

# *Side Impact Dummy Biofidelity*

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**NHTSA**

# *Overview*

- **What is Biofidelity?**
- **Impact Testing**
- **Translating Test Data to into a Biofidelity Score**
- **Biofidelity of various Side Impact Dummies**
- **Conclusions**

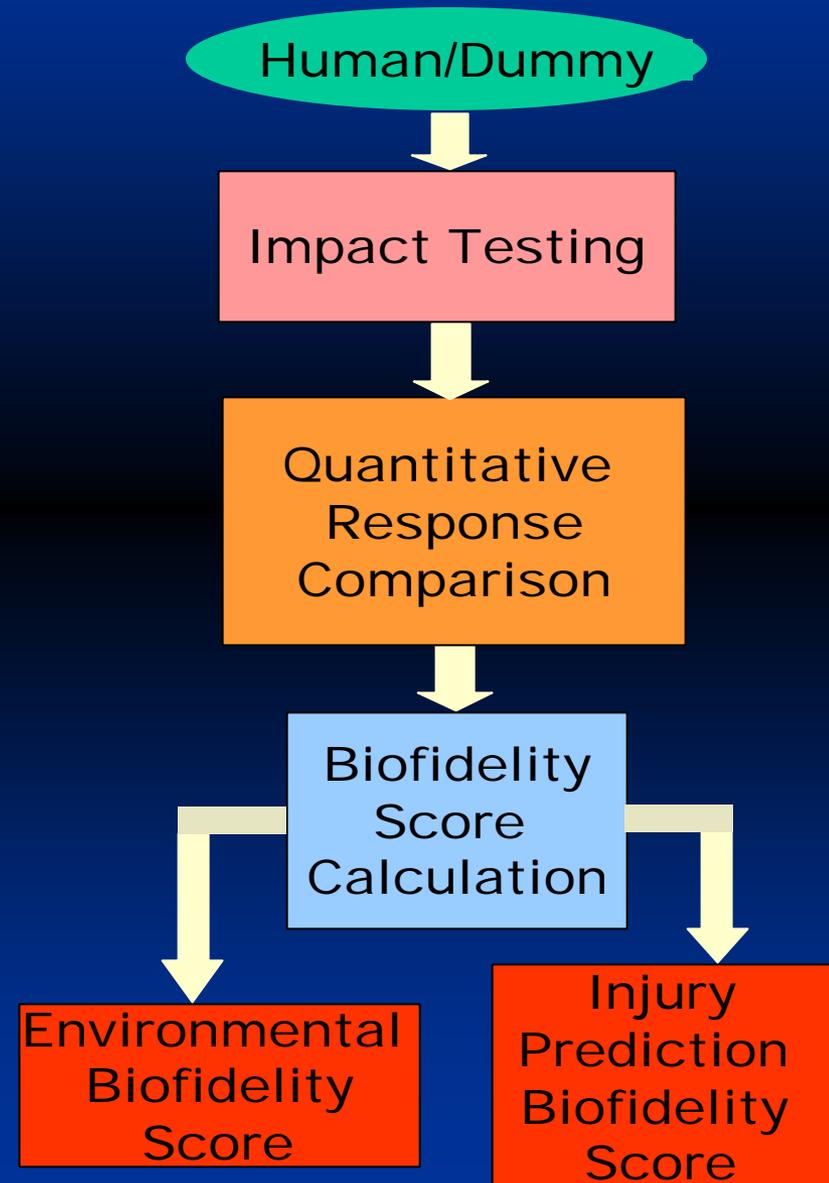
# *What is Biofidelity?*

## ■ **A crash test dummy should:**

- **Load the Crash Environment Like a Human Would**
  - a side impact dummy should impart human-like force-area-time history upon the vehicle environment
- **Predict Human Injury Consequences**
  - a side impact dummy should reproduce the necessary internal kinematic and kinetic measurements to accurately predict injury

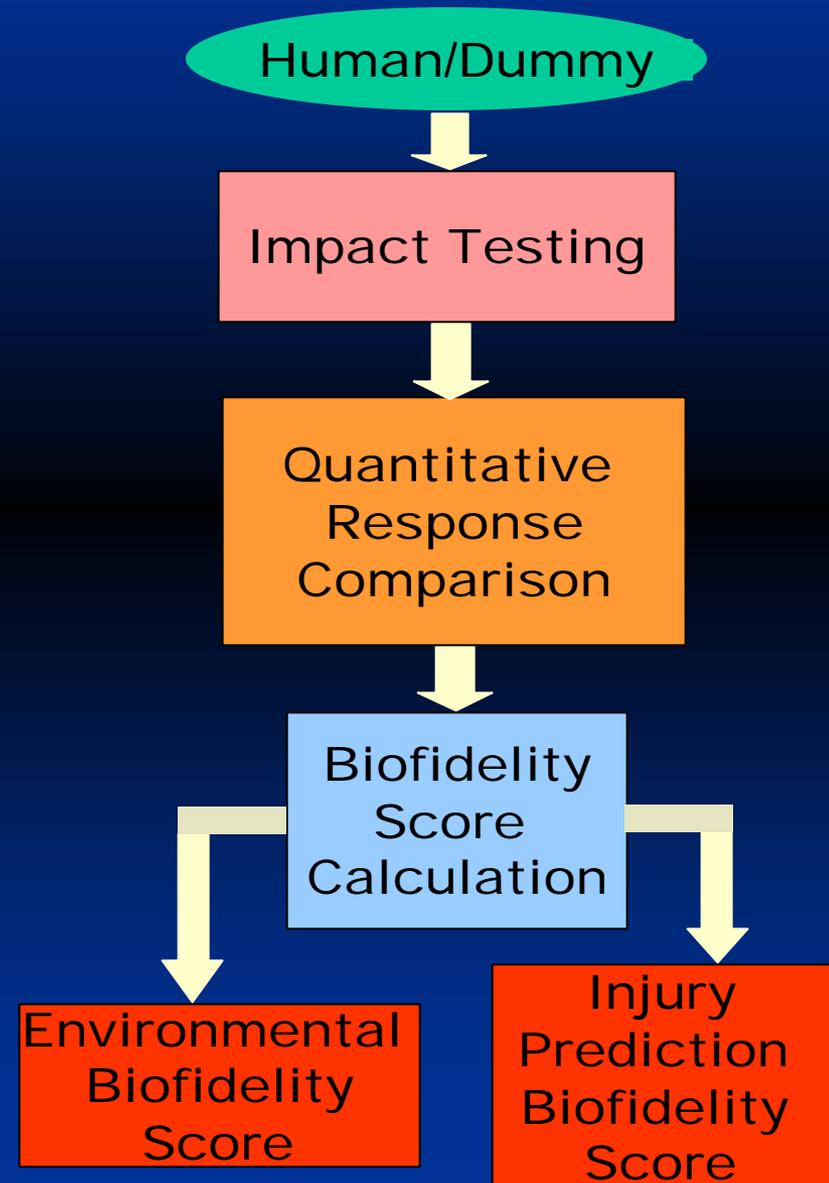
# *Biofidelity Evaluation Process*

- **Test the dummy and human surrogate in an environment similar to the crash**
- **Compare quantitatively the response of the human and dummy**
- **Combine the quantitative response comparison from each test into a meaningful score**



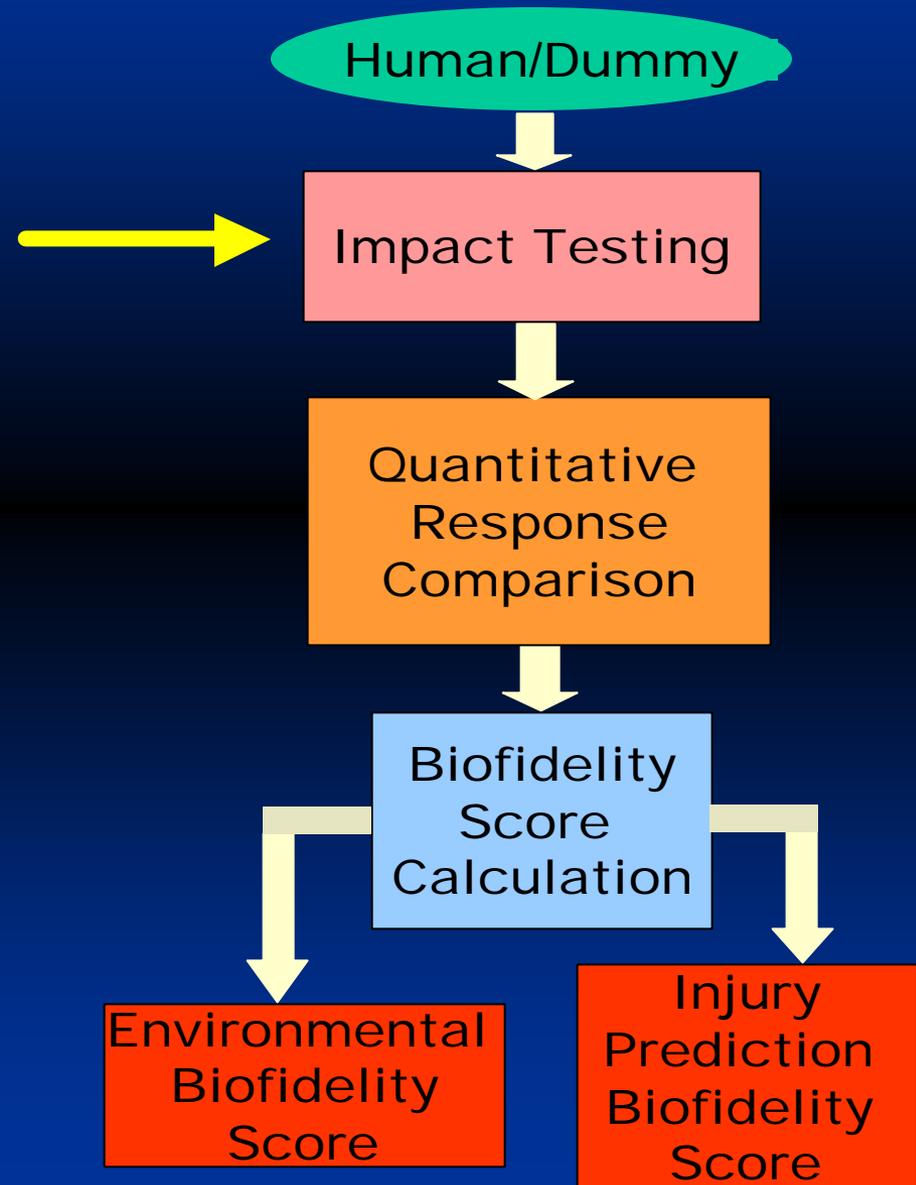
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# *Biofidelity Evaluation Process*

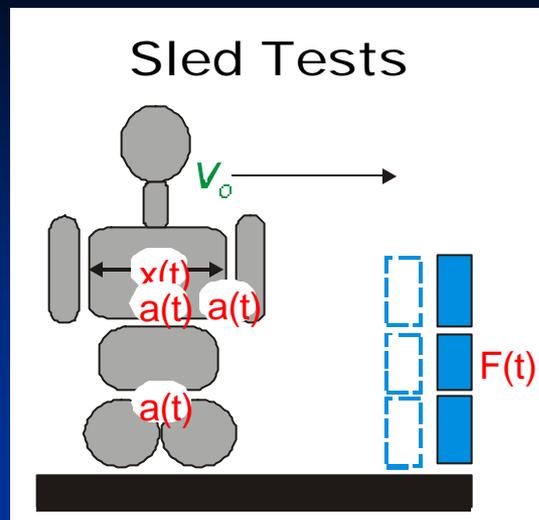
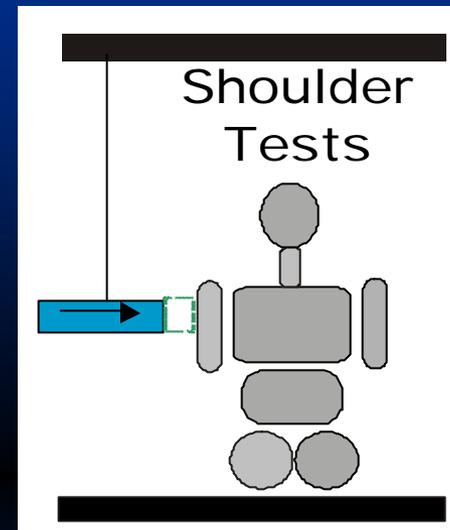
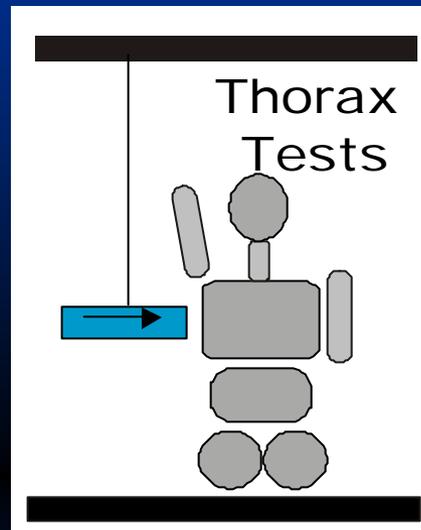
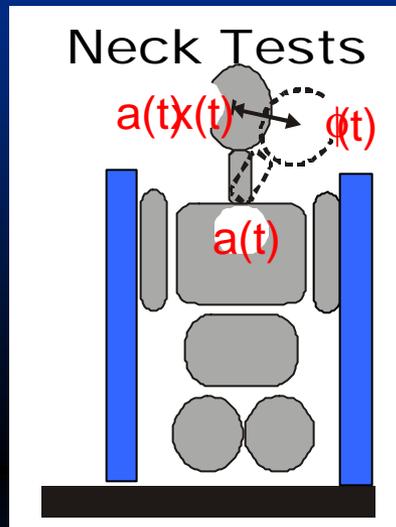
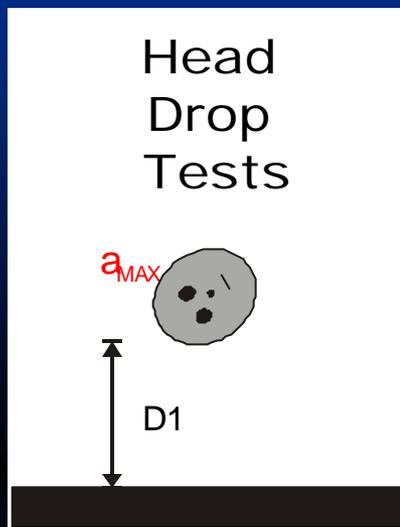
## **Impact Testing**



# ***NHTSA Biofidelity Impact Tests***

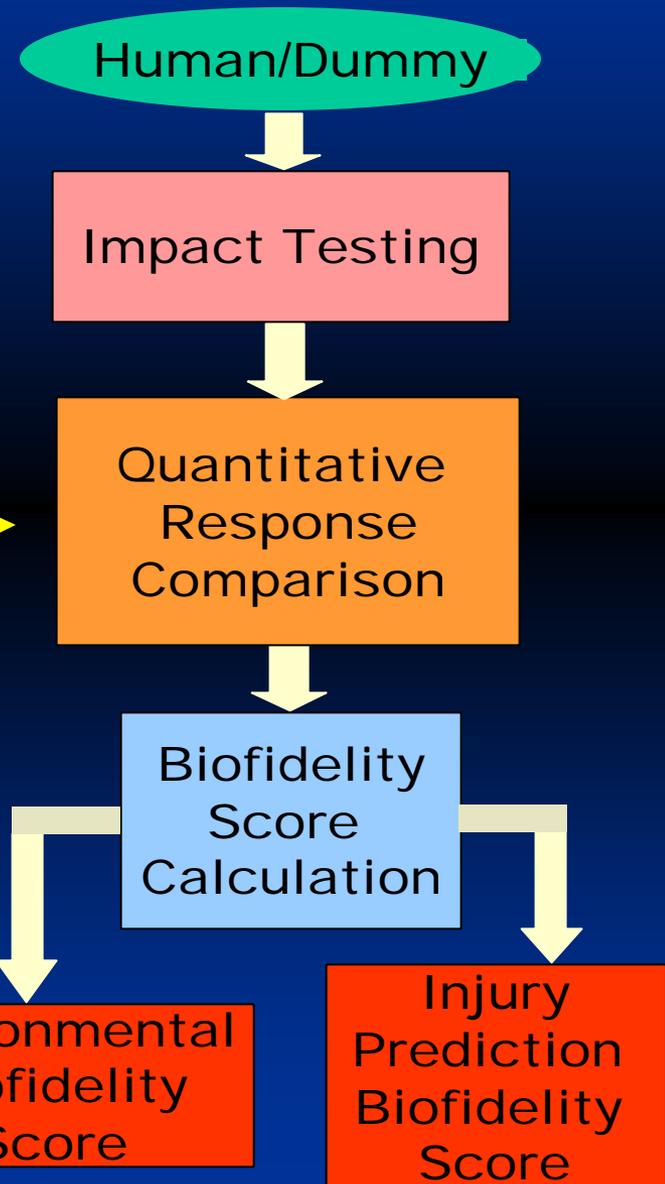
- **Biofidelity tests are conducted on both dummies and human surrogates in a variety of test conditions.**
- **Tests include:**
  - **Whole-body Sled Tests to quantify the performance of the torso and pelvis as a system.**
  - **Pendulum tests to the thorax and shoulder.**
  - **Neck tests to ensure the head is correctly positioned for a head strike.**
  - **Head Drop tests to quantify the response of the head exposed to blunt impact.**

# NHTSA Biofidelity Impact Tests



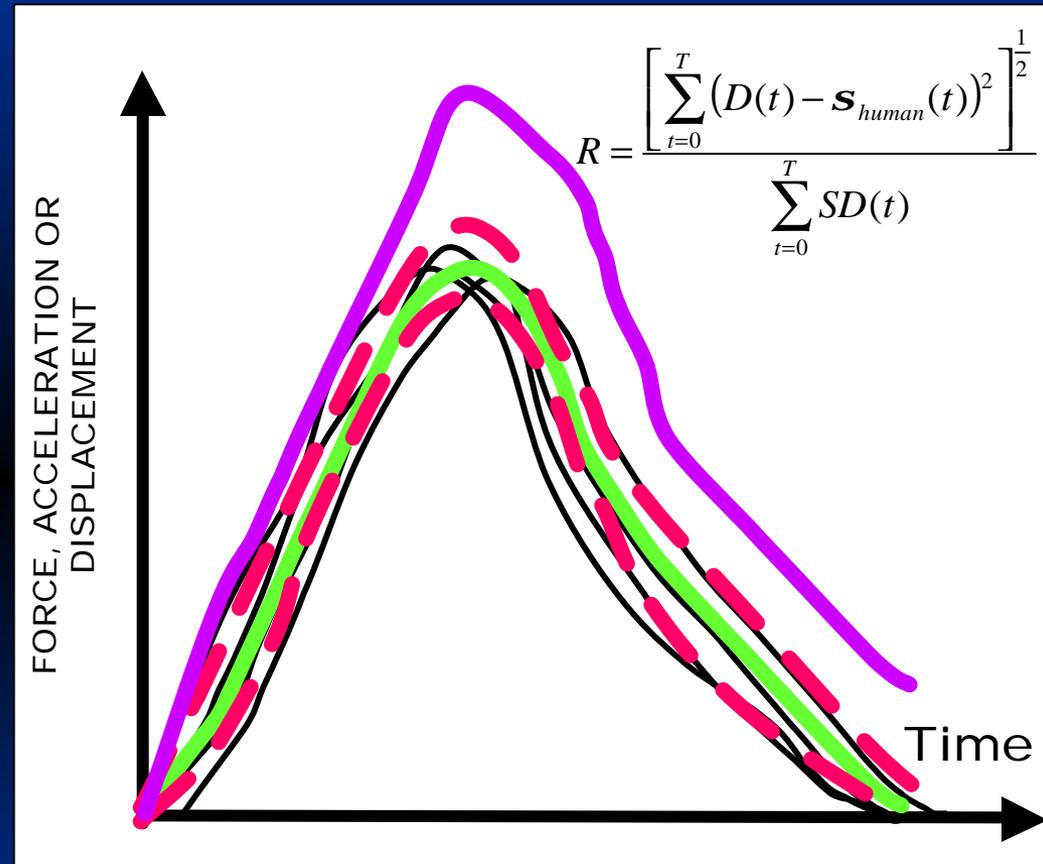
# *Biofidelity Evaluation Process*

**Quantitative  
Response  
Comparison**

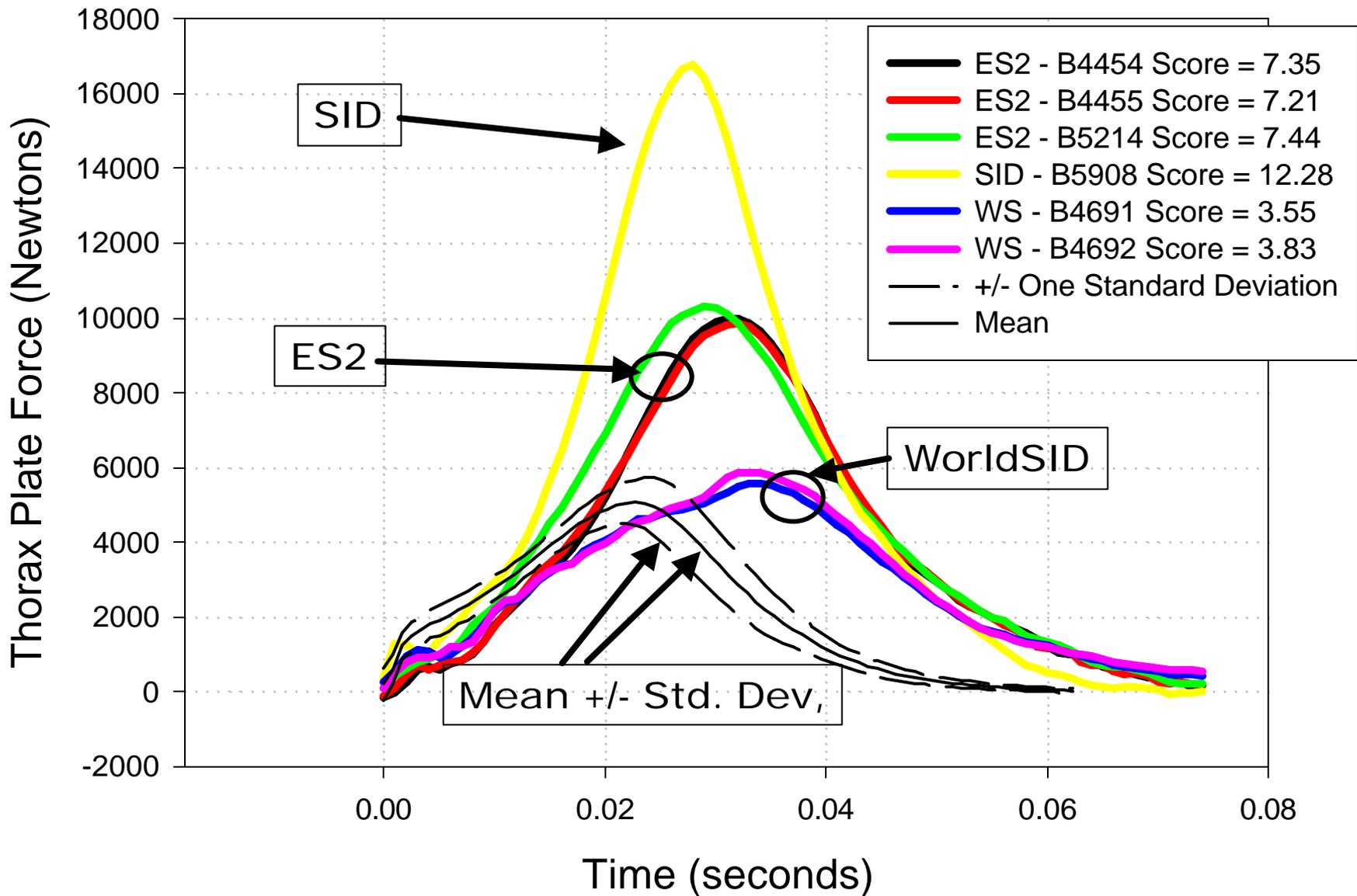


# Dummy-to-Human Comparison

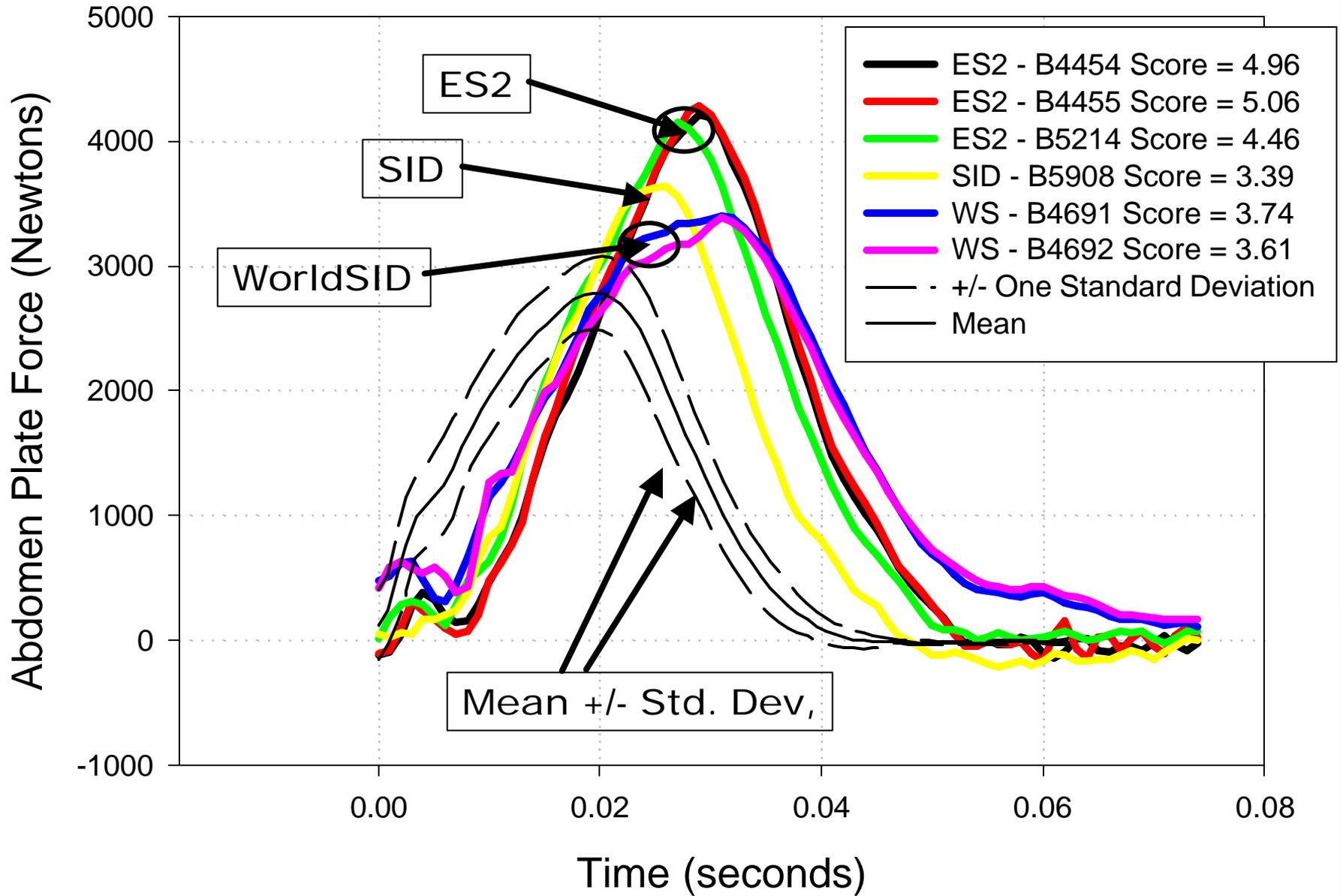
- Human surrogate and dummy response signals are overlaid
- The dummy response ( $D$ ), surrogate mean ( $F$ ), and standard deviation ( $SD$ ) are then combined to quantify ( $R$ ) how well the dummy matches the cadaver.



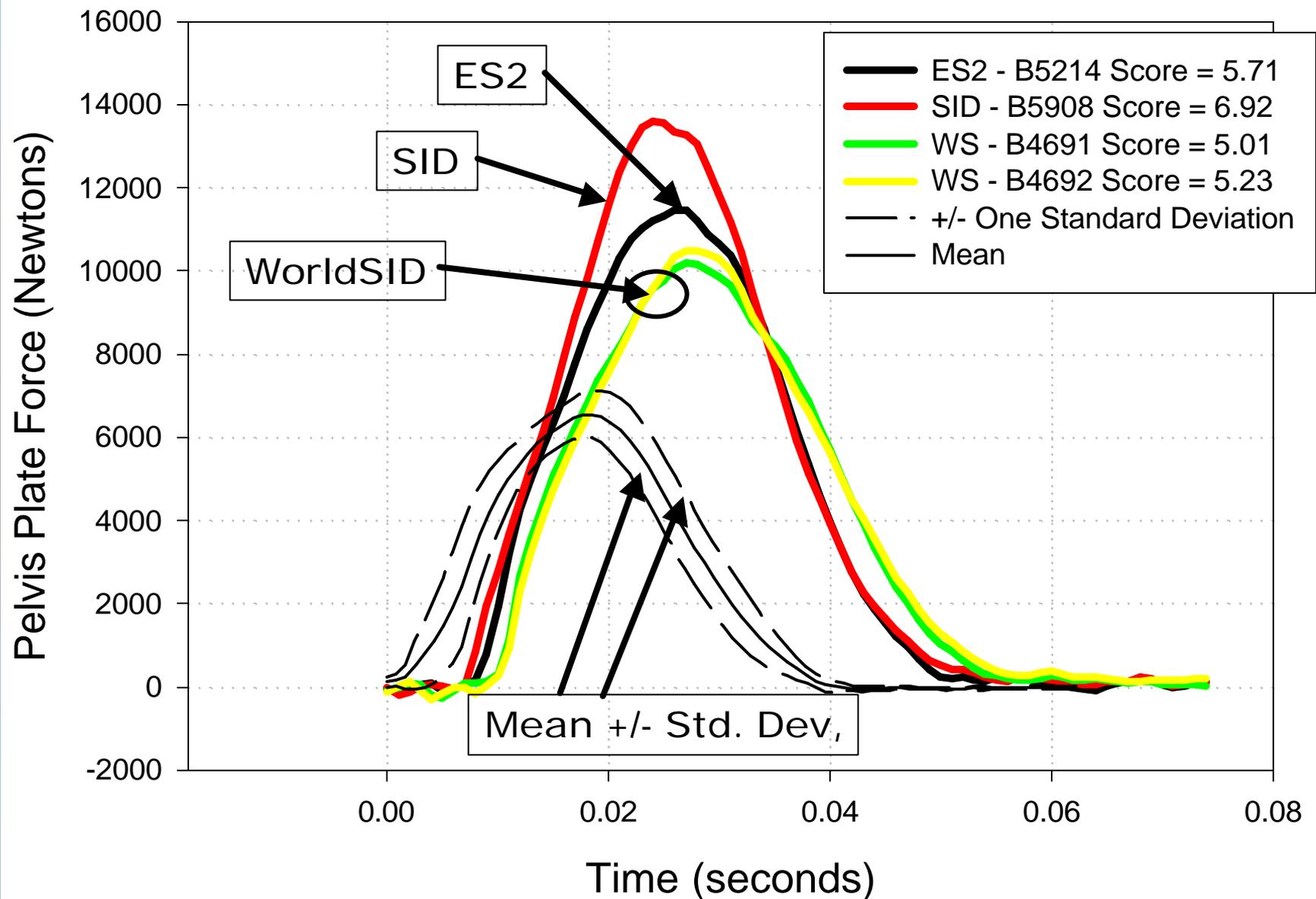
# Padded 8.9 m/s Flat Wall Sled Test



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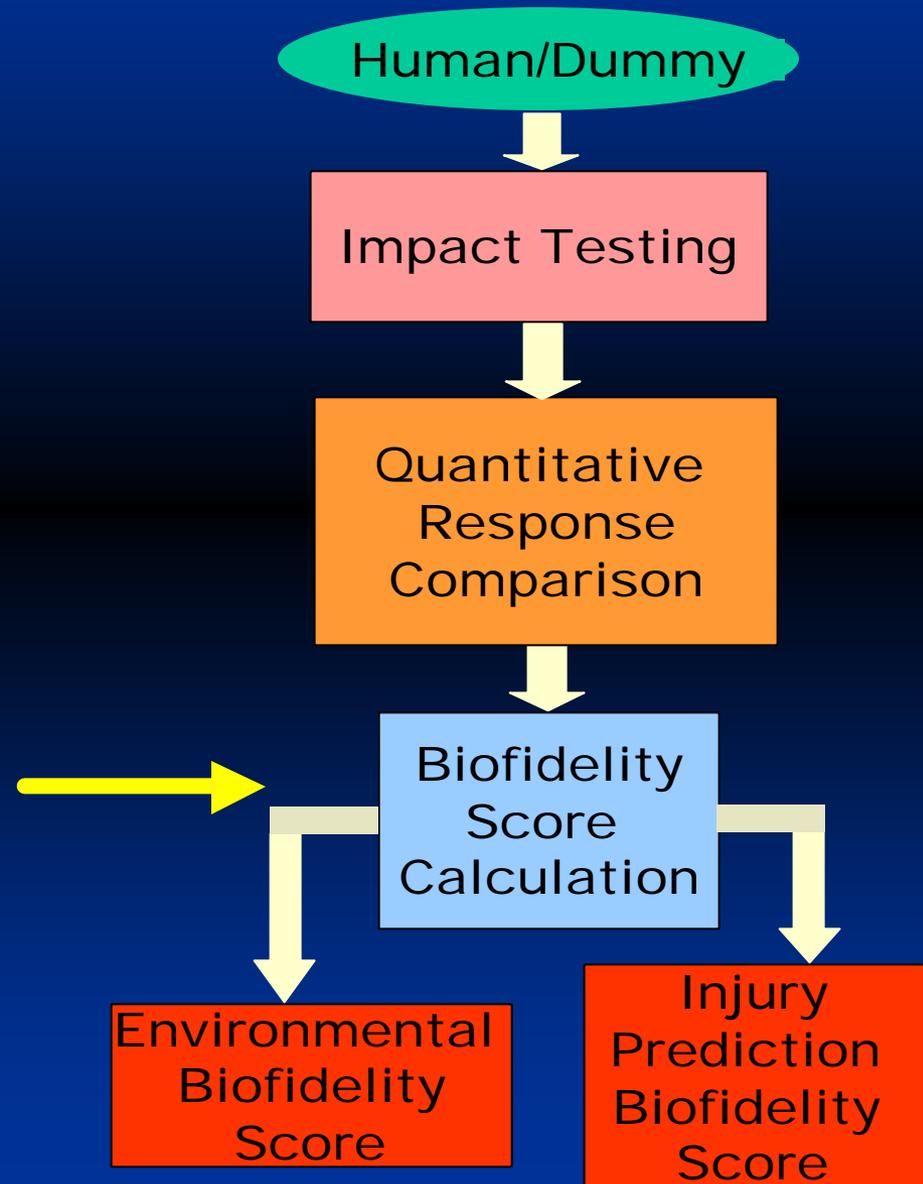


# Padded 8.9 m/s Flat Wall Sled Test



# *Biofidelity Evaluation Process*

**Biofidelity  
Score  
Calculation**

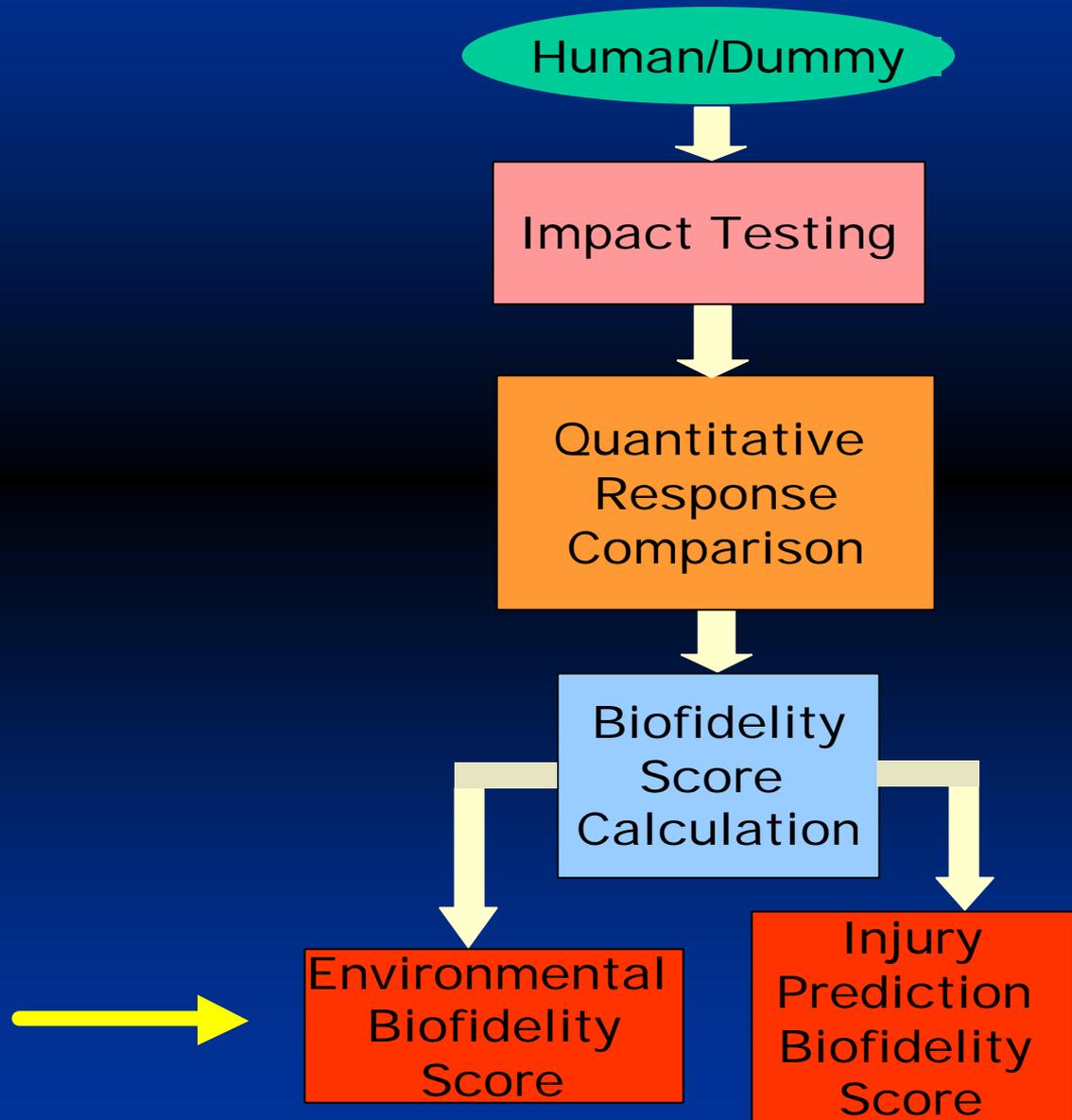


# *Test Condition Weights*

- **Each R score is weighted according to its test condition.**
- **The Test Condition Weights quantify the importance of the results from a particular test condition in the overall biofidelity score.**
- **Two factors influence the weights:**
  - the number of human surrogate test subjects used to develop the corridor.
  - the degree to which a particular test condition matches the real-world crash environment.

# *Biofidelity Evaluation Process*

**Score**



# ***Biofidelity Scores***

## **■ Two Scores are Calculated**

- **Environmental Biofidelity Rank = average of the weighted R values from Load wall and pendulum forces, as well as head/neck displacement and angle.**
- **Injury Criteria Fidelity Rank = average of the weighted R values from the signals used to calculate the injury criteria for a particular body region.**

# *Rating Dummy Biofidelity*

$0 \leq B \leq 1$	Excellent
$1 < B \leq 2$	Good
$2 < B \leq 3$	Moderate
$3 < B$	Poor



# Dummy Scores

ES-2

SID/H3

WSIDp

## Impact Biofidelity

Overall	3.4	3.6	2.5
Head/neck	3.7	1.0	2.1
Shoulder	1.2	5.6	2.1
Thorax	5.4	6.3	3.1
Abdomen	3.6	3.5	2.5
Pelvis	2.6	3.6	3.5

(Smaller/Better)

## Injury Criteria Fidelity

Head	0.6	0.6	0.4
Thorax	1.1	1.1	1.1
Abdomen	3.6	NA	1.3
Pelvis	1.8	1.8	1.9

# ***CONCLUSIONS***

- **In terms of the biofidelity of the dummy-to-vehicle interaction,**
  - the SID/H3 is less biofidelic than the ES-2, and
  - the WorldSID Prototype is more biofidelic than both the SID/H3 and the ES-2.
- **In terms of the biofidelity of the measurements on the dummy required to predict injury,**
  - the head and thorax of the SID/H3, ES-2 and WorldSID Prototype were equally biofidelic,
  - the abdomen of the WorldSID Prototype is more biofidelic than the ES-2, and the SID has no abdominal injury detection capability, and
  - the pelvis of the SID/H3, ES-2 and WorldSID Prototype have roughly the same biofidelity.

***Thank You***