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## Post Mortem Human Subject and Dummy Response in Frontal Deceleration

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### Introduction

In the European Union, the assessment of the protection offered by a vehicle to a restrained occupant in case of frontal collision, is based on biomechanical data measured on the Hybrid III crash test dummy as described by the European Frontal Directive (Directive 96/79/EC). This dummy was developed in the 70's and is based on biomechanical knowledge from that time.

The Thor dummy (Test device for Human Occupant Restraint) developed by NHTSA (USA Administration) is based on more recent biomechanical knowledge. Many parts of the dummy have been designed and modified to produce a more humanlike response to frontal impact loading.

The general objective of the FID European research program (improved Frontal Impact protection through a world frontal impact Dummy) is a European contribution to the evaluation of a worldwide dummy in the frontal impact.

The paper presents new biomechanical data, based PMHS (Post Mortem Human Subject) tests, under different frontal impact conditions. The same tests with exactly the same instrumentation mounted at the same location were performed with Hybrid III and with the Thor-alpha, to assess the biofidelity of these dummies with respect to these biomechanical data.

### Materials and methods

A catapult was used to simulate impact. A first series was conducted at 50 km/h with a 22 Gs peak sled deceleration pulse, and a restraint system composed of a lap belt, a shoulder belt with a 4kN force limiter and an airbag [1].

The second series was performed at 30 km/h and with a 15 Gs peak sled deceleration pulse, and a lap belt, a shoulder belt with a 4kN force limiter [2].

The tested dummies were the Hybrid III, standard dummy currently used in the regulatory tests, and the Thor-alpha dummy released in April 2001 by Gesac Inc. (USA).

The PMHS are unembalmed coming from the department of anatomy of medical university of Lyon.

Each test is conducted on a rigid seat. Each foot is fixed on a separated rigid toe-pan. The hands are suspended in a position corresponding to the natural posture for driver.

Three high-speed 16-mm cameras (500 frames/sec) filmed the motion and a total of 80 channels of data are recorded during the test.

Accelerometers are located on the head, the thorax, the upper and lower extremities. Force sensors are located on the belt, the toe-pan and the seat.

Initial position of each test and of the seat as well as sensor location is recorded using a 3D measuring system.

Anthropometry of the PMHS is collected. After the test, the PMHS is autopsied for injury survey.

### Results

Eighteen tests have been carried out, nine per series. The results consist of the kinematics of 6 PMHS, 6 Hybrid III tests and 6 Thor-alpha tests obtained from the analysis of the high-speed films and the dynamics coming from the sensor.

An injury description is given from the autopsy.

Time histories from dummies and PMHS for each sensor are been superposed

### Future work and conclusion

The comparisons presented in this paper are based on three cadaver results and further tests are needed to improve the response corridors. Additional measurements, particularly the study of the acceleration components that imply the measurement of the angular accelerations are necessary.

The sled test results suggest that the Thor-alpha response is in the majority of the cases more similar to those of PMHS than the Hybrid III

Other test conditions are also indispensable to assess the biofidelity of the Thor-alpha dummy.

The required updates identified by FID and NHTSA have been merged into a single list. Based on the common list, a new dummy THOR alpha will be evaluated to fill the gaps in the biomechanical knowledge on human body behavior during frontal impacts.

For further improvement an angular with the frontal direction is needed. Such an action is planned within the next European HUMOS 2 Research program (HUman Modeling for Safety 2).

### References

- [1] Vézin P et al, (2002), Comparison of Hybrid III, Thor-alpha and PMHS response in Frontal Sled Tests, Stapp Car Crash Journal, Published by Society of Automotive Engineers, Inc., Vol. 46, pp 1-26.
- [2] Kallieris D et al, (1995), On the synergism of the driver air bag and the 3-point belt in frontal crashes, Proceedings of the thirty ninth STAPP Car Crash Conference, Ed. Society of Automotive Engineers, pp 389-401.

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