

SIEMENS

Ingenuity for life

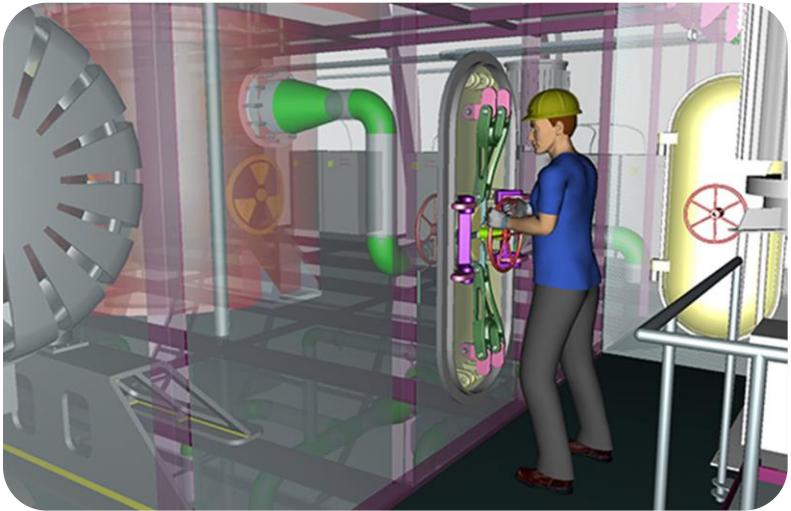
TECNOMATIX JACK 9.0



DIPARTIMENTO DI
INGEGNERIA
INDUSTRIALE



Prof. Giuseppe Di Gironimo
PhD St. Ing. Alessia Megna



JACK 9.0

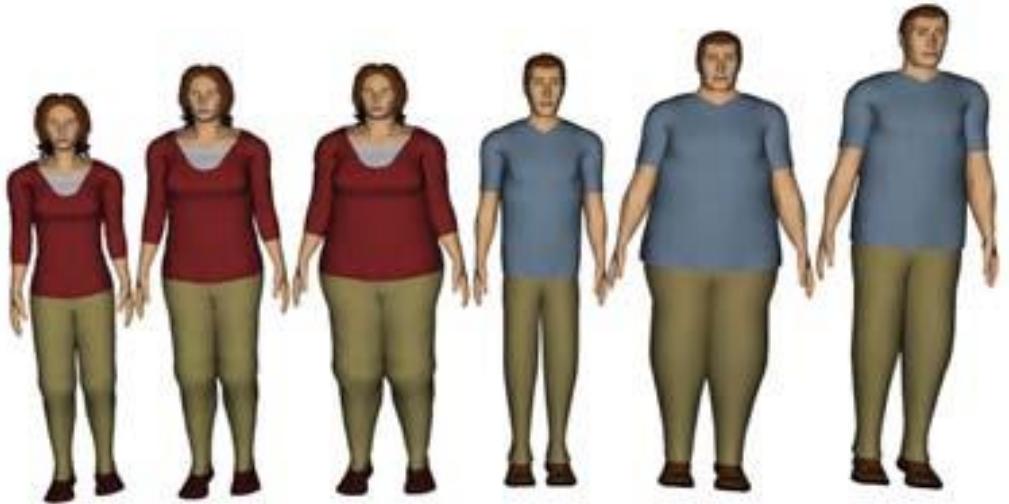
- Jack è uno strumento di modellazione e simulazione umana che ti aiuta a migliorare l'ergonomia dei prodotti e a perfezionare le attività industriali.
- Con i suoi toolkit opzionali, fornisce strumenti di progettazione incentrati sull'uomo, per eseguire analisi ergonomiche di prodotti e ambienti di lavoro virtuali.
- Ti consente di dimensionare i tuoi modelli digitali umani, in modo che corrispondano alle popolazioni di lavoratori, nonché di testare i progetti per molteplici fattori, tra cui il rischio di infortuni, il comfort dell'utente, la raggiungibilità, la linea di vista, il dispendio energetico, i limiti di fatica e altri importanti parametri umani.



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VANTAGGI

- Il software Jack consente di valutare le prestazioni umane e eventuali problemi di fattibilità dall'inizio del processo di progettazione, facendo risparmiare tempo e denaro all'azienda, identificando potenziali soluzioni per progettazioni human-friendly.
- Fornisce un'ampia serie di banche dati antropometrici per rappresentare la popolazione di interesse (ANSUR, Asiatica, Canadese, Cinese, Tedesca).
- Capacità di analisi ergonomiche, fatica, analisi carico lombare (LBA), limiti di movimentazione dei materiali, spesa energetica, NIOSH, OWAS, RULA e resistenza statica, in posture statiche e in tempo reale.



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INDICI ERGONOMICI

Il RULA è un indice che consente la valutazione del rischio ergonomico associato agli arti superiori (collo, tronco e braccia) considerando il carico biomeccanico e posturale per le attività “overhead”.



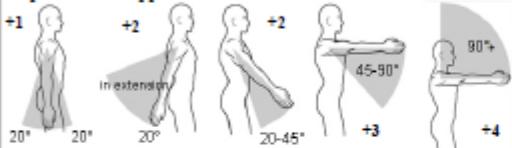
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RULA Employee Assessment Worksheet

based on RULA: a survey method for the investigation of work-related upper limb disorders, McAtamney & Corlett, Applied Ergonomics 1993, 24(2), 91-99

A. Arm and Wrist Analysis

Step 1: Locate Upper Arm Position:



Step 1a: Adjust...

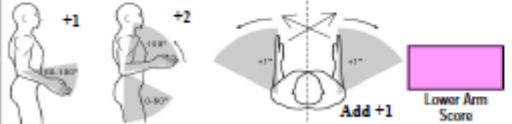
- If shoulder is raised: +1
- If upper arm is abducted: +1
- If arm is supported or person is leaning: -1

SCORES

Table A: Wrist Posture Score

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

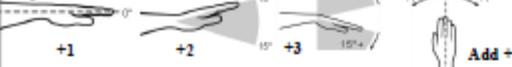
Step 2: Locate Lower Arm Position:



Step 2a: Adjust...

- If either arm is working across midline or out to side of body: Add +1

Step 3: Locate Wrist Position:



Step 3a: Adjust...

- If wrist is bent from midline: Add +1

Step 4: Wrist Twist:

- If wrist is twisted in mid-range: +1
- If wrist is at or near end of range: +2

Step 5: Look-up Posture Score in Table A:

Using values from steps 1-4 above, locate score in Table A

Step 6: Add Muscle Use Score

- If posture mainly static (i.e. held>10 minutes), Or if action repeated occurs 4X per minute: +1

Step 7: Add Force/Load Score

- If load < 4.4 lbs (intermittent): +0
- If load 4.4 to 22 lbs (intermittent): +1
- If load 4.4 to 22 lbs (static or repeated): +2
- If more than 22 lbs or repeated or shocks: +3

Step 8: Find Row in Table C

Add values from steps 5-7 to obtain Wrist and Arm Scores. Find row in Table C.

Table C: Neck, trunk and leg score

Wrist and Arm Score	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

Scoring: (final score from Table C)

- 1 or 2 = acceptable posture
- 3 or 4 = further investigation, change may be needed
- 5 or 6 = further investigation, change soon
- 7 = investigate and implement change

Final Score

Task name: _____ Reviewer: _____ Date: _____ / _____ / _____

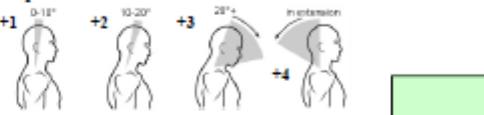
This tool is provided without warranty. The author has provided this tool as a simple means for applying the concepts provided in RULA.

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B. Neck, Trunk and Leg Analysis

Step 9: Locate Neck Position:



Step 9a: Adjust...

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

Step 10: Locate Trunk Position:



Step 10a: Adjust...

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

Step 11: Legs:

- If legs and feet are supported: +1
- If not: +2

Neck Posture Score	1	2	3	4	5	6	7
Legs	Legs	Legs	Legs	Legs	Legs	Legs	Legs
1	1	2	2	1	2	1	2
2	2	3	2	3	4	5	6
3	3	3	3	4	4	5	7
4	4	5	4	4	5	6	8
5	5	5	5	6	6	7	8
6	7	7	7	7	8	8	9
7	8	8	8	8	9	9	9
8	9	9	9	9	9	9	9

Step 12: Look-up Posture Score in Table B:

Using values from steps 9-11 above, locate score in Table B

Step 13: Add Muscle Use Score

- If posture mainly static (i.e. held>10 minutes), Or if action repeated occurs 4X per minute: +1

Step 14: Add Force/Load Score

- If load < 4.4 lbs (intermittent): +0
- If load 4.4 to 22 lbs (intermittent): +1
- If load 4.4 to 22 lbs (static or repeated): +2
- If more than 22 lbs or repeated or shocks: +3

Step 15: Find Column in Table C

Add values from steps 12-14 to obtain Neck, Trunk and Leg Score. Find Column in Table C.

Final Score

Neck, Trunk & Leg Score

INDICI ERGONOMICI

Il REBA è un indice che considera sia gli angoli ai giunti degli arti superiori che quelli inferiori del sistema muscolo-scheletrico per valutare il rischi biomeccanici associati all'attività lavorativa oggetto di valutazione.

REBA Employee Assessment Worksheet

based on Technical note: Rapid Entire Body Assessment (REBA), Hignett, McAtamney, Applied Ergonomics 31 (2000) 201-205

SCORES													
		Neck			Lower Arm			Upper Arm			Legs		
		1	2	3	1	2	3	1	2	3	1	2	3
A. Neck, Trunk and Leg Analysis	Table A												
Step 1: Locate Neck Position	 Step 1a: Adjust... If neck is twisted: +1 If neck is side bending: +1												
Step 2: Locate Trunk Position	 Step 2a: Adjust... If trunk is twisted: +1 If trunk is side bending: +1												
Step 3: Legs	 Step 4: Look-up Posture Score in Table A Using values from steps 1-3 above, locate score in Table A												
Step 5: Add Force/Load Score	 Step 6: Score A, Find Row in Table C Add values from steps 4 & 5 to obtain Score A. Find Row in Table C.												
Scoring:	1 = negligible risk 2 or 3 = low risk, change may be needed 4 to 7 = medium risk, further investigation, change soon 8 to 10 = high risk, investigate and implement change 11+ = very high risk, implement change												
B. Arm and Wrist Analysis	Table B												
Step 7: Locate Upper Arm Position:	 Step 7a: Adjust... If shoulder is raised: +1 If upper arm is abducted: +1 If arm is supported or person is leaning: -1												
Step 8: Locate Lower Arm Position:	 Step 9: Locate Wrist Position: Step 9a: Adjust... If wrist is bent from midline or twisted: Add +1												
Step 10: Look-up Posture Score in Table B	Using values from steps 7-9 above, locate score in Table B												
Step 11: Add Coupling Score	 Step 12: Score B, Find Column in Table C Add values from steps 10 & 11 to obtain Score B. Find column in Table C and match with Score A in row from step 6 to obtain Table C Score.												
Step 13: Activity Score	 +1 1 or more body parts are held for longer than 1 minute (static) +1 Repeated small range actions (more than 4x per minute) +1 Action causes rapid large range changes in postures or unstable base												
Final REBA Score Table C Score + Activity Score													

Task name: _____ Reviewer: _____ Date: _____ / _____ / _____

This tool is provided without warranty. The author has provided this tool as a simple means for applying the concepts provided in REBA .

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INDICI ERGONOMICI

E' possibile includere uno scripting di facile accesso per creare analisi aggiuntive, come ad esempio il calcolo di ulteriori indici ergonomici tra cui il REBA,PEI e WEI.

$$PEI = \frac{LBA}{3400} + \frac{RULA}{5} + \frac{REBA}{7}$$

$$WEIj = \sum_{i=1}^M PEI_i \times W_i$$

$$W_i = \frac{ST}{CT}$$

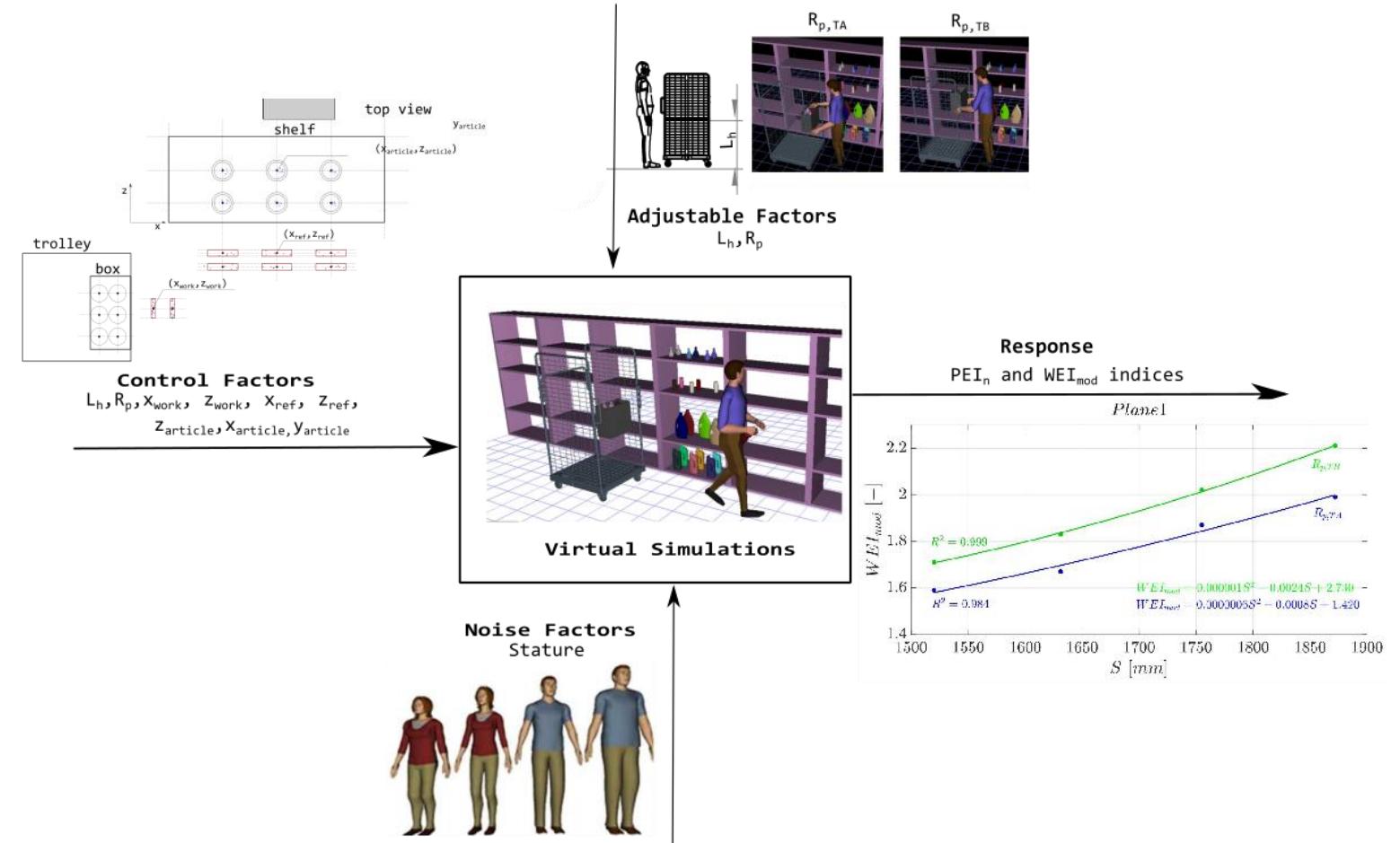
ANGOLI AI GIUNTI PER IL CALCOLO DEGLI INDICI IL REBA:

- flessione-estensione spalla
- abduzione-adduzione spalla
- flessione-estensione gomito
- prono-supinazione polso
- flessione-estensione polso
- flessione-estensione tronco
- flessione laterale del tronco
- rotazione assiale del tronco
- flessione-estensione collo
- flessione-estensione collo
- flessione laterale del collo
- rotazione assiale del collo
- flessione-estensione del ginocchio



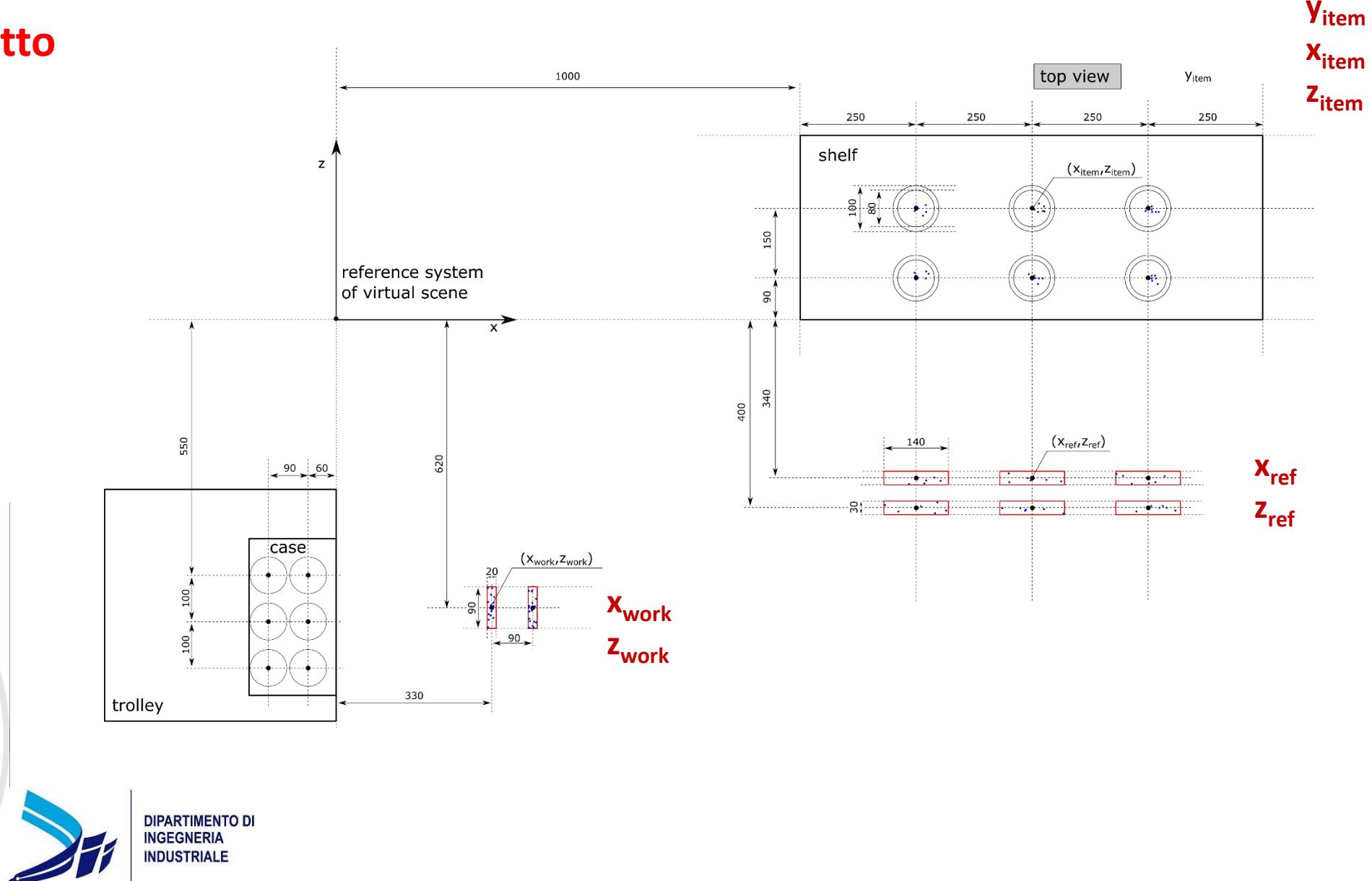
ESEMPIO APPLICAZIONE: LOGISTICA SUPERMERCATI

- **Parametri di progetto:** tutti i parametri di progettazione relativi alla valutazione ergonomica
- **Parametri di progetto regolabili:** parametri di progettazione da ottimizzare
- **Fattori di disturbo:** parametri di input esterni relativi alla valutazione ergonomica
- **Risposta:** indici ergonomici sintetici



ESEMPIO APPLICAZIONE: LOGISTICA SUPERMERCATI

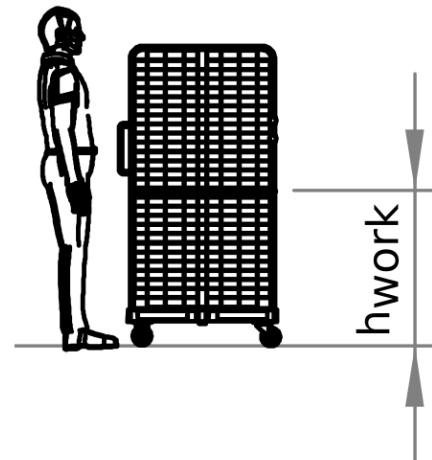
Parametri di progetto



ESEMPIO APPLICAZIONE: LOGISTICA SUPERMERCATI

Parametri di progetto regolabili

h_{work}
altezza di lavoro del compito di sollevamento



W_{TI} : processo di riempimento “Take Item”



W

W_{TC} : processo di riempimento “Take Case”

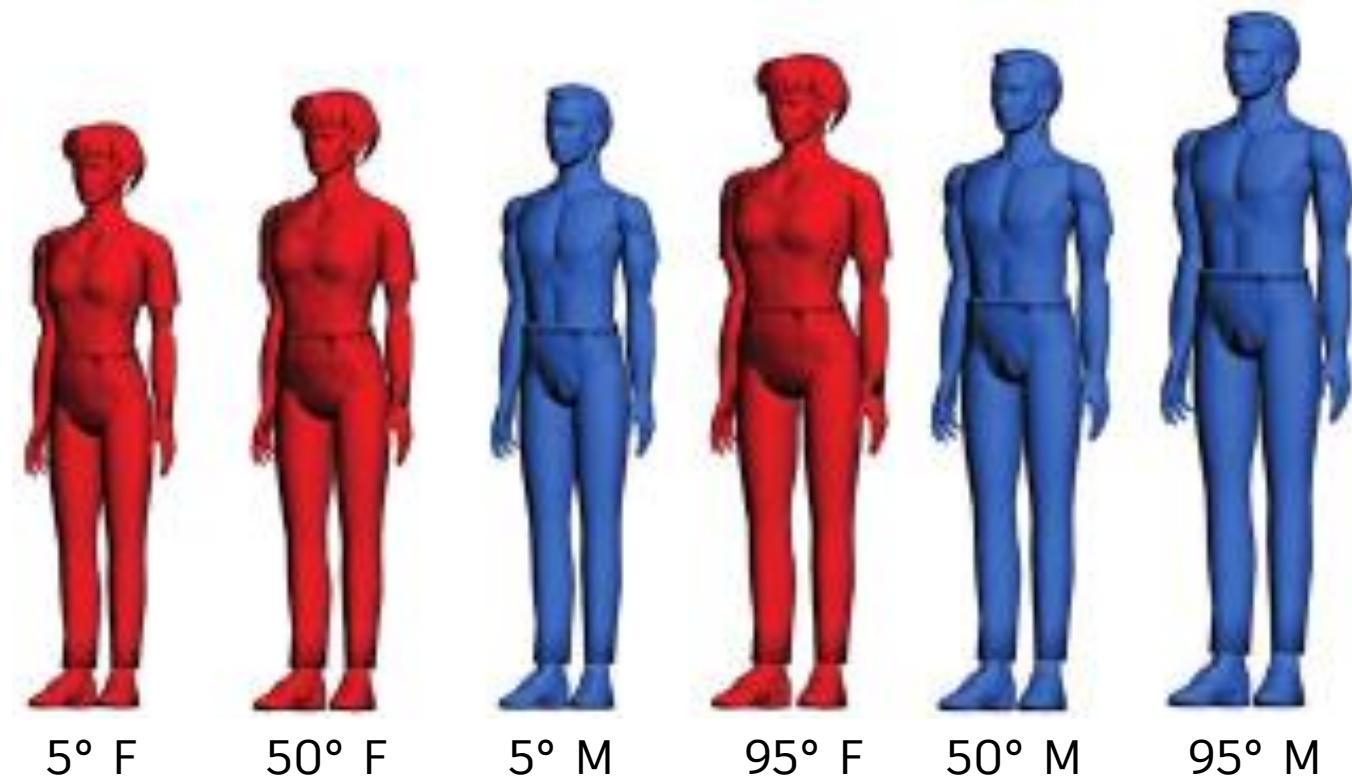


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ESEMPIO APPLICAZIONE: LOGISTICA SUPERMERCATI

Fattori di disturbo

- Variabile: altezza delle spalle dell'operatore
- 3 percentili (5°, 50° and 95°)
- Maschio e Femmina
- Range da 1254 mm to 1537 mm



ESEMPIO APPLICAZIONE: LOGISTICA SUPERMERCATI

Risposta: Indici Ergonomici sintetici

$$PEI = \frac{LBA}{3400} + \frac{RULA}{5} + \frac{REBA}{7}$$

$$WEI_j = \sum_{i=1}^M PEI_i \times W_i \quad W_i = \frac{ST}{CT}$$

$$WEI_{cor,j} = \left(\frac{CT_j - CT_{max}}{CT_{max}} \right) \cdot WEI_j + \left(1 - \frac{CT_j - CT_{max}}{CT_{max}} \right) \cdot PEI_{min}$$

Simulazioni

Angoli ai giunti, PEI, tempi
dei singoli tasks (ST)

LBA	CT	WEI WEI _{corr}
-----	----	----------------------------

h_{opt}

CT_{opt}

W_{opt}



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ESEMPIO APPLICAZIONE: LOGISTICA SUPERMERCATI

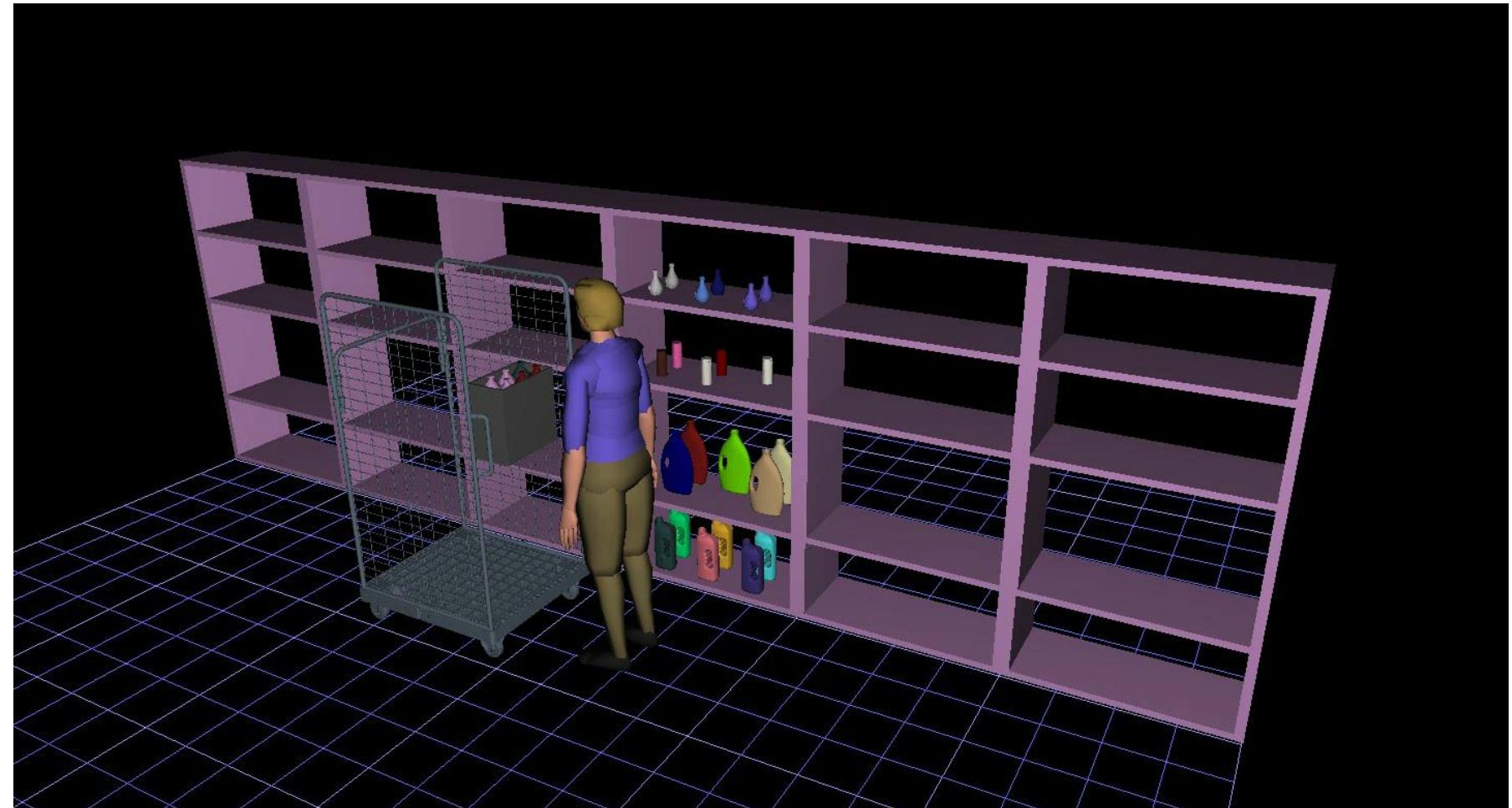
Simulazione
processo W_{TI} :
processo di
riempimento“Take
Item”



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ESEMPIO APPLICAZIONE: LOGISTICA SUPERMERCATI

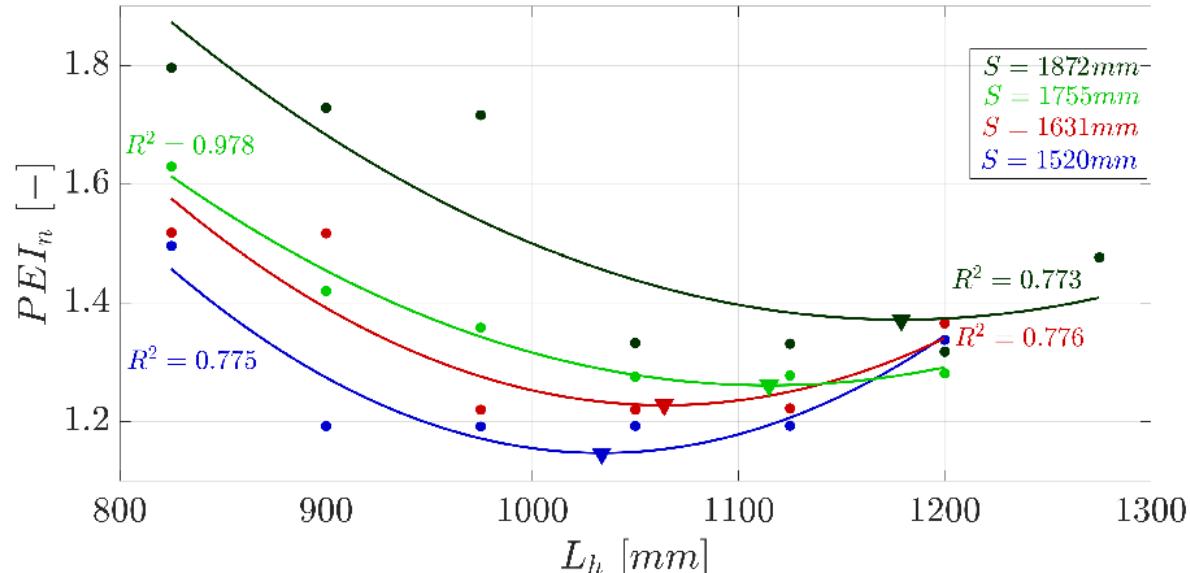
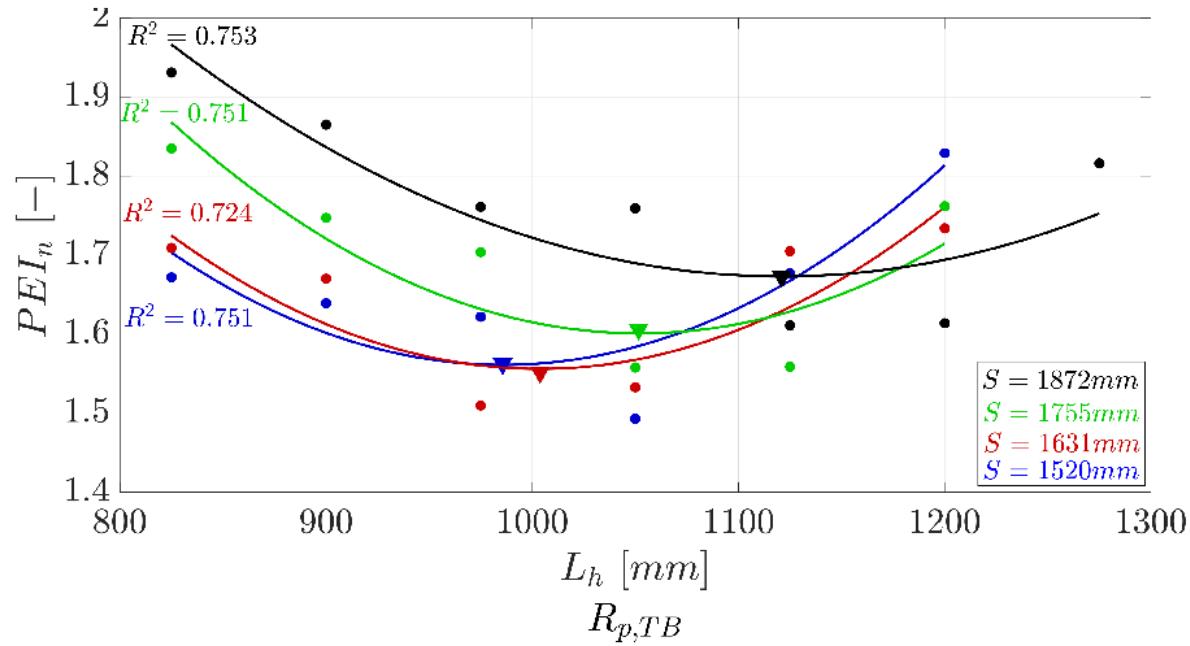
Simulazione
processo W_{TC} :
processo di
riempimento “Take
Case”



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ESEMPIO APPLICAZIONE: LOGISTICA SUPERMERCATI

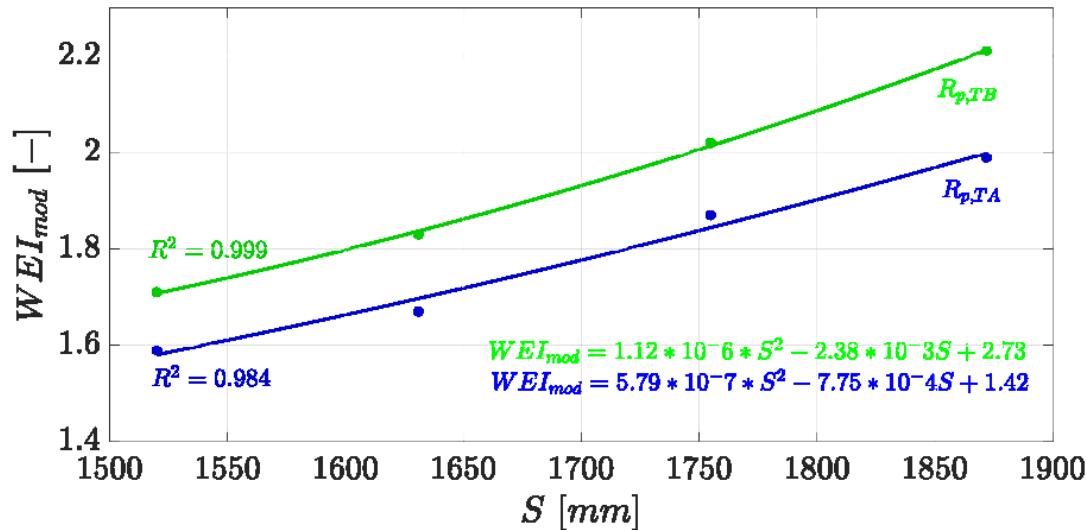
Ottimizzazione
Altezza di lavoro
(h_{opt})



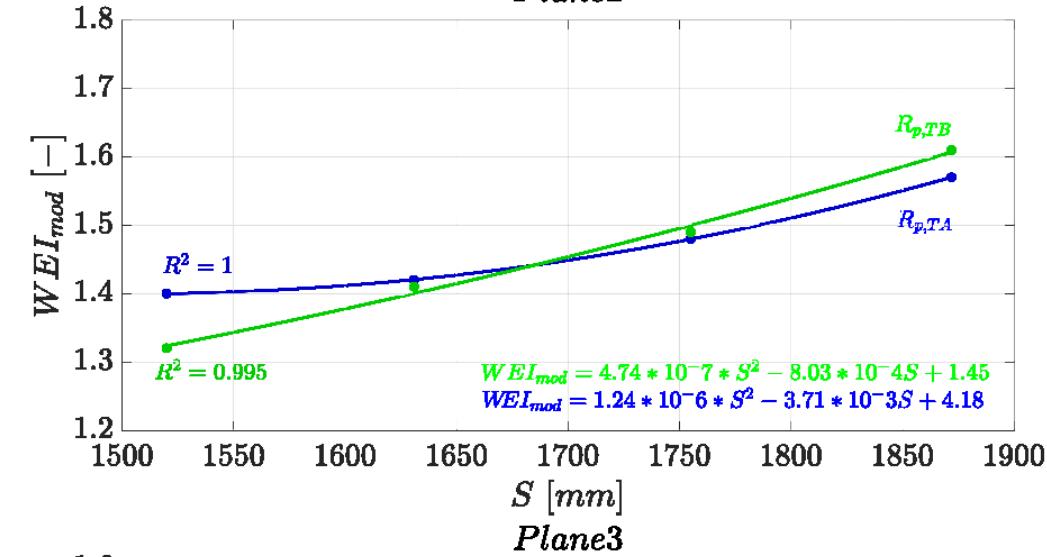
ESEMPIO APPLICAZIONE: LOGISTICA SUPERMERCATI

Ottimizzazione processo di riempimento (W_{opt})

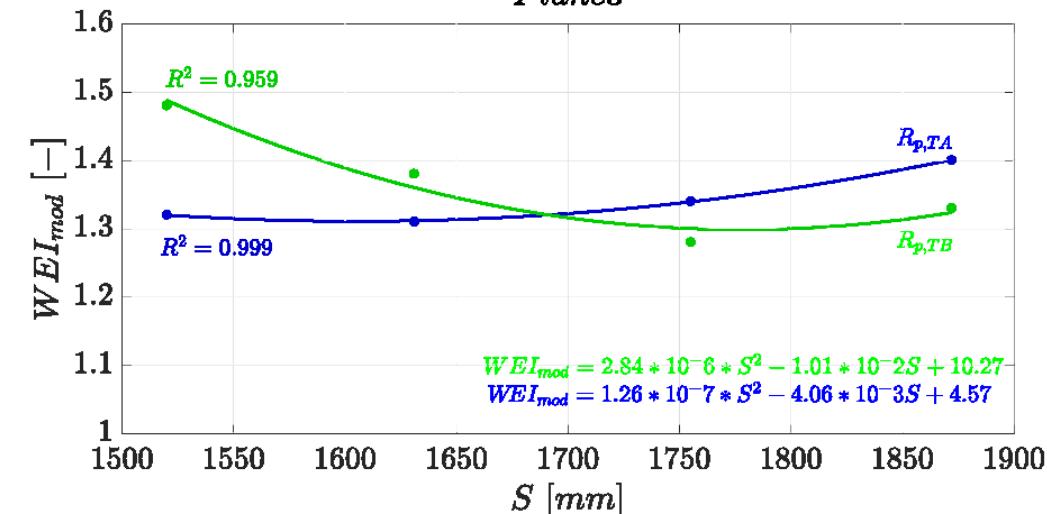
Plane1



Plane2

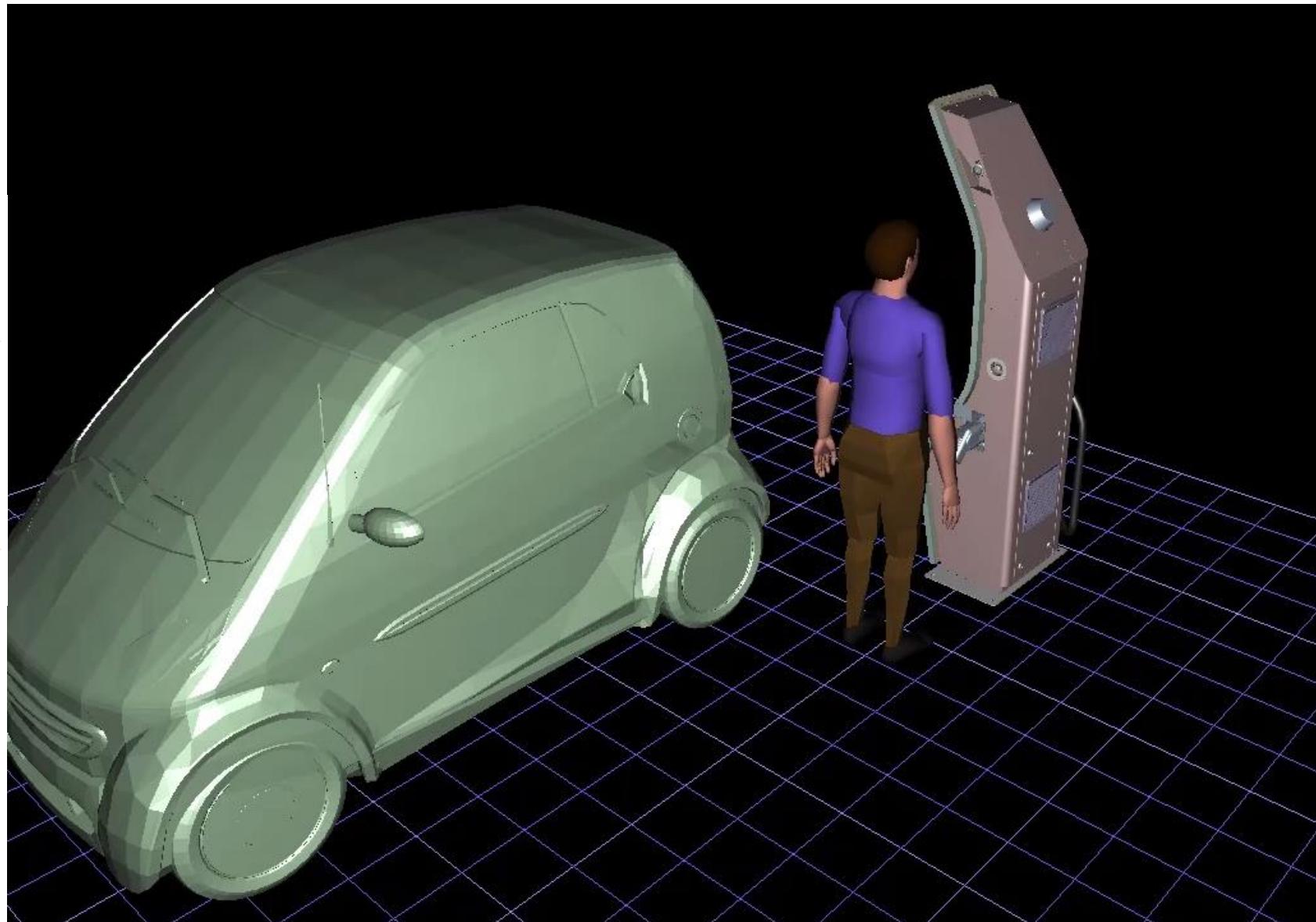
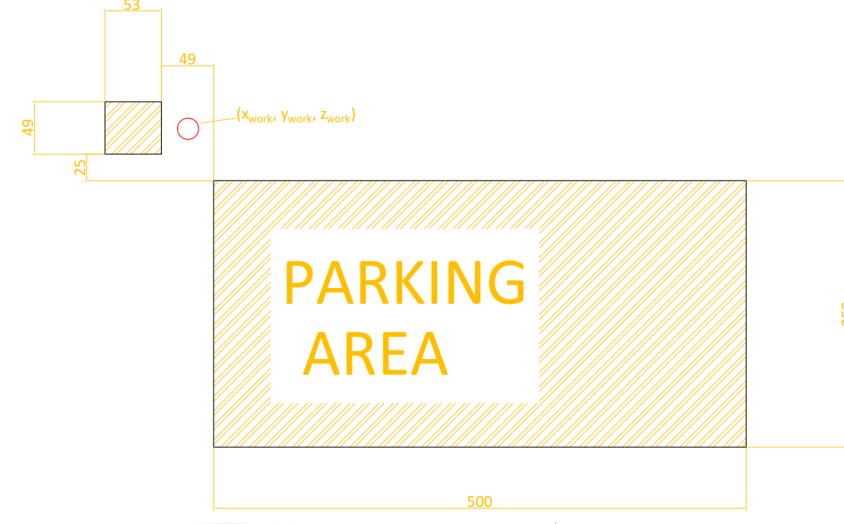


Plane3



ESEMPIO APPLICAZIONE: RICARICA AUTO ELETTRICA

- Valutazione ergonomica di diverse configurazioni per ricarica auto-elettriche



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ESEMPIO APPLICAZIONE: RICARICA AUTO ELETTRICA

REBA SCORE

1
2 , 3
4 , 7
8 , 10
11+

RULA SCORE

1 , 2
3 , 4
5 , 6
6+

LBA SCORE

1 , 2100
2100 , 3400
3400+

PEI SCORE

0,50 , 1,50
1,50 , 2,50
2,50+

DISPENSER NEW

MAN	RULAScore	REBAScore	LBA	PEIScore	
<i>GET</i>	5	6	1097,61	2,18	
<i>POSITION</i>	6	8	1837,11	2,88	
<i>GO-ARISE FROM BEND</i>	4	5	1303,62	1,90	
<i>GO-WALK</i>	3	4	851,29	1,42	
<i>PUT</i>	4	5	1190,41	1,86	
<i>POSE</i>	4	6	910,84	1,93	
<i>GET</i>	4	6	1034,11	1,96	
<i>PUT-WALK</i>	4	4	922,33	1,64	
<i>PUT-BEND AND REACH</i>	5	6	1512,17	2,30	
<i>POSE</i>	5	6	1037,57	2,16	
				WEI	2,05

DISPENSER OLD

MAN	RULAScore	REBAScore	LBA	PEIScore	
<i>GET</i>	6	8	1285,26	2,72	
<i>POSITION</i>	7	9	2246,70	3,35	
<i>GO-ARISE FROM BEND</i>	5	6	1559,36	2,32	
<i>GO-WALK</i>	3	4	845,07	1,42	
<i>PUT</i>	4	5	1097,15	1,84	
<i>POSE</i>	4	6	920,49	1,93	
<i>GET</i>	4	6	995,52	1,95	
<i>PUT-WALK</i>	4	4	976,99	1,66	
<i>PUT-BEND AND REACH</i>	6	8	1809,77	2,88	
<i>POSE</i>	6	8	1414,70	2,76	
				WEI	2,44



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Logistica industriale

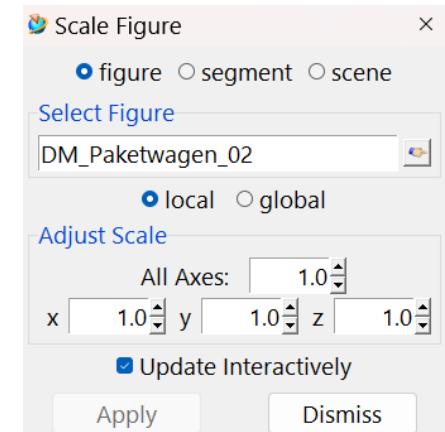
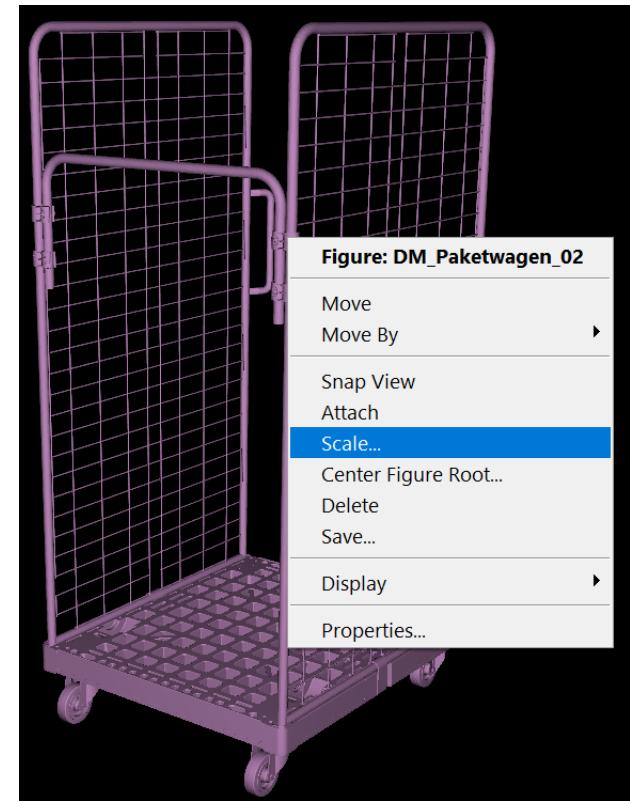
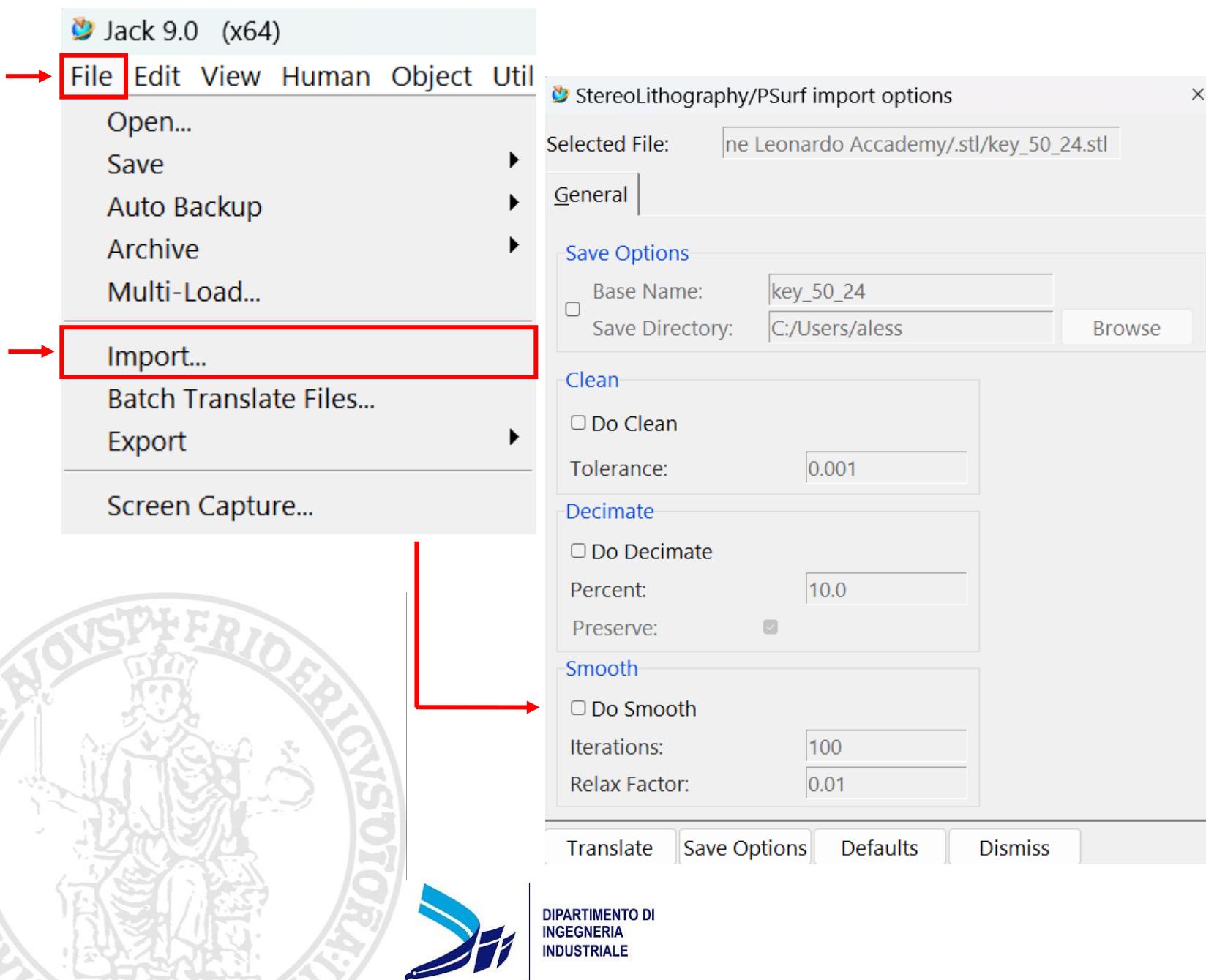
Il team di ingegneri logistici, analisti, progettisti e Project Manager, lavorando a stretto contatto con i clienti, è in grado di trasferire la propria esperienza e le best practices aziendali per gestire le tematiche di movimentazione interna, preparazione kit, consegna ai reparti di produzione e miglioramento dell'ergonomia delle risorse addette ai processi logistici e produttivi.

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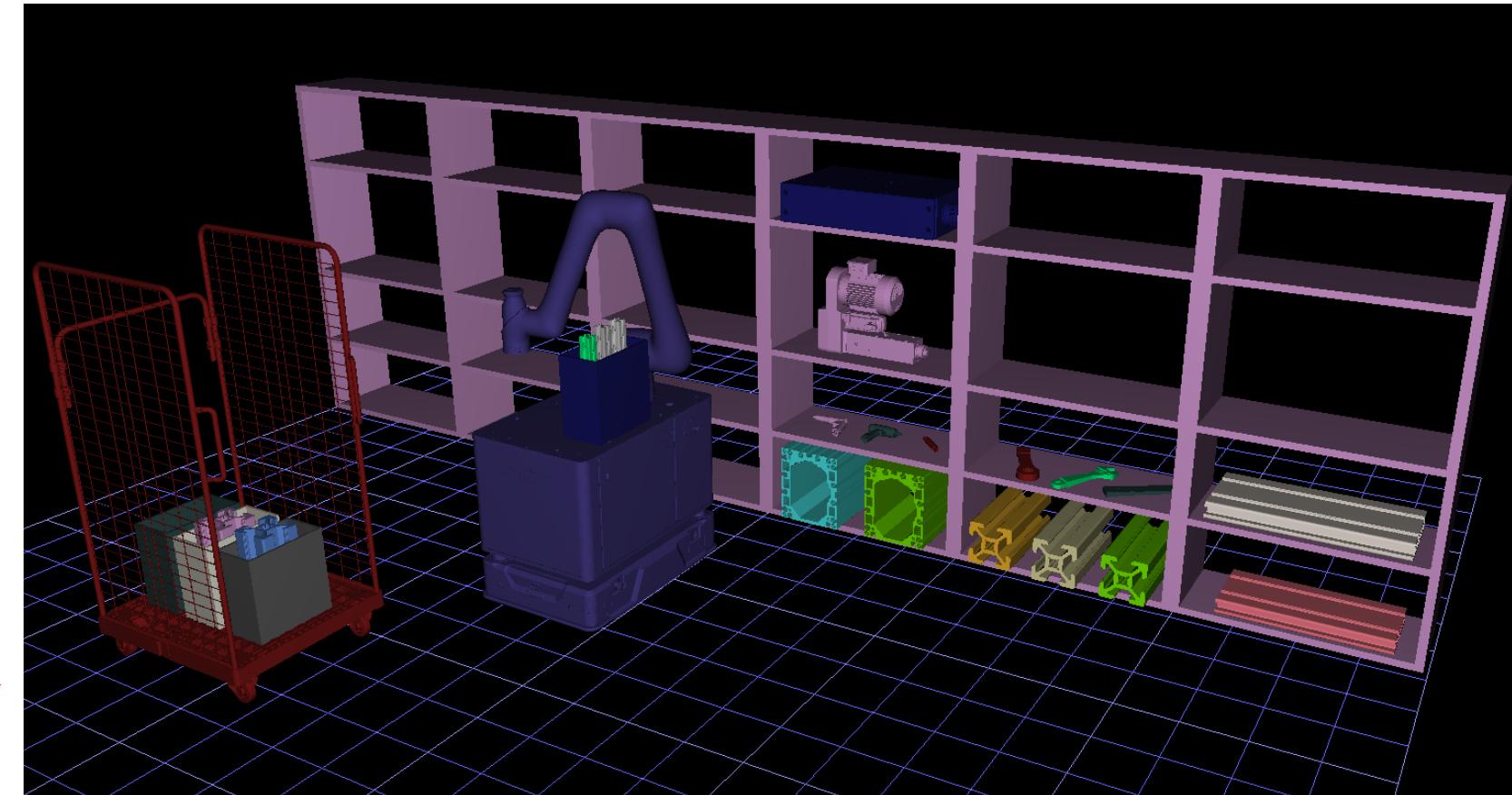
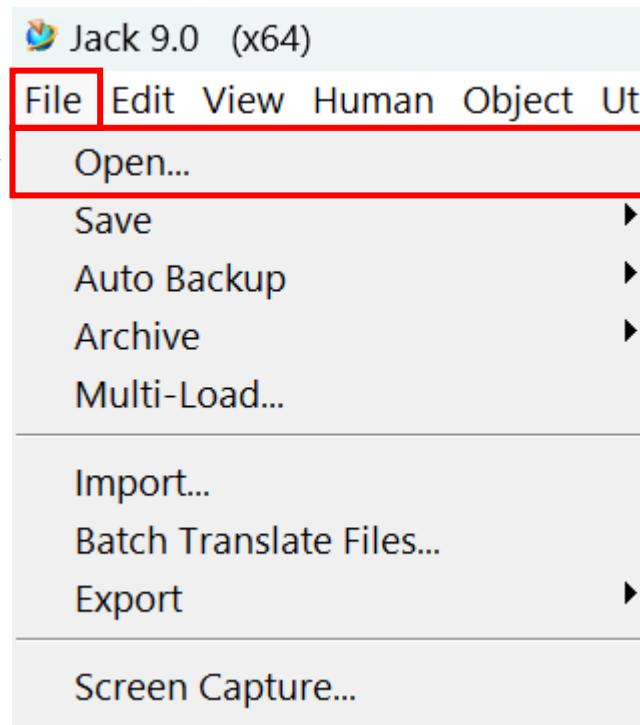
ESERCITAZIONE: GESTIONE LOGISTICA OFFICINA AERONATICA



SCENARIO: IMPORT CAD



SCENARIO: OPEN .env



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MODELLO UMANO DIGITALE

Human Object Utilities Analysis Modules

Create ▾

- Default Male
- Default Female
- Human from Library...
- Custom...**

D
D1
D2

Eye View...
View Cones...

Build Human...

Type

Female
 Male
 Child

Height

Custom Ht: 163.0
 99
 95
 Percentile 50
 05
 01

Weight

Custom Wt: 63.0
 99
 95
 Percentile 50
 05
 01

Database

ANSUR

System Units

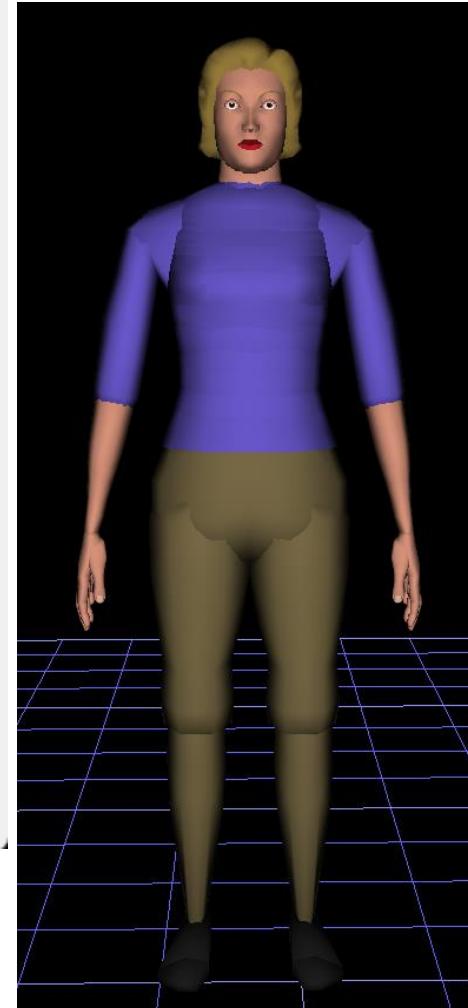
Weight: kg
Height: cm

Save as...

Name
Add to Menu **Create New**

Scale Existing...

Human
Scale Existing Anchor: Heel
Advanced Scaling Body Part Scaling Dismiss



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MODELLO UMANO DIGITALE PERSONALIZZATO

Build Human...

Type	Height
<input checked="" type="radio"/> Female	<input type="radio"/> Custom Ht: 163.0
<input type="radio"/> Male	<input type="radio"/> 99
<input type="radio"/> Child	<input type="radio"/> 95
	<input checked="" type="radio"/> Percentile <input checked="" type="radio"/> 50
	<input type="radio"/> 05
	<input type="radio"/> 01

Database: ANSUR →

System Units: Weight: kg Height: cm

Save as...

Name	Scale Existing
Add to Menu	Create New

Advanced Scaling **Body Part Scaling**

Build Human...

Direct Copy

Human: [Human icon]

Body Part: head →

	Internal Value	Desired Value	Current Value	Use
Length:	*	1.0	/ 1.0	<input checked="" type="checkbox"/>
Breadth:	*	1.0	/ 1.0	<input checked="" type="checkbox"/>
Height:	*	1.0	/ 1.0	<input checked="" type="checkbox"/>

Apply Values

Basic Scaling **Advanced Scaling** Dismiss

Build Human...

Stature: Hand Length: [input fields]

bdominal Dep Head Breadth: [input fields]

Ankle Hgt: Head Height: [input fields]

Cromion Height Head Length: [input fields]

Arm Length: Hip Breadth: [input fields]

Biacromial Br. Interpupil Dist: [input fields]

Bideltoid Br. Shoulder-Elbow: [input fields]

Buttock-Knee Sitting Acromial: [input fields]

Elbow Rest Hgt: Sitting Eye: [input fields]

Foot Breadth: Sitting Fingertip Hgt: [input fields]

Foot Length Thigh Clearance: [input fields]

Hand Breadth Thumbtip Reach: [input fields]

Gender: Female Male Units: cm ↓

Save as... Edit Existing...

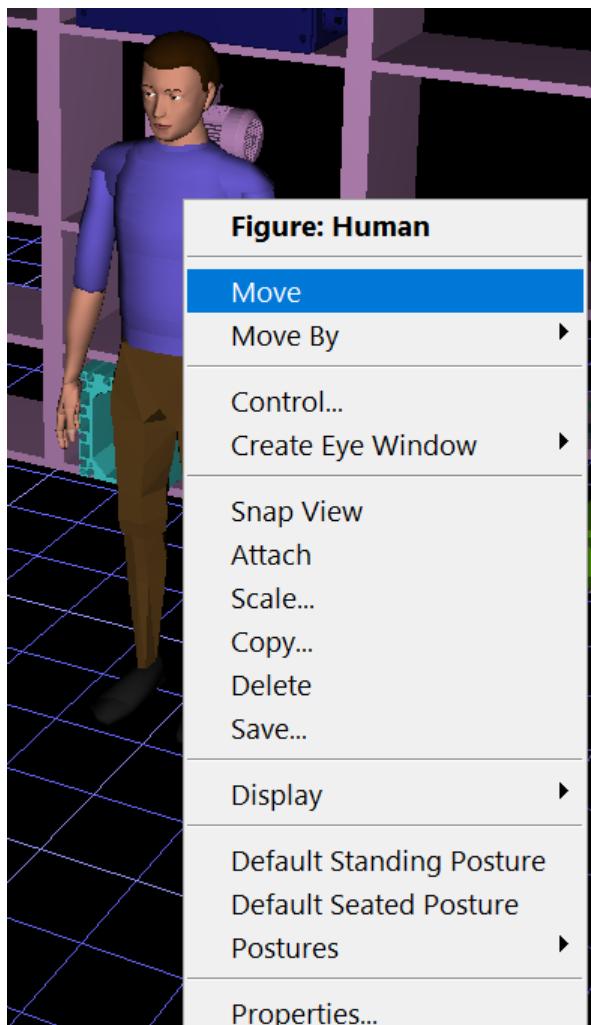
Name	Human
Add to Menu	Create New

Basic Scaling Body Part Scaling Usage Clear Dismiss

26 misure antropometriche



COMANDI DI POSIZIONAMENTO

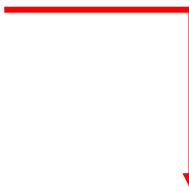


SCENARIO:

- CTRL + tasto destro mouse -> zoom
- CTRL + tasto sinistro mouse -> rotazione

OGGETTI:

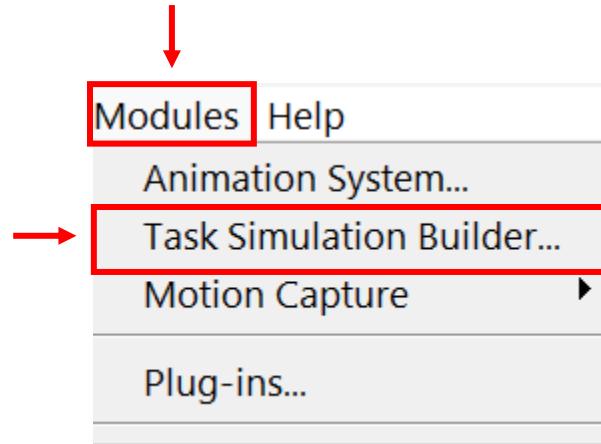
- tasto destro/sinistro mouse -> coordinate x,y,z
- shift + tasto destro/sinistro mouse -> rotazioni x,y,z



Human	<input type="button" value=""/>	cm:	-44.82	78.91	-12.82	Move By:	Root	Snap:	Cursor Point
<input type="button" value="Move"/>	<input checked="" type="radio"/> global <input type="radio"/> local	deg:	-90.0	0.0	0		<input type="button" value=""/>		<input type="button" value=""/>



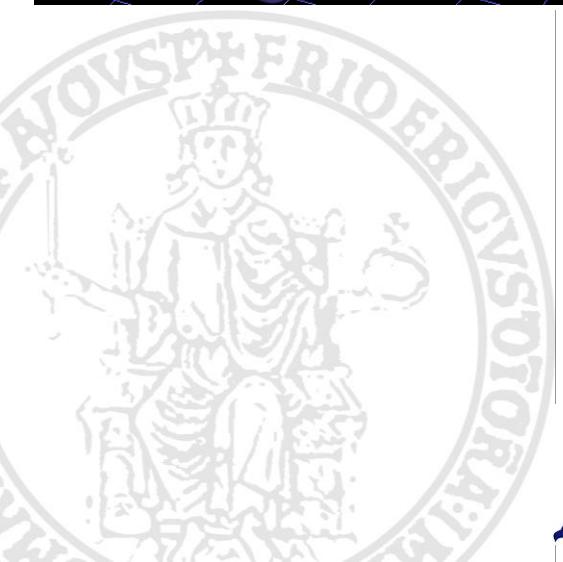
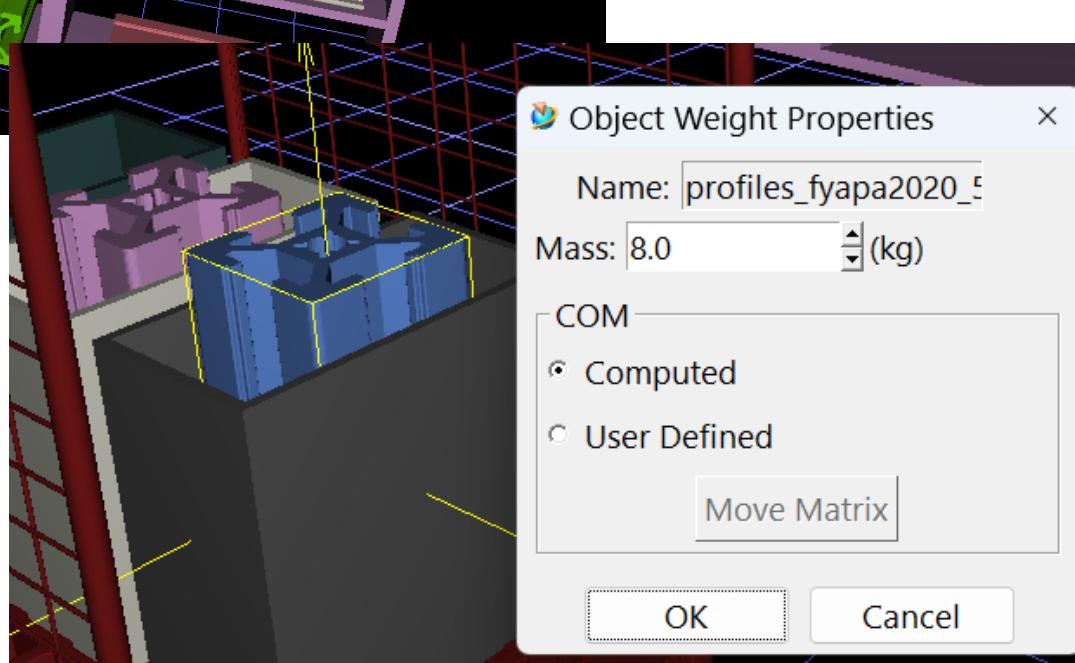
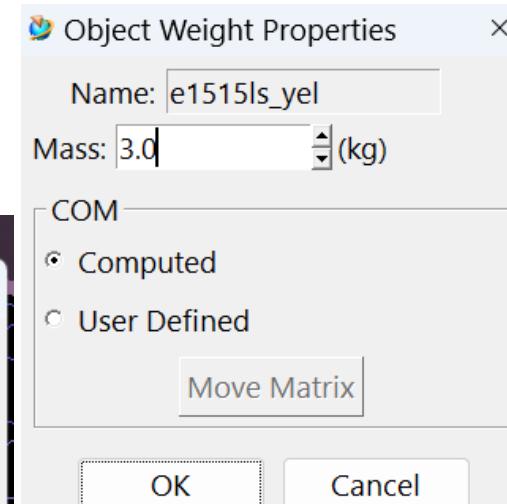
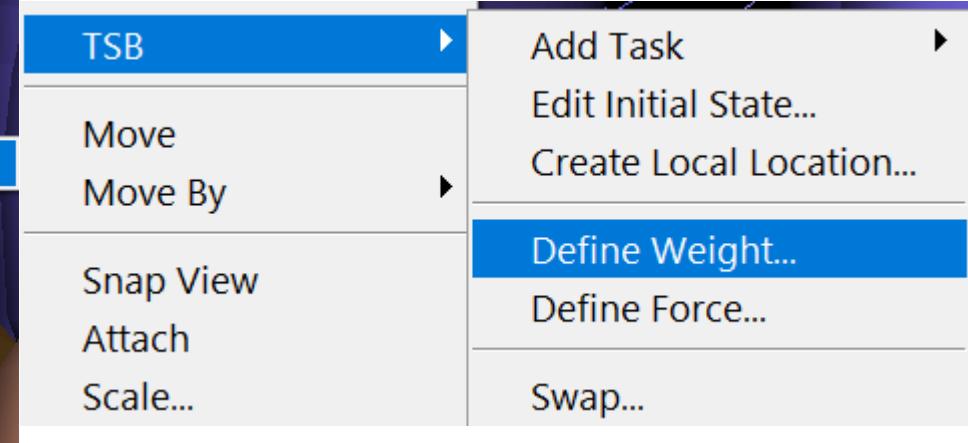
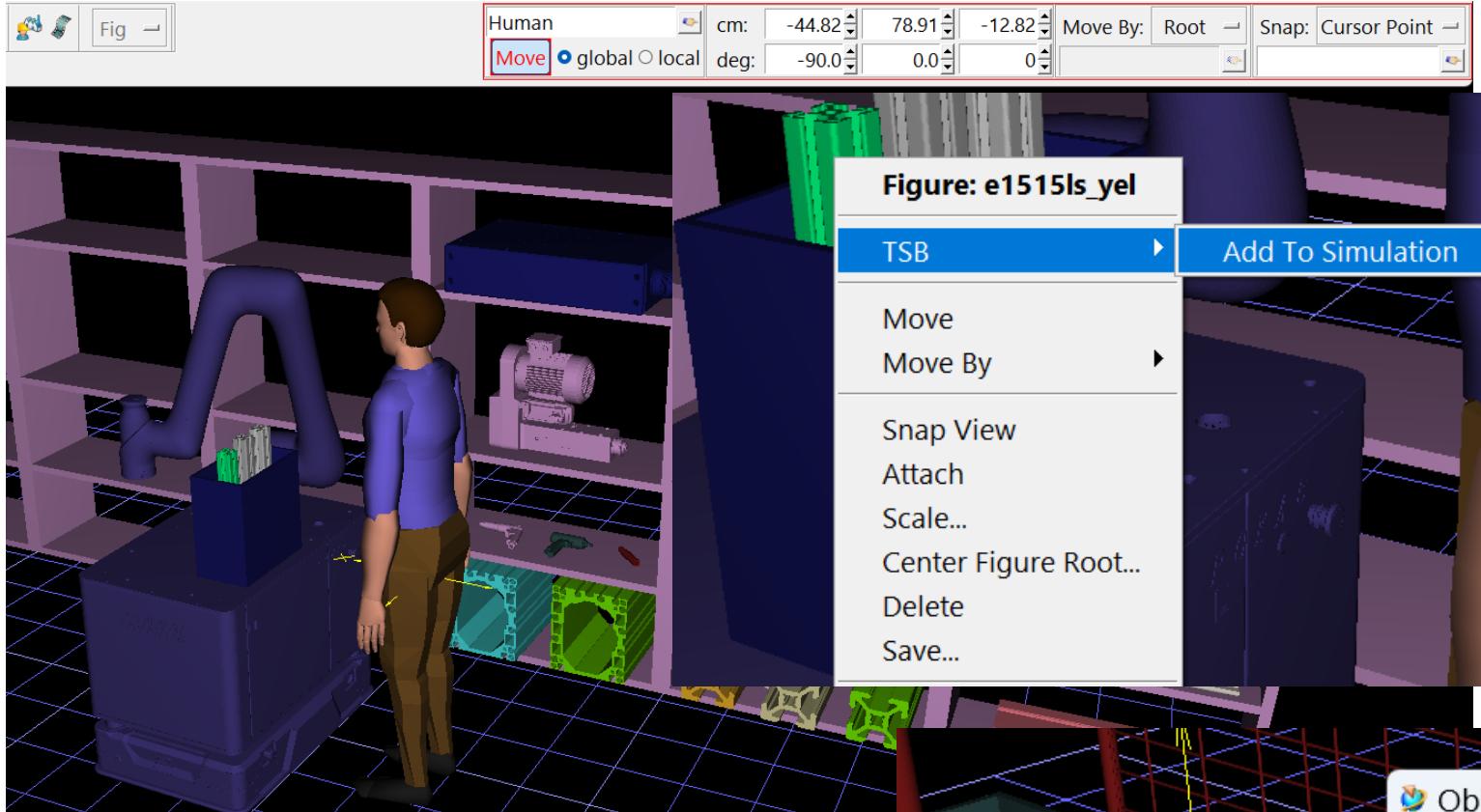
TASK SIMULATION BUILDER



- Attraverso comandi di alto livello, questo tool, permette di istruire il modello digitale umano all'interno dell'ambiente di lavoro virtuale.
- Una volta che una particolare sequenza di attività è stata definita per il modello umano, è possibile testare gli scenari cambiando le dimensioni delle figure umane, spostando gli oggetti nell'ambiente o cambiando il peso di un oggetto. Le posture umane e i movimenti sono automaticamente ricomposti per riflettere la scena aggiornata.
- La simulazione fornisce parametri ergonomici e stime dei tempi.
- Sono implementati specifici metodi per la previsione della postura del modello umano, tra cui la capacità di prevedere la postura basata sul carico di forza applicato alla mano.



1. SIMULAZIONE



DIPARTIMENTO DI
INGEGNERIA
INDUSTRIALE

2. SIMULAZIONE

Human | Object

Go

Get

Put

Position

Pose

Regrasp

Get_e1515ls_yel

Who: Human

What: e1515ls_yel

Hand(s): Right

<<Back Next>>

Options

DIPARTIMENTO DI INGEGNERIA INDUSTRIALE

Edit

Change Final Posture & Grasp

Add Via Point

Clear Via Point

Human Control Panel

Human: Human

Predefined Postures

Full Body Hands

Standing

Side: Right

full_hand_grasp

hose_insertion_twist_0.5in_dia

lateral_key_grip

maximum_grip

Manipulate

Grasp Segment

Grasp Figure

Precision Grasp Segment

Precision Grasp Figure

Adjust Grasp

Follow Object

Mirror The Left Arm

Adjust Wrist Joint

Adjust Finger Joints

Cancel

Right

right

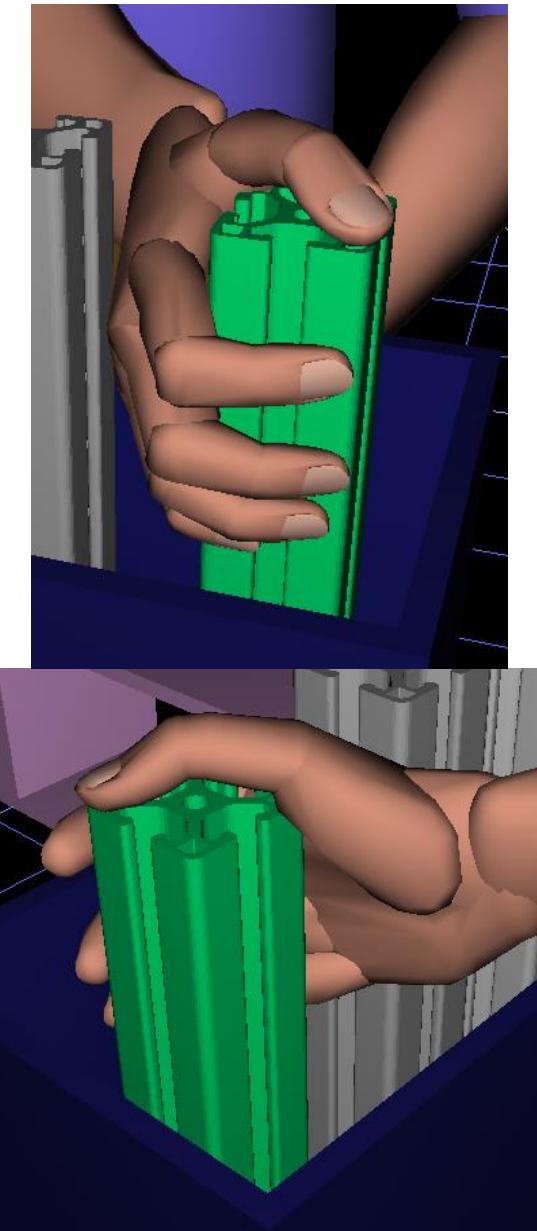
2

Posture

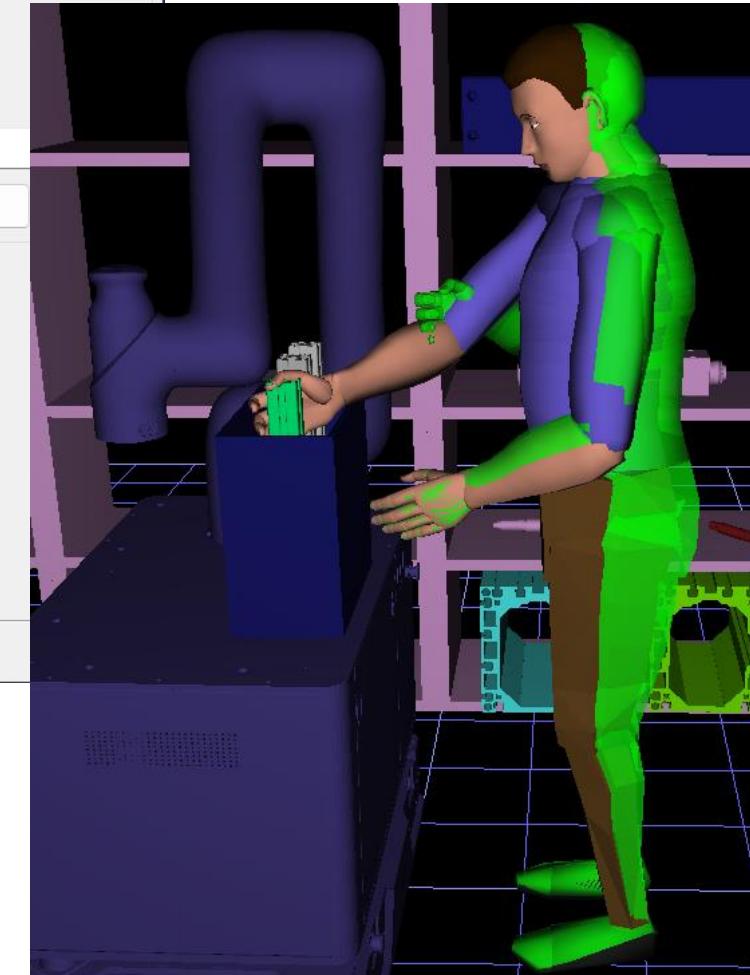
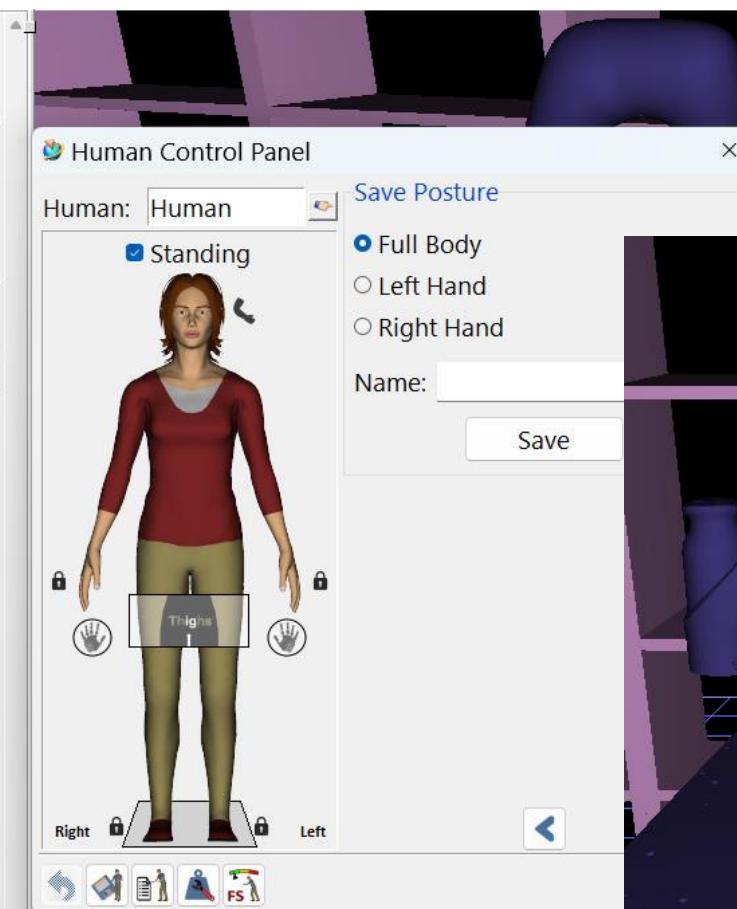
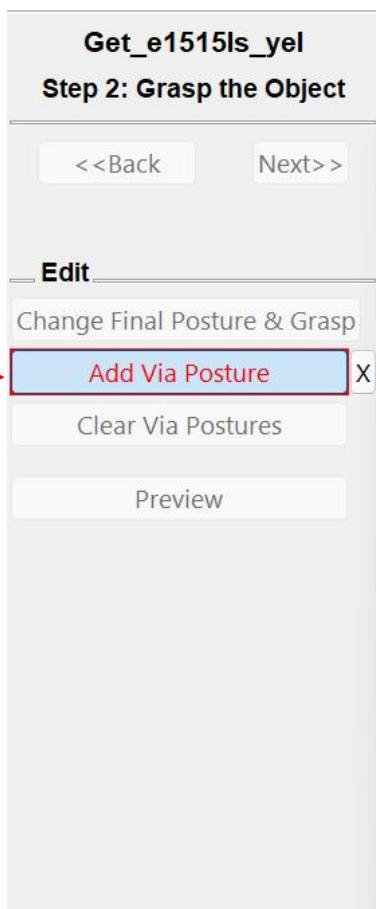
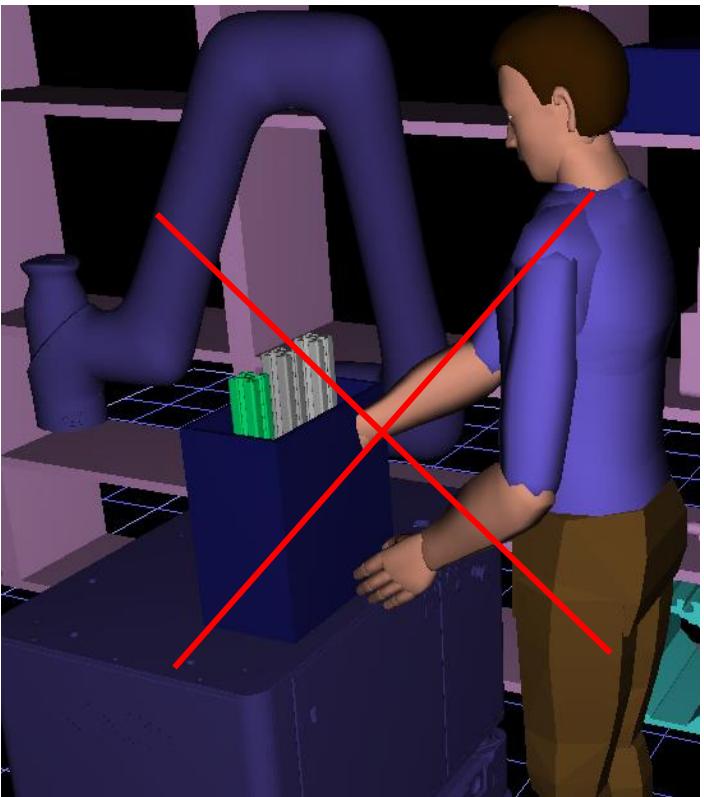
50

?

X



3. SIMULAZIONE



DIPARTIMENTO DI
INGEGNERIA
INDUSTRIALE

4. SIMULAZIONE

Human Object

Regrasp_e1515ls_yel

Who: Human
What: e1515ls_yel
Pose: Define Regrasp Post
Grasp Hand(s): Right

<<Back Next>>

Options

Regrasp

Human Object

Go Get Put Position Pose

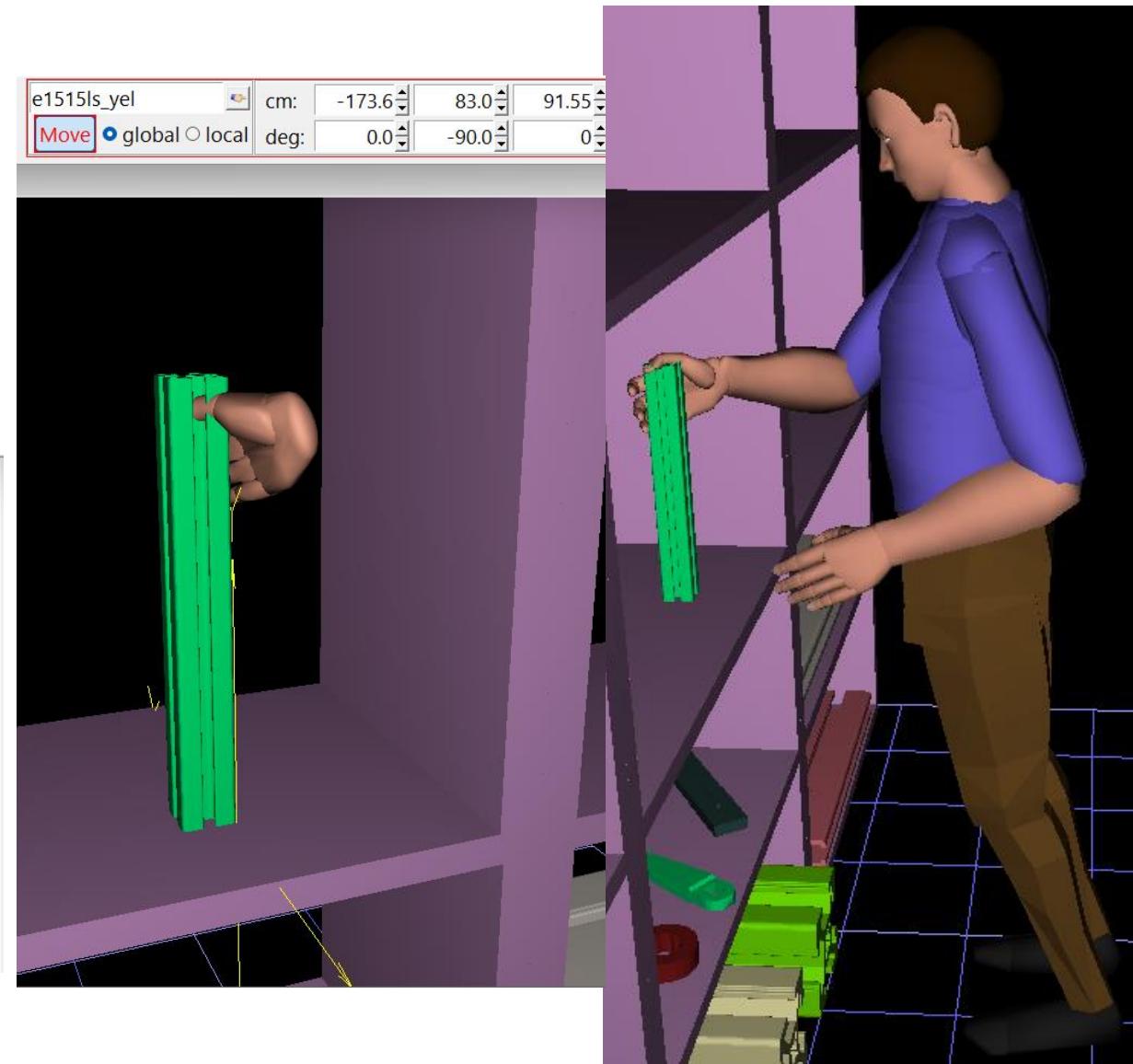
Put_e1515ls_yel

Who: Human
What: e1515ls_yel
Where: Place Object
Link To:

<<Back Next>>

Options

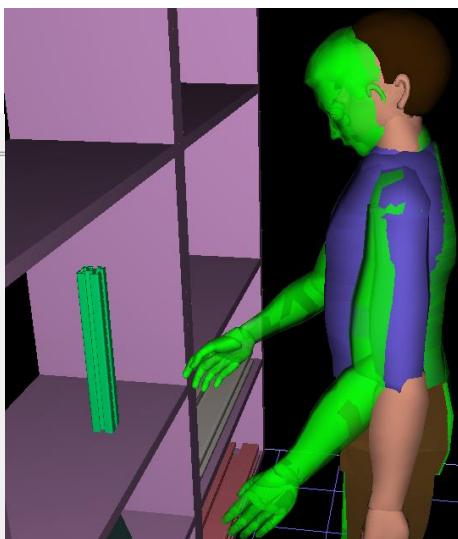
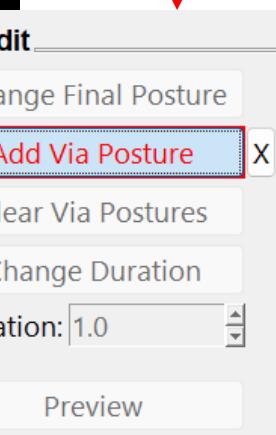
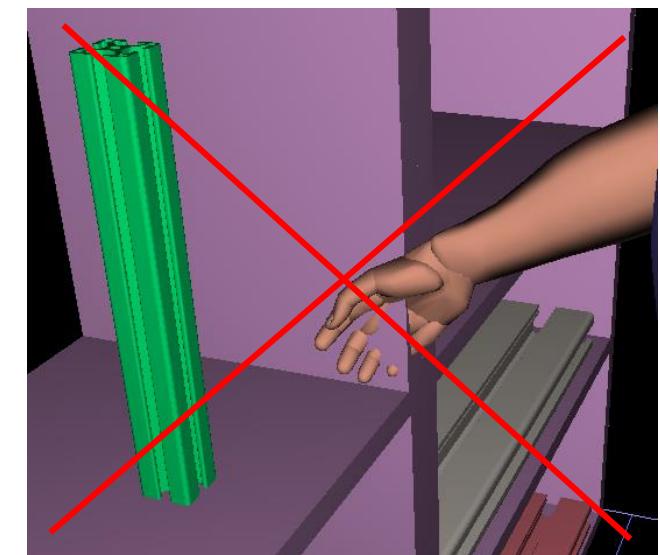
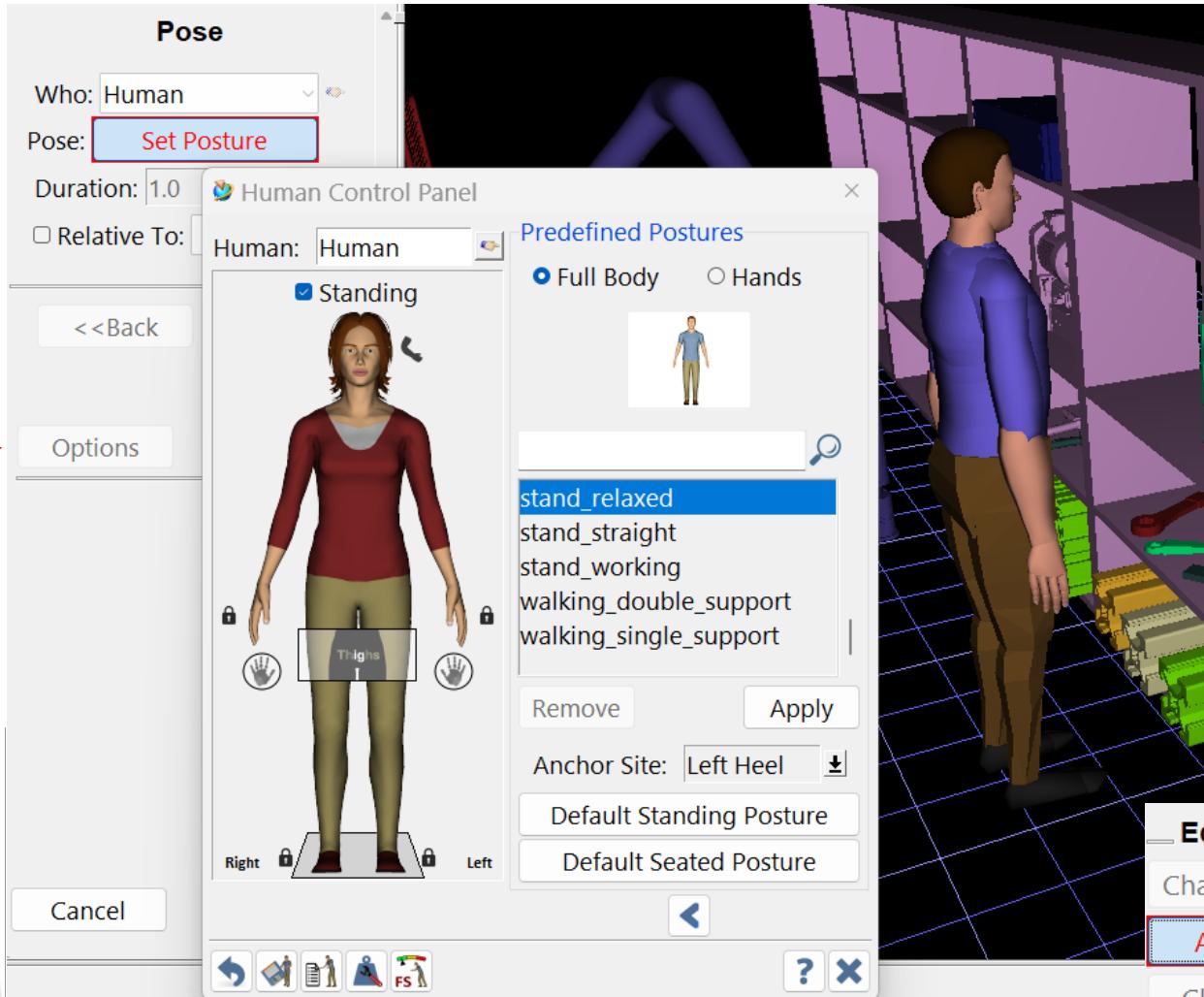
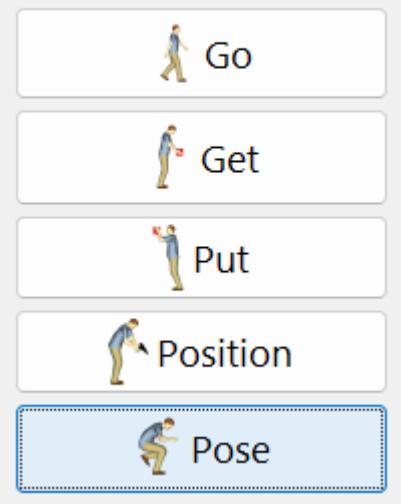
The interface shows a sequence of actions. It starts with a 'Regrasp' step, indicated by a red arrow pointing to the 'Regrasp' button. This is followed by a 'Put' step, indicated by a red bracket pointing to the 'Put' button. Finally, it moves to a 'Move' step, indicated by a red box around the 'Move' button in the 'Put' dialog.



DIPARTIMENTO DI
INGEGNERIA
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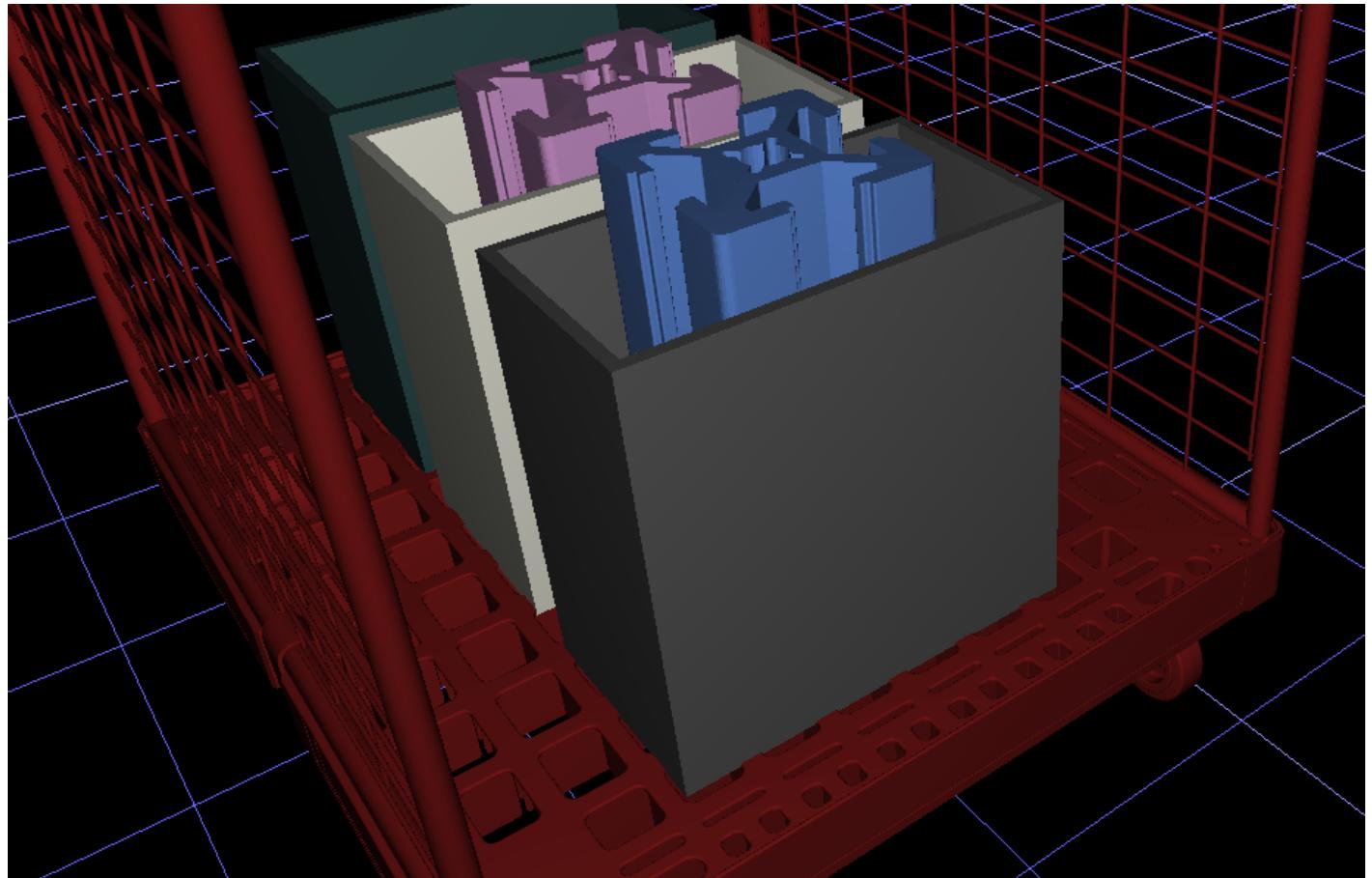
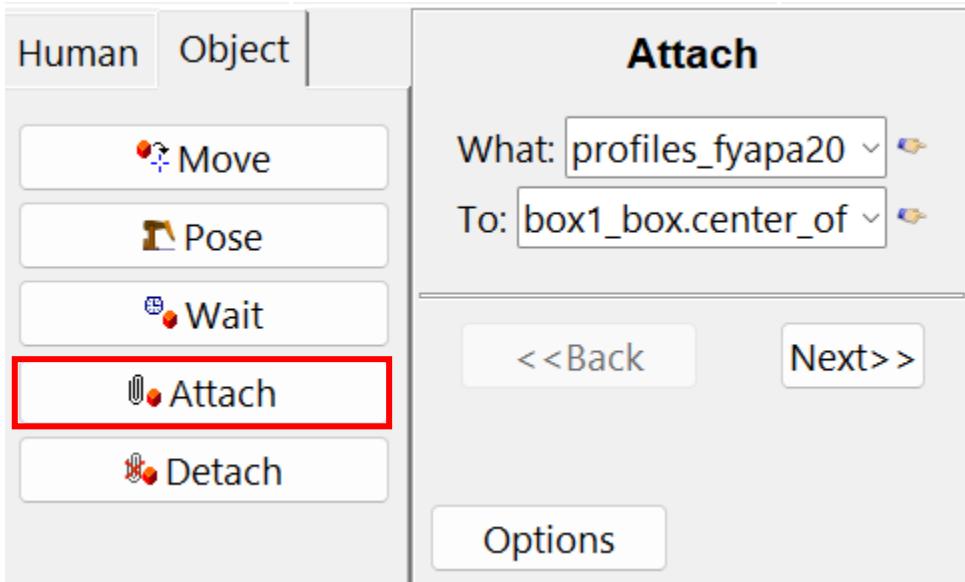
5. SIMULAZIONE

Human Object



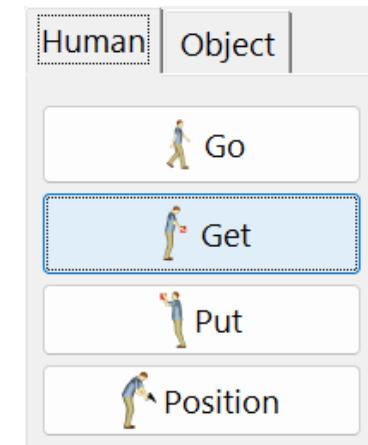
DIPARTIMENTO DI
INGEGNERIA
INDUSTRIALE

6. SIMULAZIONE



DIPARTIMENTO DI
INGEGNERIA
INDUSTRIALE

7. SIMULAZIONE

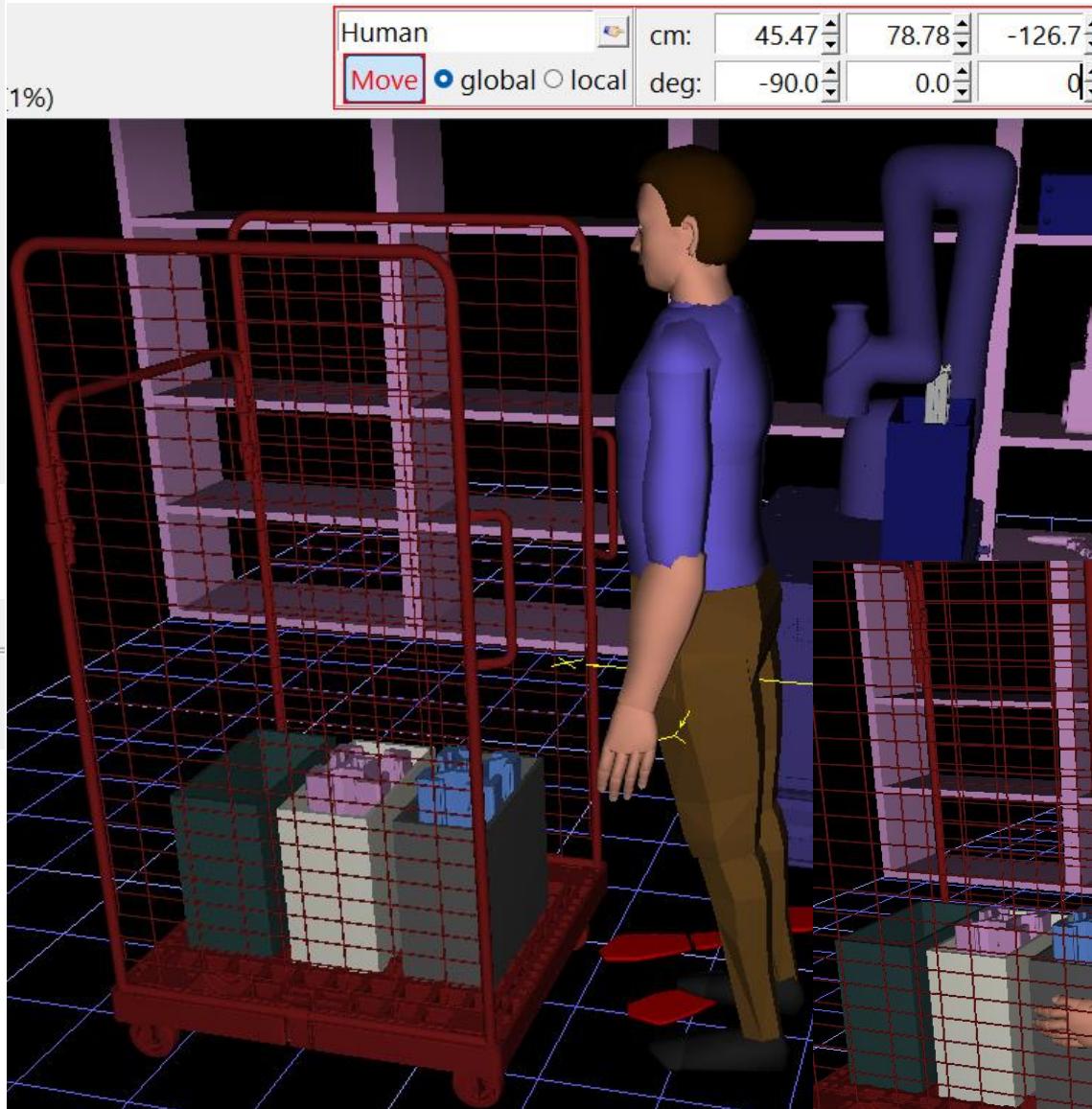


Edit:
Get_box1

Who: Human
What: box1
Hand(s): Both

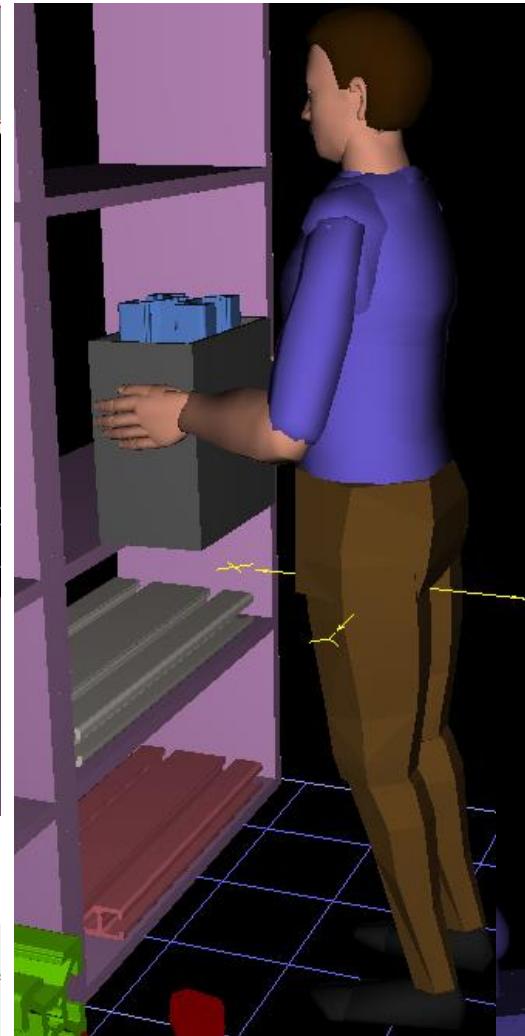
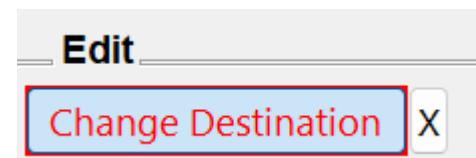
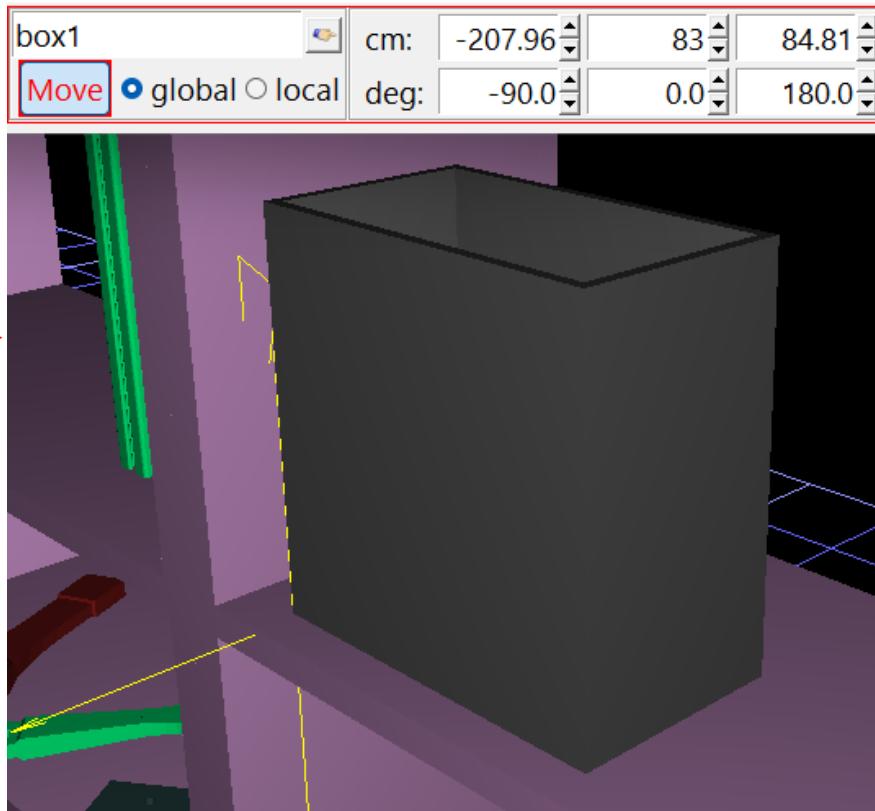
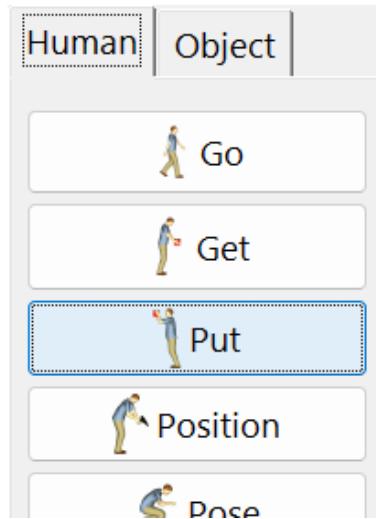
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Options



DIPARTIMENTO DI
INGEGNERIA
INDUSTRIALE

8. SIMULAZIONE



DIPARTIMENTO DI
INGEGNERIA
INDUSTRIALE

RISULTATI



Results

- Play Animation
- Generate Movie...
- Save Channelset...
- Export To Animation System
- Create Timing Report...
- Create Ergonomic Report...**
- Report Ergonomics Metrics...

Static strength prediction



DIPARTIMENTO DI
INGEGNERIA
INDUSTRIALE

TSB Ergonomic Report

Human: Human

Title: TSB Ergonomic Report

Report Header

Job Title:
Job Number:
Location:
Analyst:
Date:
Comments:

Include in report

SSP LBA Fatigue Cumulative Loading MEE

Include Joints

<input checked="" type="checkbox"/> Wrists	<input checked="" type="checkbox"/> Hips	<input checked="" type="checkbox"/> Angles
<input checked="" type="checkbox"/> Elbows	<input checked="" type="checkbox"/> Knees	<input checked="" type="checkbox"/> Torques
<input checked="" type="checkbox"/> Shoulders	<input checked="" type="checkbox"/> Ankles	<input checked="" type="checkbox"/> Mean Strength & Std Dev
<input checked="" type="checkbox"/> Torso		<input checked="" type="checkbox"/> % capable

Include Data

<input checked="" type="checkbox"/> Forces
<input checked="" type="checkbox"/> Moments
<input checked="" type="checkbox"/> Muscle Tensions

Lower back analysis

SSP **LBA** Fatigue Cumulative Loading MEE

Include Data

<input checked="" type="checkbox"/> Forces
<input checked="" type="checkbox"/> Moments
<input checked="" type="checkbox"/> Muscle Tensions

Metabolic energy expenditure

SSP LBA Fatigue Cumulative Loading **MEE**

Cycle Time (sec): 16.119

Use simulation duration

Task Frequency/Cycle: 1

Enter individually by task

Energy Expenditure Limit: 5.0 kcal/min

Calculate energy expenditure limit