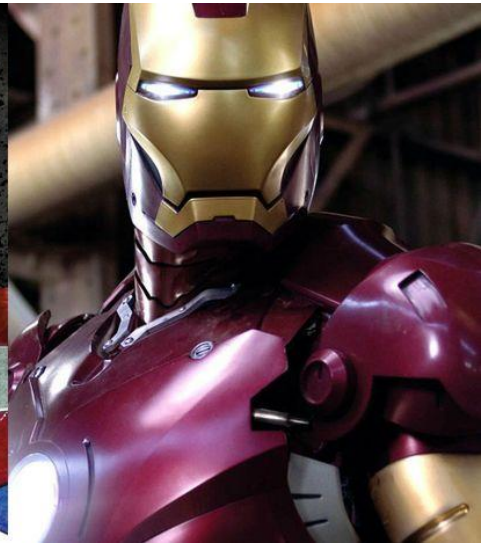
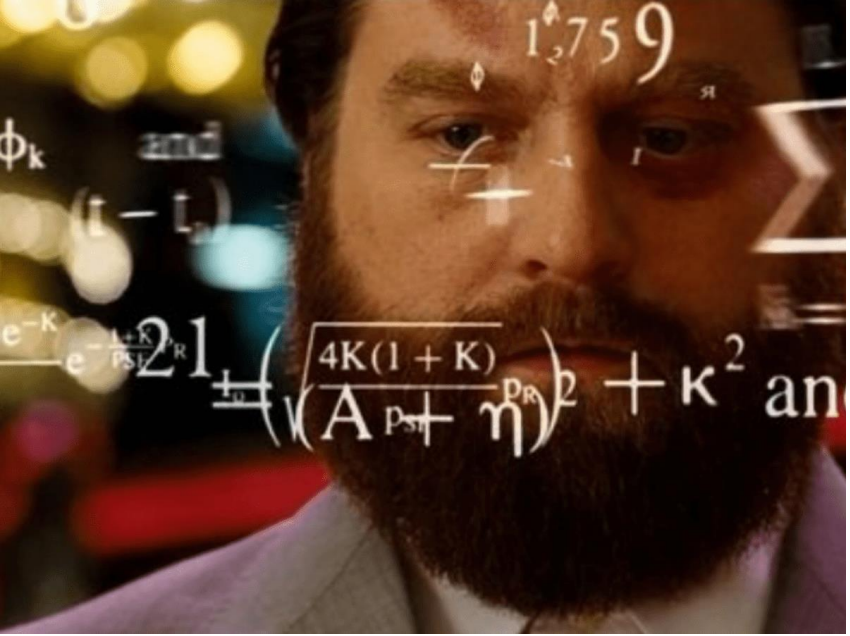
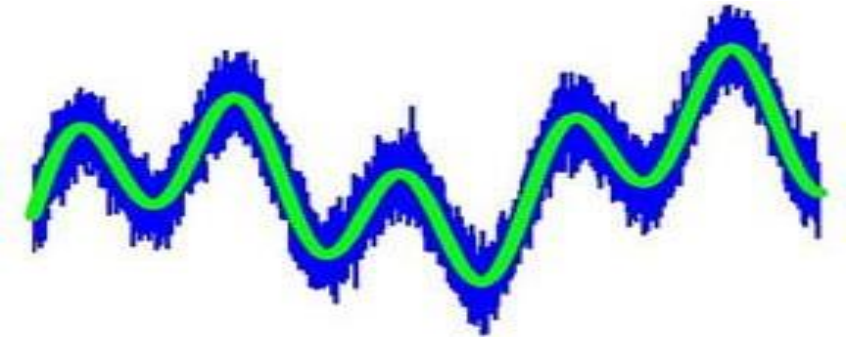
1200 Nm AT 45+ KNOTS WITH 30+ G IMPACTS MEASURED ON HULLS AND HUMANS

9G Exposure 40+G Exposure?







IT'S NOT MEASURED G VALUE THAT IS HARMFULL
IT'S ABSORBED ENERGY THAT HURTS

ENERGY AT PEAK

Sampling rate 500 Hz

40G = 78,6 Joules

Sampling rate 10 Hz

7,86G = 78,6 Joules

Sampling rate 1 Hz

0.786G = 78,6 Joules

Biomechanical Tolerance of Whole Lumbar Spines in Straightened Posture Subjected to Axial Acceleration

Brian D. Stemper,[1,2,3] Sajal Chirvi,[1,3] Ninh Doan,[1,3] Jamie L. Baisden,[1,3] Dennis J. Maiman,[1,3] William H. Curry,[1,3] Narayan Yoganandan,[1,3] Frank A. Pintar,[1,2,3] Glenn Paskoff,[4] Barry S. Shender[4]

[1]Department of Neurosurgery, Medical College of Wisconsin, Milwaukee, Wisconsin, [2]Department of Biomedical Engineering, Marquette University and Medical College of Wisconsin, 5000 West National Avenue, Research 151, Milwaukee, Wisconsin 53295, [3]Neuroscience Research, Clement J. Zablocki Veterans Affairs Medical Center, Milwaukee, Wisconsin, [4]Aircraft Division, Naval Air Warfare Center, Patuxent River, Maryland

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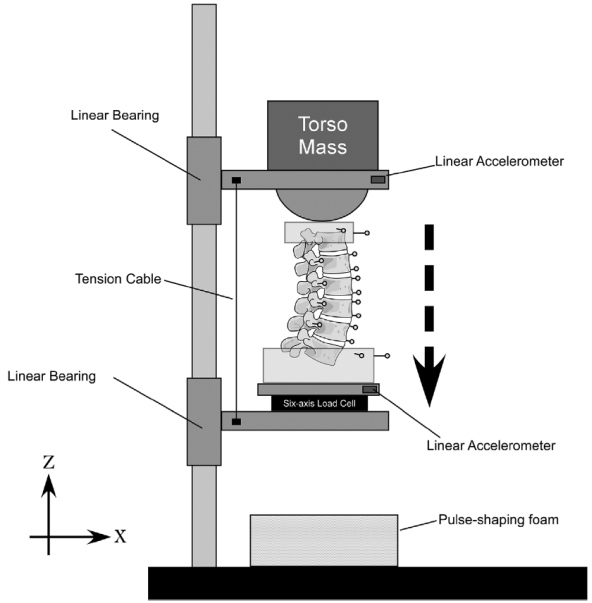
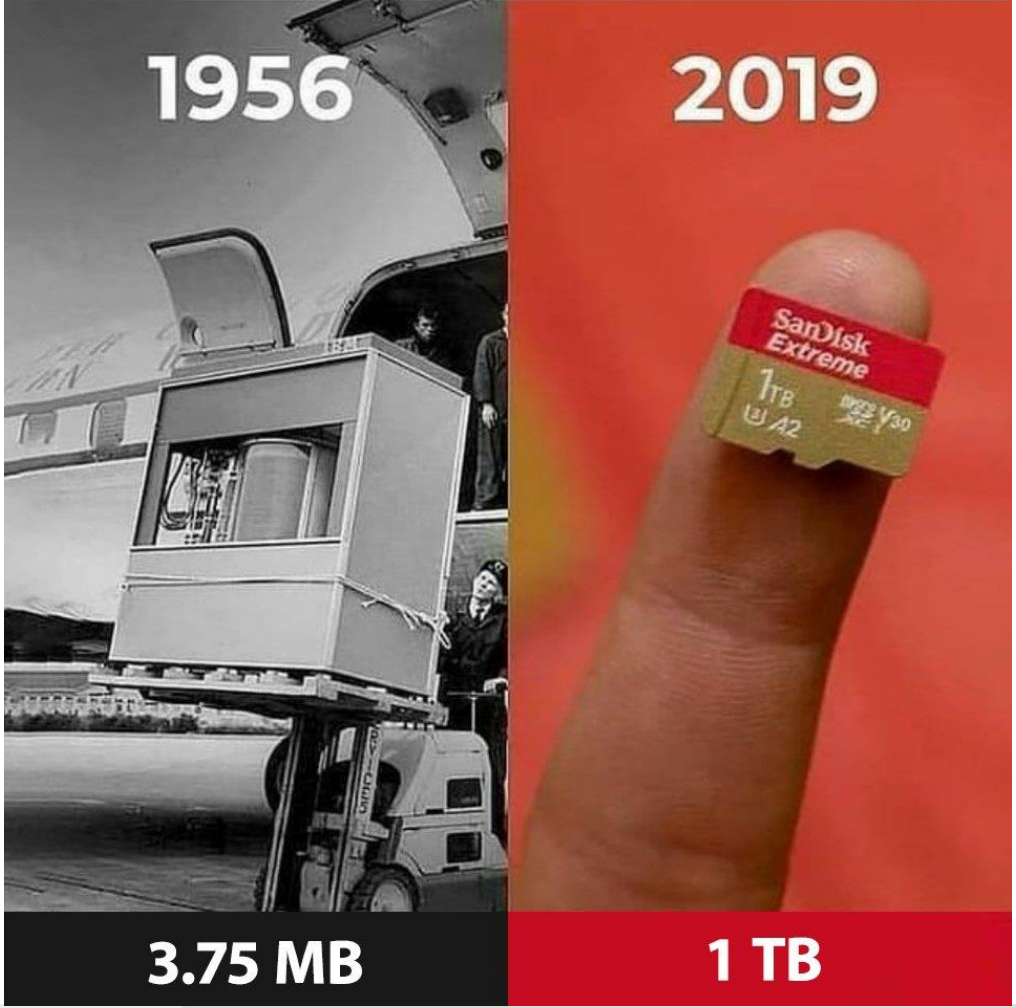


Figure 1. Vertical accelerator test setup to simulate high rate loading of the specimen.

TABLE 1. Specimen-by-Specimen Biomechanical Data for Tests Producing Injury, Along With Injury Characteristics

Test ID	Age	Sex	Rate of Onset (g/s)	Force (kN)	Acceleration (g)	Injured Level	Fracture Classification	# Tests
1	18	F	221	5.6	19	L1 L2	Endplate Anterior Compression	5
7	38	F	122	4.4	11	L1 L2	Anterior Compression Compression	1
9	44	M	317	4.8	23	L1 L1	Anterior Compression Burst	1
10	45	M	1,044	5.8	22	L4	Anterior Compression	6
11	45	F	289	3.8	23	L1	Anterior Compression	1
12	49	M	2,398	5.1	55	L3 L5	Bilateral Pars Burst, Bilateral Facet	6
13	49	F	266	6.3	20	L5 L2	Endplate Anterior Compression	1
14	50	F	2,083	7.9	57	L3	Burst, Bilateral Facet	3
15	50	F	195	3.8	20	L1	Burst	1
16	52	M	205	4.5	17	L1	Anterior Compression	2
17	54	M	289	5.8	17	L1	Anterior Compression	2
18	54	M	1,079	6.5	38	L1 L2 L3	Anterior Compression Chance Bilateral Facet	1
19	55	M	608	7.4	34	L1	Burst, Chance	1
20	55	F	433	4.5	21	L1	Anterior Compression	1
21	58	F	670	5.3	40	L1 L2	Burst, Chance Anterior Compression	1
22	58	M	476	5.9	32	L1	Burst	1
23	63	F	224	6.8	20	L4 L5	Anterior Compression Facet	4
Mean (Std Dev)			642 ± 665	5.5 ± 1.2	28 ± 13			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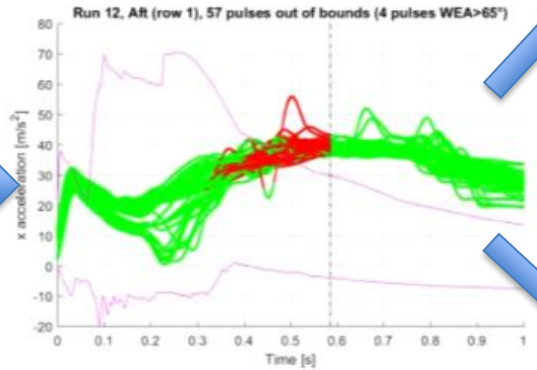
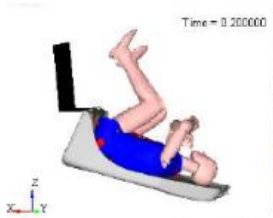
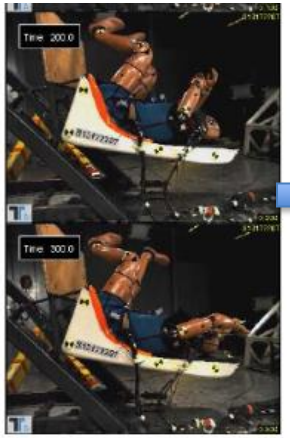
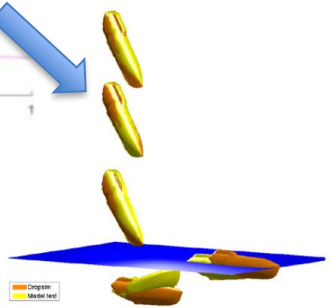
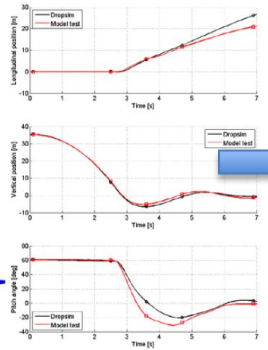


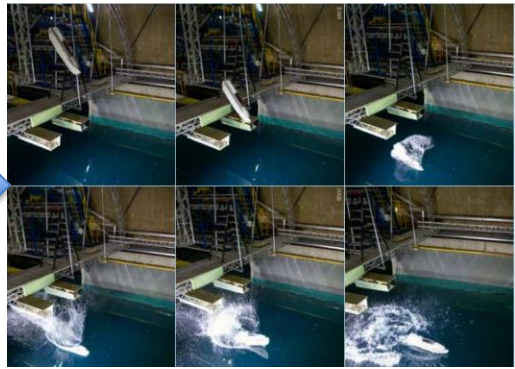




			Sled Test	Simulation
Test			S13172207	S13172207
parameter	lower limit	upper limit		
HIC	250	650	84	70
NFx_p [N]	400	733	321	311
NFx_a [N]	306	788	136	426
NFy [N]	240	900	408	296
NFz_c [N]	600	1500	1310	1472
NFz_t [N]	-	1500	303	393
NMx [Nm]	-	62	33	27
NMy_e [Nm]	65	73	29	35
NMy_f [Nm]	88	190	33	35
Nij_LC	-	-	0.21	0.51
Nij_LT	-	-	0.53	0.15
Nij_NTE	-	-	0.28	0.10
Nij_NTF	-	-	0.09	0.05
Nij_NCE	-	-	0.20	0.36
Nij_NCF	-	-	0.31	0.33
Nkm_NFA	0.75	1.10	0.42	0.90
Nkm_NEA	0.75	1.10	0.00	0.29
Nkm_NFP	0.75	1.10	0.46	0.06
Nkm_NEP	0.75	1.10	1.16	1.08
T12_Fz_comp [N]	-	6700	4675	4863
T12 x [g]	-	60	19	14
T12 y [g]	-	20	17	16
T12 z [g]	-	-	50	39
T12_3ms [g]	-	60	29	41
Pelvis x+ into seat [g]	-	-	13.1	15.5
Pelvis x- out of seat [g]	-	-	3.8	2.0
Pelvis y [g]	-	-	5.8	4.3
Pelvis z+ into seat [g]	-	-	31.2	33.5
Pelvis z- out of seat [g]	-	-	10.8	9.0





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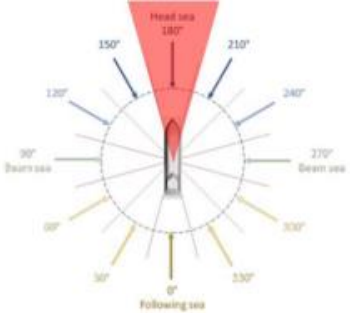


Case	HostCond	Hs_min	Hs_max	Wdir	PC	PAX
114	Intact	6	8	180	99	55
121	Intact	8	10	180	99	55
128	Intact	10	12	180	99	55
135	Intact	12	14	180	99	55
142	Intact	14	17	180	99	55

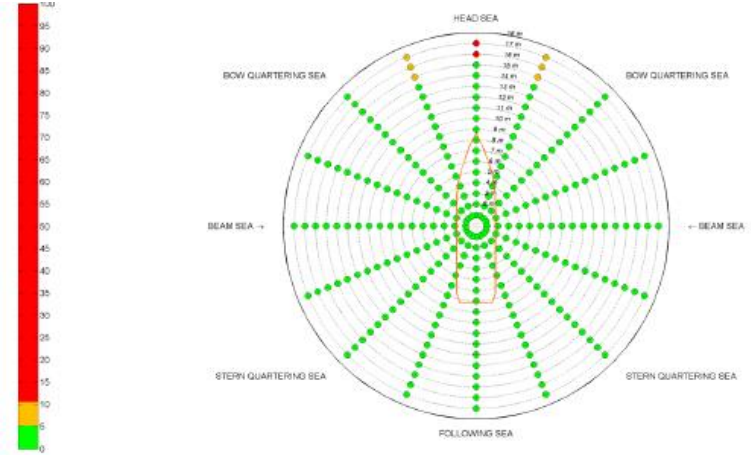


Figure 23: Polar plot with collision probability [%] for lifeboat 1.

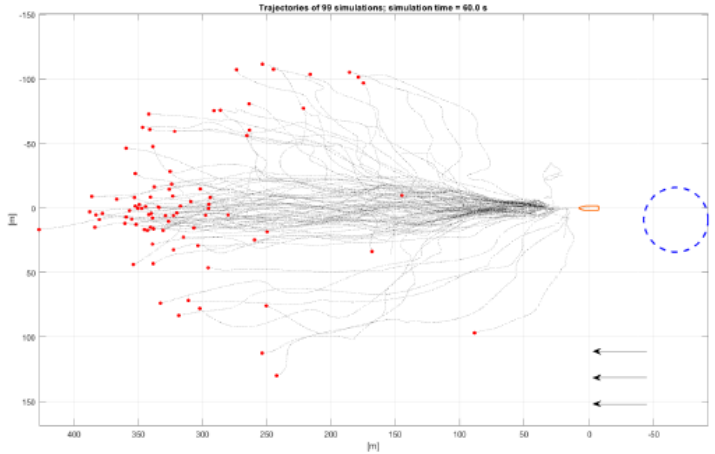


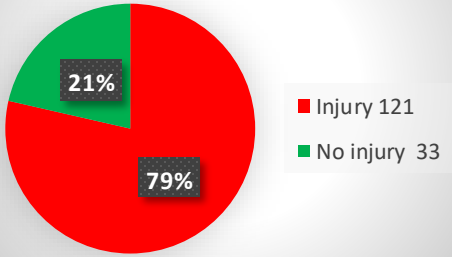
Figure 8: Example of sail away trajectories for lifeboat 1, at 17m wave significant wave height.


Are they ok?!?!

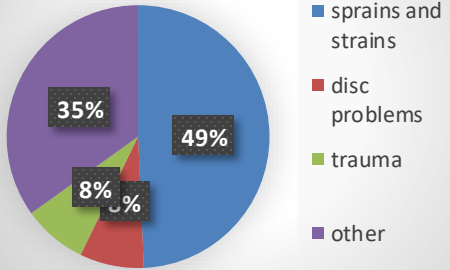
Injury risk in High-speed boats

- *«A survey of self-reported injuries among special boat operators» By Naval Health research center*
  - *Based on reports from 154 professional high speed pilots*
  - *With average 12 years of military service and average 4,7 years in special boats units.*

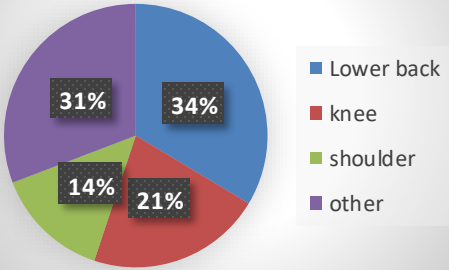
Reported injuries



Injury type



Injured body part



Injury resulted in:	Days
hospitalization	145
Sick leave	929
Limited duty	4223
limited job/mission performane	4218
lost mission training time	2294
lost physical conditioning time	4089

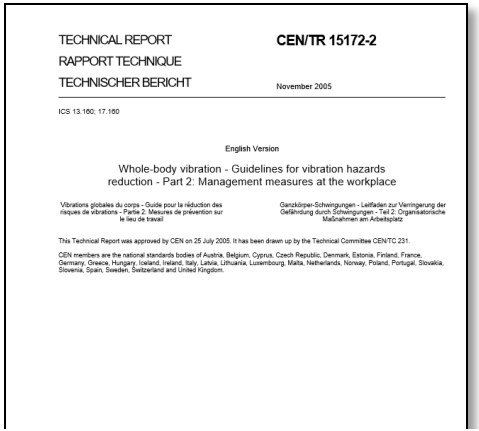
Research VS Regulation

“ Impact and vibration exposure are potentially of a greater magnitude than the forces experienced by a fast-jet pilot ejecting from their stricken aircraft ”

“ Despite the consequentially high risk of chronic injury, *ADM* understands that there is currently no system in place to monitor the hours Navy personnel spend in RHIBs ”

Lessons Learnt:

- Operators of high-speed craft should conduct Whole Body Vibration and shock impact risk assessments in accordance with the requirements of the Vibration Regulations to reduce the risk of injury to their employees and passengers to a level which is as low as reasonably practicable (MGN 353 (M+F) refers).
- Helmsmen should be made aware, through appropriate training, of the risks posed to crew and passengers from shock impacts when conducting high speed passages or when encountering large waves or wakes at lower speeds.



TECHNICAL REPORT
RAPPORT TECHNIQUE
TECHNISCHER BERICHT

CEN/TR 15172-2

November 2005

ICS 13.160; 17.160

English Version

Whole-body vibration - Guidelines for vibration hazards reduction - Part 2: Management measures at the workplace

Vibrations globales du corps - Guide pour la réduction des risques de vibrations - Partie 2: Mesures de prévention sur le lieu de travail

Ganzkörper-Schwingungen - Leitfaden zur Verringerung der Gefährdung durch Schwingungen - Teil 2: Organisatorische Maßnahmen am Arbeitsplatz

This Technical Report was approved by CEN on 25 July 2005. It has been drawn up by the Technical Committee CEN/TC 231.

CEN members are the national standards bodies of Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

SEA RESCUE MISSIONS MUST NOT SLOW DOWN

Johan Ullman M.D. Ullman Human Design Gothenburg SWEDEN

SUMMARY

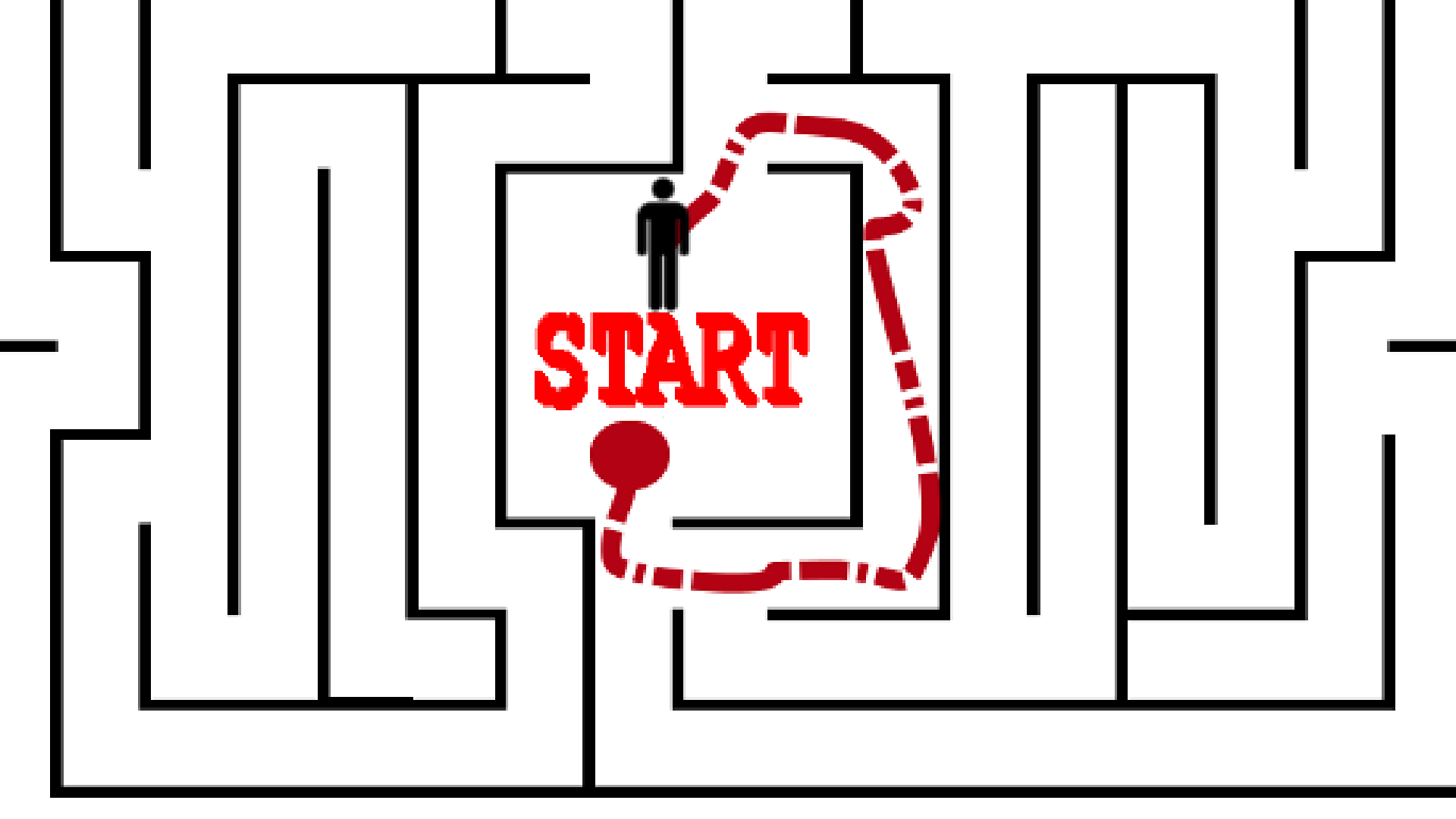
High-speed boats generate significant impacts slamming against the water surface. These impacts are transferred into the bodies of people on board causing not just fatigue, but also have the potential to cause severe injuries, both acute and cumulative. Higher boat speeds and higher waves increase the amount of energy transferred to human body. No other professional environment exposes workers to vibration and impacts of the same magnitude.

To protect workers from dangerous exposure to shock and vibration the EU Parliament and Council have passed EU Directive 2002/44/EG ”**on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents - vibration**”.
Applying this directive in high-speed boat environments can result in unreasonable restrictions for patrol and rescue operations and military training.

Potentially life-threatening impacts can still occur without exceeding the exposure limits stated in the directive. Solid data cannot ethically and practically be obtained to determine safe levels of exposure.

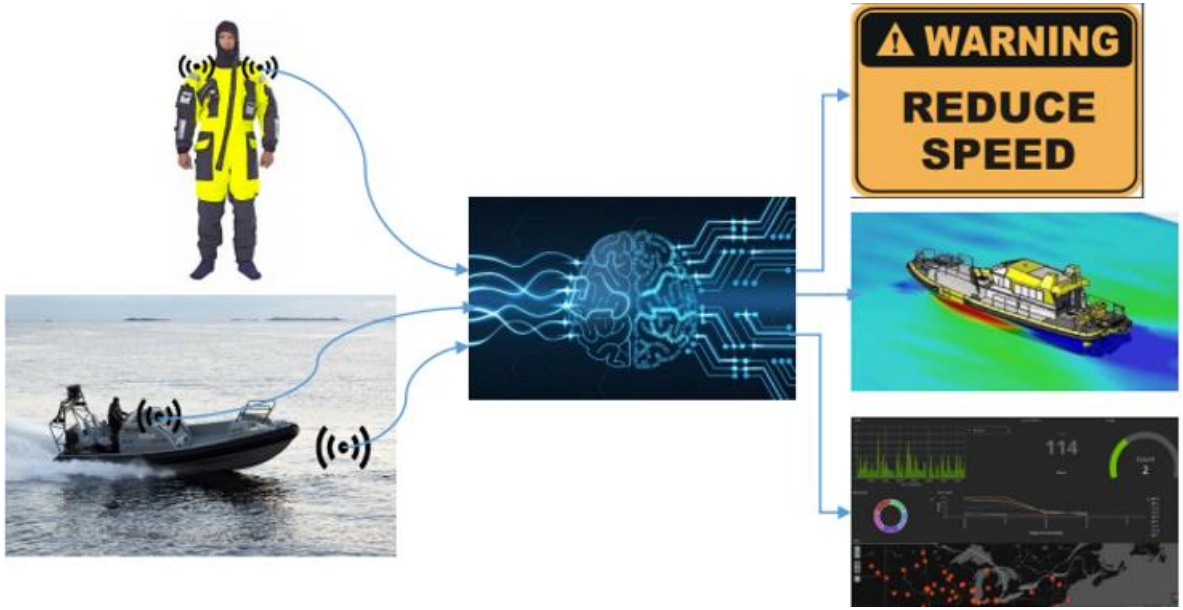
The directive needs to be adapted for high-speed boat applications regarding exposure limits, as well as methods of measuring exposure.

The directive states that, in the mean time, employers are obligated to seek new solutions, and implement the best available routines and technologies, in order to reduce the exposure to potentially dangerous shock and vibration exposure.


START

Intelliboat 1.0

Develop performance evaluation methods of the high-speed boats with respect to occupant safety and sea keeping properties



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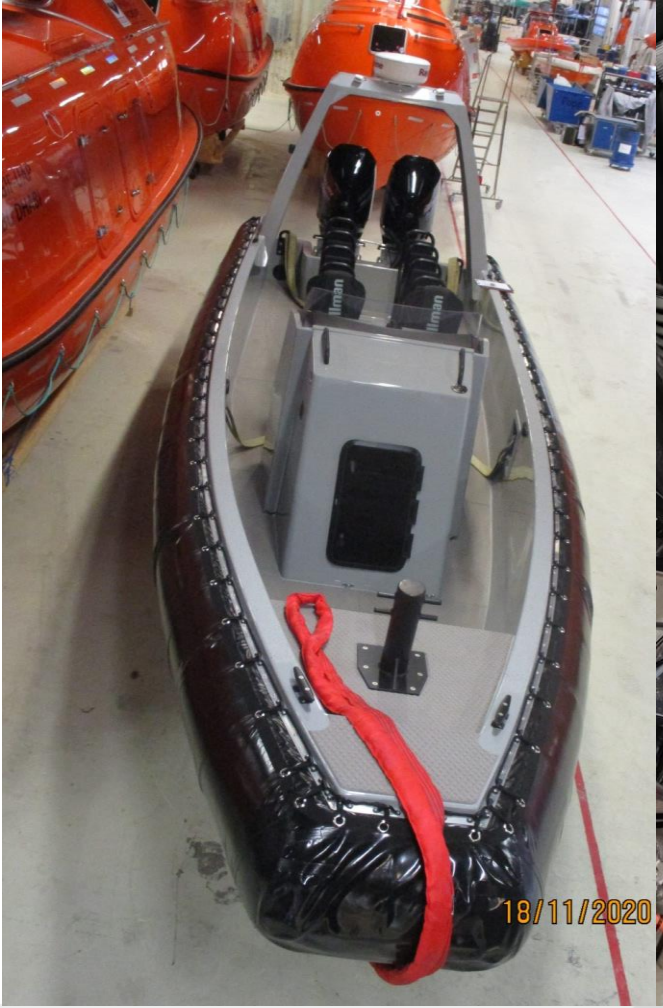
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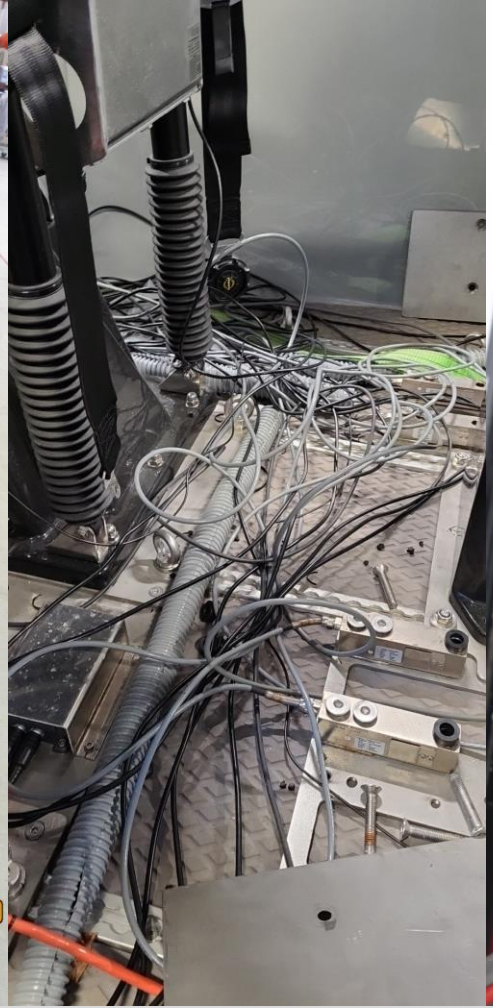

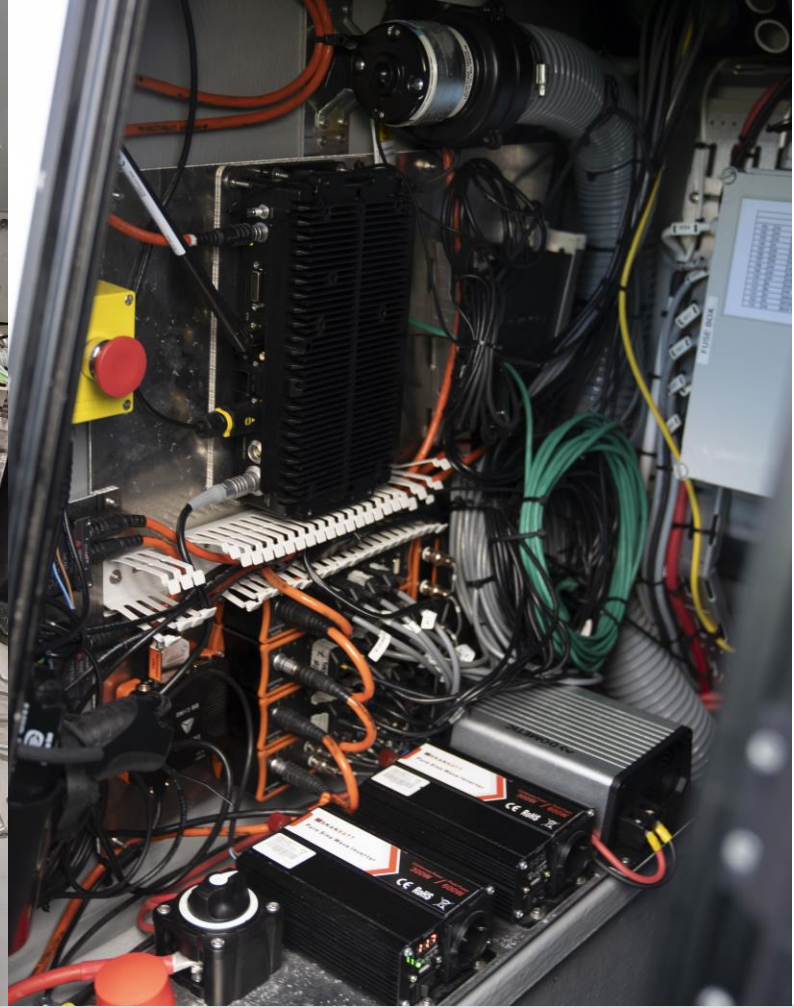


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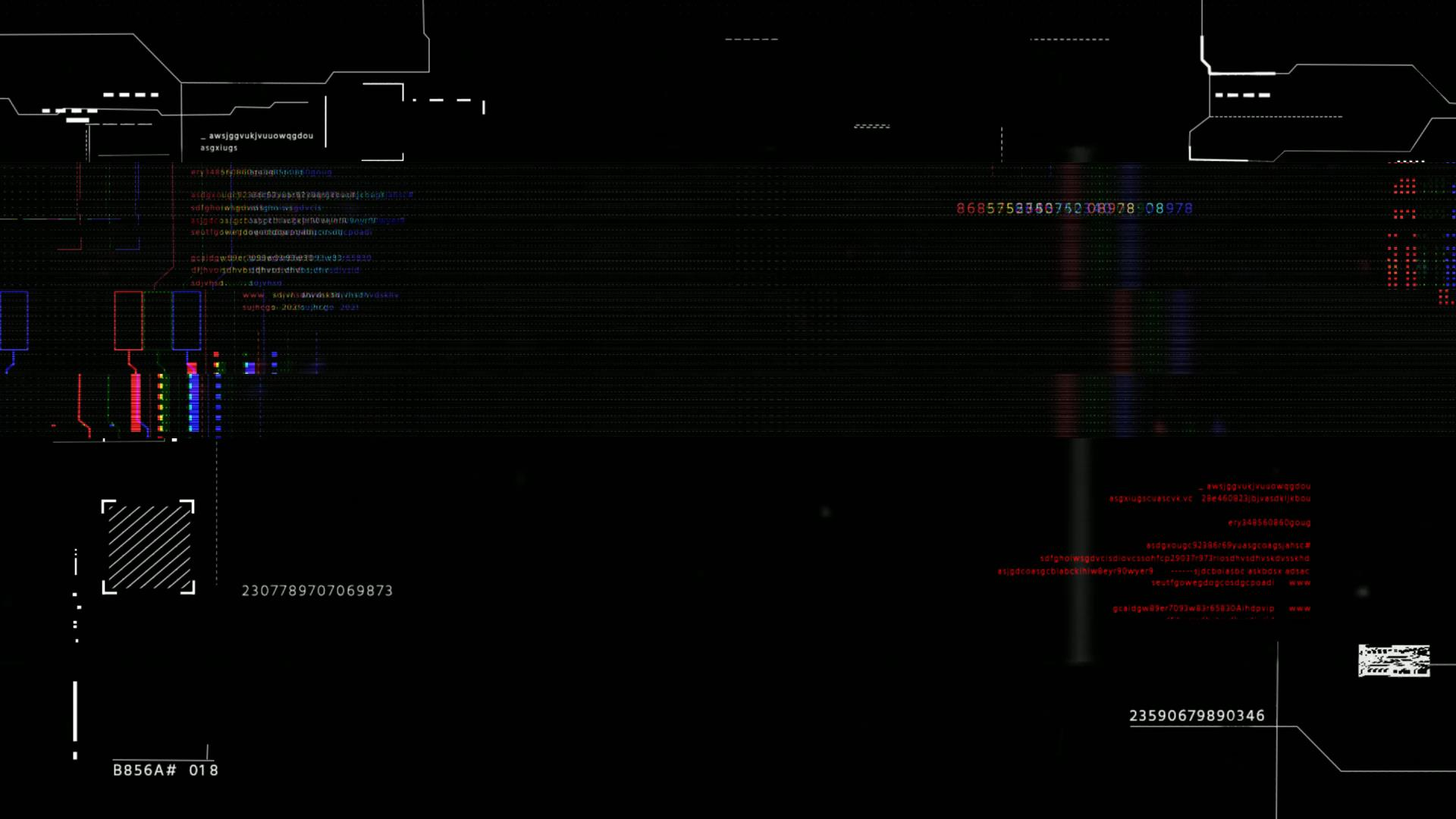
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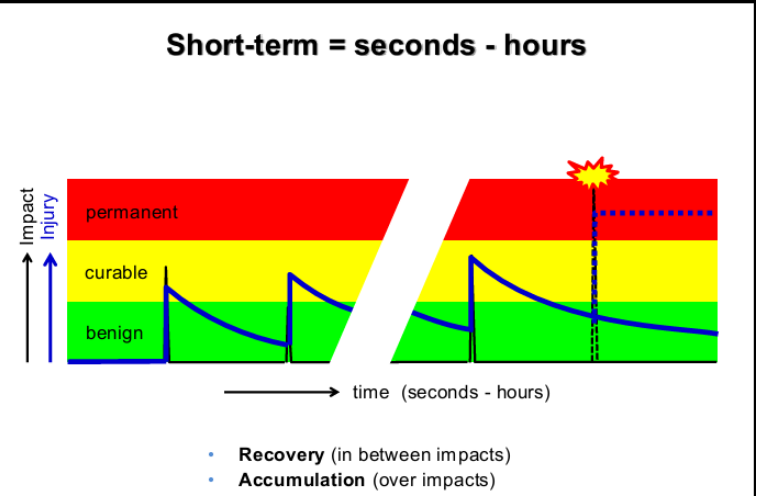
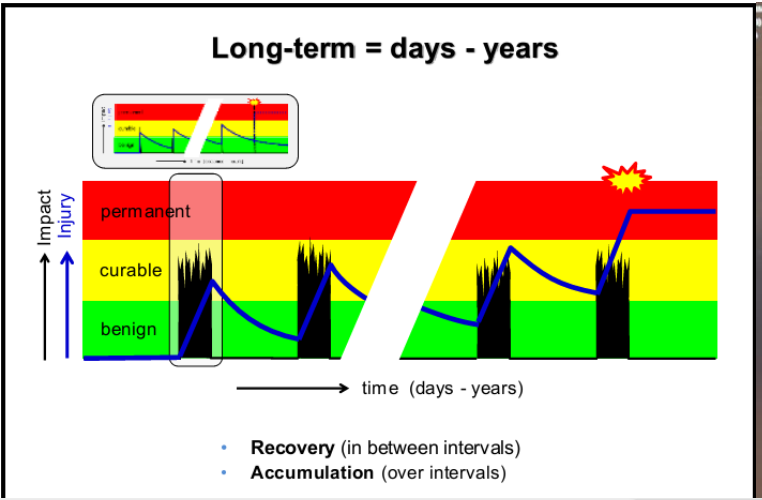
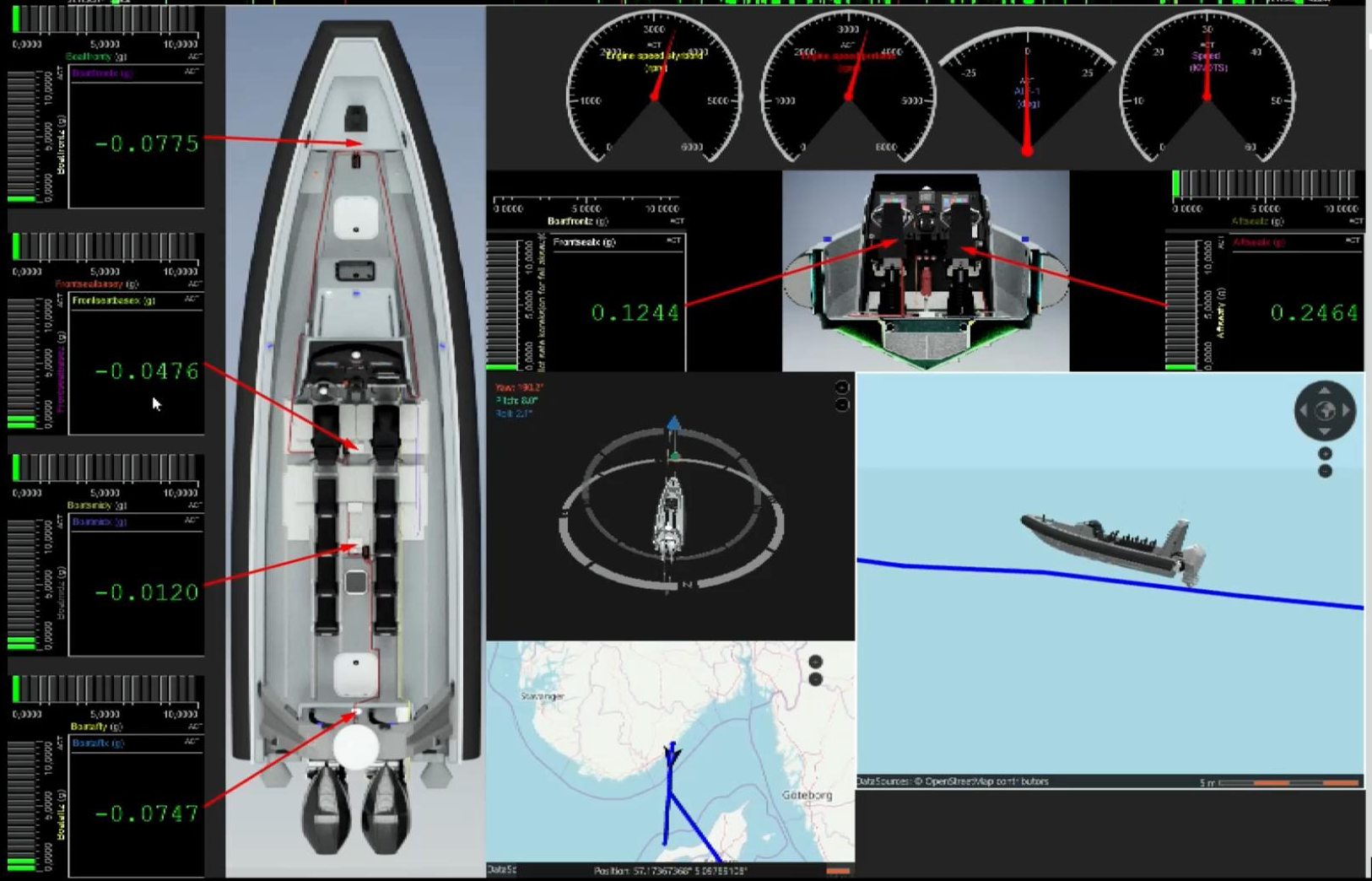


- Torn Biceps
- Partial rupture supraspinatus



3 x Cervical Herniated Disc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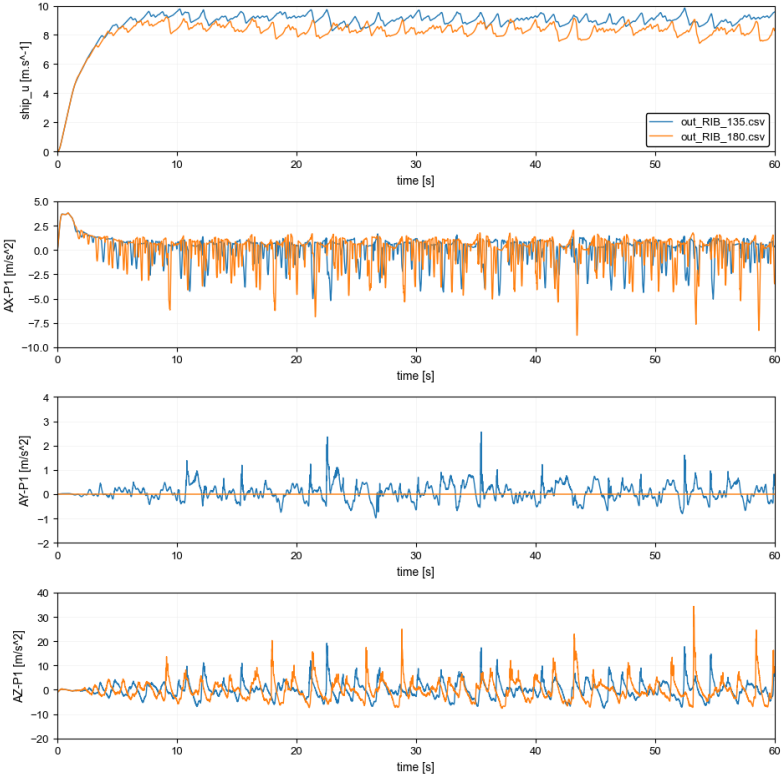
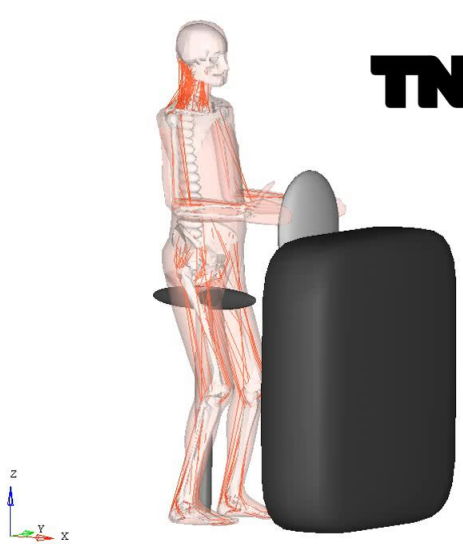
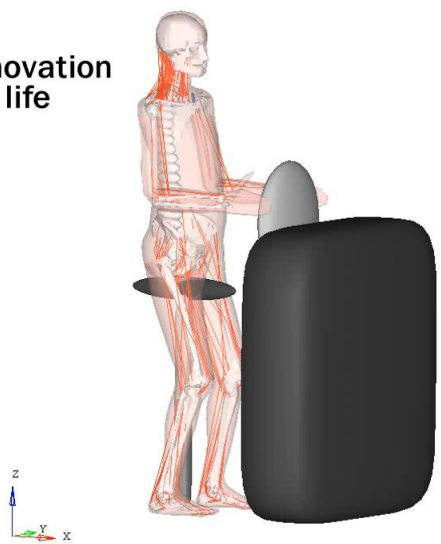
Göteborg

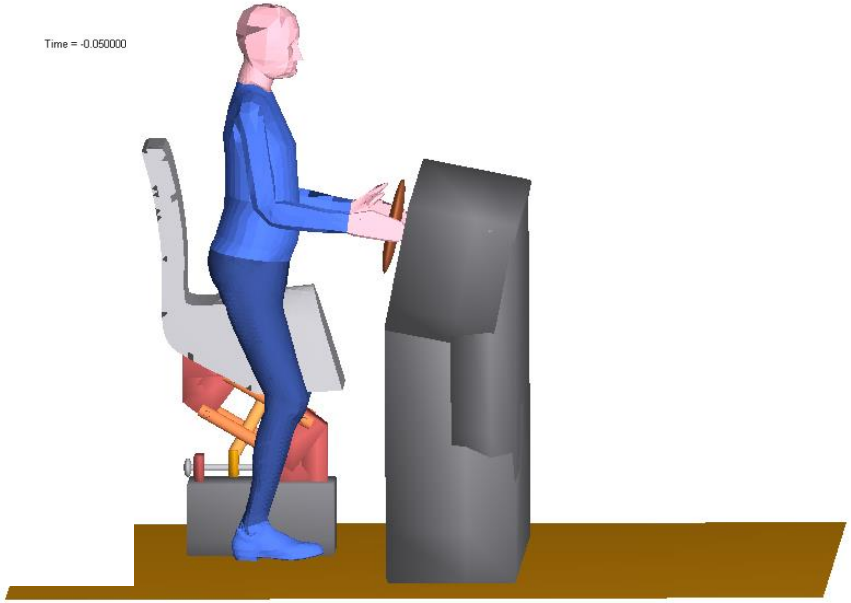
SEA KEEPING PROPERTIES



OCCUPANT SAFETY







Remaining work

- Development of sea keeping simulation enviroment
- Develpment of occupant injury risk evaluation tool
- Develoment of benchmarking priniciple for sea keeping and occupant injury risk evaluataion

Intelliboat 2.0 ?

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