



## **Humanetics Innovative Solutions, Inc.**

The Brand Harmonization of the Hybrid III 50<sup>th</sup> Male Crash Test Dummy

78051-218



The ATD Harmonization Task Group  
November 2011

## Table of Contents

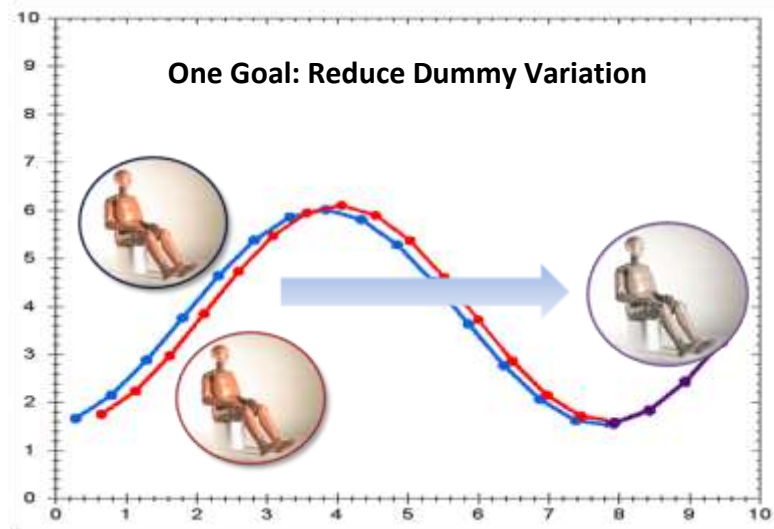
An Introduction to Crash Test Harmonization .....	2
The Harmonization Process .....	3
Vinyl Material Harmonization .....	3
Foamed Vinyl Part Sealing .....	4
Surface Coatings and Finishes.....	5
The Hybrid III 50 <sup>th</sup> Male.....	5
Head Assembly.....	5
Neck Assembly .....	6
Upper Torso .....	7
Lower Torso .....	7
Arm Assembly .....	7
Leg Assembly.....	8
Shoe Brand.....	8
Phase-in .....	8



## An Introduction to Crash Test Dummy Harmonization

Crash test dummies, known in technical jargon as Anthropomorphic Test Devices (ATDs), have been the center of attention for a worldwide community of scientists, engineers, and technicians focused on harmonizing two brands of dummies into test devices that will narrow performance variability and help reduce crash test to crash test variation.

In April of 2010, the two leading manufacturers of ATDs, *First Technologies Safety Systems Inc. (FTSS)* and *Denton ATD Inc.* became subsidiaries of *Humanetics Innovative Solutions Inc.* For almost two decades these two companies produced many of the most common dummies in regulation today. Utilizing federalized drawing packages, each organization manufactured their own translation of the Part 572 specifications of the same ATDs. By nature, these specifications have allowed for some differences in the production of these various test dummies-differences the global community would like to see minimized or eliminated entirely.



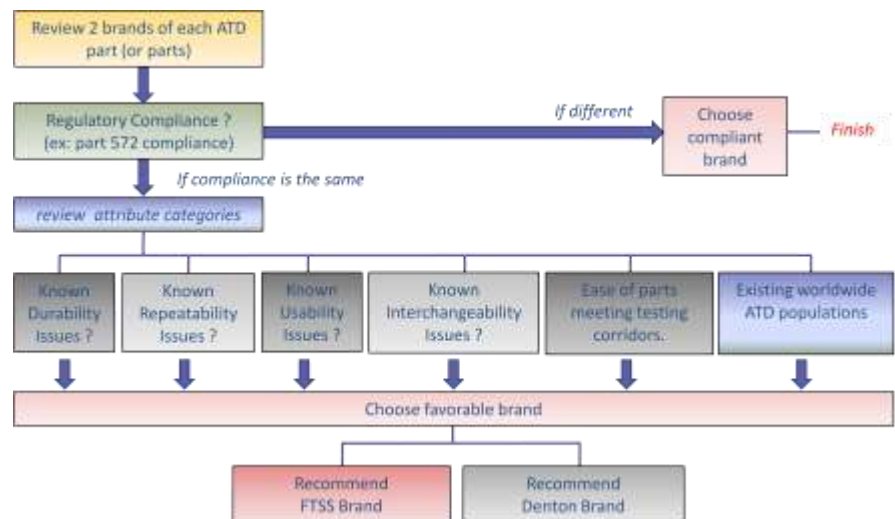
The first organizational meeting was held in November of 2010 to create a global harmonization working group. This initial meeting brought together worldwide members from the Partnership for Dummy Technology and Biomechanics (PDB), the European Auto Manufacturers Association (ACEA), the Occupant Safety Research Partnership (OSRP), the Japan Auto Manufacturers Association (JAMA), Hyundai, and GESAC, as well as regulators and insurance bodies such as the European New Car Assessment Program (EuroNCAP), the National Highway Traffic Safety Administration (NHTSA), Transport Canada, and the Insurance Institute for Highway Safety (IIHS). With these organizations in support of the harmonization strategy, the new committee was able to shape the process in use throughout the year.

The goal of this group was to make technical recommendations towards the consolidation of current brands of ATDs and ATD parts. The intention of the group was not to advocate a particular ATD manufacturer, but rather make technical recommendations regarding harmonizing brands within a manufacturer. No NHTSA documentation changes were recommended. Recommendations were based on adherence to the current drawing packages.

The benefits to the auto industry are to reduce dummy to dummy and crash test to crash test variations for both those who manufacture vehicles as well as those who evaluate them. The harmonized ATDs do not create a third band of variability since they are based on components already found within the current mix of brands in the field. No statistically known performance differences are known. The current brands of dummies and components conform to the specified regulations and can be used until their life cycles are depleted.

## The Harmonization Process

During 2011, almost thirty voting and non-voting members of the Harmonization Task Group have consistently met on a monthly basis to review the individual dummy components with Humanetics. These ongoing monthly harmonization meetings have successfully produced recommendations for consolidated ATDs for the most common dummies in use and regulation today.



Selected ATDs are reviewed from head to toe and the similarities and differences of each brand are discussed. Humanetics provides the design and manufacturing history of the dummies as well as engineering knowledge generated from the multiple brand versions. Members in attendance also provide feedback from their own experiences with each brand. Body segment attributes of design, manufacturing, testing, durability and general interchangeability are shared and examined. A wide variety of characteristics including component shape, conformance to specified drawing packages, performance history, worldwide populations, and molding capabilities are carefully considered. During these discovery phases, the analyses have uncovered many more similarities between the brands than differences, primarily because each manufacturer has historically strived to produce an optimal ATD while conforming to the relevant specifications.

Before adjourning the meetings, voting members cast their votes for the component brand of choice. The task group provides their final recommendations to Humanetics, but does not offer legal or regulatory advice or solicitation.

The task group's in depth review of each brand of crash test dummy examined a wide variety of characteristics including component shape, conformance to specified drawing packages, performance history, worldwide populations, manufacturing efficiency, and molding capabilities. During the initial discovery phase of review, the analysis uncovered many more similarities between the brands than differences. Historically, each manufacturer has committed to producing the optimal performing ATD while conforming to the relevant specifications.

## Vinyl Material Harmonization

The technical reviews of the Hybrid III family of ATDs have also produced a harmonized vinyl and foam material that incorporates the best practices and features of the Denton and FTSS brands. The common vinyl material will utilize a light brown pigment that will set it apart from the flesh hues of the current Hybrid III family. The chemical and material composition has been optimized for the best performance while still meeting the requirements outlined in regulations.

The general vinyl flesh formulations of each ATD brand are very similar; both the Denton and FTSS material use the same resins, plasticizers, and stabilizers that are merely mixed slightly different. Currently, both brands of raw vinyl are manufactured by the same vendor using individual color pigments. The major control verification is durometer (hardness) based on the drawing specifications.



Since pink flesh tones can be challenging to color match and keep consistent, the European brown color utilized on the EuroSID-2 was a natural choice to help distinguish harmonized parts from many of the current Denton and FTSS versions. Some of the many benefits of the brown pigment include a reduction in vinyl trimming during manufacture with fewer surface imperfections on the final product. The new color will also be photo friendly with a hue that's not too light or too dark to capture under high speed filming conditions.

The two brand's process variations have yielded different surface finishes and 'feel' from their respective flesh. The final step of vinyl surface polish is distinctive for each brand. The FTSS version uses acetone for exterior conditioning once the parts have been trimmed and any imperfections sanded out. Acetone produces a slightly dull, matte surface finish. The Denton brand uses methyl ethyl ketone (MEK) to condition the surface, which produces a relatively shiny finish. Whether using acetone or MEK, one method does not have a protective advantage over the other. From a commercial standpoint, acetone is easier to handle during production and is more environmentally accepted relative to MEK, making it the recommended choice of the Harmonization group.

The harmonized vinyl characteristics:

- FTSS brand 52 durometer vinyl
- European brown color
- Acetone processed surface finish

### **Foamed Vinyl Part Sealing**

The foam pour holes in vinyl parts typically leave noticeable holes that have historically been patched for both brands. Generally the European manufactured parts (ex. EuroSID) have left the pour holes open. Sealing has drawbacks from a ventilation aspect; foam curing sometimes produces slight shriveling in sealed parts.

The committee agreed that any part with noticeable pour holes when the dummy is fully assembled; i.e. chest jackets and pelvis assemblies will be sealed. Abdomens will be sealed as a general rule for all dummy types. Other body parts that have hidden pour holes on the assembled dummy will not require patches.



*Leg flesh with exposed pour holes*

## Surface Coatings and Finishes



*Nickel plated  
spine box*

The recommendations of the Harmonization Task Group state that surface finishes and coatings should be consistent across all models of ATDs. These include a single type of nickel coating for steel, the anodizing of aluminum, and the treatment of casted metal surfaces.

Nickel plating is a superior coating that ensures parts do not rust through normal usage and has been in use on the Denton brand for many years with great success. Although black oxide appears on older drawing specifications, it provides very little rust protection. White rust can occur within minutes when exposed to standard salt spray tests and red rust can occur within 10 hours of exposure. Nickel plating will withstand 48 hours in a standard salt spray test without the appearance of white rust and will withstand a salt spray for 300 hours before the appearance of red rust.

Anodizing is an oxidation process that increases corrosion and wear resistance on machined aluminum. Dyes can be used to create varied shades of colors. Typically, the FTSS brand utilized a red color and the Denton brand anodized with a blue shade. Colors hues can drift from batch to batch, sometimes making it challenging to produce consistent results over time. Humanetics is currently using a clear, colorless anodizing for all machined aluminum parts and will incorporate this process into all harmonized aluminum product as well.



*Clear anodized  
aluminum neck  
bracket*

Tumble finishing for metals is the process of smoothing, cleaning, deburring and polishing rough surfaces. Within Humanetics this technique is mainly used on casted metal surfaces such as aluminum skulls and clavicle components. Originally used on the Denton brand, tumbling is being incorporated throughout the harmonized product line to reduce this type of surface variation.



*Tumbled aluminum surface*

*Non-tumbled aluminum surface*

**The Hybrid III 50<sup>th</sup> Male**

The Task Group’s recommendation for the brand harmonized HIII 50<sup>th</sup> Male consists of the following brand based components:

<i>DN = Denton Brand FTSS = FT Brand</i>	Head	Neck	Upper Torso	Lower Torso	Legs & Feet	Arms & Hand
<b>HIII 50<sup>th</sup> Male*</b>	DN	DN	FTSS	DN	DN	DN
<i>*Harmonized Vinyl for all HYIII Family and CAPPS brand shoes.</i>						

**Head Assembly**

The most evident difference observed between the two brands of head assemblies is the head skin. The Denton brand head skin has a hollow nose and an angled chin. The FTSS brand head skin has a solid nose, straight chin, thicker vinyl, and is approximately a ¼ lb heavier than the Denton version.



*Ballast attached to interior of skull cavity*

The FMVSS part 572 head skin drawing calls out a vinyl thickness of .441 +/- .030 inches. The Denton brand measures .471 and the FTSS version measures .513. The drawing also references the original GM pattern (mold) as the basis for the head skin shape and size specification. The GM mold has a hollow nose. Denton brand head skins will fit onto FTSS brand skulls, but will produce a lighter assembly that will need re-ballasting. Part of the weight difference is from the thicker wall of the FTSS head skin. *\*\*Customers who purchase harmonized head skins to install on FTSS brand skulls will be required to verify weight and CG of the complete head assembly and make any ballast adjustments that are necessary.*

One of the Task Group’s goals is to eliminate as many deviations from the drawings and specifications as possible. The head skin thickness and pattern should conform as closely to the drawings as possible. For this reason, the group decided to incorporate the Denton brand head assembly into the harmonized ATD. The group agreed that there would probably be no differences in airbag testing since both brands of head skins currently pass certification.

**Neck Assembly**

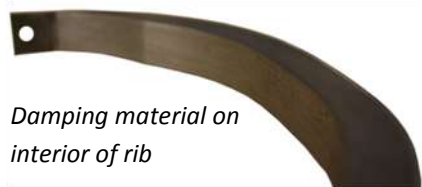
Both necks use 70-80 durometer butyl rubber and both are shipped with the nodding blocks used to certify the neck. The committee’s decision was to keep the neck brand the same as the head brand.

## Upper Torso

The chest jacket brands have slight differences in height, arm hole shape, and foam fill areas. The bottom of the vinyl jacket is solid on the FTSS version and filled with foam on the Denton brand. The arm holes are longer on the FTSS version and the Denton jacket is slightly taller overall. The shoulder width is the same, but the original pattern is not symmetrical, which is reflected in both jackets. The jacket drawing references the pattern from Humanoid Systems, which resides with GM. The final comparison results determined that the FTSS brand jacket is closer to the pattern and the drawing.



The current rib damping material thickness used to tune each brand's thorax impact performance is similar using either brand jacket. The interchangeability testing has been very good during internal Humanetics comparisons. Since FTSS and Denton use the same material from the same manufacturer, both brands tune the thickness in similar ways.



*Damping material on interior of rib*

Although the metal skeletal components are the same across brands, the FTSS brand investment shoulder castings are recommended because of their consistency and quality.

## Lower Torso

FTSS and Denton used the same pelvis bone pattern when originally creating their pelvis versions, so the casting shape is consistent between the two. The distance between the ASIS points show the biggest measurement difference, but they are within casting tolerances.

The upper femur cavities of the molded pelvis have slight size differences between brands. The pelvis bone was casted from a human bone and is not symmetrical. This has produced a ten degree angle difference between the right and left ball socket locations. No appreciable differences in the femurs have been noticed.

Measurements of the rubber lumbar showed that both brands had the same nominal 45 degree angle, but the Denton brand height is approx 3.6mm taller and was found to be closer to the original drawing specifications for height. The SAE committee will continue with the development of static and dynamic lumbar tests. The Denton version lumbar has revised sprue locations for quality purposes and is the recommended version.

There is not much physical difference in abdomen height, width, and length between the two brands.

## Arm Assemblies

There are a few noticeable differences in arm components. These include foam fill areas around the wrist and the joint interfacing at the elbow. It was decided to maintain one brand throughout the arm components, regardless which version was recommended.



**Leg Assemblies**

The most noticeable difference occurs in the knee flesh and the rubber knee insert. The standard FTSS version of the 50<sup>th</sup> knee has a shorter, squared off rubber knee insert with a corresponding sized insert cavity within the flesh. Denton has produced this same version for the Japanese market, but the standard Denton brand 50<sup>th</sup> dummy includes the longer, tapered rubber insert found in the drawing package. It was concluded that the squared off rubber knee insert will be used because of an increased consistency in positioning the insert inside of the knee flesh.

**Shoe Brand for HIII Adult Family**

The Denton and FTSS brands both meet the drawing specifications of MIL-S13192 change "P." They both have rubber soles, removable insoles, and conform to the 11EEE sizing, but the toe box length of the Denton brand is slightly longer. The FTSS CAPPs version is recommended.

**Phase-in**

The majority of both brands of ATD components is already interchangeable and will have no effect on use. Currently, these types of parts may only be identifiable by their metal surface coating or the shade of the vinyl flesh. The major discussion points have included the head, pelvis, and the chest jacket components.

The Harmonization Task Group emphasizes to individual labs and companies that there is no need to replace all ATDs and ATD parts immediately. A user may choose to replace parts only as typically needed, but do so with the harmonized versions. Some groups such as NHTSA, IIHS, and others expressed that they would prefer to start ordering harmonized parts as soon as possible. Therefore, Humanetics has begun to harmonize Hybrid III components and will provide Technical Bulletins as each part is ready for sale.

Once brand specific components are depleted from stock, current orders will be fulfilled with harmonized versions. New components available for sale will be completely based upon the harmonization decisions recommended by the Task Group.