Those analysis help to identify critical task and evaluate the manikin's action.

Accessing the workbench

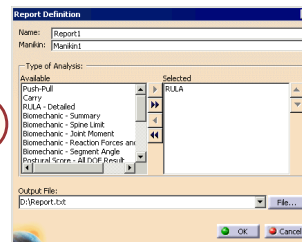
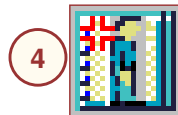
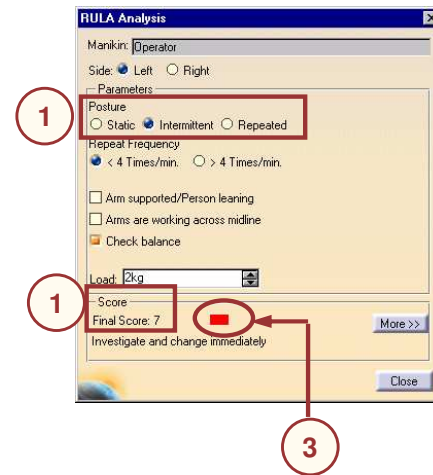
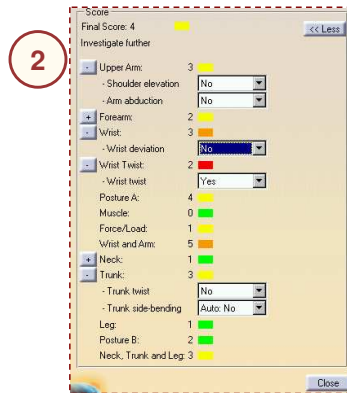


RULA Analysis



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.

1. The RULA analysis is mainly use for static posture. The analysis record the current posture of the manikin and once the specifications have been input, RULA provides you with a Score
2. In some case, the record of the manikin's posture might be different than from a real worker. At this time, you can change manually some input in order to reflect with more accuracy the reality
3. The score (1-7 is associated with a specific color code (green to red) and a comments.
4. Once the specifications have been input in the panel, Create a report and add RULA or RULA detailed in the report .
5. Click update when ever you want to compile a RULA analysis and out put in the Report.

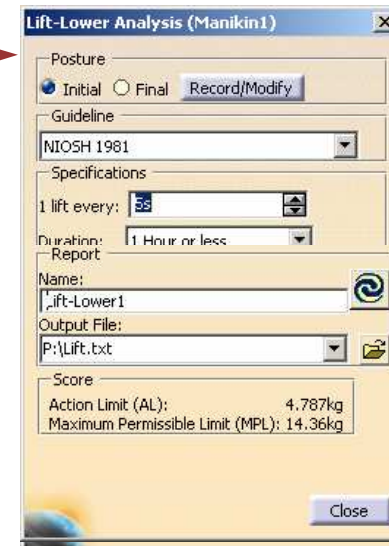
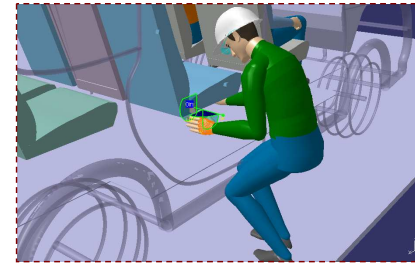


Lift / Lower Analysis (1/2)



This concept consists in three different analysis: NIOSH 81, NIOSH 91 and Snook&Ciriello. Those analysis are standard matrix that analyze the current posture of the manikin and some specifications such as initial posture, final posture, duration, repetition, etc. Those analysis are mainly used for lifting and lowering tasks. Each of them are using different specifications and provide you with specific results.

- 1 Once you have identified two postures into the lift and lowering panel, you can conduct 3 different lifting and lowering analysis: NIOSH 81, NIOSH 91 and Snook & Ciriello.



NIOSH 81 is mainly for symmetric tasks and provides you with two recommended weights.

Based on different population SAMPLE, NIOSH 91 allows to simulate trunk rotation and provide one recommended weight.

Snook&Ciriello allows you to introduce different grabbing condition and provide you with two recommended weights and a Lifting Index (current lifted weight/recommended weight).

Lift / Lower Analysis (2/2)



- Place the manikin in the first posture, click initial in the panel and click Record/modify button, perform the same operation for the final postures. By toggling the buttons initial and final the postures can be automatically updated and double checked.

Specifications (depending of the guidelines choice)

1 lift every: Increase or decrease the value according to the lift frequency.

Duration: Duration of the work (hours per day). Occasional if the value is one hour or less
continuous if the value is 8 hours

Coupling condition: Quantify the quality of the hand-to-object. (Good, Fair or 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 object is hard to handle (irregular, bulky, sharp edges, etc.)

Object weight: Enter the load weight. This value is used for the lifting index calculation.

Population sample: Three population percentiles are provided: 90th, 75th, and 50th.

Score

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

Destination : This result is based on the final posture of the manikin

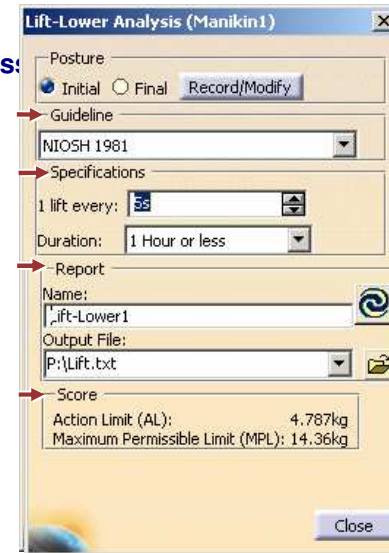
Action Limit (AL): Represents the weight below which the task could be considered as reasonably safe.

Maximum Permissible Limit (MPL): Represents a limit above which the lifting task is considered as hazardous and requires engineering controls.

Maximum Acceptable Weight: The weight that can be handled with reasonable safety

Recommended Weight Limit (RWL): Load weight that healthy workers can lift over a certain period of time without risk.

Lifting Index (LI): Relative estimation of the level of physical stress



- A report of these analysis can be generated automatically. The access to update the report is specific to these analysis because initial and final posture need to be identified manually.

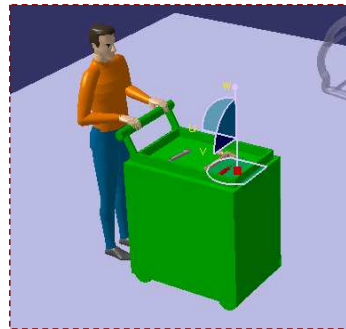
Student Notes:

Push / Pull Analysis

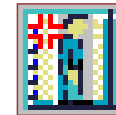


This analysis is a standard matrix that analyze the current posture of the manikin and some specifications such as duration, distance, etc. Those analysis are mainly used to evaluate the recommended effort that should be deployed when a worker is pushing or pulling on a kart in a specific posture.

1. Once the pushing posture has been identifies, activate the Push-Pull Analysis icon



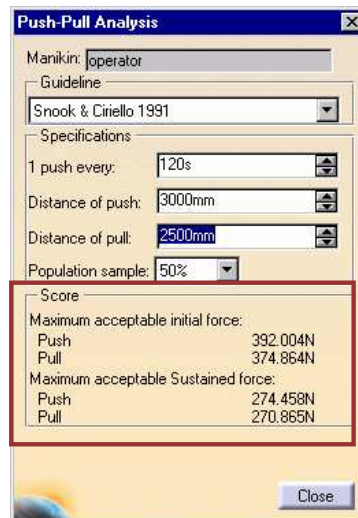
3. Once the specifications have been input in the panel, Create a report and add PUSH/PULL detailed in the report .



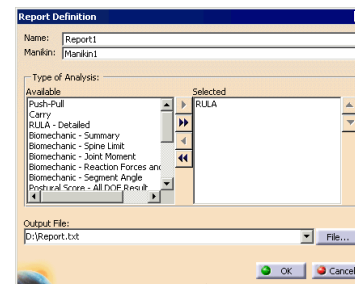
2. Considering the current posture of the manikin, input the specifications (Distance of push, distance of pull, the frequency and the population sample)

Smaller is the weight, bigger is the percentage of the population that can perform the task.

Snook & Ciriello provides you two scores: Initial force and Sustained force.



4. Click update when ever you want to compile a RULA analysis and out put in the Report.



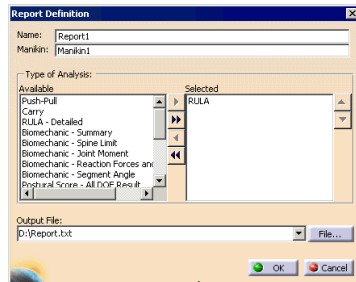
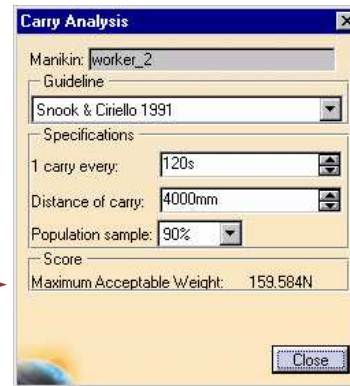
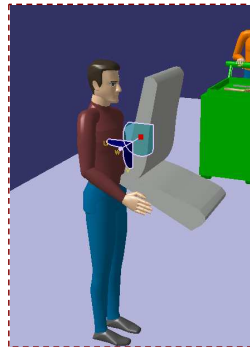
Student Notes:

Carry Analysis



This analysis is a standard matrix that analyze the current posture of the manikin and some specifications such as duration, distance, etc. Those analysis are mainly used to evaluate the recommended effort that should be deployed when a worker is pushing or pulling on a kart in a specific posture.

1. Select the desired posture for carrying the object.
2. Activate the carry analysis.
3. Input the specifications (Distance of push, distance of pull, the frequency and the population sample).
4. Once the specifications have been input in the panel, Create a report and add Carry in the report.
5. Click update when ever you want to compile a RULA analysis and out put in the Report.

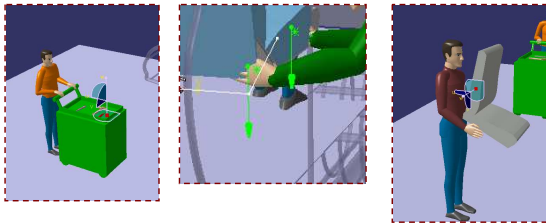


Depending of the manikin's posture, the Maximum Acceptable Weight (in the score section) is different.

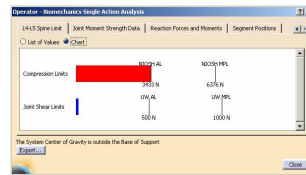
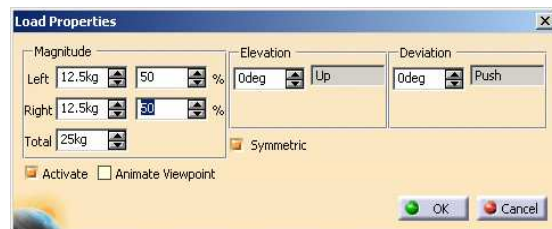
3D Biomechanics Analysis

Contrary to the standard analysis (NIOSH, Snook&Ciriello, etc.), the 3D Biomechanics analysis is the more flexible and accurate analysis for exertion. It allows you to calculate the compression spine, moment, shear and compare it with recognized standard. It can be used for an unlimited case study (push, pull lift, twist, etc).

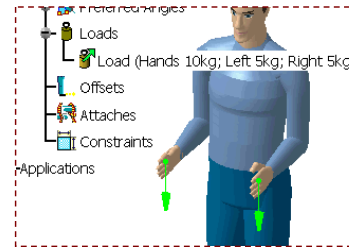
Considering the current posture of the manikin. The stress on several joints can be evaluated efficiently. The load can be apply for different contexts.



1. In Human builder Workbench, create loads on the hands of the manikin. Only one load can be created at the same time.
2. Input the magnitude and the orientation of the loads.



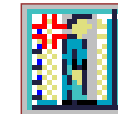
Several types of result output are available in each tab.



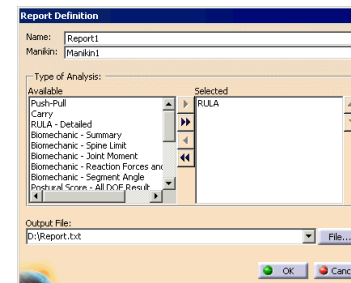
3. Activate the biomechanics analysis.



4. Once the specifications have been input in the panel, Create a report and add Biomechanics in the report (Select which output).



5. Click update when ever you want to compile a RULA analysis and out put in the Report.



Course Sum Up

In this course you have seen :

- Forward and Inverse Kinematics
- Constraints
- Standard pose
- Attach object
- Catalogues and libraries
- Range of motion
- Preferred angle
- Anthropometrics variable
- Boundary manikins
- Simulation and track
- Reach function and reach envelop
- Vision
- Various ergonomics analysis

