الأكاديمية العربية للعلوم والتكنولوجيا والنقل البحري

Arab Academy for Science, Technology & Maritime Transport

9 Marlog 2020

The International Maritime Transport and Logistics Conference "Marlog 9"

Impacts of the Fourth Industrial Revolution on Port-City Integration

"World Port Sustainability Program Aspects"

BENEFITS AND OPPORTUNITIES OF SIMULATORS FOR PORT TRAINING

Fancello Gianfranco, Serra Patrizia, and Fadda Paolo

DICAAR – Department of Civil and Environmental Engineering and Architecture, University of Cagliari, Cagliari, Italy

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ACCIDENTS causes in Terminal Container

- *Human Factors*
- *Technical Factors*
- *Environmental Factors*

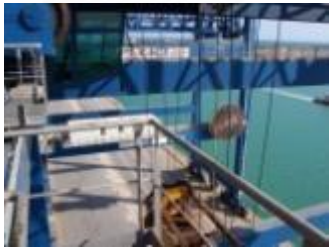
Human error reasons

- Human-Machine Interface not well defined
- Task management badly fittedt
- Staff training limited

Container terminal needs

Less accidents

High performance



High competitiveness

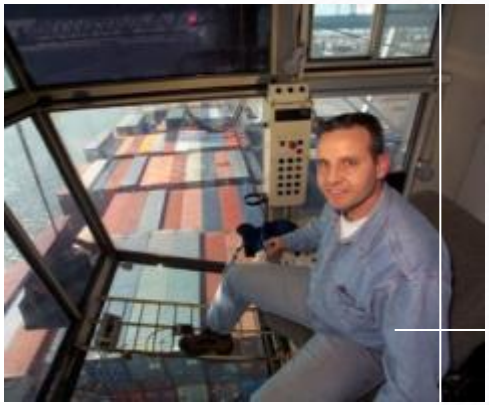
How can this be achieved?

Improving the quality level of human resources

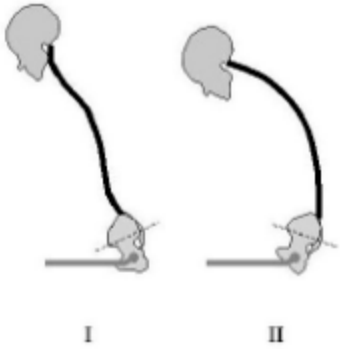
***"Human Factors"* approach**

Human factors in quay crane task operator

Task routine, stress and fatigue



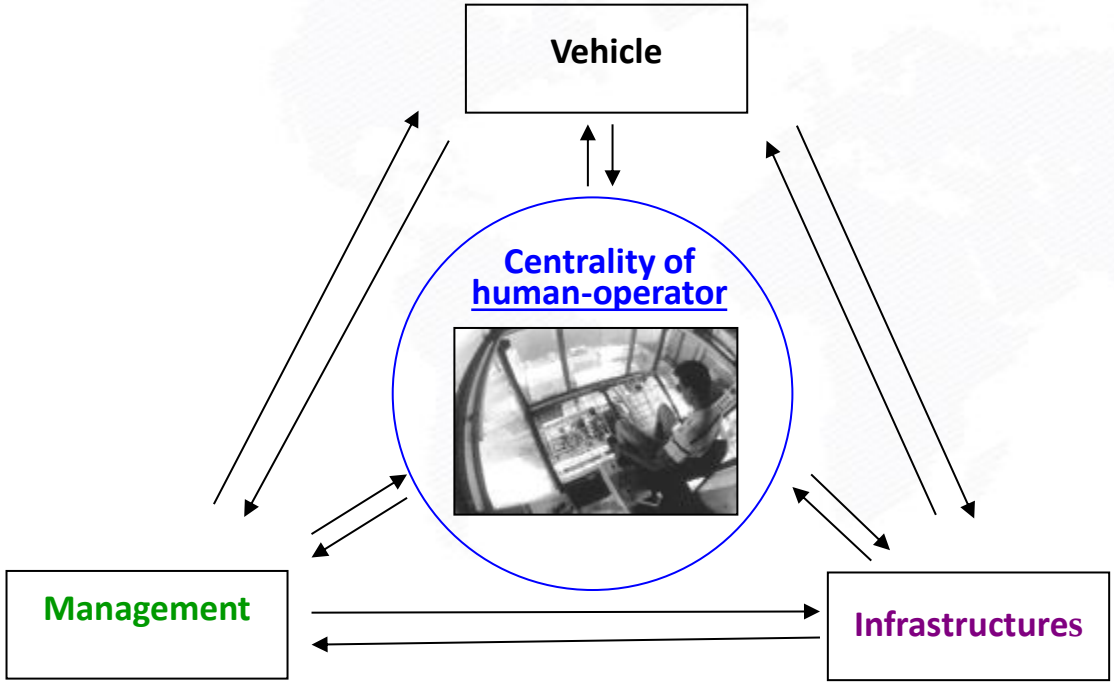
Bad postural position, exposure at high vibrations and operational view facing down



View optimization

Human Factors approach:

putting the Human Factors' aspects at the center of transport system



It means:

- Improving human task
- Decreasing the stress level
- Reducing the task fatigue
- Improving the postural seat
- Supporting the task with devices

HOW?

Simulation approach

A right option to approach these aspects is simulation

Operational
Man-operator performance level analysis

Technologies:
innovative solutions research and validation

Training:
including periodic refresher training

NECESSARY CONDITIONS FOR ACTIVITIES EFFECTIVENESS

High fidelity of immersive Virtual Reality

Flexibility and versatility of HW/SW structure

Simulation approach

Simulation allows to:

1. Repeat a task – always the same – always with same conditions
2. Measure the performance task level of operator
3. Compare two or more operators on the same task
4. Erase bother aspects
5. Record the task and analyse data in back office
6. Develop research activity for new tasks
7. Use several instruments (big size too) for measuring performances
8. Leave crane to operational tasks

Task simulators in transportation

Aerospace

The 1960's

Aeronautics

The 1970's

Road

The 1980's

Maritime

Nowadays

Portainer simulators in the world

GlobalSIM (USA)

Hitec-O
(Norway)

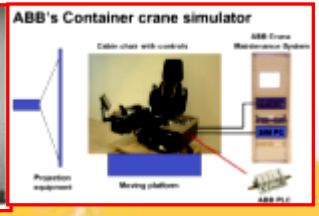
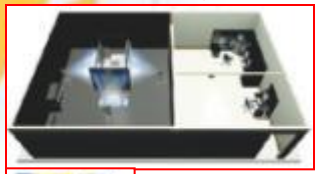


ABB – Goteborg Port
(Sveden)

L-3 MRPRI Ship
Analitics - USA

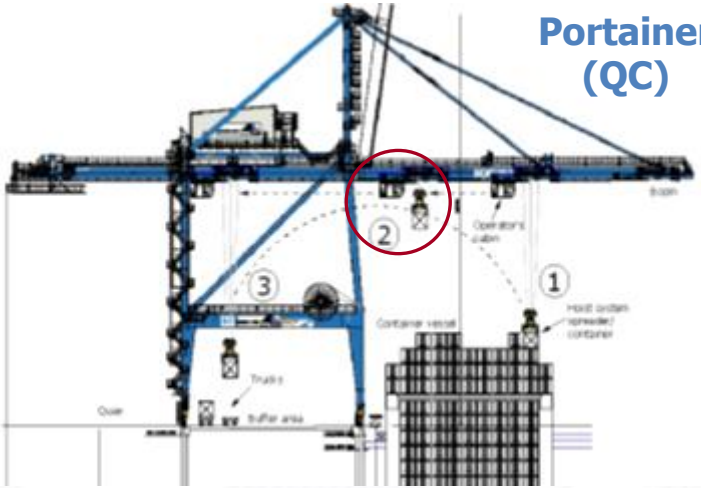
Drilling Systems – Port of
Felixstowe (UK)



ARI - India

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

Crane operator task in Terminal Container



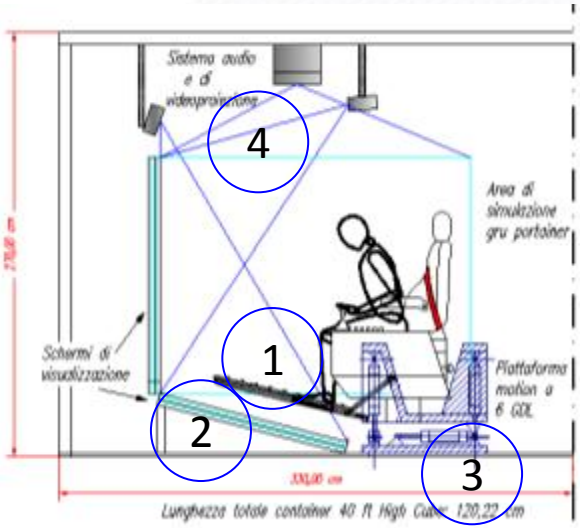
Portainer (QC)

Task optimization (containers moved from QC to ships and back)

Crane operator posture

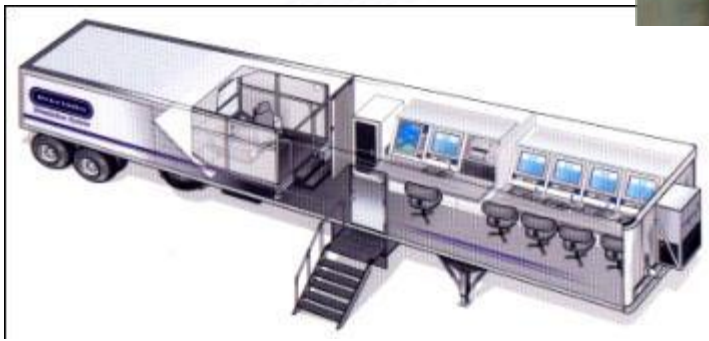
View optimization

Quay Crane simulator



Two typical different modalities

Fixed installation



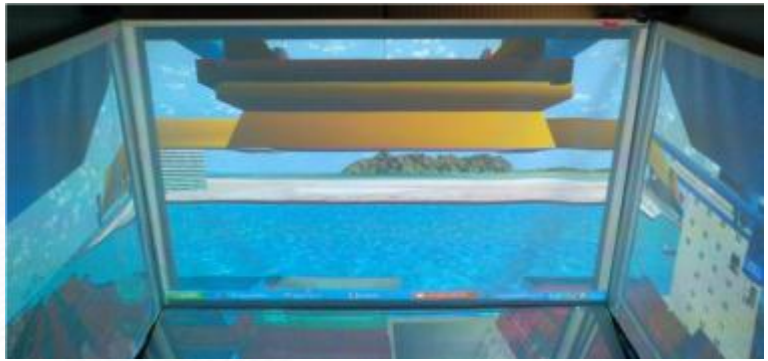
Mobile training facility

QC simulator hardware structure: 4 components

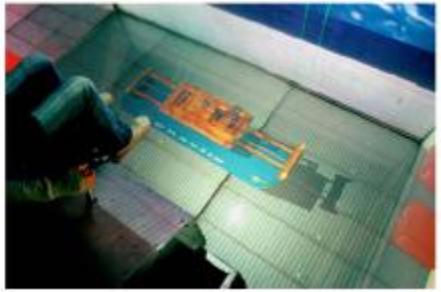
1. **Cockpit**: a replica of the crane operator cab interface, generally integrated with a ***motion platform (with 3 or 6 dof)***

2. **Instructor workstation interface:** allows to follow trainees exercises in real time. Instructor can create innumerable simulation scenarios

3. **Visual display and Audio System** : recreates a real scene as real as possible



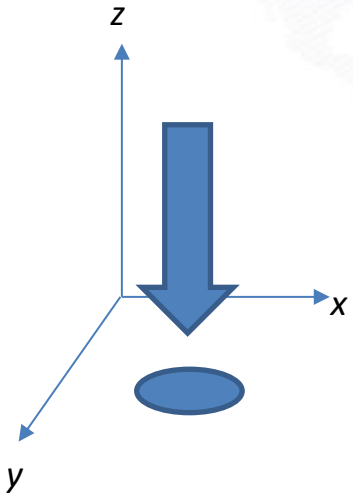
4. **Central operating system:** the simulator "brain", controls operations and executes different simulation scenarios

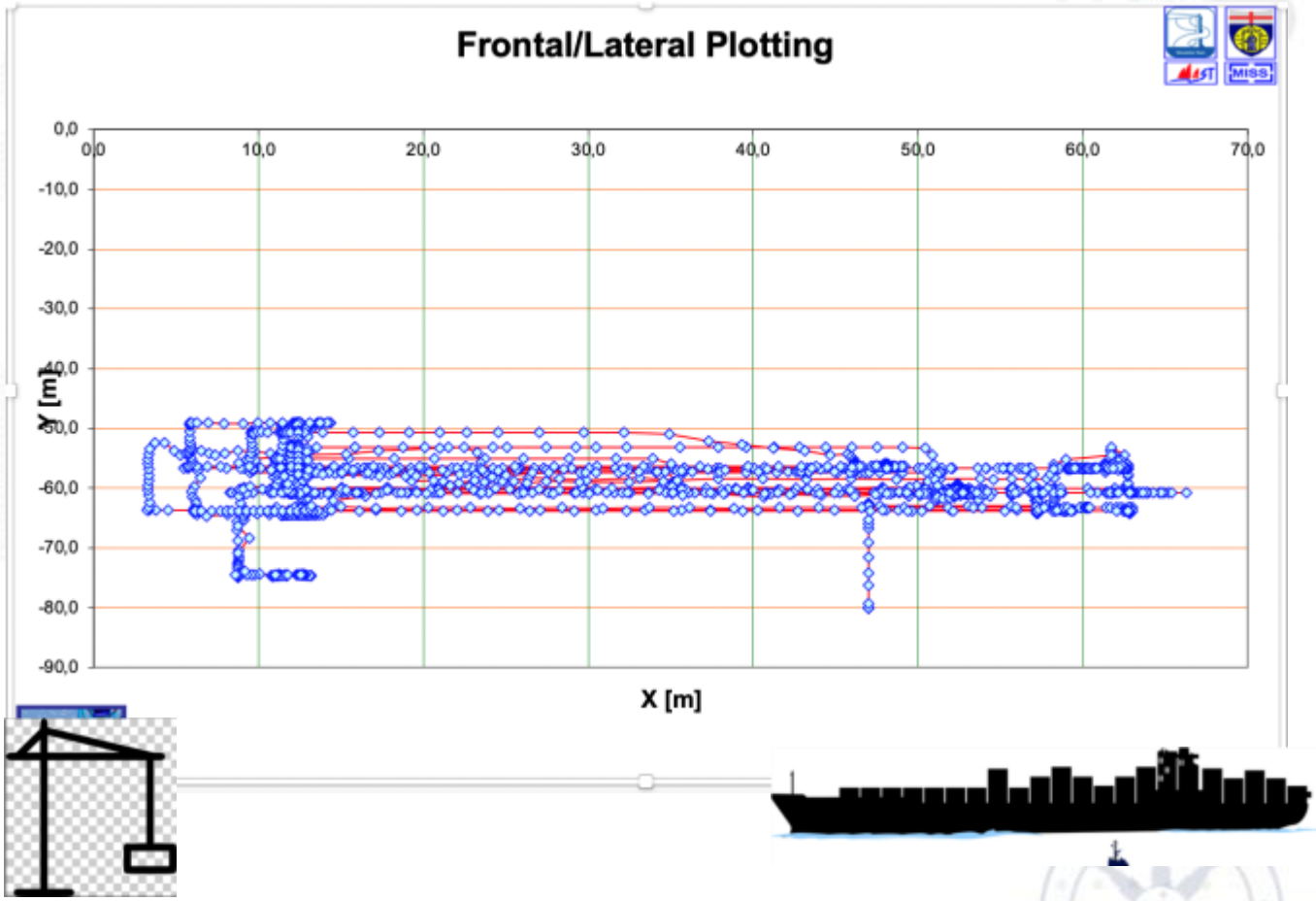


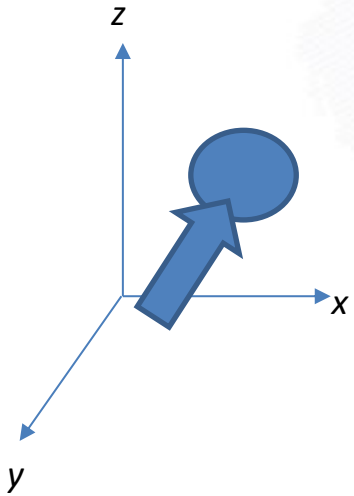
Simulation Scenarios

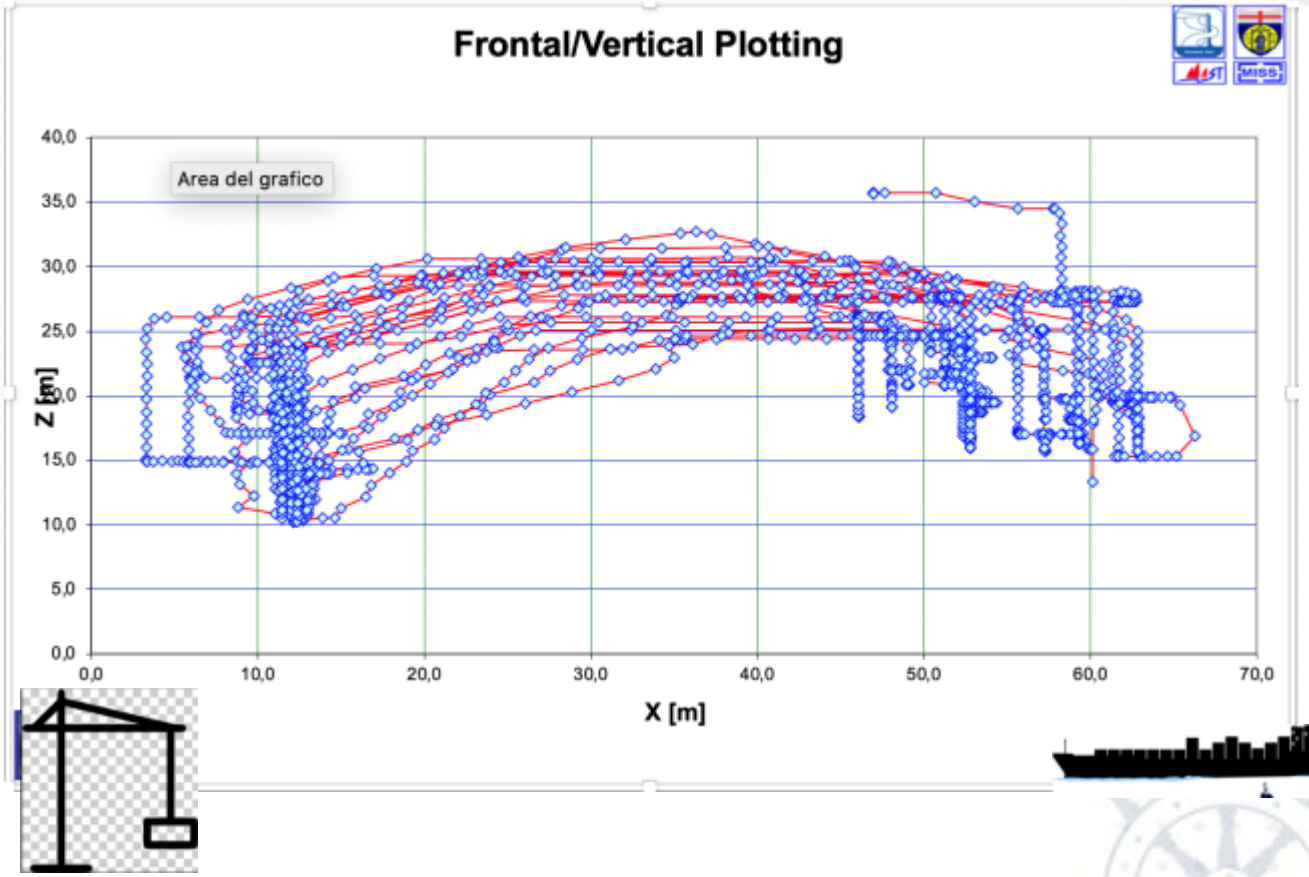
- Loading and unloading from ship;
- Combined operations involving other terminal equipments (other cranes, trucks, reach stackers);
- Weather conditions (rain, fog, wind, lighting changes, etc.)
- Performance measurements and reports (trajectories, efficiency of operations, safety parameters, collisions, etc.).

To improve operational task - Some results






z
x
y


Frontal/Vertical Plotting
Area del grafico
Z [m]
X [m]
40,0
35,0
30,0
25,0
20,0
15,0
10,0
5,0
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0,0
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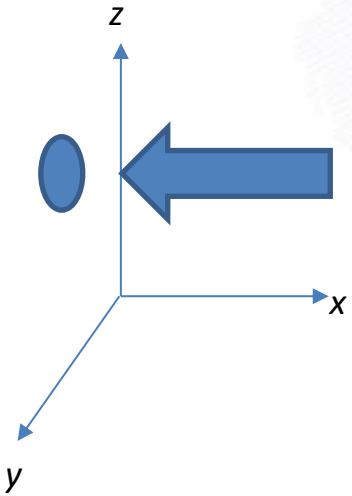
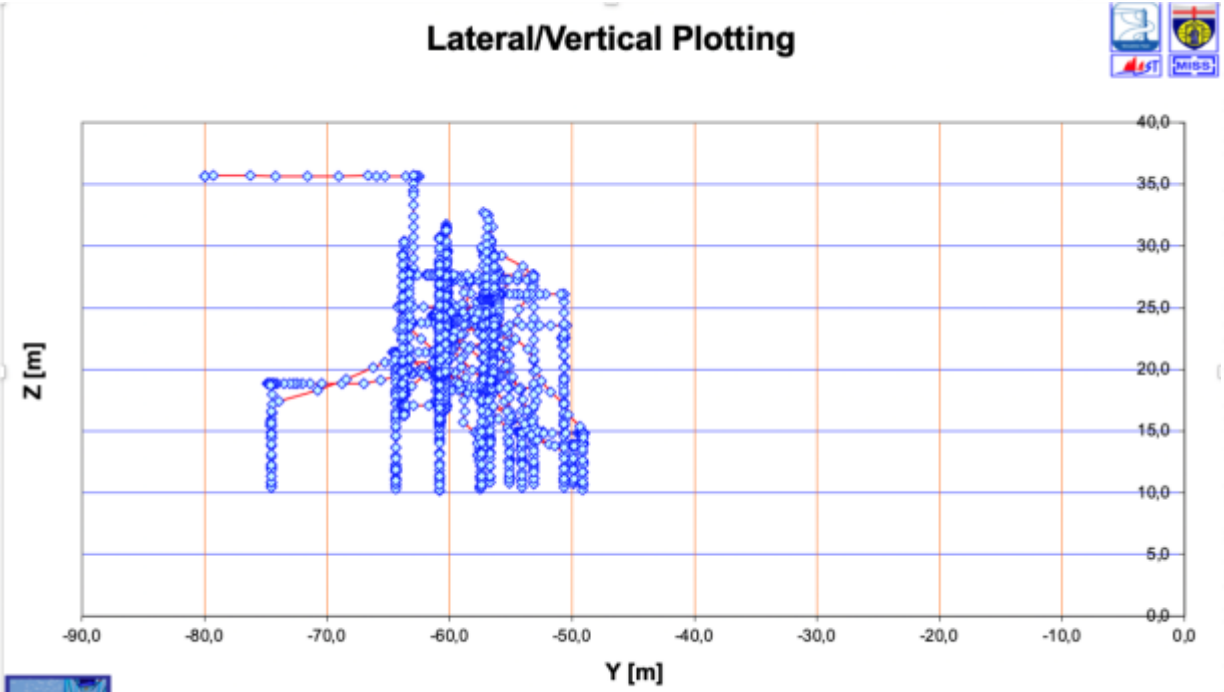
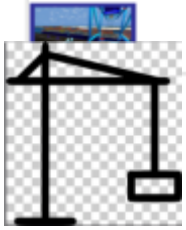
20,0
30,0
40,0
50,0
60,0
70,0


z
x
y


Lateral/Vertical Plotting
Z [m]
Y [m]
40,0
35,0
30,0
25,0
20,0
15,0
10,0
5,0
0,0
-90,0
-80,0
-70,0
-60,0
-50,0
-40,0
-30,0
-20,0
-10,0
0,0



********** CYBERSAR **********

Stampa del giorno: 09/10/20 Ora: 22:49:2
Nome: Operatore Cognome: 2TdT
Mezzo Utilizzato: PT-1
Durata Esercitazione Ore: 0 Minuti: 55 Secondi: 17
Numero Collisioni: 111
Movimenti Totali: 23
Produttività [cont/h]: 26,4

Main

Stampa

Confronto Container

Task results: n° of containers moved

	Operatore 1	Operatore 2	Operatore 3	Operatore 4	Operatore 5	Operatore 6	Operatore 7	Operatore 8	Media	Deviazione standard
0 - 30 min.	28	10	17	11	15	16			**16,17**	**6,43**
30 - 60 min.	9	15	20	13	16	18	6	12	**13,63**	**4,63**
60 - 90 min.	9	12	17	25	32	16	19	21	**18,88**	**7,28**
90 - 120 min.	9	11	20	8		23	26	24	**17,29**	**7,70**
120 - 150 min.	9	15	18	10	12	19	14	10	**13,38**	**3,78**
150 - 180 min.	8	17	18	15	17	18	15	20	**16,00**	**3,63**
180 - 210 min.	5	8	20	15	19	21	14	11	**14,13**	**5,82**
210 - 240 min.	10	9	17	16	16	19	17		**14,86**	**3,80**
Media	**10,88**	**12,13**	**18,38**	**14,13**	**18,14**	**18,75**	**15,86**	**16,33**		
Deviazione standard	**7,08**	**3,23**	**1,41**	**5,19**	**6,47**	**2,38**	**6,04**	**6,02**		

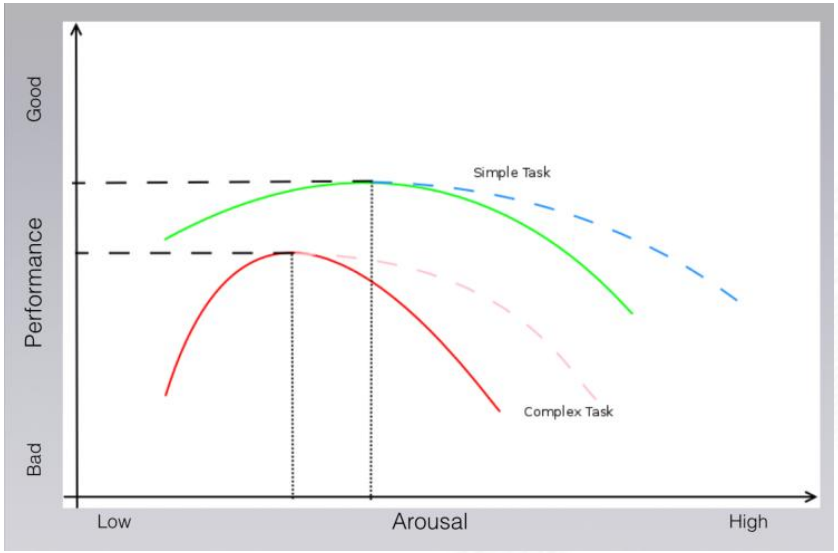
Task results: n° of collisions

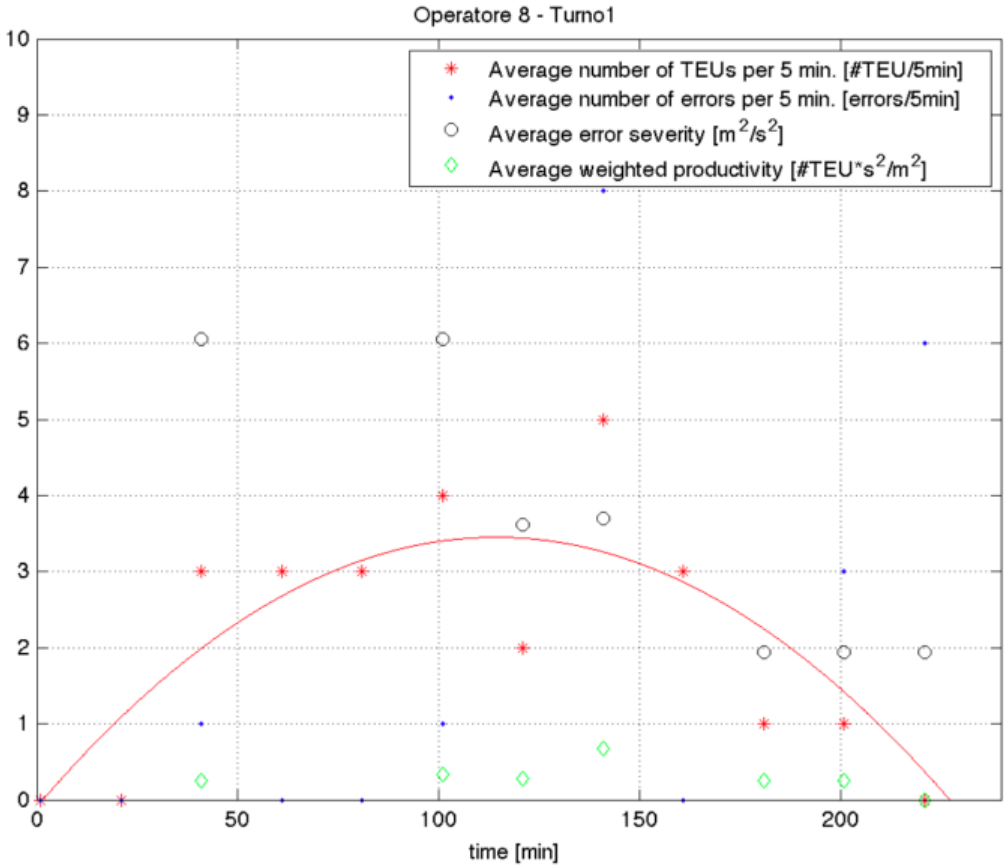
	Operatore 1	Operatore 2	Operatore 3	Operatore 4	Operatore 5	Operatore 6	Operatore 7	Operatore 8	Media	Deviazione standard
0 - 30 min.	56	29	25	114	75	30	29	0	**44,75**	**35,74**
30 - 60 min.	45	104	76	28	34	82	104	42	**64,38**	**30,96**
60 - 90 min.	56	17	37	91	24	38	17	0	**35,00**	**28,24**
90 - 120 min.	61	17	34	1	50	120	17	59	**44,88**	**37,28**
120 - 150 min.	43	28	12	9	36	152	28	68	**47,00**	**46,28**
150 - 180 min.	167	22	47	61	29	90	46	99	**70,13**	**47,54**
180 - 210 min.	1	37	94	51	25	58	17	94	**47,13**	**34,13**
210 - 240 min.	0	36	68	76	0	88	31	42	**42,63**	**33,01**
Media	**53,63**	**36,25**	**49,13**	**53,88**	**34,13**	**82,25**	**36,13**	**50,50**		
Deviazione standard	**51,76**	**28,42**	**27,86**	**39,68**	**21,72**	**40,81**	**29,14**	**37,55**		

Task results: productivity (n° of TEUs/h)

	Operatore 1	Operatore 2	Operatore 3	Operatore 4	Operatore 5	Operatore 6	Operatore 7	Operatore 8	Media	Deviazione standard
0 - 30 min.	33,45	4,66	6,68	6,64	11,82	16,32			**13,26**	**10,77**
30 - 60 min.	5,64	9,87	14,08	6,67	11,50	15,30	3,95	4,51	**8,94**	**4,39**
60 - 90 min.	4,39	13,68	7,98	18,96	60,63	8,19	21,65		**19,35**	**19,23**
90 - 120 min.	4,74	3,82	12,63	46,48		23,72	9,03	8,42	**15,55**	**15,17**
120 - 150 min.	9,44		5,05	14,04	7,83	4,62	6,17	10,89	**8,29**	**3,41**
150 - 180 min.	3,19	7,50	10,41	8,77	16,22	4,14	13,13	6,19	**8,69**	**4,44**
180 - 210 min.	1,81	4,28	9,61	11,92	12,08	22,44	17,42	29,11	**13,58**	**9,10**
210 - 240 min.		18,38	8,94	13,32		23,44	9,84		**14,79**	**6,09**
Media	**8,95**	**8,88**	**9,42**	**15,85**	**20,01**	**14,77**	**11,60**	**11,82**		
Deviazione standard	**11,06**	**5,49**	**2,97**	**13,05**	**20,08**	**8,25**	**6,26**	**9,96**		

The objective is to create a task profile for each operator

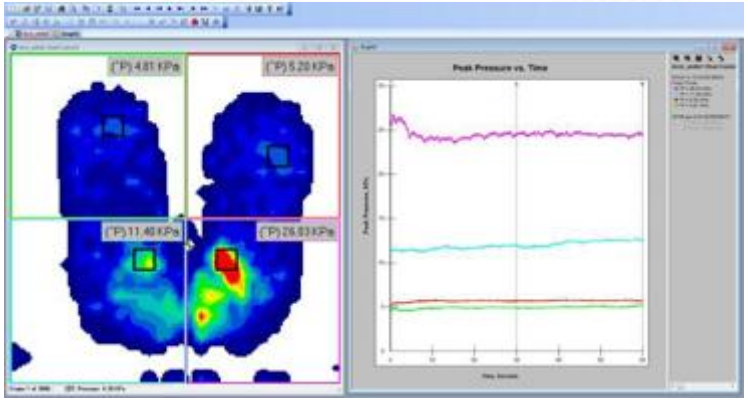




Other Simulator use: Postural analysis

BEFORE

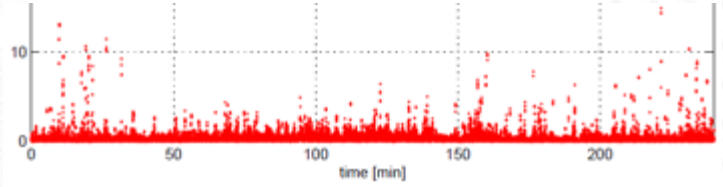
AFTER



PRESSURE SEAT ANALYSIS

Other Simulator use: View Optimization

Eye tracker



Average eye fixations

Turno 1				
Operatore	Stiva	Banchina sx	Banchina e ralla	Banchina dx
Operatore 1	17,94%	3,15%	76,49%	2,38%
Operatore 2	26,64%	2,75%	63,22%	7,38%
Operatore 3	4,11%	3,15%	91,66%	1,08%
Operatore 4	12,22%	2,21%	83,74%	1,83%
Operatore 5	23,50%	5,40%	69,22%	1,87%
Operatore 6	13,76%	1,72%	80,54%	3,98%
Operatore 7	0,22%	2,92%	95,62%	1,24%
Operatore 8	7,37%	5,24%	86,67%	0,72%
Media	13,22%	3,32%	80,90%	2,56%
SD	8,63	1,24	10,26	2,05

Conclusion

Less time for training -

Full safety conditions -

Less money costs -

Training on unusual conditions -

Thank you for your attention