CNH INDUSTRIAL

Ergonomics and HMI

Claudia Campanella

Modena, Italy

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Research and Innovation on components:
during Program Planning

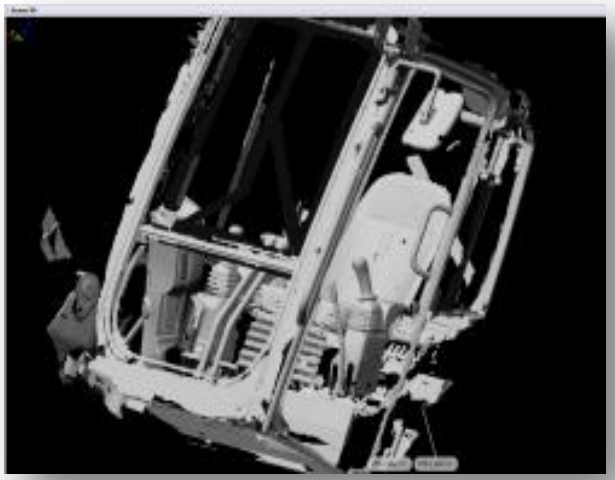
• **Real users observation** using the armrest on various missions/fields, to define in objective way what are primary-secondary controls, sequences-grouping of controls

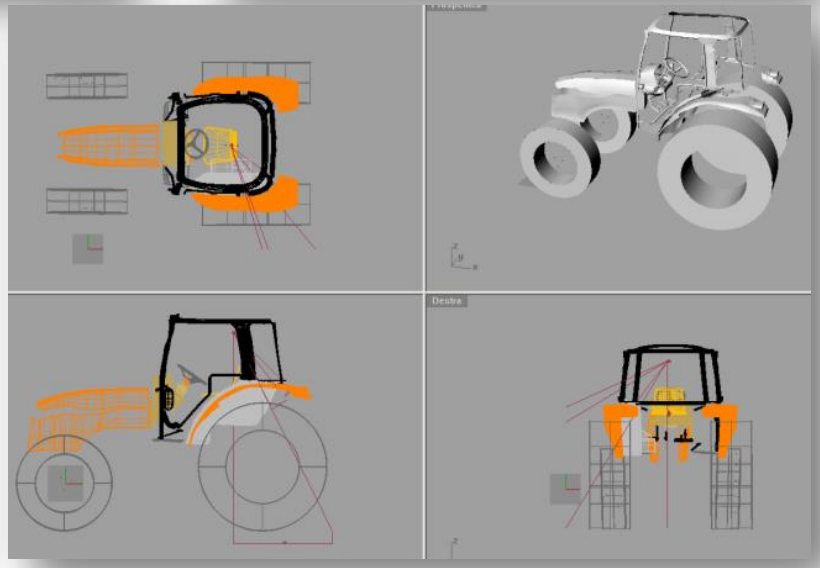
Mission	Scrapping	Ripping	Plowing	Listing	Disking	Mean	Std.	Grand Mean	Std.
Diff-Lock On	1	0	9	0	4	2.8	3.4	3.8	4.8
Upshift	13	0	11	4	8	7.2	4.7		
Downshift	5	0	12	1	2	4.0	4.3	Frequently	>9
Skip-shift	1	1	8	0	0	2.0	3.0	Moderately	≥3 & ≤9
Hand Throttle								Seldom	<3
Inching Pedal									
ETC Gear Select	19	1	18	5	9	10.4	7.1		
CRPM	0	0	0	1	0	0.2	0.4		
MFH Auto-guid									
MFH Rear EDC Lower	0	2	9	3	0	2.8	3.3		
MFH Rear EDC Raise	0	2	6	2	0	2.0	2.2		
MFH Direction Change Forward	2			0			2.3		
MFH Direction Change Reverse	1						3.0		
MFD On/off	1	0	0	0	0	0.2	0.4		
EHR1	71	0	11	0	16	19.6	26.4		
Hydraulic Link Retract	0	1	0	0	0	0.2	0.4		
Rear EDC Draft Control	0	1	2	0	0	0.6	0.8		
Rear EDC Position Control	0	0	1	0	0	0.2	0.4		
FSUS	0	0	3	0	0	0.6	1.2		

Example: just representative of real users

Benchmarking
during Program Planning

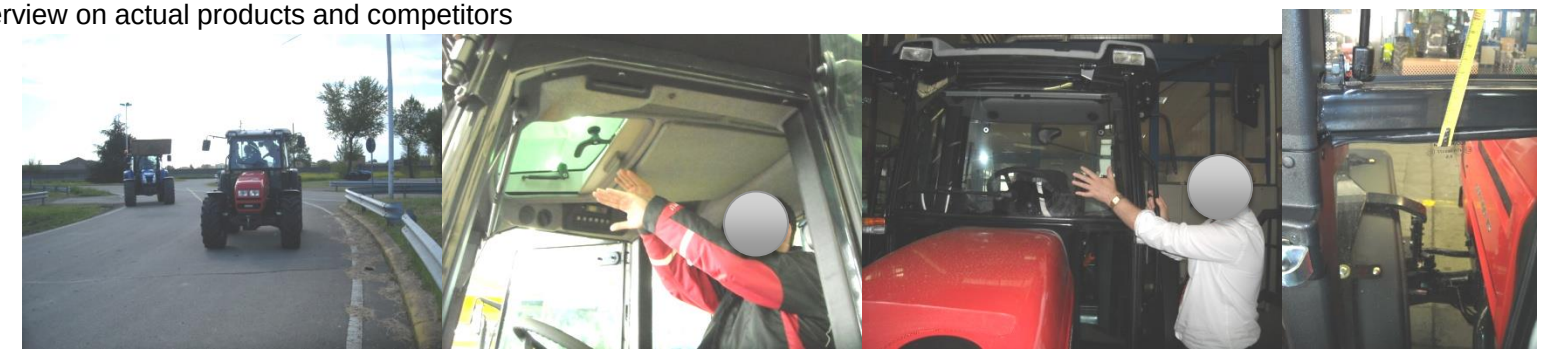
- **3d scan of competitors**, to have precise dimensions on interiors and ergonomic analysis on competitors





Benchmarking
during Program Planning

MARCH 2012 needs definition:
Users interview on actual products and competitors



NOVEMBER 2012 check on 1st mock-up:
Second users interview on UTL mock up and competitors

MARCH 2012 - SEPTEMBER 2014 continuous checks on virtual mock-up

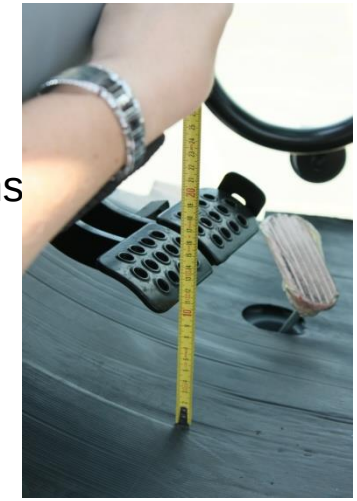
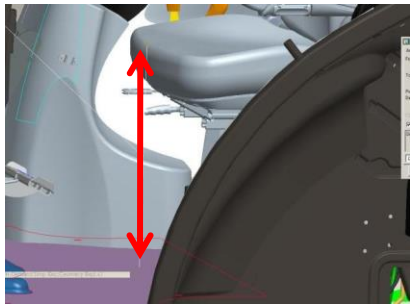
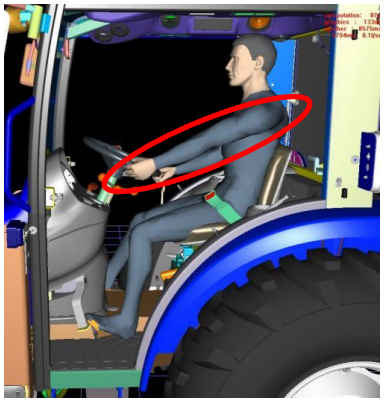
Benchmarking
during Program Planning

Measure main features:

- Easy ingress and egress



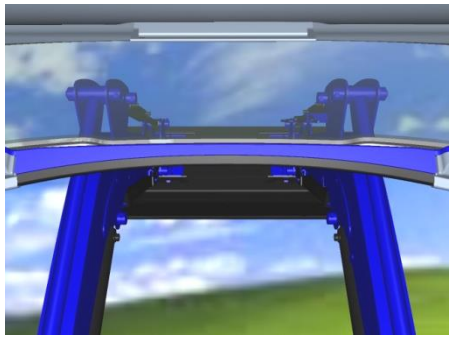
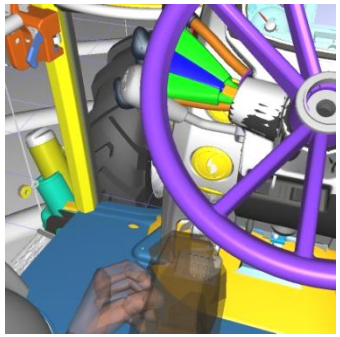
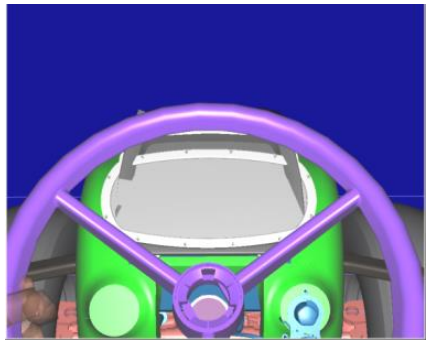
- Roominess for legs and arms

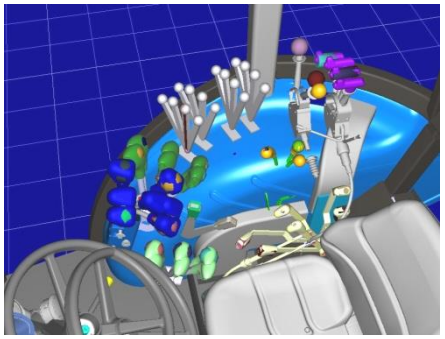
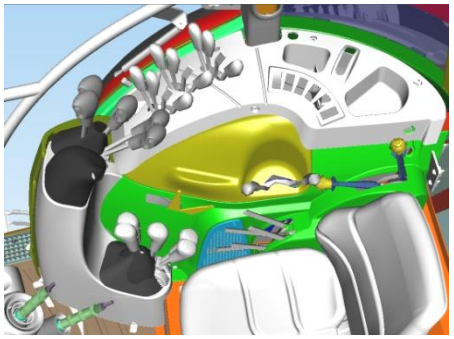
Benchmarking
during Program Planning

Measure main features:

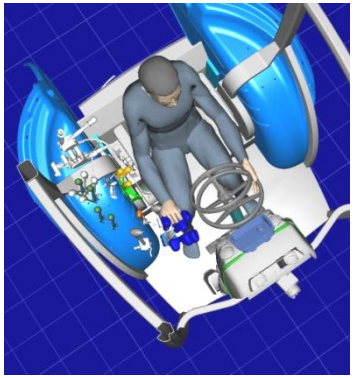
- Visibility

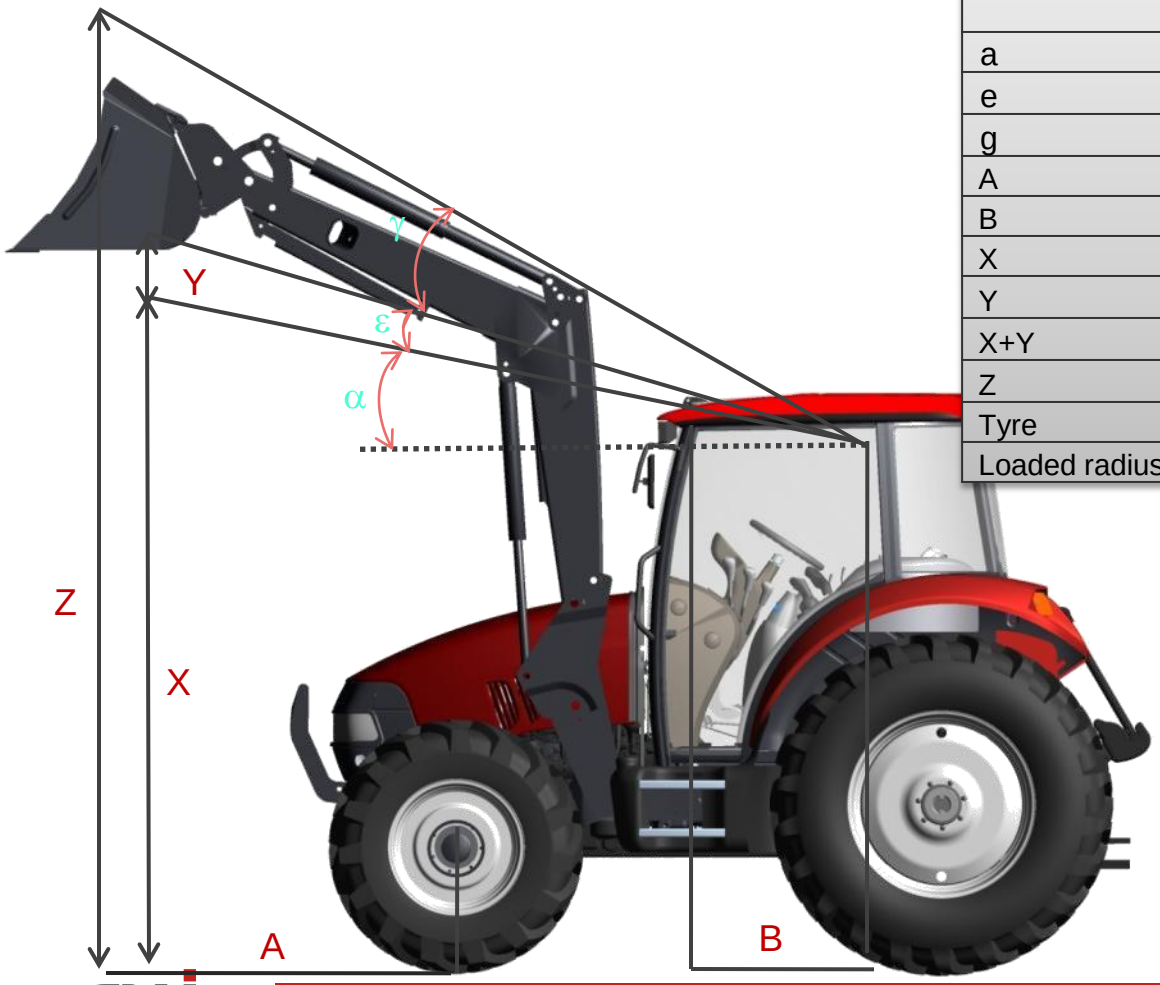
- Controls layout

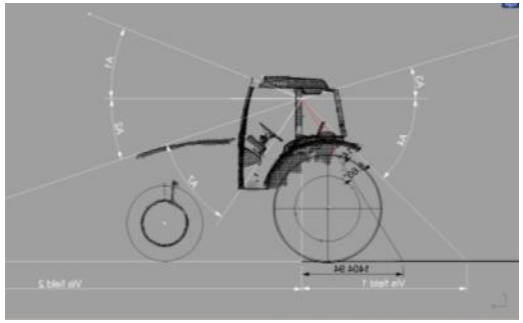

- Comfort


Benchmarking: visibility
during Program Planning

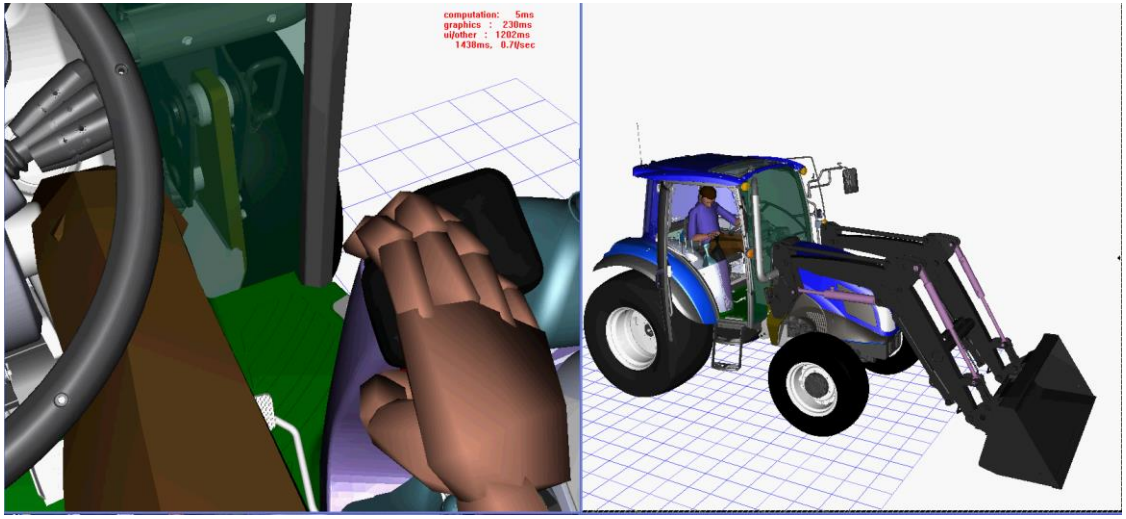


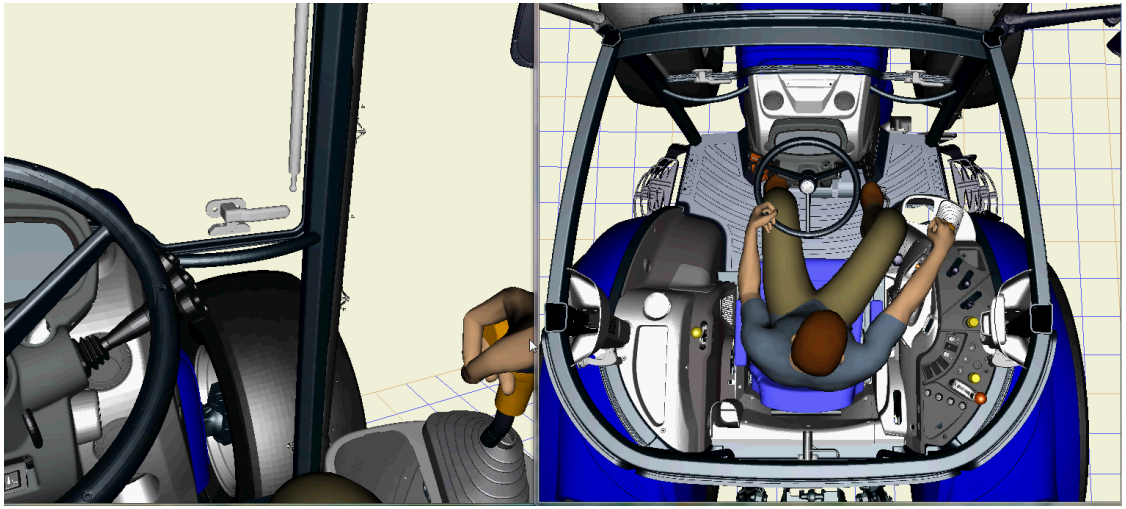
	KUBOTA	SAME	UTL	UTL
	9540	dorado 76	T4000	Light
a	16,3	12	16,2	18
e	_	10	_	3
g	_	18	_	24
A	2150	1950	1950	1950
B	624	_	_	750
X	3426	2290	3100	3345,0
Y	_	515	_	205,0
X+Y	_	2805	_	3550,0
Z	_	_	_	5300,0
Tyre	18,4 R30	420/70 R30	16,9 R30	16,9 R30
Loaded radius	695	635	665	665



Dynamic visibility of exterior implement

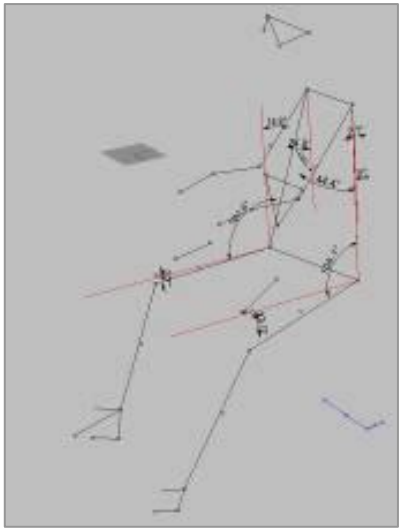
during Develop Concept and Prove Feasibility

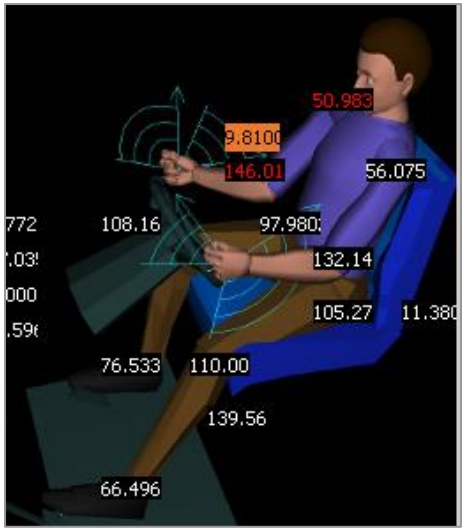




ABITA for Tractors
during Program Planning

Analysis in Proprietary Software to find comfortable location of : pedals, seat, floor, steering and armrest.





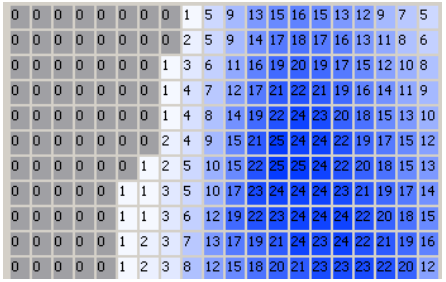
Pedals comfort

Single Seat Map

Y-Axis

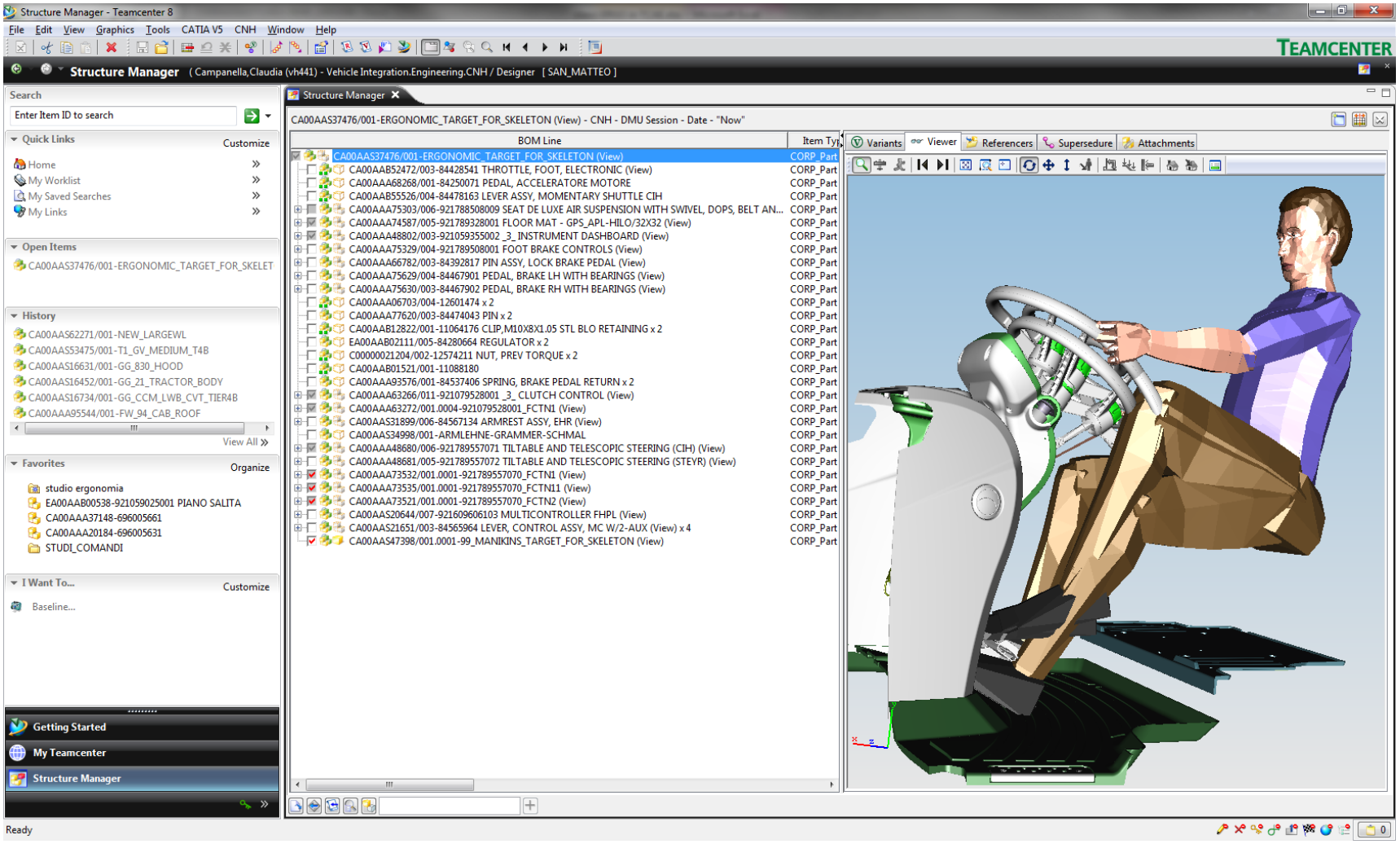
X-Axis

Global Seat Map



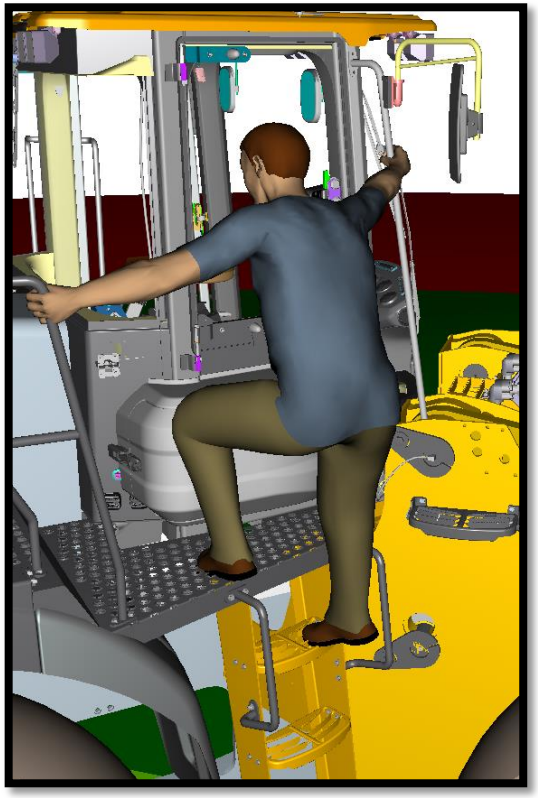
X-Axis

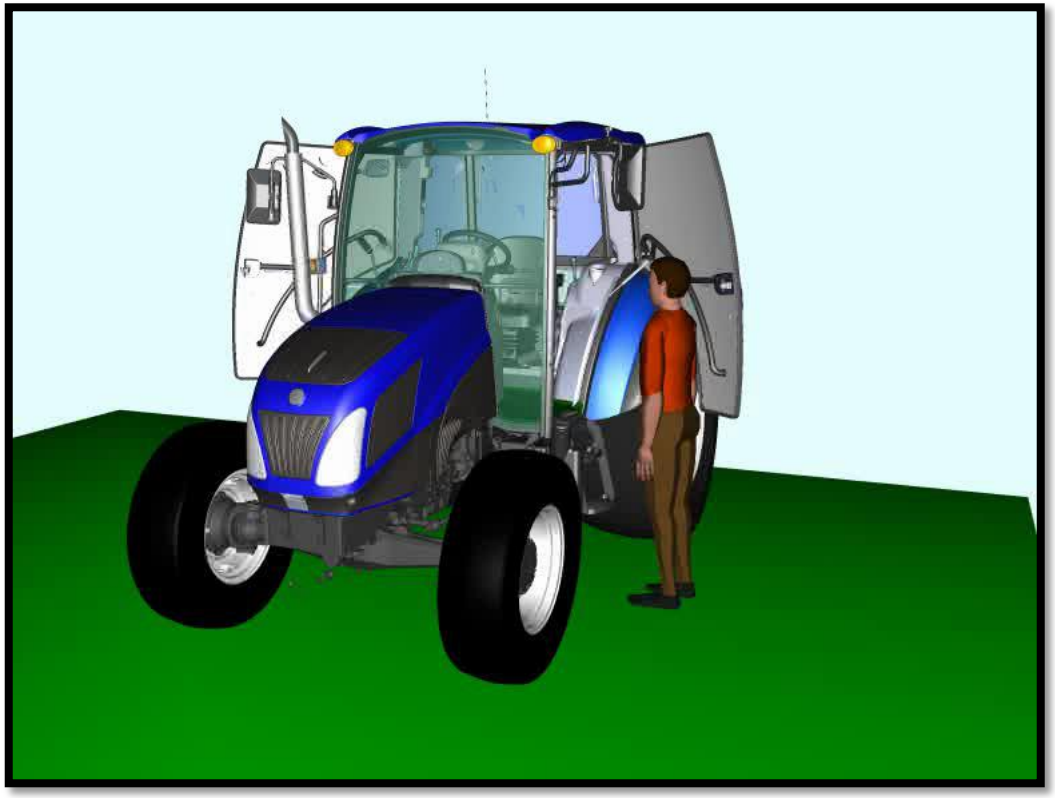
Release Jack manikins for ergonomic postures
during Program Planning, Concept Development



Jack simulation: analysis ingress-egress

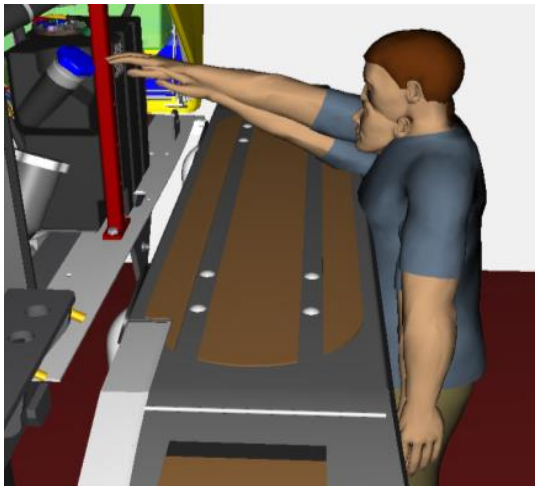
during Concept Development and Feasibility Proof

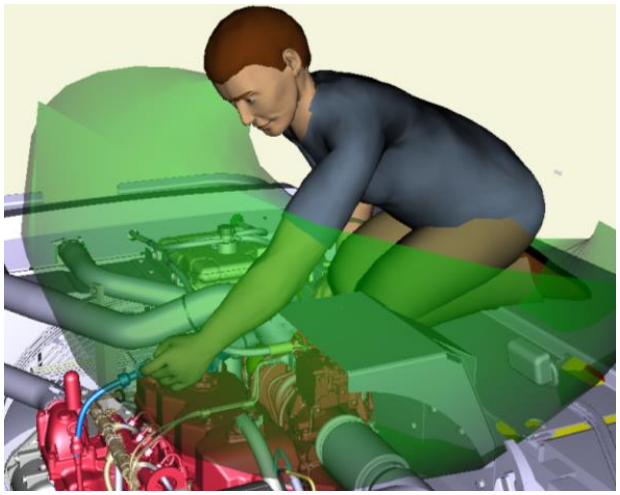
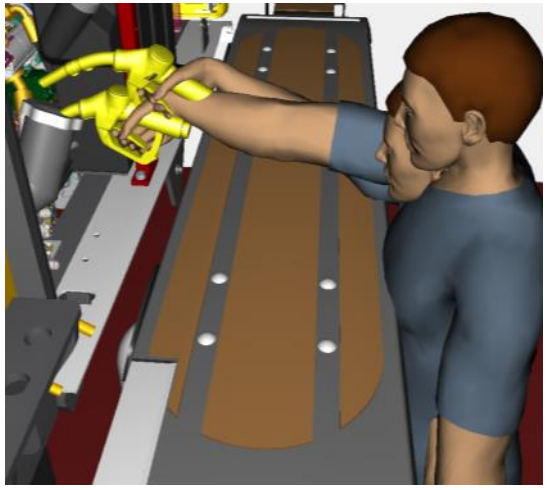


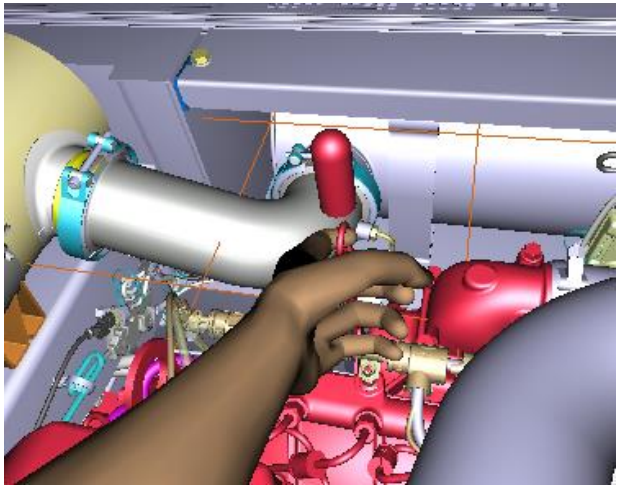


Jack: Easy reach tanks for serviceability

during Concept Development and Feasibility Proof

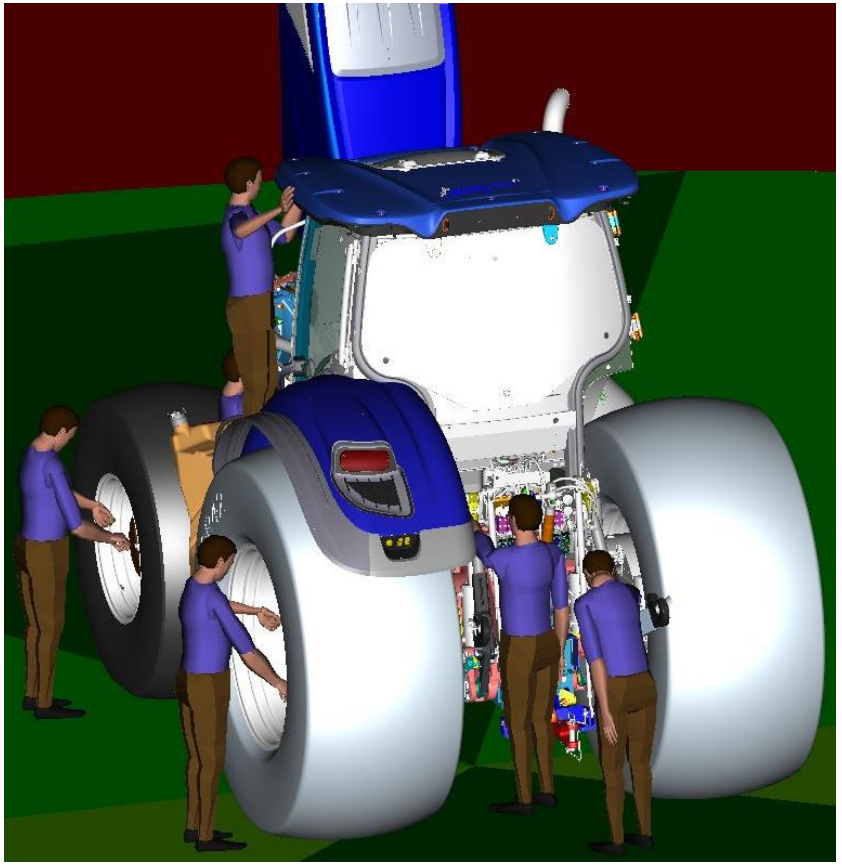




Jack simulation: Serviceability

during Concept Development and Feasibility Proof



CCM HD Service Index - SAE J817

Items	Service	Location	Accessibility	Operation	Miscellaneous	Subtotal 1	Quantity Multiplier	Sub-total	Interval	Frequency Multiplier	Total	% of Grand Total	Remark	DONE	TO DO	REPORT
Engine air cleaner inner element	Change	2	4	3	0	9	1	9	1200 or two years	1	9	0%	not count ladder	1	0	
Engine breather filter	Change	2	50	7	0	59	1	59	1200 or two years	1	59	0%	to be verified	0	1	
Tappet clearance	Check	15	50	10	0	75	12	900	1200 or two years	1	900	4%	Present on HD	0	0	
Change engine coolant fluid.	Drain	2	15	3	2	22	1	22	1199 or two years	1	22	0%	as today	1	0	
Change engine coolant fluid.	Fill	1	4	1	0	6	1	6	1200 or two years	1	6	0%	as today	1	0	
Change Air brake drier reservoir	Change	25	1	1	100	127	1	127	1200 or two years	1	127	1%	better than LWB	1	0	
A/C system	Change	2	10	15	100	127	1	127	three years	1	127	1%	verify tools needed	1	0	
nce																
Cleaning the tractor.	Clean	1	1	10	0	12	1	12	When necessary	2	24	0%	as today	0		
Fuel system Pre-filter and water trap check.	Check	1	10	5	0	16	1	16	When necessary	2	32	0%	new lateral cover	1	0	
Check brake pedal latching unlatching.	Check	15	1	2	0	18	1	18	When necessary	2	36	0%	as today	1	0	
Adjust cab suspension.	Adjust	1	1	2	0	4	2	8	When necessary	2	16	0%	not count ladder	1	0	
Adjust automatic pick up hitch.	Adjust	1	1	2	0	4	2	8	When necessary	2	16	0%	to be verified	1	0	
Headlight and worklamp adjustment	Adjust	50	4	2	40	96	1	96	When necessary	2	192	1%	need ladder	1	0	
Bulb replacement	Replace	50	15	2	40	107	1	107	When necessary	2	214	1%	need ladder	1	0	
Fuses and relays replacement	Replace	10	15	2	0	27	1	27	When necessary	2	54	0%	not count ladder	1	0	
Battery removal and installation	Replace	2	15	7	40	64	1	64	When necessary	2	128	1%	as today	1	0	
														58	2	

Grand Total:

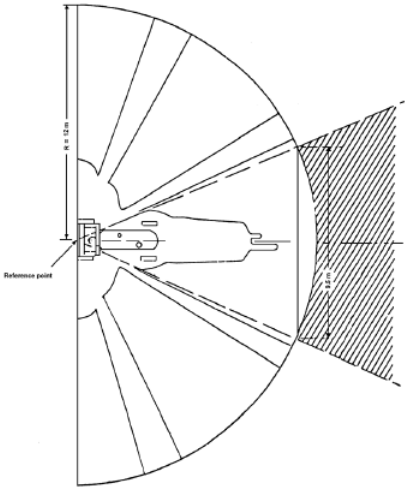
All items listed in Op.Manual 21.771

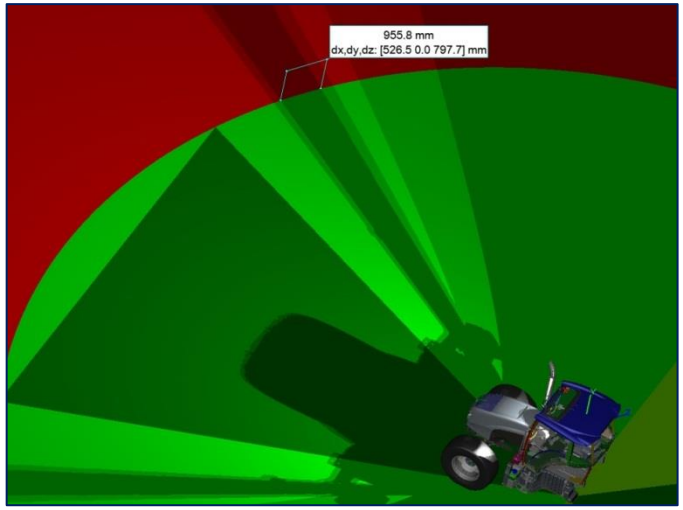
Subtotal 3.639

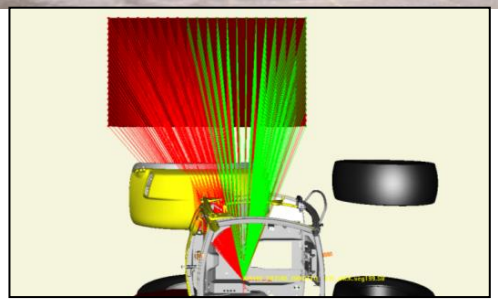
Quantitative Visibility- Homologation

during Concept Development and Feasibility Proof

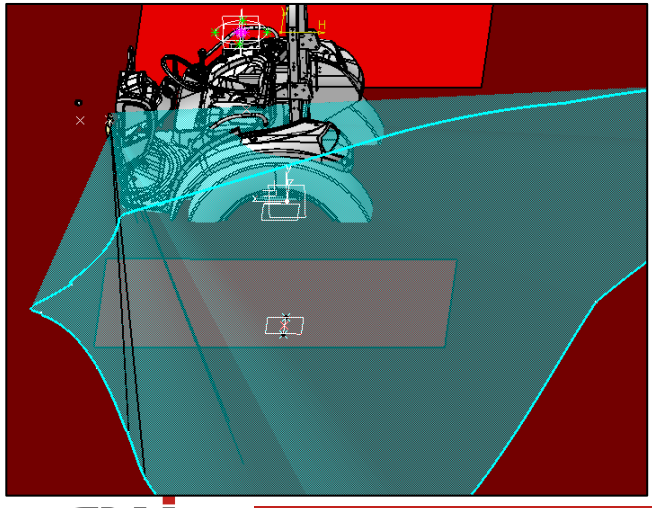
Direct Visibility Homologation

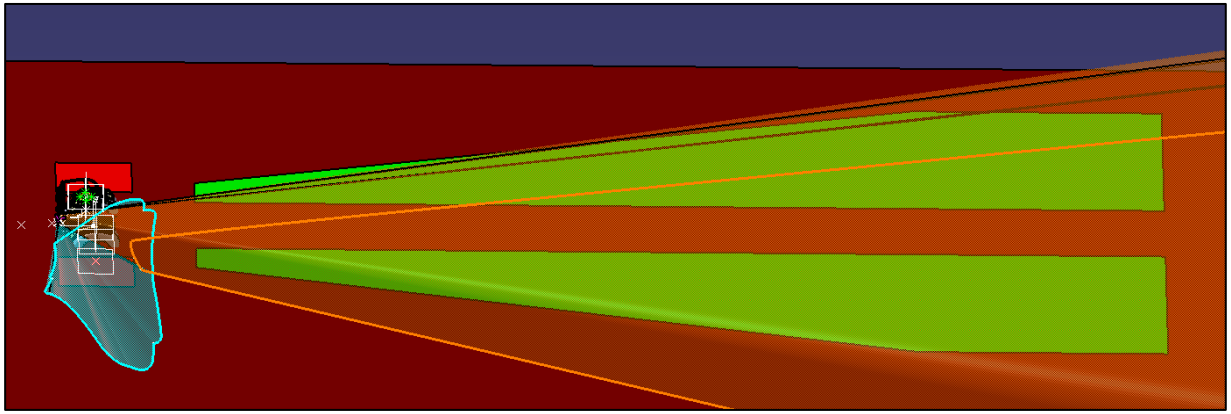






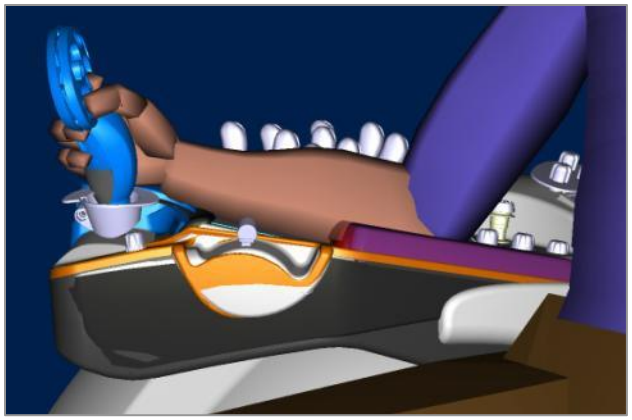
Indirect (Mirrors) Visibility Homologation

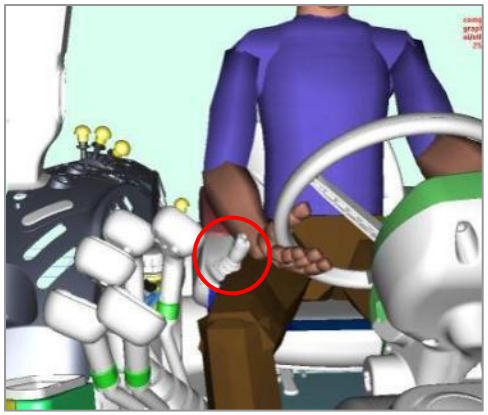


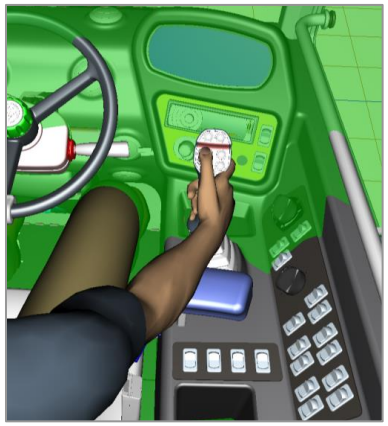


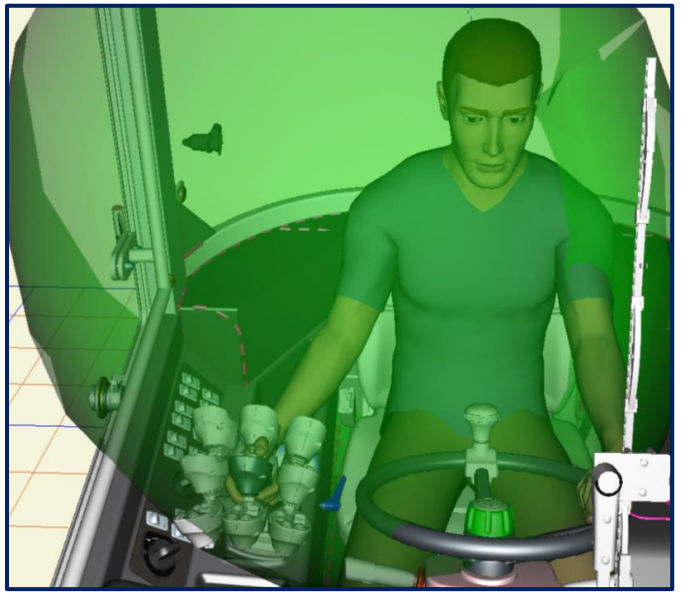
Jack simulation: interaction with all controls

during Concept Development and Feasibility Proof



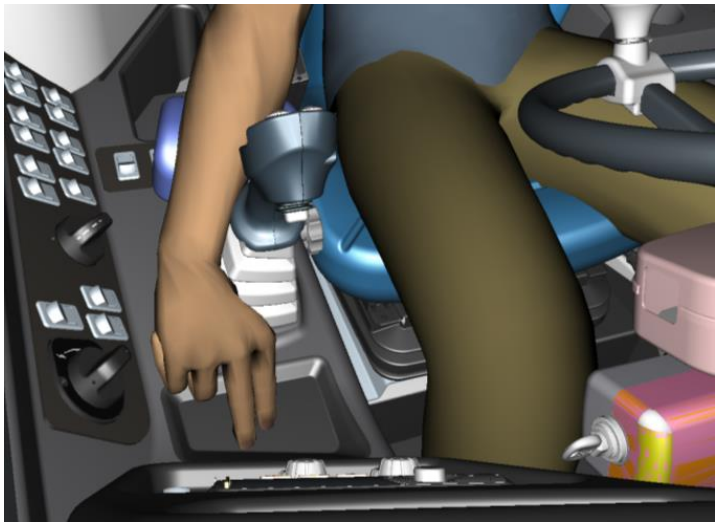


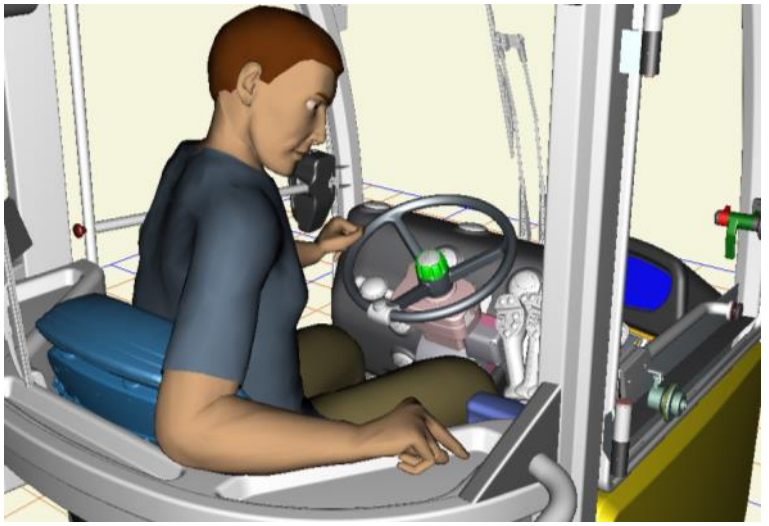


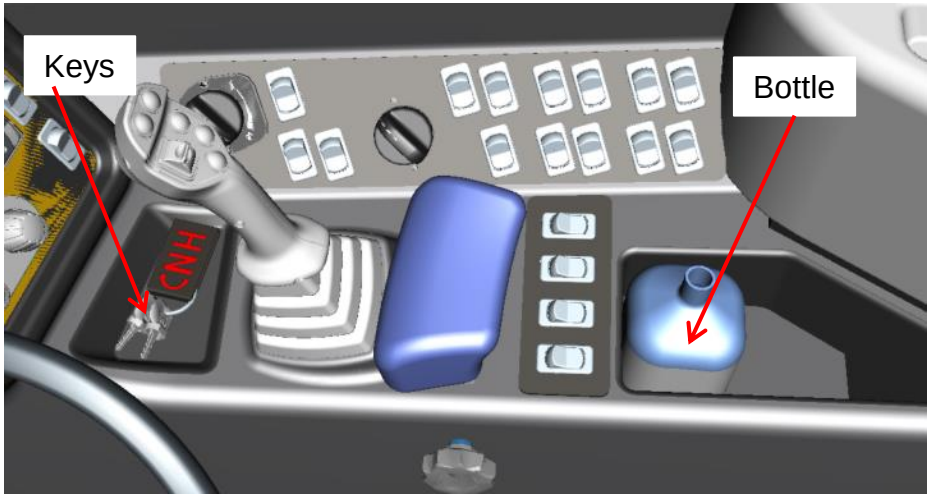


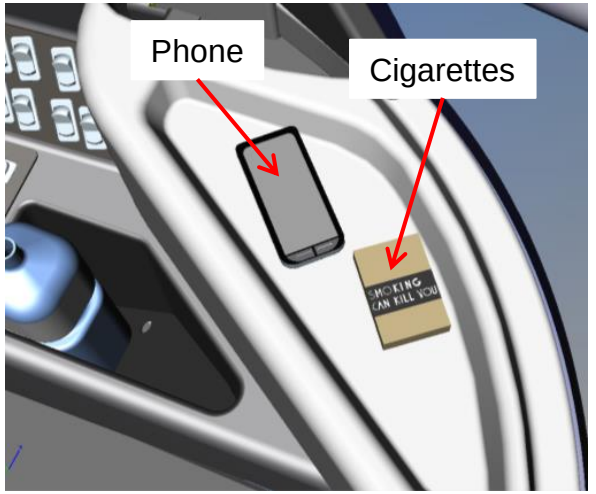
Jack simulation: interaction with storage

during Concept Development and Feasibility Proof









FUTURE DEVELOPMENTS

- Virtual homologation
- Force feedback analysis
- Immersive ergonomic evaluation
- Work load cognitive analysis

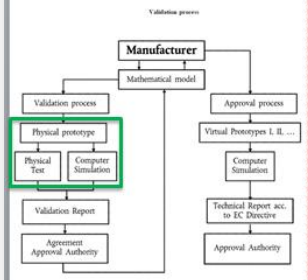
Future development
Virtual Homologation of Visibility as ISO 5721-1

ISO 5721-1 VISIBILITY

INNOVATION, DESIGN ANALYSIS and VALIDATION METHODS

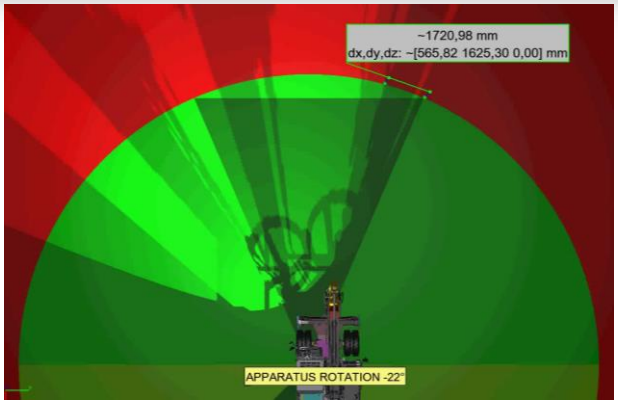
360° FIELD OF VIEW – SECOND EXAMPLE ON WHEX

- **The mathematical model shall be validated in comparison with the actual test conditions**. To that effect a physical test shall be conducted for the purposes of comparing the results obtained when using the mathematical model with the results of a physical test. Comparability of the test results shall be proven.



Physical Test

- Machine and virtual model with same configuration (tools, pipes, …)
- More precise tool was built for light bar support
- Tool bar fixed on floor, not on seat
- SIP position well checked before the test



ISO 5721-1 VISIBILITY

INNOVATION, DESIGN ANALYSIS and VALIDATION METHODS

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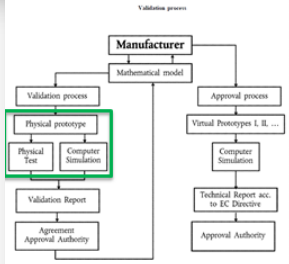
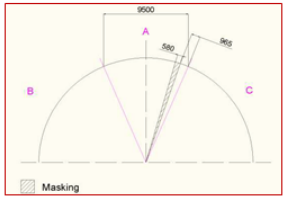
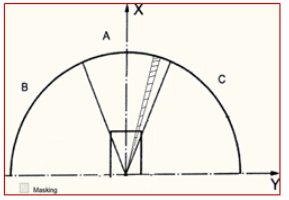


Physical Test



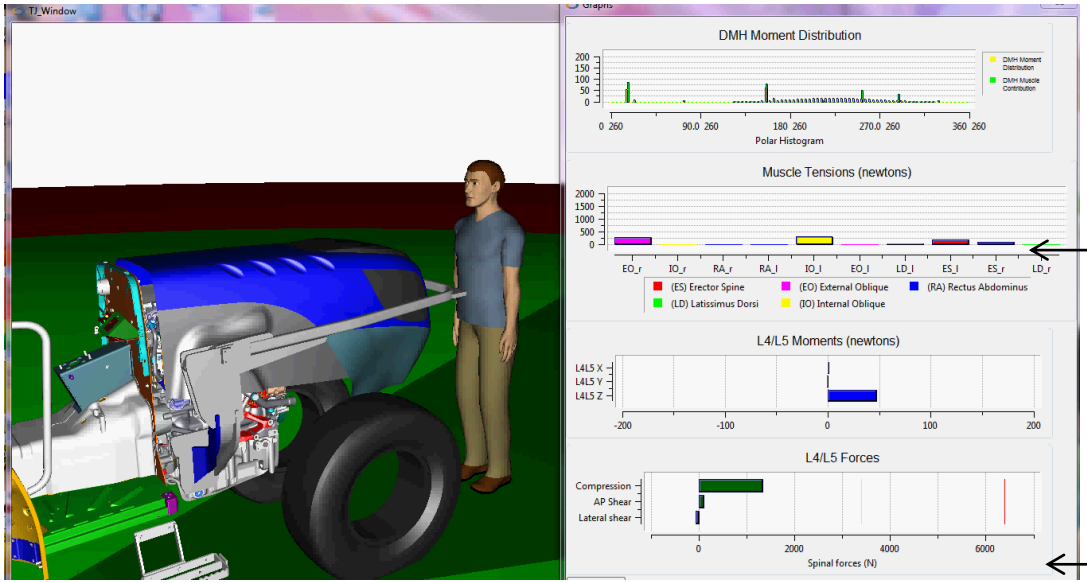
Virtual Simulation



This time virtual results has a good correlation vs the physical ones:
1. About 97% for the masking effect;
2. About 92% for the masking position on.

Future development

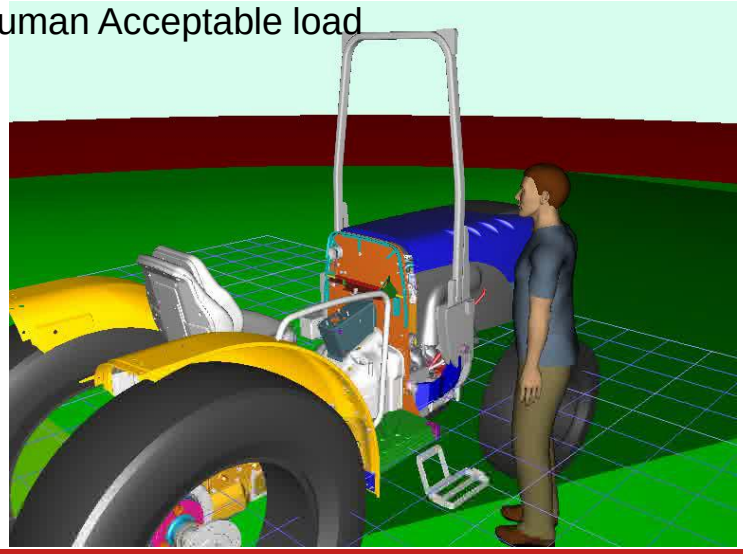
Force Analysis



Muscle Tension

L4L5 compression

Human Acceptable load



Human force computation on controls and openings

Future development

Immersive Ergonomic Evaluation

- ✓ Definition of a methodology for integrated product-process design according to the design specifications

- ✓ Development of an interactive virtual environment for the simulation of human-produced agricultural and human-trial for manual assembly.




Future development

Work Load Cognitive Analysis