



Informal document GRSP-53-17
(53rd GRSP, 13-17 May 2013,
agenda item 2)

Proposal on actual needed height of head restraints

Netherlands MOT RDW

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Terms of reference of the informal group on Head Restraints phase 2

Text from doc. GTR7-01-08 (ECE/TRANS/WP.29/2009/130):

“ III. SUBJECTS FOR REVIEW AND TASKS TO BE UNDERTAKEN

6. With regard to head restraint height, the informal group should decide:

- (a) How to define the effective height;
- (b) The height requirements ”



History

- the study UMTRI-83-53-1, Dec. 1983 delivered anthropometric specifications for a small female, a mid-sized male and a large male,
- these anthropometric data describe also the seated (automotive!) posture of these three family members (originally also a mid-sized female was foreseen but because of funding this was not further explored),
- these data were used for the constitution of an adult-dummy family, consisting of a mid-sized male, a small female and a large male,
- much later the HRMD-concept is used to replicate the height, location and profile of the head of the seated mid-sized male, known from the UMTRI drawing (MM-104).



History

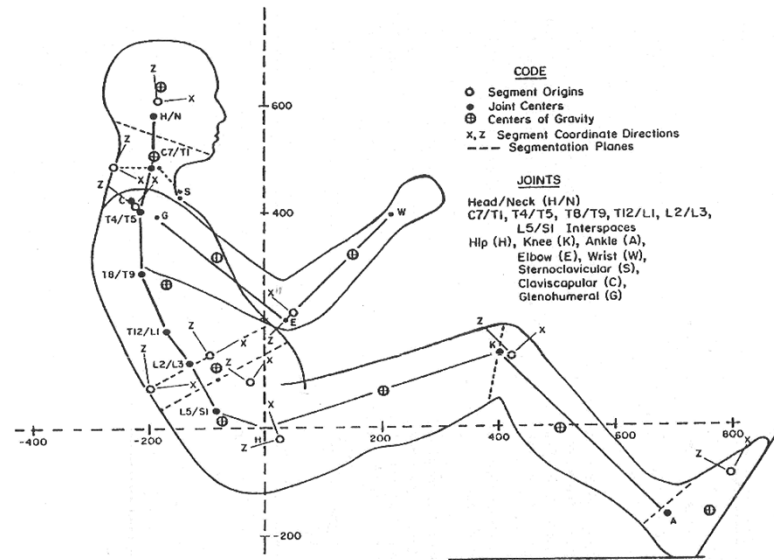
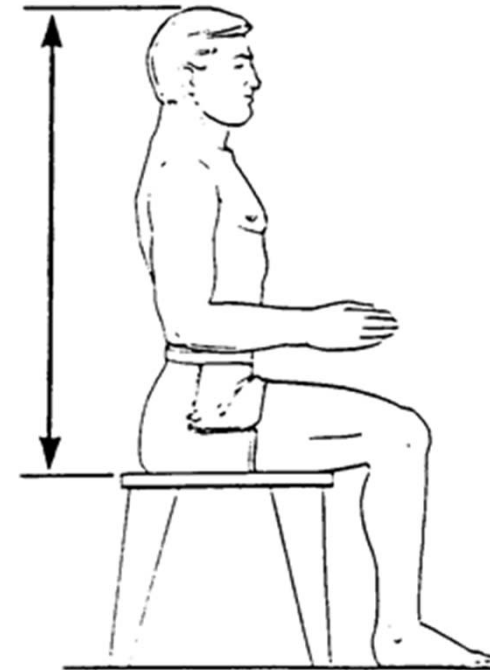


FIGURE 5-1. Anthropometric specifications for mid-sized male dummy.



Sitting height in automotive posture

Erect sitting height



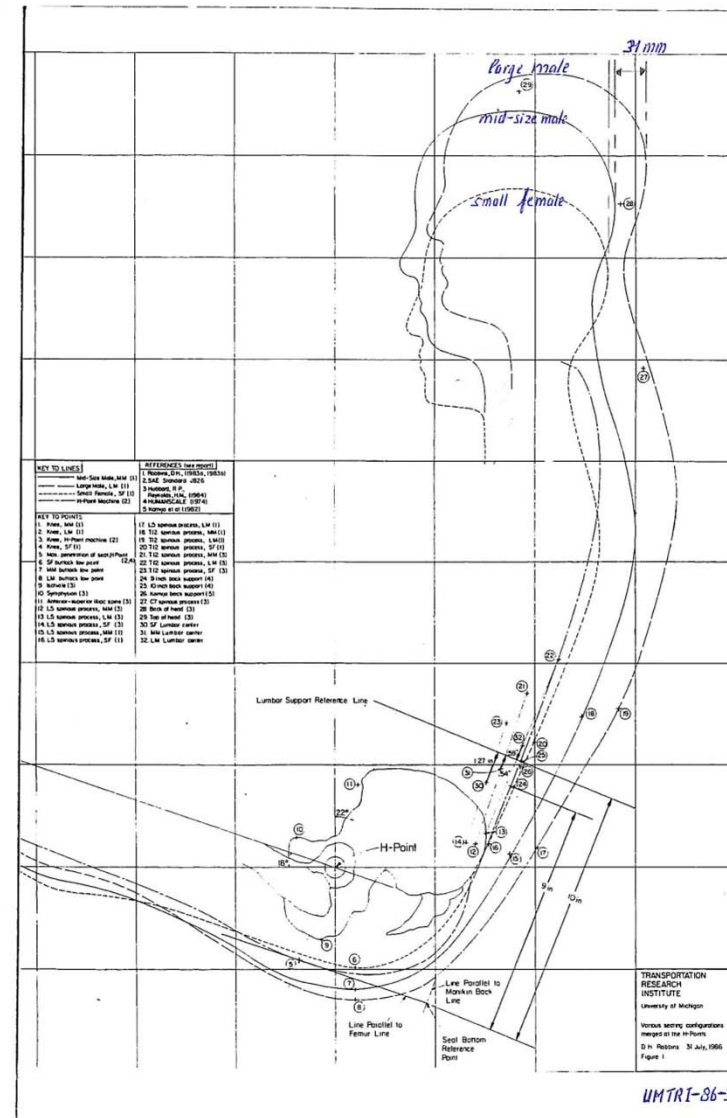
History

Robbins, one of the co-authors of the earlier study from 1983 conducted the study UMTRI-86-39.

By merging the H-points of the family it was found that the position of the back-of-head of the large male, compared to the mid-sized male, is on a “distance x” which is 31mm more rearwards.

However this result is reached with:

- an arbitrary seatback angle,
- a large male dating from the 1980’s, so not representing the nowadays large male car occupant.



Nowadays humans in the UMTRI automotive posture I

TNO (study GTR7-04-03) has positioned NL 2004 males in the UMTRI automotive posture using CAESAR data (**C**ivilian **A**merican and **E**uropean **S**urface **A**nthropometry **R**esource)

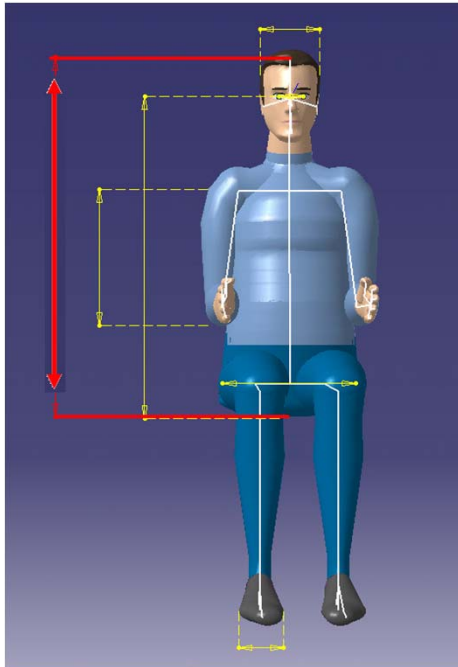


Fig.1 Sitting height

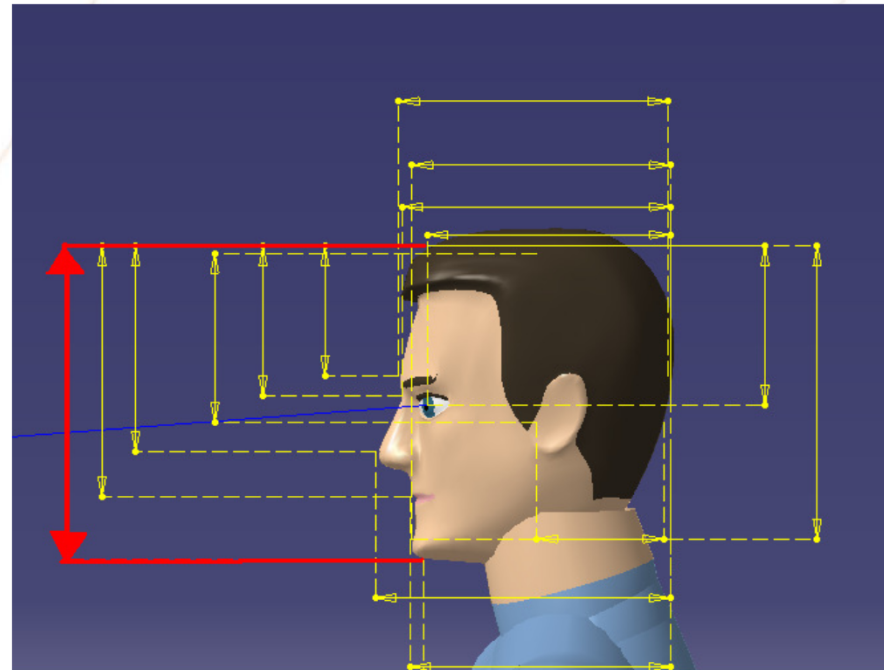


Fig. 2 Menton to top of head



Nowadays humans in the UMTRI automotive posture II

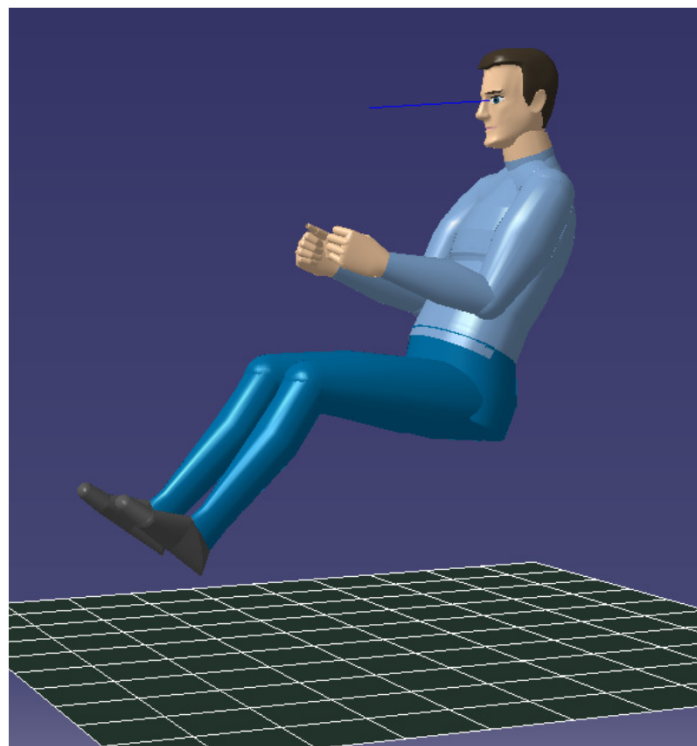


Fig.3 Resulting body position

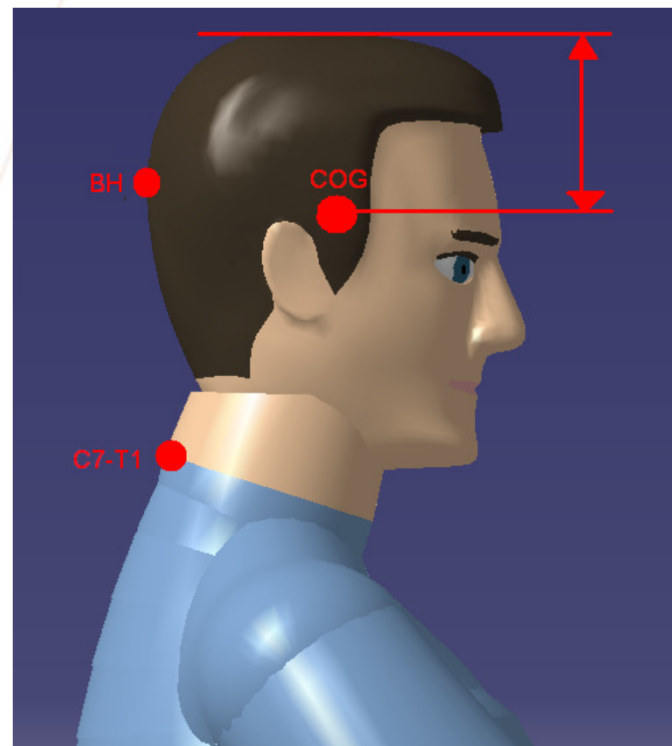


Fig.4 Projection BH /COG /C7 T1



Nowadays humans in the UMTRI automotive posture III

- the mentioned TNO study delivered a.o. the X- and Z-coordinate of the back-of-head of the 2004 NL large male (in **automotive** posture with a torso angle of 25 degrees).

- compared with the HRMD installed on the 3-D H-machine this leads to the following:

	HRMD on 3-D H-point machine (= based on UMTRI mid-sized)	Large male (= Caesar 2004 NL)
Z-coordinate back-of head w.r.t. H-point	669	763
X-coordinate back-of head w.r.t. H-point	263	302

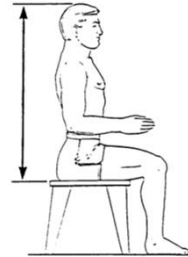
- these new found coordinates mean that the back-of-head of a nowadays large male (at a torso angle of 25°) is now **39** mm more rearwards >>> this has been elaborated in the method to measure effective head restraint height (using CMM), **however**

- this same back-of-head is also 91 mm higher!!!



Head restraint height based on automotive posture, -what does this mean-

- In the world of anthropometry the erect sitting height is used.



- In the automotive world the use of automotive posture is very common.

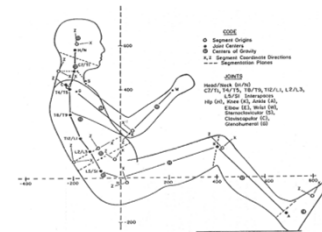


FIGURE S-1. Anthropometric specifications for mid-sized male dummy.

- For our head restraint regulation is made use of automotive posture.
- **However**, one should take account of two effects that will extra raise the head in case of a rear impact, namely:
 - when using automotive posture, one should realize there is the extra effect of spine straightening,
 - there is always the effect of ramping up too!



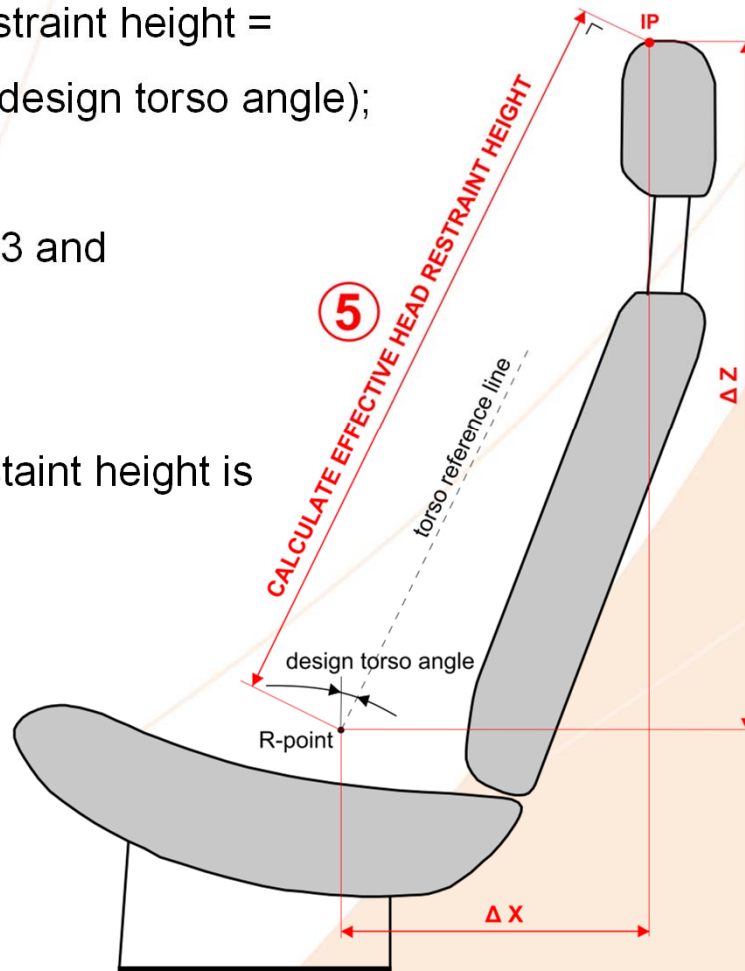
Calculation of needed head restraint height I

- Available are the X- and Z-coordinate of the back-of-head of the large male being 302 respectively 763 mm;
- It is assumed that there will be no spine straightening and no ramping up of the body, so the head would travel horizontally rearward;
- It is assumed that the distance (backset) from the head to the contact point on the head restraint is 30 mm;
- So the X- and Z-coordinate of the point of the head restraint that is supposed to catch the head will be 332 respectively 763 mm;



Calculation of needed head restraint height II

- The formula for calculating effective head restraint height = $\Delta X * \text{SIN}(\text{design torso angle}) + \Delta Z * \text{COS}(\text{design torso angle})$;
- Used values will be $\Delta X = 332 \text{ mm}$, $\Delta Z = 763$ and a design torso angle of 25 degree;
- The outcome for the actual needed head restraint height is **831 mm**,
without taking account of
 - spine straightening, and
 - ramping up.



Calculation needed head restraint height

-accompanying notes from two sides-

- From research is reported an upward movement of the head that can easily reach a value of 35 mm, this is in automotive seats and resulting from together spine straightening and ramping up (e.g. SAE paper 983158 Human Head-Neck Responses During Low-speed Rear Impact from Kroonenberg, A. van den, Philippens, M., Cappon, H., Wismans, J., Hell, W., Langwieder, K.).
- From anthropometry research we know that the population in the Netherlands and Scandinavia is taller than in e.g. the UK and the USA (e.g. the erect sitting height of: the tall NL CAESAR 2004 male = 1016 mm, the tall USA CAESAR 2000 male = 994 mm, the tall UK 1998 male = 980 mm, the tall German 2005 male (DIN) = 965 mm).



Conclusions on needed head restraint height

- In the Informal Group of GRSP on Head Restraints (phase 1) the Netherlands has proposed a head restraint height that would reach to at least **850** mm based on the principle of erect sitting height;
- The EEVC WG20 report “UK Cost-Benefit Analysis: Enhanced Geometric Requirement for Vehicle Head Restraints”, reported that a head restraint height of **840** mm and a backset of 40 mm would deliver the greatest benefit after subtracting the associated cost!
- The Netherlands concludes now that with a head restraint that reach to an effective height of **830** mm legislation will get a better balanced height of head restraints (compared to the historic 800 mm) serving more Parties.



Thank you for your attention

