



Transport
Canada

Transports
Canada

HR-7-5

Measuring Backset With the ICBC Head Restraint Measuring Device (HRMD)

7th Head Restraint Informal Working
Group Meeting

**Montréal, Québec, Canada
September 12-14, 2006**

Prepared by Éric Bergevin



Objective of Study

- Verify whether the ICBC HRMD is an adequate tool to measure the backset by verifying:
 - Specifications and dimensional tolerances of the ICBC HRMD headform and measuring probes
 - Information regarding the variability of the OSCAR three-dimensional H-point machine (HPM)
 - Repeatability of the ICBC HRMD
 - Reproducibility of the ICBC HRMD



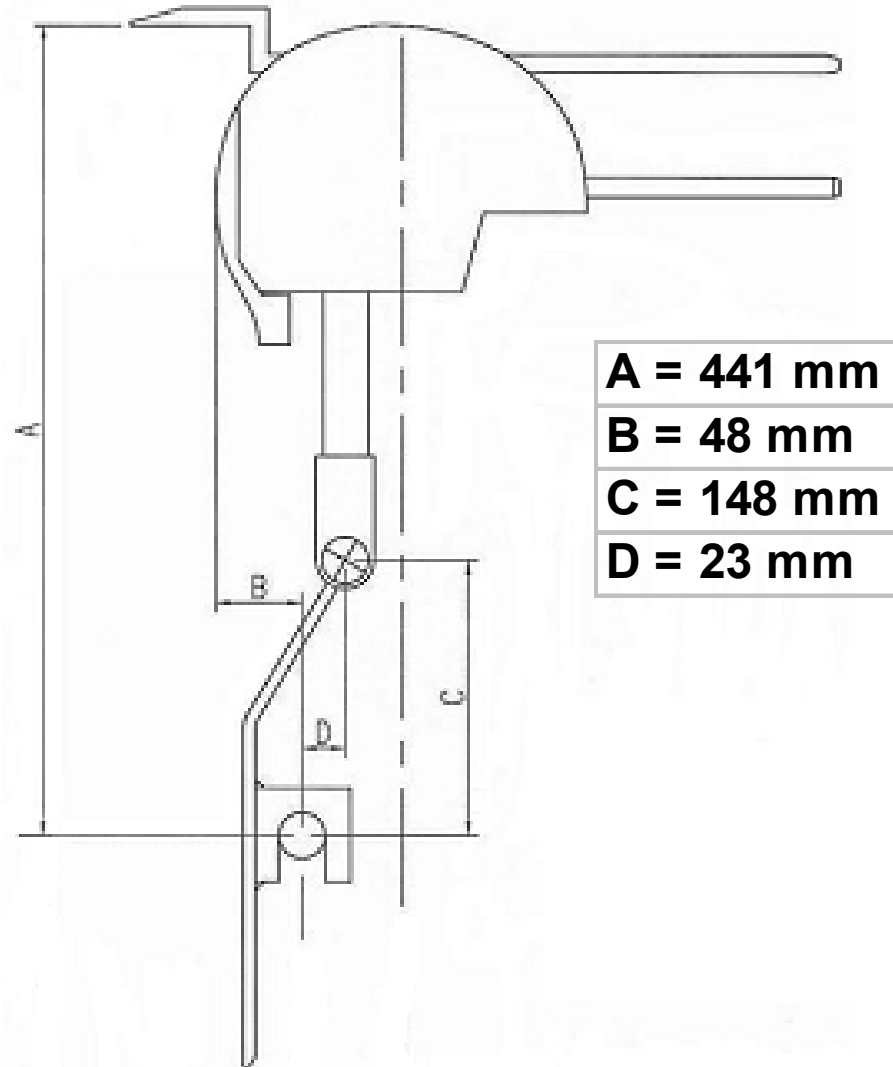
ICBC HRMD

- The headform is manufactured to have:
 - A mass of 3150 +/- 50 grams
 - All linear dimensions of the headform within +/-0.25 mm of the drawing specifications for the headform size “J” provided in ISO DIS 6220 – Headforms for use in the testing of protective helmets



ICBC HRMD (2)

- Both height and Backset probes are within +/- 2 mm of the RONA Kinetics drawing specifications





ICBC HRMD (3)

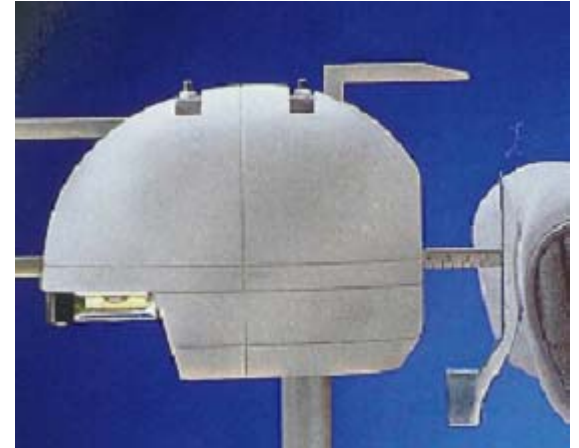
- Conformity with the drawing specifications is accomplished with a specially designed Jig





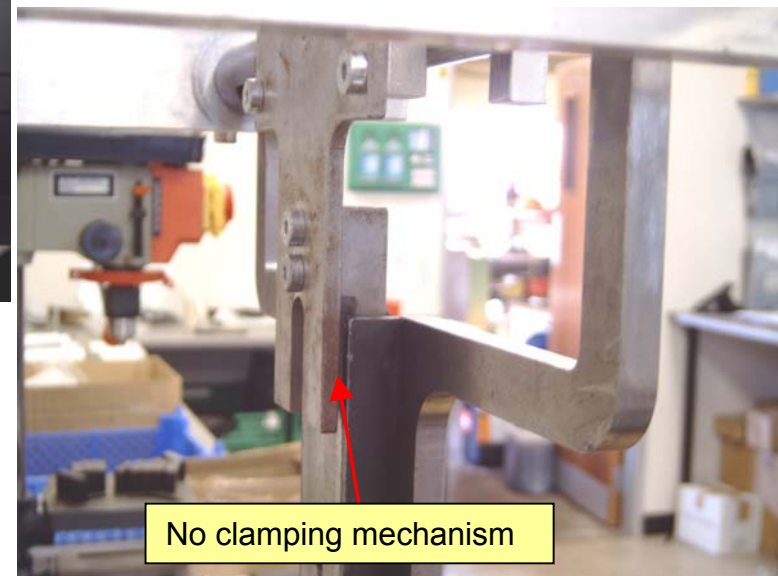
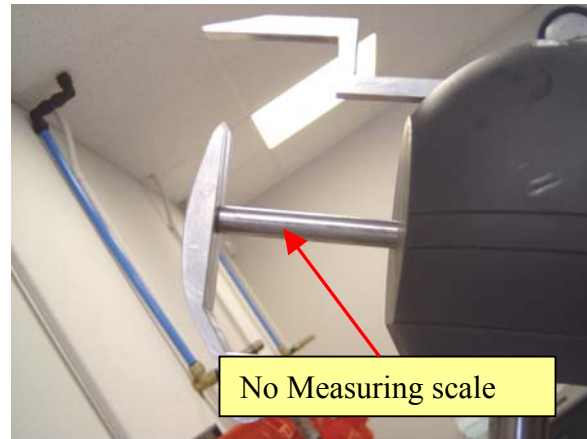
ICBC HRMD (4)

- First 25 units manufactured:
 - Cast magnesium
 - Sandblasted (Dull Aspect)
- Units 26 to 35:
 - Cast aluminium
 - Sandblasted (Dull Aspect)
- Units 36 and newer:
 - Aluminium machined out of a solid block
 - Polished (Shiny aspect)



ICBC HRMD (5)

- The ICBC HRMD is not patented and imitations do exist.





ICBC HRMD (6)

- The ICBC HRMD bears the ICBC/RONA Kinetics nameplate guaranteeing its authenticity and construction accuracy





OSCAR HPM Variability

- IIWPG (RCAR) identified that variability between OSCAR units is an issue when using the ICBC HRMD due to:
 - Position and alignment of torso weight hangers
 - Parallelism of H-point Sight buttons
 - Play at the H-point/torso pivot due to excessive wear
 - Offset back pan to seat pan adjustment

OSCAR HPM Variability (2)

- IIWPG developed the Gloria jig to calibrate the combination together as one single unit



SAE J4002 – Aspect (HPM-II)

- Developed by SAE to replace the OSCAR HPM
- Principal improvement:
 - It has an articulated lumbar spine
- Not compatible with the ICBC HRMD



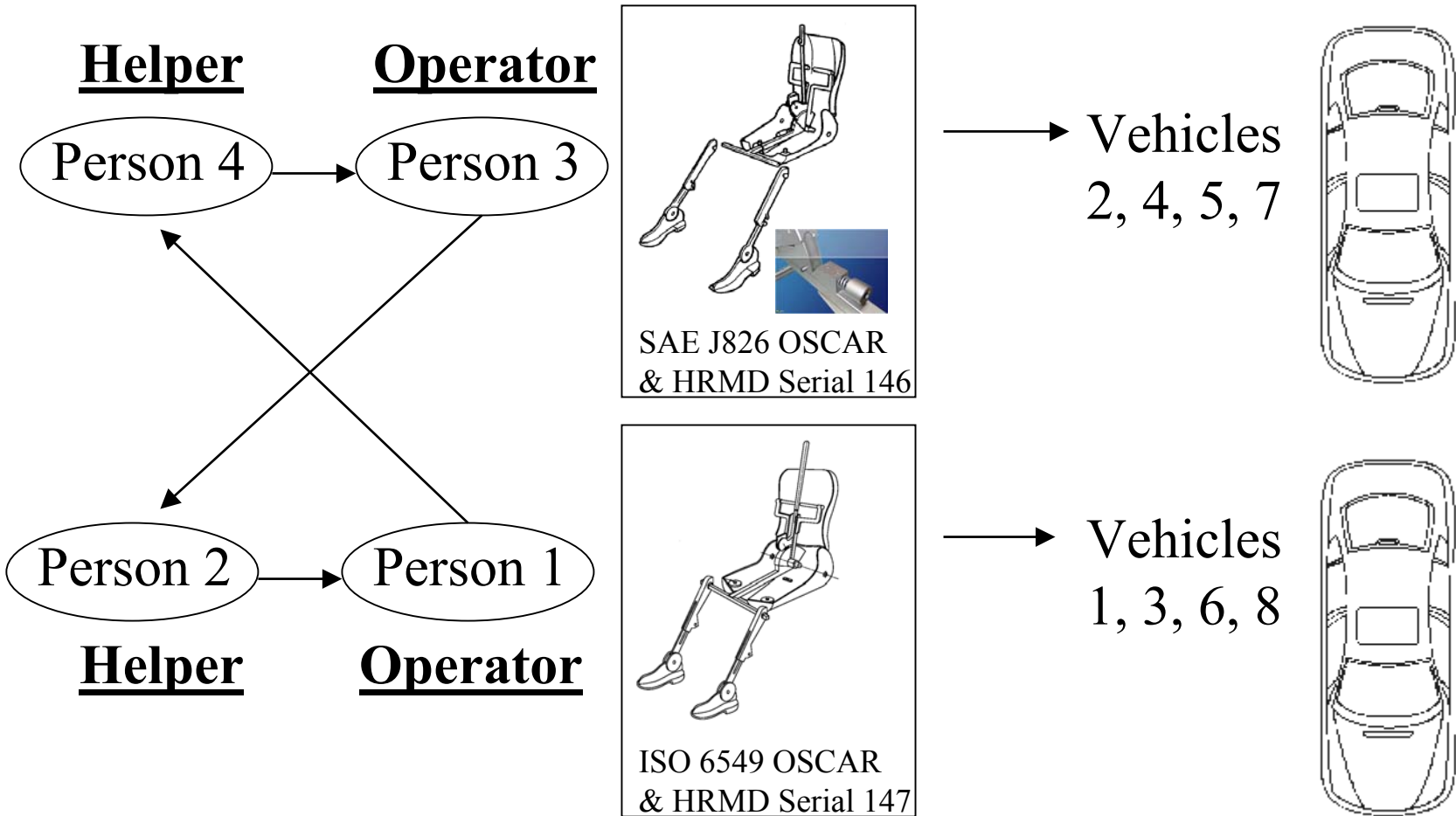


Vancouver Study





Test Matrix





Test Matrix (2)

- Explicitly designed to exclude:
 - variability between OSCAR/HRMD combinations
 - Seat build variability by having all operators measure the same seats
 - Seat setup variability



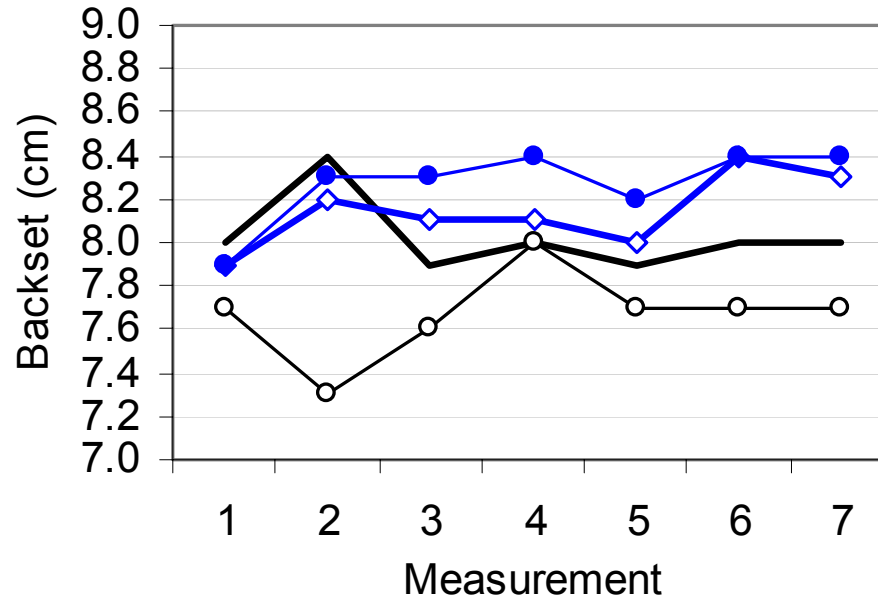
List of Vehicles Tested

- No. 1 - 2006 Chevrolet Silverado (leather seats)
- No. 2 - 2006 Jeep 3.7 L
- No. 3 - 2006 Toyota Sienna CE
- No. 4 - 2006 Chevrolet Malibu
- No. 5 - 2006 Hyundai Accent
- No. 6 - 2007 Ford Focus
- No. 7 - 2007 Dodge Caliber
- No. 8 - 2006 Mercedes C230 (leather seats)

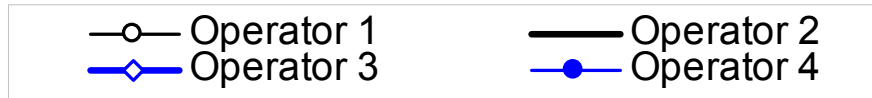


Vehicle No. 1 - Silverado

HPM Torso Angle (Degrees)	
Average	23.7
Min	23.0
Max	24.5
Range	1.5
Std Dev	0.5



Note: It was not possible to position the HPM/HRMD centreline within 15mm of the head restraint centreline on this vehicle.

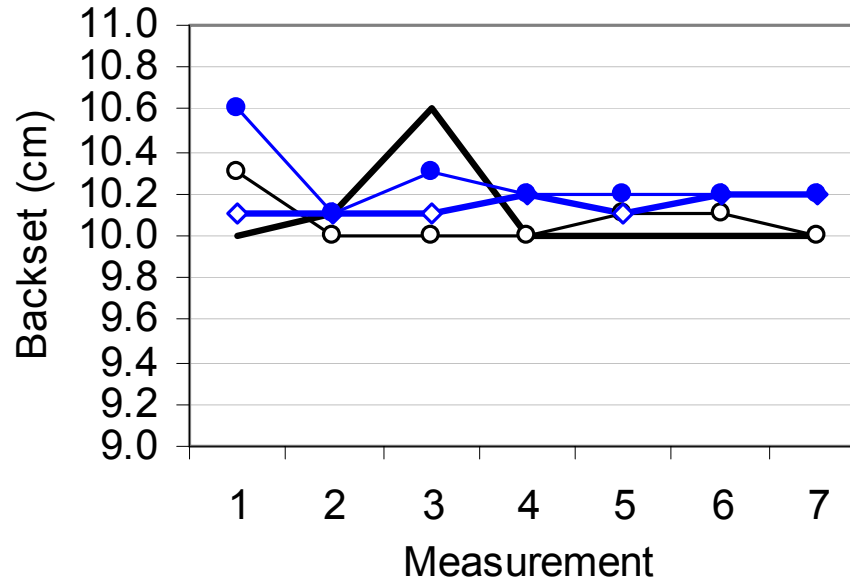


	Repeatability (mm)				Reproducibility (mm)
	Operator 1	Operator 2	Operator 3	Operator 4	All Operators
Average	76.7	80.3	81.4	82.7	80.3
Std Dev	2.1	1.7	1.7	1.8	2.9
Min	73.0	79.0	79.0	79.0	73.0
Max	80.0	84.0	84.0	84.0	84.0
Range	7.0	5.0	5.0	5.0	11.0



Vehicle No. 2 – Jeep 3.7 L

HPM Torso Angle (Degrees)	
Average	24.1
Min	23.5
Max	24.5
Range	1.0
Std Dev	0.4



Note: It was not possible to position the HPM/HRMD centreline within 15mm of the head restraint centreline on this vehicle.

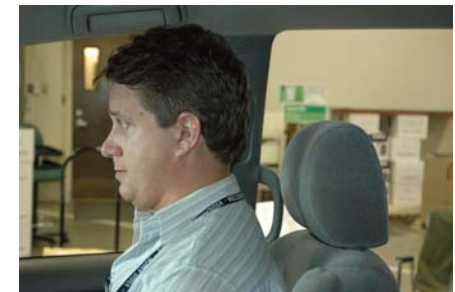
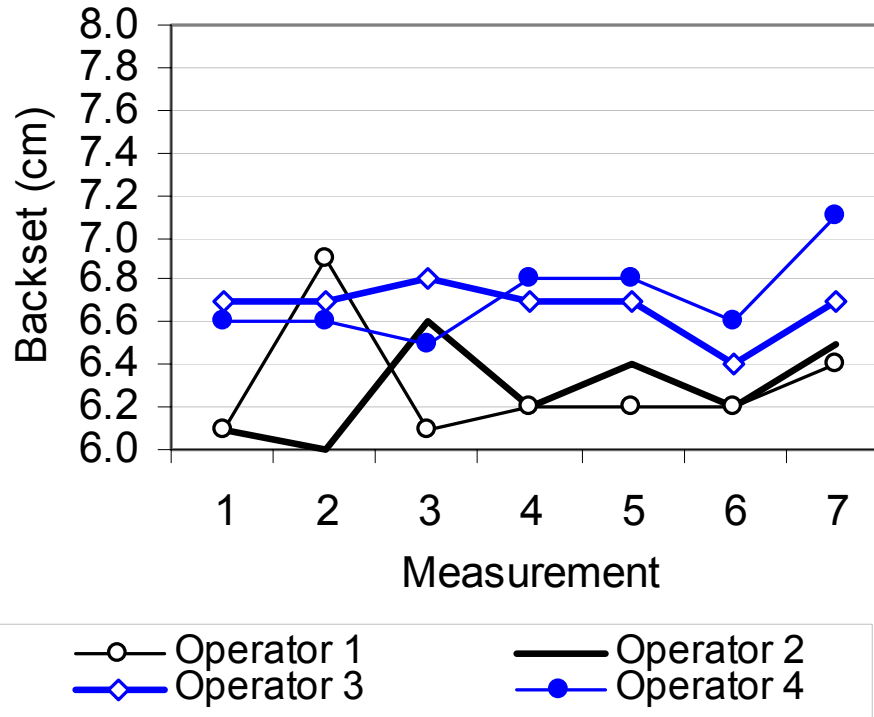


	Repeatability (mm)				Reproducibility (mm)
	Operator 1	Operator 2	Operator 3	Operator 4	All Operators
Average	100.7	101.0	101.4	102.6	101.4
Std Dev	1.1	2.2	0.5	1.6	1.6
Min	100.0	100.0	101.0	101.0	100.0
Max	103.0	106.0	102.0	106.0	106.0
Range	3.0	6.0	1.0	5.0	6.0



Vehicle No. 3 – Toyota Sienna

HPM Torso Angle (Degrees)	
Average	23.8
Min	23.0
Max	26.5
Range	3.5
Std Dev	0.8

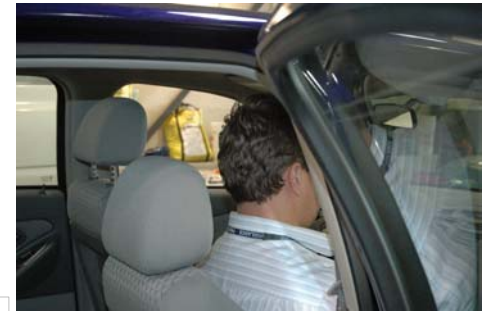
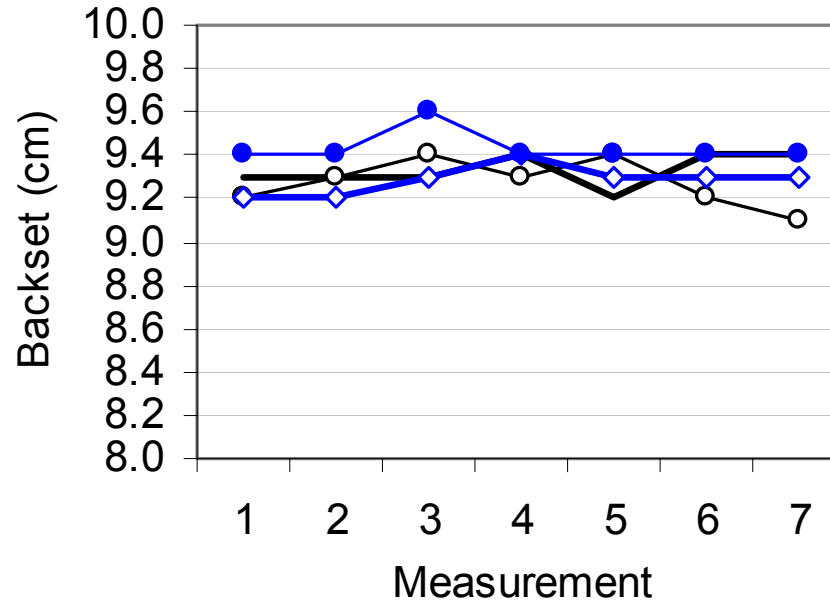


	Repeatability (mm)				Reproducibility (mm)
	Operator 1	Operator 2	Operator 3	Operator 4	All Operators
Average	63.0	62.9	66.7	67.1	64.9
Std Dev	2.8	2.2	1.3	2.0	2.9
Min	61.0	60.0	64.0	65.0	60.0
Max	69.0	66.0	68.0	71.0	71.0
Range	8.0	6.0	4.0	6.0	11.0



Vehicle No. 4 – Chevrolet Malibu

HPM Torso Angle (Degrees)	
Average	23.8
Min	23.0
Max	24.5
Range	1.5
Std Dev	0.4

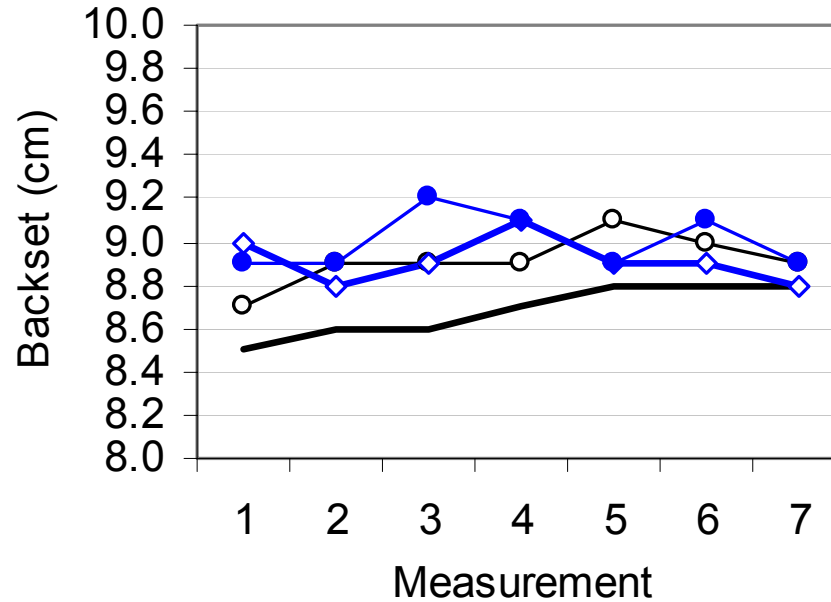


	Repeatability (mm)				Reproducibility (mm)
	Operator 1	Operator 2	Operator 3	Operator 4	All Operators
Average	92.7	93.3	92.9	94.3	93.3
Std Dev	1.1	0.8	0.7	0.8	1.0
Min	91.0	92.0	92.0	94.0	91.0
Max	94.0	94.0	94.0	96.0	96.0
Range	3.0	2.0	2.0	2.0	5.0



Vehicle No. 5 – Hyundai Accent

HPM Torso Angle (Degrees)	
Average	22.7
Min	22.0
Max	23.5
Range	1.5
Std Dev	0.4

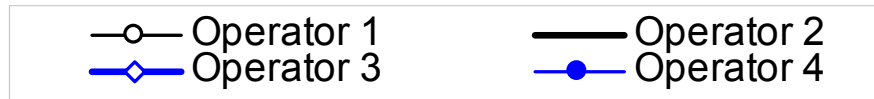
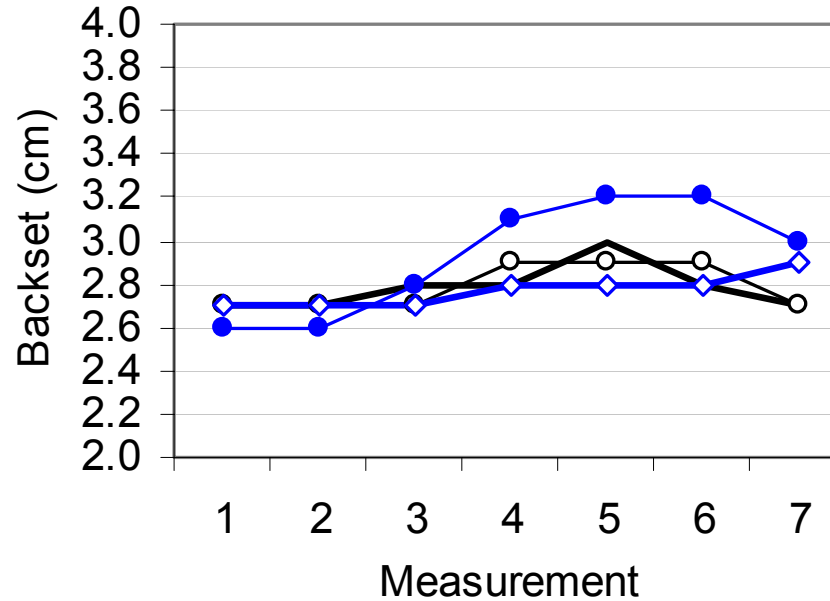


	Repeatability (mm)				Reproducibility (mm)
	Operator 1	Operator 2	Operator 3	Operator 4	All Operators
Average	89.1	86.9	89.1	90.0	88.8
Std Dev	1.2	1.2	1.1	1.3	1.6
Min	87.0	85.0	88.0	89.0	85.0
Max	91.0	88.0	91.0	92.0	92.0
Range	4.0	3.0	3.0	3.0	7.0



Vehicle No. 6 – Ford Focus

HPM Torso Angle (Degrees)	
Average	23.4
Min	22.5
Max	24.0
Range	1.5
Std Dev	0.4

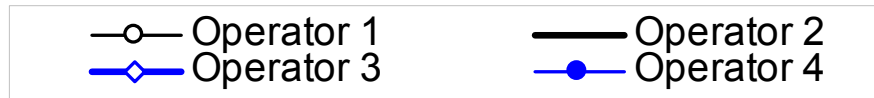
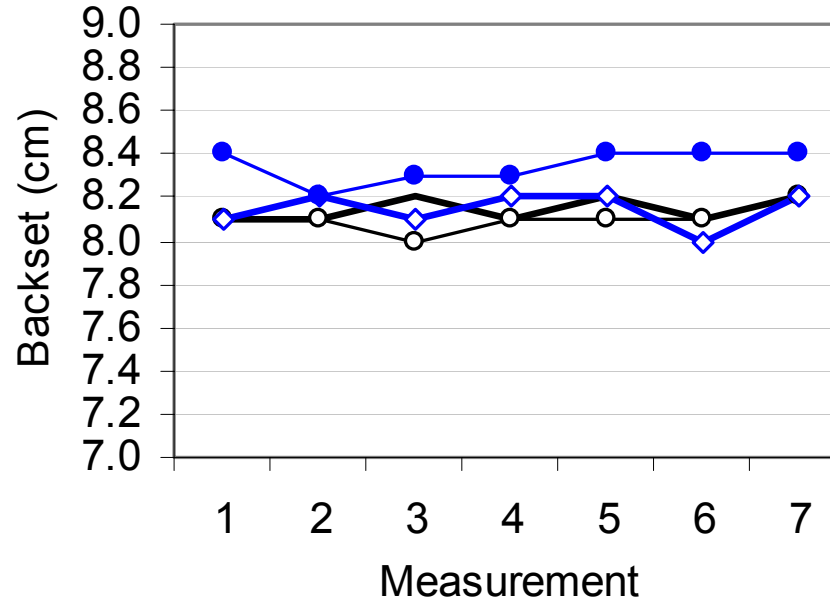


	Repeatability (mm)				Reproducibility (mm)
	Operator 1	Operator 2	Operator 3	Operator 4	All Operators
Average	27.9	27.9	27.7	29.3	28.2
Std Dev	1.1	1.1	0.8	2.6	1.6
Min	27.0	27.0	27.0	26.0	26.0
Max	29.0	30.0	29.0	32.0	32.0
Range	2.0	3.0	2.0	6.0	6.0



Vehicle No. 7 – Dodge Caliber

HPM Torso Angle (Degrees)	
Average	25.0
Min	24.5
Max	25.5
Range	1.0
Std Dev	0.1

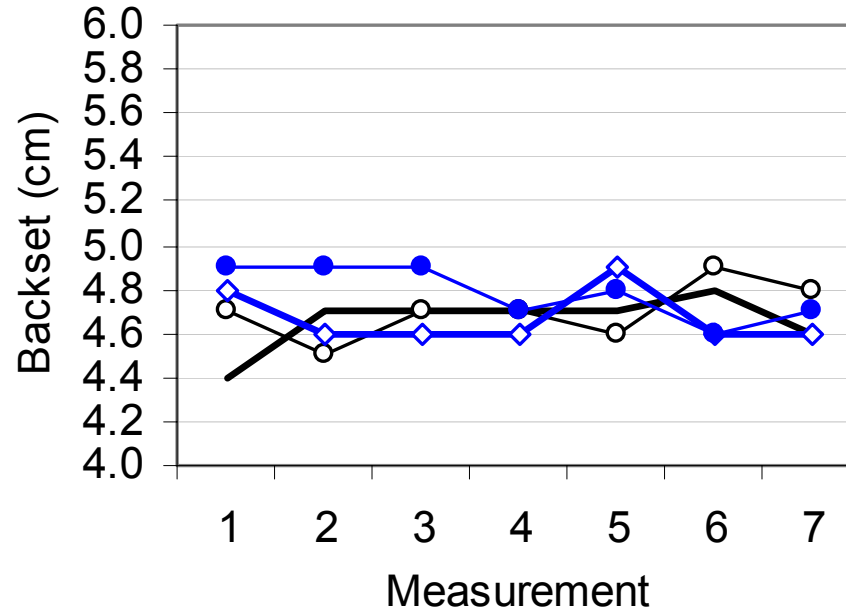


	Repeatability (mm)				Reproducibility (mm)
	Operator 1	Operator 2	Operator 3	Operator 4	All Operators
Average	81.0	81.4	81.4	83.4	81.8
Std Dev	0.6	0.5	0.8	0.8	1.2
Min	80.0	81.0	80.0	82.0	80.0
Max	82.0	82.0	82.0	84.0	84.0
Range	2.0	1.0	2.0	2.0	4.0



Vehicle No. 8 – Mercedes C230

HPM Torso Angle (Degrees)	
Average	24.1
Min	23.5
Max	24.5
Range	1.0
Std Dev	0.4



	Repeatability (mm)				Reproducibility (mm)
	Operator 1	Operator 2	Operator 3	Operator 4	All Operators
Average	47.0	46.6	46.7	47.9	47.0
Std Dev	1.3	1.3	1.3	1.2	1.3
Min	45.0	44.0	46.0	46.0	44.0
Max	49.0	48.0	49.0	49.0	49.0
Range	4.0	4.0	3.0	3.0	5.0



Procedural Issues

- The headroom probe from the OSCAR HPM has a mass of approximately 2500 grams (5.5 lbs) and the ICBC Instruction Manual for the HRMD instructs that it be removed.
- On two vehicles, the centerline of the HPM/HRMD combination was off from the seat centerline by more than 1.5mm.



Backset Measurement Maximum Seat Range *(All Results in mm)*

	Max Range	Min Range	Average Range	s.d.	2s.d.	3s.d.
Operator 1 (1 iteration) All Vehicles	8.0	2.0	4.1	2.2	4.5	6.7
Operator 2 (1 Iteration) All Vehicles	6.0	1.0	3.8	1.8	3.7	5.5
Operator 3 (1 Iteration) All Vehicles	5.0	1.0	2.8	1.3	2.6	3.8
Operator 4 (1 Iteration) All Vehicles	6.0	2.0	4.0	1.7	3.4	5.1
All Operators (1 Iteration) All Vehicles	11.0	4.0	6.9	2.7	5.4	8.1

•1s.d.= 68.32%, 2s.d. = 95.54%, 3s.d. = 99.97% of the data lies below the s.d.

	Max Range	Min Range	Average Range	s.d.	2s.d.	3s.d.
Operator 1 (3 iterations) All Vehicles	3.7	0.7	2.0	0.9	1.7	2.6
Operator 2 (3 Iterations) All Vehicles	2.3	0.3	1.6	0.7	1.5	2.2
Operator 3 (3 Iterations) All Vehicles	3.0	1.0	1.5	0.7	1.3	2.0
Operator 4 (3 Iterations) All Vehicles	5.0	0.7	2.2	1.3	2.7	4.0
All Operators (3 Iterations) All Vehicles	8.7	3.0	5.1	1.3	2.6	3.9



Backset Measurement Variability

Measurement Iterations	Level of Certainty	
	2s.d.	3s.d.
1	5.4	8.1
3	2.6	3.9
7	1.2	1.9

(All Results in mm)

Recommended Increase in Backset Limit to Account for Measurement Variability

Measurement Iterations	Range (mm)
1	5-8 + Gloria Jig Calibration Tolerance Value
3	2-4 + Gloria Jig Calibration Tolerance Value
7	1-2 + Gloria Jig Calibration Tolerance Value



Vancouver Study Conclusions

- No variability problem exists with the measuring probes of the ICBC HRMD
- IIWPG noted some variability with the OSCAR HPM (the Gloria Jig may address this)
- The ICBC HRMD on the HPM provides repeatable and reproducible results
 - The vehicles with the largest range of backset measurements also had the largest range of torso angles

Vancouver Study Conclusions (2)

- Increasing the number of measurements always reduced the backset measurement variability
- If three measurements are taken, backset limit would need to be increased 2 to 4 mm plus the “Gloria Jig calibration tolerance” to account for measurement variability