

SHOX5



Shock-Mitigating Suspension Seats for Marine Vehicles

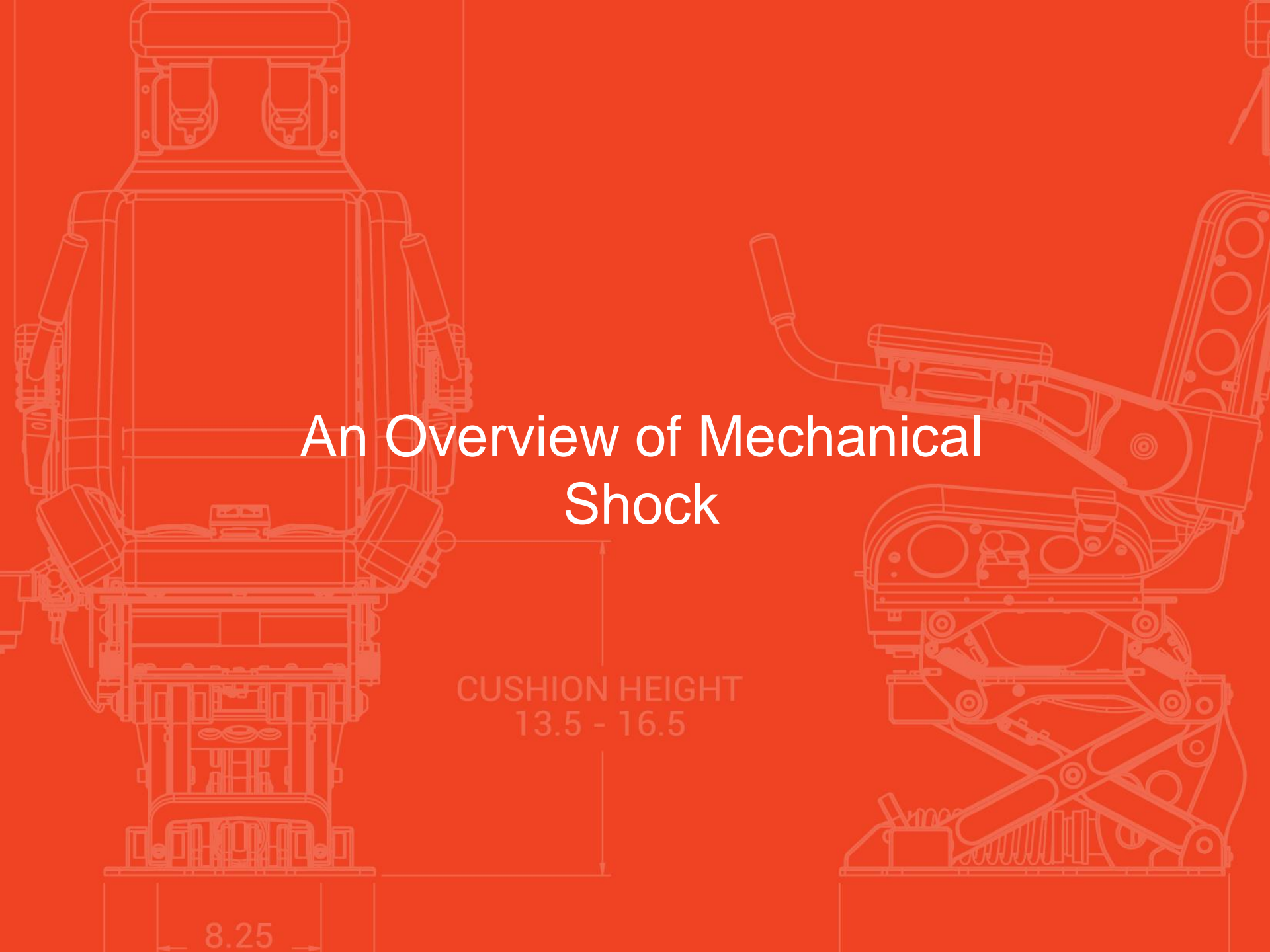
An update on performance measurements and
scientific research.

Tim Rees, Ph.D.

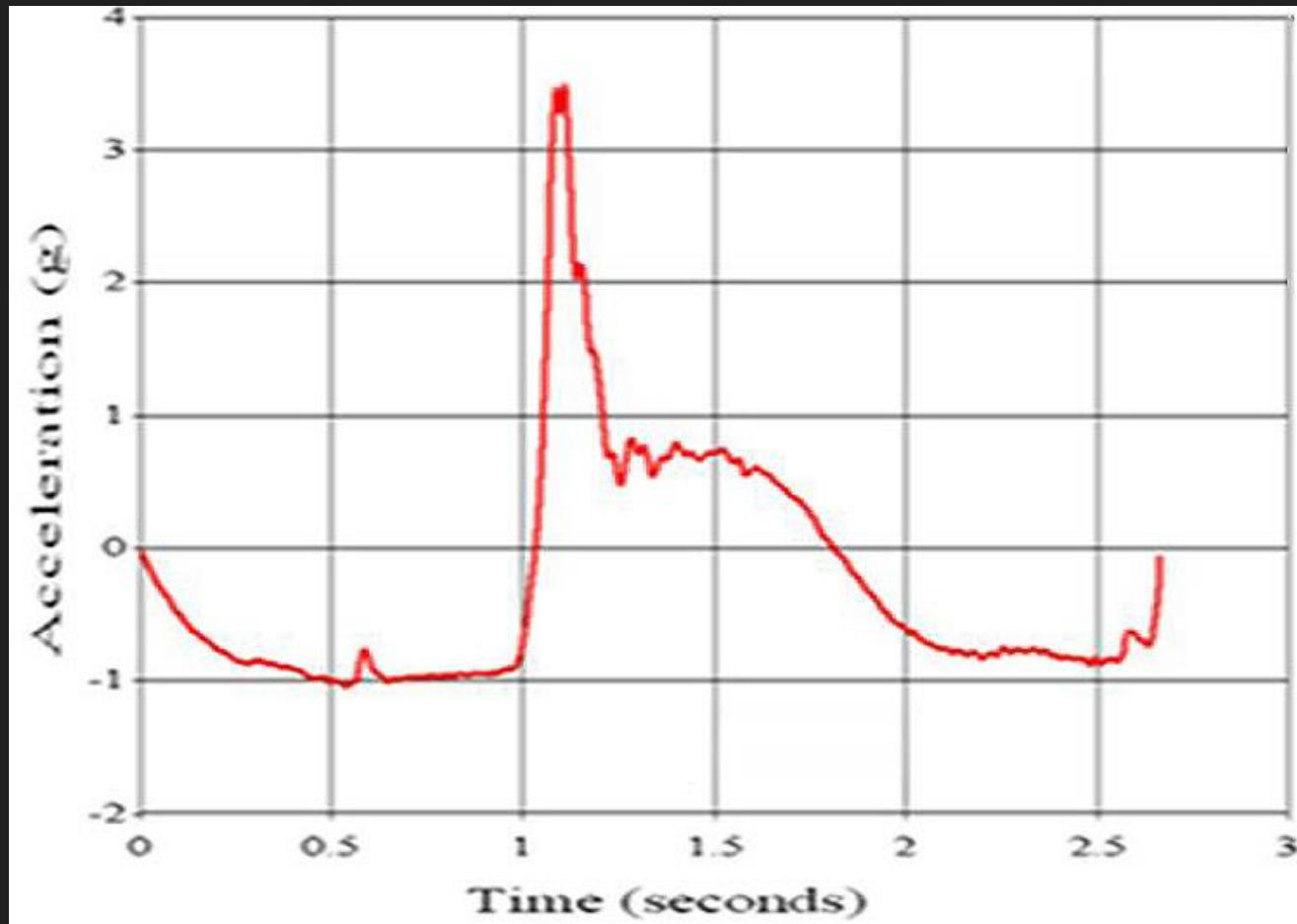
An Overview of Mechanical Shock

CUSHION HEIGHT
13.5 - 16.5

8.25



What is Mechanical Shock?



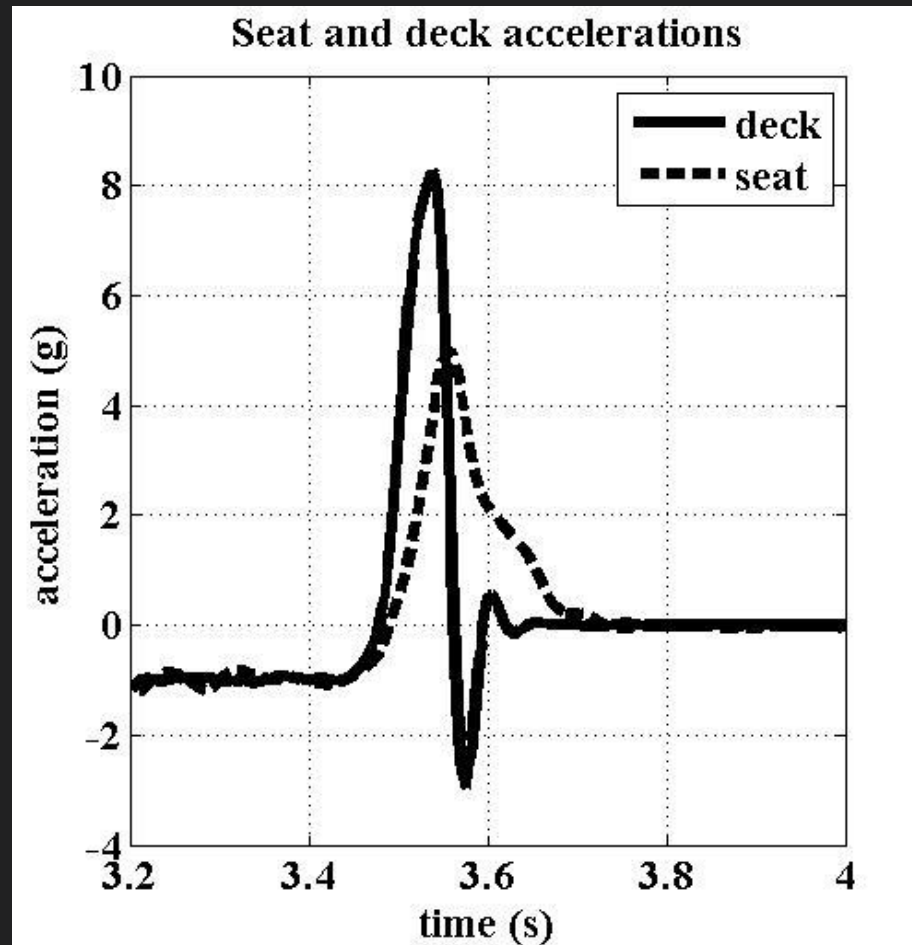
- A survey of U.S. Navy special boat operators was conducted (Ensign et al, 2004), and found:

Occupation	SBU	Navy
Hospitalizations per 100,000 man-years	2687	479

Injury Location	Injury Rate
Lower back	33.6 %
Knee	21.5 %
Shoulder	14.1 %

- Only 18% of injuries occurred during unusual sea-states.

What is Shock Mitigation?





How is Shock Mitigation Achieved?





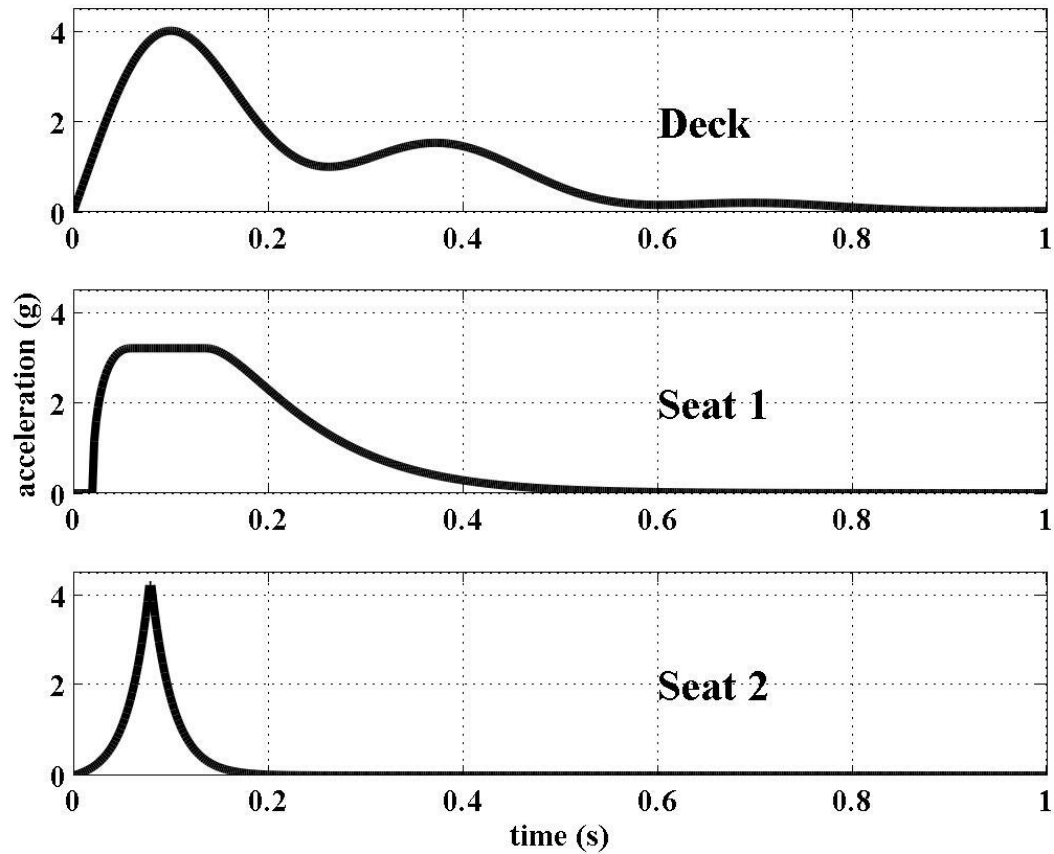
The background of the slide features a technical line drawing of a vehicle seat and its suspension system. The drawing is rendered in a light orange color against a darker orange background. It shows the seat's internal structure, including the backrest, seat pan, and base. Dimensions are indicated with lines and numbers: a vertical line on the right side of the seat pan is labeled 'CUSHION HEIGHT 13.5 - 16.5', and a horizontal line at the bottom left is labeled '8.25'. The suspension system, including springs and shock absorbers, is visible beneath the seat pan.

The Challenges of Assessing Acceleration Severity

CUSHION HEIGHT
13.5 - 16.5

8.25

Which Acceleration is Most Severe?



You may have heard things like:

- “...our seats achieve 70% shock mitigation.”
- “...our seats don’t bottom-out in the most severe conditions.”
- “...our seats are scientifically proven to be the best.”

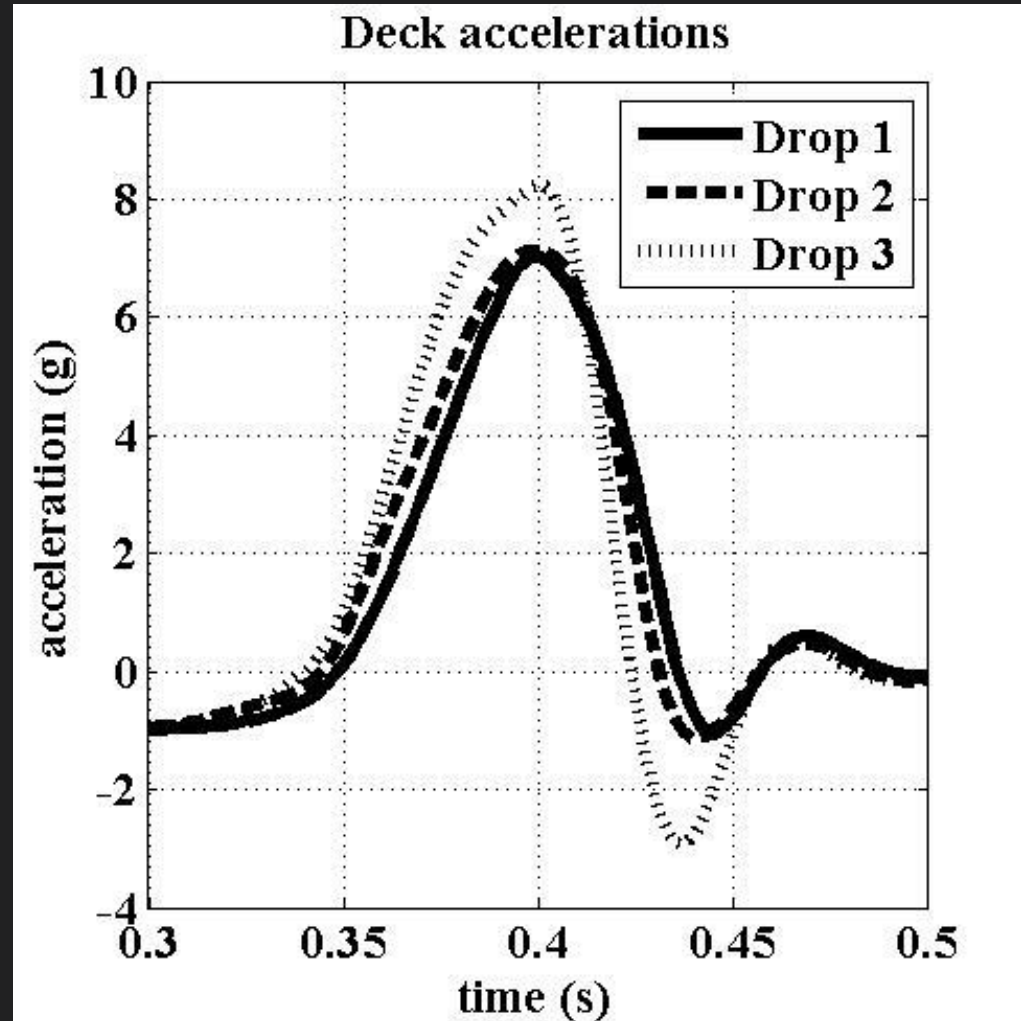
- ISO 2631 TC108/SC4 WG18 is developing a laboratory drop-test standard for evaluating marine seat shock mitigation performance.
- Participants include U.S. Navy, UK MOD, Canada's DND, industry and academics. SHOXS is a member and an active contributor.
- Developing a robust shock-mitigation metric is a key focus.



A Drop-Testing Platform



- Repeatability
- Fair head-to-head comparisons
- No reliance on weather/sea-state
- Economical





Growing Acceptance

- The UK MOD has recently awarded a large contract to BAE Systems for sixty PAC 24 boats with SHOX5 seats.

BAE SYSTEMS



Ministry
of Defence





The image is a technical line drawing of a vehicle seat and suspension system, rendered in white lines on a solid orange background. The drawing shows a side profile of a seat with a headrest, backrest, and seat cushion. The seat is mounted on a complex suspension system, including a frame, springs, and shock absorbers. Two dimensions are indicated: a vertical dimension for the cushion height and a horizontal dimension for the seat width. The text 'The Science of Measuring Shock Mitigation' is overlaid in the center of the image.

The Science of Measuring Shock Mitigation

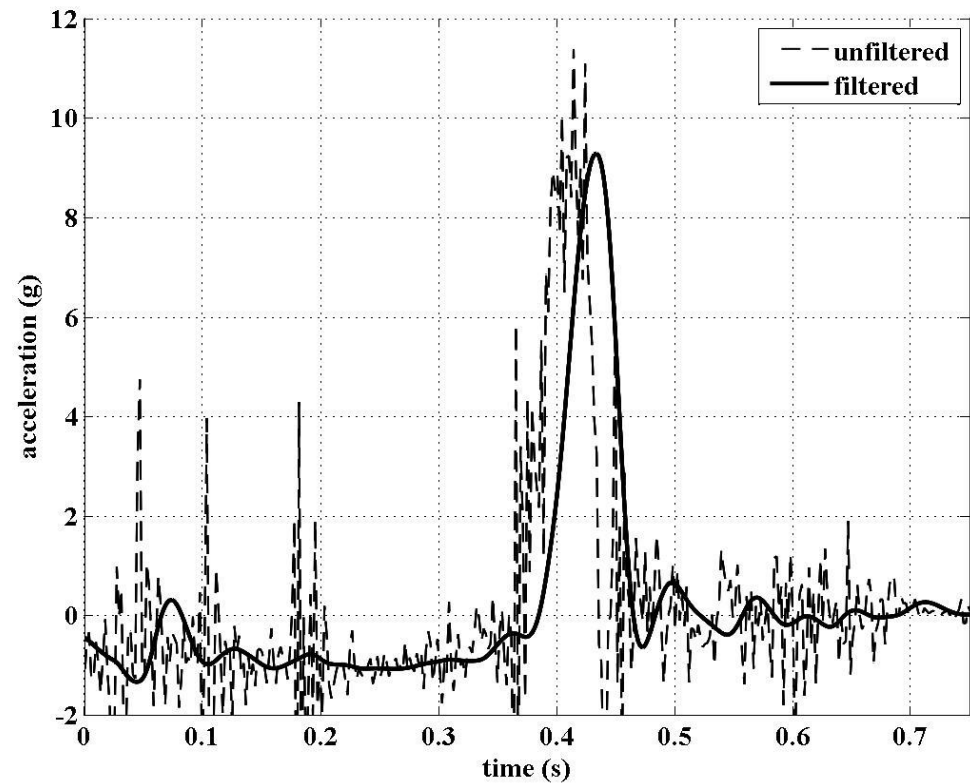
CUSHION HEIGHT
13.5 - 16.5

8.25



So, How is Shock Mitigation Measured?

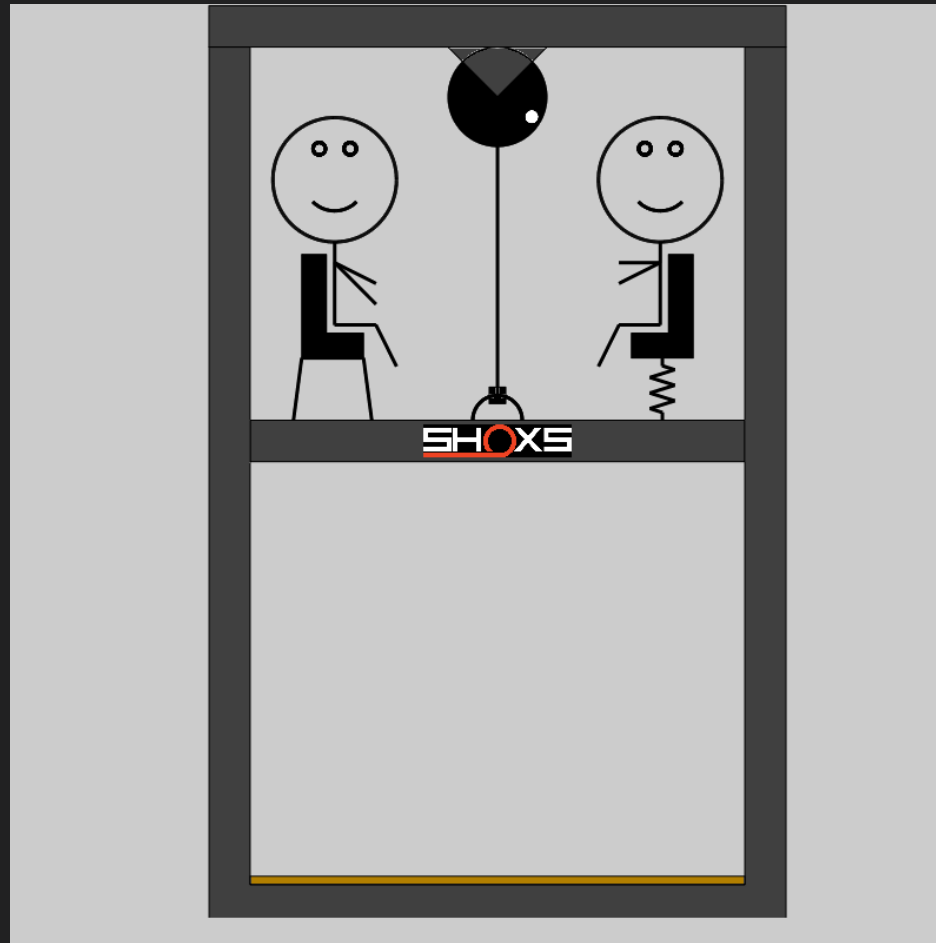
- Step 1: filter the signals
- Step 2: feed filtered signals into severity algorithm
- Step 3: calculate ratio of severities (MR)



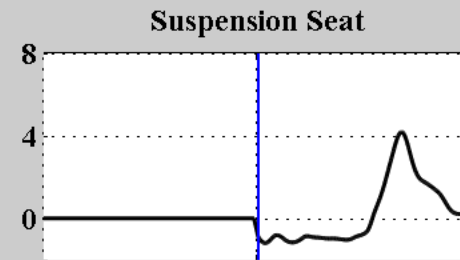
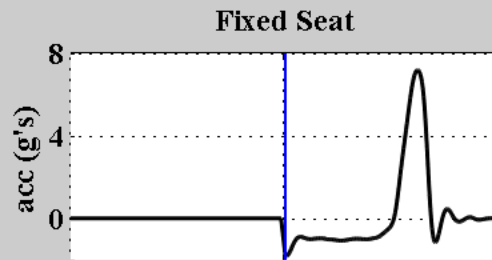


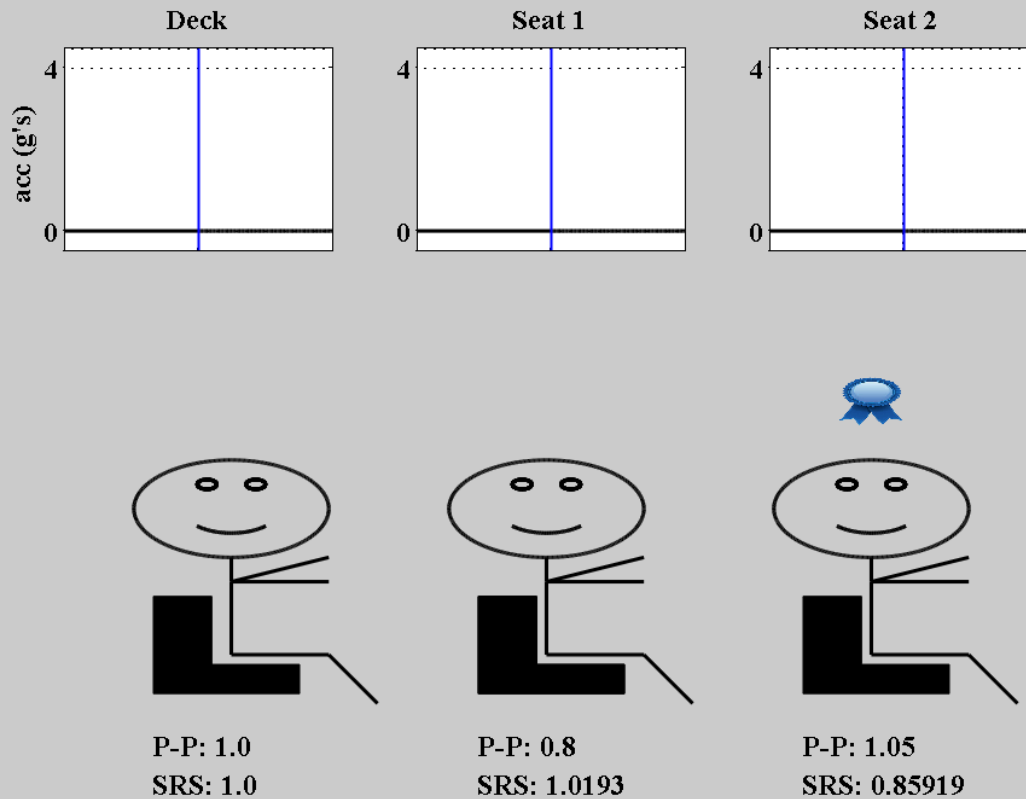
Performance Metrics: P-P, VDV, & SRS

- P-P MR: take ratio of peak acceleration values
- VDV MR: calculate vibration dose values
- SRS MR: calculate the effects of acceleration on a simple physical model



- Solve: $z''(t) + 2\zeta\omega z'(t) + \omega^2 z(t) = -a(t)$





Myths and Misconceptions



A technical line drawing of a scissor lift, shown from a side-rear perspective. The drawing is rendered in white lines on a solid red background. It illustrates the mechanical components of the lift, including the scissor arms, hydraulic cylinders, and the platform. Two specific dimensions are highlighted with white dimension lines and labels: 'CUSHION HEIGHT 13.5 - 16.5' and '8.25'.

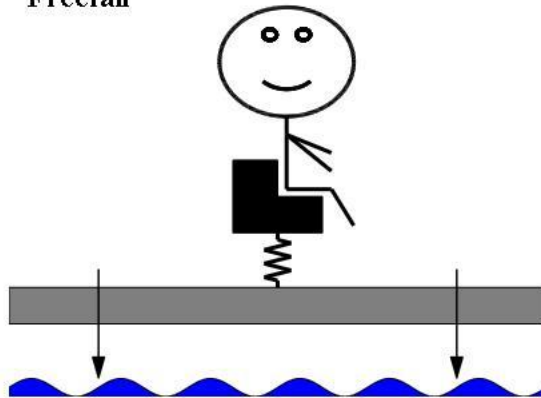
CUSHION HEIGHT
13.5 - 16.5

8.25

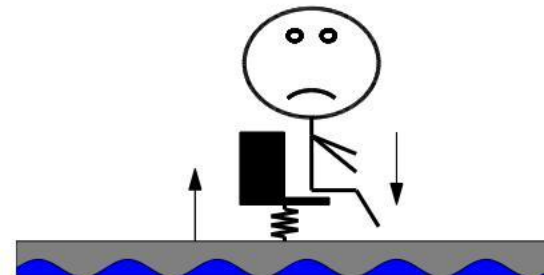
- Fallacy #1: On-water testing is the best/only way to assess shock mitigating performance
- Fallacy #2: Comparing unfiltered peak accelerations provides accurate indications of shock-mitigating performance
- Fallacy #3: Complex adjustments are required to achieve high-performance shock mitigation
- Fallacy #4: Comfort determines shock-mitigating performance

- Comfort and shock mitigation are not the same
- Seat cushions can amplify shocks
- Seating decisions should not be based purely on comfort

Freefall



Rebound



Conclusions

CUSHION HEIGHT
13.5 - 16.5

8.25

- A new standard for evaluating shock-mitigating performance of marine seats is under development
- The methods required to accurately measure shock-mitigating performance are sophisticated
- The cost of not using shock-mitigating seats should be carefully considered

- M. Riley, T. W. Coats, and H. P. Murphy, and H. C. N. Ganey. “Acceleration response mode decomposition for quantifying wave impact load in high-speed planing craft .” US Navy Technical Report NSW-CCD-TR-2014/007.
- W. Ensign, J. A. Hodgdon, W. K. Prusaczyk, D. Shapiro, and M. Lipton. “A Survey of Self-Reported Injuries Among Special Boat Operators”, Naval Health Research Center, Report 00-48, 2004.
- ISO 2631 TC 108/SC 4 WG 18. “Laboratory evaluation of marine seat shock isolation,” in progress, 2015.
- M. Riley, T. W. Coats, H. P. Murphy, and H. C. N. Ganey. “A Method to Quantify Mitigation Characteristics of Shock Isolation Seats Before Installation in a High-Speed Planing Craft .” SNAME World Maritime Technology Conference & Ship Production Symposium, 2015.



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