

A Methodology for Creating PMHS Targets with a Two-Dimensional Standard Deviation Ellipse Tolerance for Quantitatively assessing Dummy Biofidelity

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I. INTRODUCTION

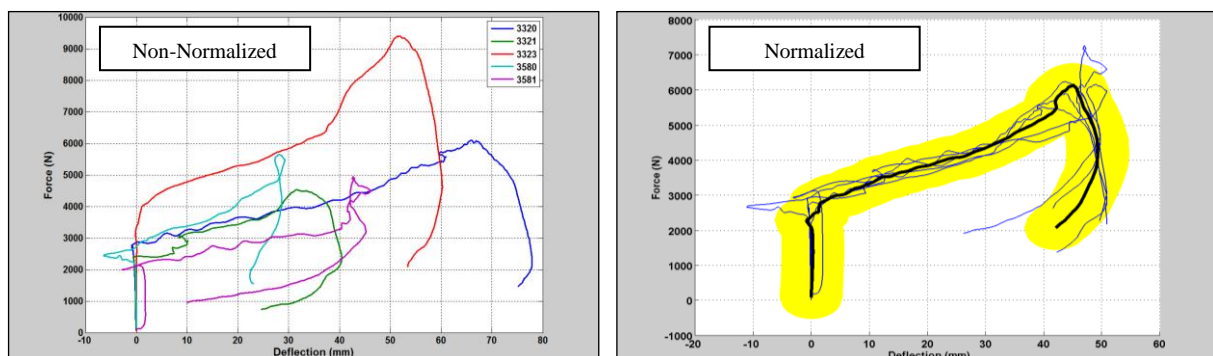
Generating a target for the quantitative assessment of crash dummy biofidelity based on normalized post-mortem human subject (PMHS) response data is important for both dummy design and evaluation. The dummy being studied generally represents a particular sized human based on standard anthropometry, e.g. the 50th percentile male. Normalization is the process of modifying a set of PMHS response data to represent a particular sized human. A mechanistic and statistically based methodology is presented for normalizing PMHS response data and generating a force versus displacement biofidelity target consisting of a mean response curve with a two-dimensional standard deviation ellipse tolerance corridor [1].

II. METHODS

Given a set of well documented PMHS response data (e.g. lateral and oblique thoracic pendulum impacts [2]), the following data processing steps are taken.

1. Calculate the absorbed energy for each subject by integrating the force versus deflection time histories from time zero to maximum deflection. Calculate the mean maximum absorbed energy. In this example force was measured with a load cell and deflection with a chestband [3].
2. Normalize the chest deflection time histories for each subject to the average maximum chest displacement (average maximum deflection/individual maximum deflection) [4].
3. Select a maximum time duration suitable for all subjects and interpolate the normalized deflection time histories to the same time base as the force time histories (if necessary).
4. Calculate a revised absorbed energy for each subject using the force and the normalized deflection.
5. Calculate a force scale factor for each subject using absorbed energy (average maximum absorbed energy/revised individual maximum absorbed energy).
6. Normalize the subject forces at each time increment using the force scale factor.
7. Calculate a mean and standard deviation for the normalized deflections at each time increment.
8. Calculate a mean and standard deviation for the normalized forces at each time increment.
9. Plot the mean scaled force versus the mean scaled deflection with a mean standard deviation ellipse at each point.

III. INITIAL FINDINGS



IV. DISCUSSION

The method creates a mean normalized response based on average absorbed energy. The mean and standard deviation ellipses provide a target such that a dummy response that lies within the combined ellipse area is less than one standard deviation from the mean [5]. A dummy response can be quantitatively compared to the target and assessed in terms of the number of standard deviations different from the mean. A limitation is the assumption that the average deflection is equivalent to a 50th percentile male response; however, the subjects were selected to approximate a 50th percentile population and more subjects would improve the estimate.

V. REFERENCES

- [1]Shaw J, Stapp 2006. [2]Rhule, Stapp 2011. [3]Maltese, Stapp 2002. [4]Lessley, SAE 2004-01-0288. [5]Rhule, ESV 2013.
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