An Evaluation Tool

A crash test dummy is a tool to evaluate the safety of occupants. The first dummy, developed in the late 1940’s, evaluated aircraft ejection seats. Since then, dummies have evolved into high-tech tools used worldwide in evaluating occupant injuries. Their most common usage is in full-scale and simulated crash tests. These tests assess occupant injuries in the automotive, aircraft, marine, and rail industries. Most people have seen the television footage of the crash tests used for determining the star or vehicle ratings given to vehicle models by the National Highway Traffic Safety Administration (NHTSA) and the Insurance Institute for Highway Safety (IIHS). The dummies are the stars in these injury evaluation tests. Did you know that the same dummies are used to evaluate injuries for a light rail mass transit crash? Did you know that aircraft seats are designed for occupant injury protection in survivable accidents? These dummies are used throughout the entire transportation industry.

The Dummy Family

Dummies are designed to match body measurements and weight distribution of specific human sizes. There are dummies for newborn, 6-month, 12-month, 18-month, 3-year, 6-year, and 10-year-old children. Adult dummies are available for the small stature female, average male, and large male sizes. The dummies also vary in construction depending on their use: frontal, side, and rear impacts. In each of these cases, the body parts are configured and instrumentation is placed strategically throughout the dummy to evaluate specific criteria. For example, the DOT-SID (Side Impact Dummy) is designed without arms in order to minimize the affect the arms have on torso measurements. The arms are replaced by foam blocks that are placed next to the rib cage.

Dummy Parts

Body segments are constructed to provide human-like motion and sustain repeated impacts. These parts are made of aluminum, steel, plastic, foam, and rubber. For instance, the neck is constructed of flexible, molded rubber and aluminum discs that provide human-like forward and rearward bending. Also, the rib cage, represented by spring steel ribs with plastic-based damping material, simulates a human’s rib cage deflection characteristics.
History

If there was to be a grandfather of all test dummies, it would most likely be Sam Alderson. His company, Alderson Research Laboratory (ARL), helped to develop the first test dummy in the late 1940’s. This dummy was named Sierra Sam, the first member of the Sierra dummy family. These first test dummies were used to test military aircraft ejection seats. In the early 1950’s, the Grumman-Alderson Research Dummy (GARD), was developed as a successor and used in early crash testing programs by Cornell Aeronautical Laboratory. During the 1960’s, the Sierra family grew with the addition of Sierra Stan, Sierra Susie (5th%), and Sierra Sammie (child). The Alderson family also grew with the addition of the VIP (Very Important People) series that included a 95th, 50th, and 5th percentile, and also 6-year and 3-year old test dummies.

In the early 1970’s, there was a wedding of the Sierra and Alderson dummies at General Motors laboratories and the Hybrid I was born. A short time later, the Hybrid II was born as a further development of the Hybrid I. The ATD family continued to grow during the 1970’s with the development of the Hybrid III, which was introduced in 1976, and then in the late 70’s, the SID (Side Impact Dummy). In the 1980’s, the Hybrid III family added the 5th percentile female and 95th percentile large male dummies to be followed by the Hybrid III 3-year and 6-year-old dummies in the 1990’s. SID’s family also grew in the 80’s adding the BioSID and EuroSID-1. Some of the latest young members of the family are known to be CRABI (Child Restraint Air Bag Interaction). In the 1990’s, the CRABI series was developed for use in child passenger seat testing programs. Currently, the Hybrid III 10-year-old is under development as well as the THOR and SIDII-s dummies. As years go by, the dummy family will continue to grow just like their human counterparts.

Dummy Calibration

Each dummy has a set of calibration tests that are performed prior to being used in the test environment. These calibration tests are verifications that the appropriate part meets its design performance criteria and when it doesn’t, it is replaced. The dummy can have a very long lifetime (over 30 years) with its parts replaced on a routine basis depending on their test exposure. For the average adult male dummy, the head, neck, chest, pelvis, and knees have tests performed on them. The other dummies have similar tests depending on the type of test for which they are designed. Dummy calibration fixtures are designed and constructed at the MGA Manufacturing Center.

Dummy Data

The skin consists of vinyl and urethane molded over the metal parts. Each dummy is clothed with a shirt, shorts, and shoes. During most tests, a chalk or grease paint color scheme is applied to various body areas of interest to determine if contact is made. Also, many times, targets are placed on a dummy to track the motion of a particular part in the test video.

The dummies are designed to obtain useful measurements in a crash environment. These measurements must be repeatable under similar test conditions. The dummies are not designed to record soft tissue injuries such as abrasions and bruises. The measurements include accelerations, forces, moments, and displacements. Sensors are placed in the head, neck, thorax, pelvis, upper and lower legs, and feet. Test engineers compare these measurements to established threshold tolerances developed from cadaver tests to assess injuries.

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Dummy Calibration Engineer

Being a recent college graduate, I frequently get asked, “What do you do?” Most people would find this to be a simple question to answer, but when you work with crash test dummies, the response is quite different. I usually start with “I work at a facility that does crash tests on automobiles to make sure they pass safety standards” to ease into the situation, and then add, “my job is to prepare the crash test dummies that are put into the vehicles”. After telling this to my family, friends, and people I have just met, laughter, along with a little bit of confusion, is the most common reaction. For the typical person, crash test dummies are things only seen in TV commercials and magazine advertisements.

After answering the “What do you do” question, the next one is “How did you get that job?” This is an easier answer. I went to Marquette University and studied biomechanical engineering, which focuses on how the human body can use advances in engineering, biology, and medicine to improve health. Typically, a biomechanical engineering degree leads to a career in prosthetics/orthotics, medical devices, or research and design. However, my background seems to fit well with understanding the role that crash test dummies play in evaluating the safety of automobiles.

I, now being at MGA for six months, would have never thought that my background in biomechanical engineering would have led me to a career with crash test dummies. However, I am more than happy with the experiences I have gained as being one of the newest members of MGA-Wisconsin.

Dummy Storage

At the Crash Test Center in Burlington, Wisconsin, the test dummies receive the finest care available. They are housed in a temperature-controlled environment, any “injuries” are immediately attended to, and they have their own “personal trainers” to make sure they are always healthy (through periodic maintenance and calibration). And even though they don’t have much privacy in their living quarters, they do have their own space.

Storage of dummies is critical to their overall performance characteristics. To ensure that dummies are stored properly, the NHTSA specifies storage requirements for adult and child dummies. Most dummies are stored on a cart specifically designed to minimize compression on the spine. Some of the child dummies are hung by their necks or heads. The designs for the storage cart are provided by the NHTSA. However, storing each dummy on its own cart requires a significant amount of floor space.

In order to minimize the space required, MGA developed a vertical rack storage system for dummy carts. The NHTSA designs for the dummy carts were modified to include a lifting bar and “wedge” on the back of the dummy cart. A two-tier rack system with mating “wedges” was designed to allow the dummy carts to be hung at any location on the rack, allowing twice the number of dummies to be stored in the same amount of space. An overhead crane is used to easily maneuver the dummy carts on and off the racks. Each cart also has casters to allow the dummies to be transported easily, and a tray on the bottom of the cart for cable storage.

For storage solutions, calibration equipment, training in handling, storage, calibration of dummies, or dummy rentals, contact Jessica Gall at (262) 763-2705 or e-mail jessica.gall@mgaresearch.com.
Touching Base
with Dr. Patrick Miller, President

Ancestral Dummies

Our character was likely influenced by our ancestors. Most of us have contact with or can recall our grandparents. And, as we become older, our appreciation for our ancestors usually increases. Well, modern dummies also have ancestors, and these ancestral dummies significantly influence the characteristics of modern dummies.

Early dummies were not much interested in automobiles, they were interested in high-speed aircraft. The introduction of military jet planes after World War II about doubled aircraft speeds. Then, on October 14, 1947, Chuck Yeager, broke the sound barrier (exceeding Mach 1) while piloting the Bell X-1 rocket plane. On November 20, 1953 Scott Crossfield reached Mach 2 and seven years later on December 10, 1960 he exceeded Mach 3 (three times the speed of sound).

During this period, military aircraft made dramatic strides in performance and the sound barrier was routinely broken. Ejecting pilots from planes under duress was a challenge well beyond that of parachuting a pilot out of a propeller driven airplane. The Air Force undertook several programs to develop suitable methods for pilot ejection. As part of this effort, contracts were awarded to Alderson Research Laboratories and Sierra Engineering Company to develop and manufacture dummies which could be used in the development of ejection seat technology.

These dummies were 95th percentile males having characteristics somewhat representative of seated, male pilots. The dummies were subjected to ejections at speeds in excess of 600 mph. They might look at their descendants, the modern dummies, as having it easy, where crash impact speeds of only 30 to 50 mph are experienced. (Somewhat like telling my grandson, “When I was your age, we walked two miles, in two feet of snow each day, in order to get to school.”)

During the 1950’s and 1960’s, attention was focused on highway safety as about 40,000 people were killed each year in automobile accidents. During the past 30 years, dummy development has, for the most part, been a cooperative effort among governments (particularly the NHTSA), automotive companies, and dummy manufacturers. This effort has resulted in a family of dummies ranging from infants to 95th percentile males, where considerable sophistication in both design and instrumentation are evident. These dummies are used in front, side, rear, and rollover crash tests. Yet, none will likely experience the “ride” or “thrill” their ancestors had while ejecting from an aircraft at Mach 1 speeds.