A Comparison of Transportation Research Driving Simulators (N2016-006)

In considering the available simulators for use in automotive research, the primary considerations are availability for public research, visual system capacity, motion cuing capacity, and sufficient staffing to support development needs in a timely manner. When considering the availability of the simulators, privately owned simulators such as those owned by automotive manufacturers tend to have restrictions or are not available for external use. Simulators owned by academic institutions or the government are widely available for public use. A summary of these characteristics for each simulator is presented in Table 1.

The visual system is important for providing a realistic representation of the driving environment. This can be largely broken down into the field of view and the quality of the visuals (resolution/visual acuity accommodated). Field of view is critically important when conducting research where attention away for the forward roadway is important such as looking over the driver's shoulder or navigating an intersection. Evaluating lane change crash warning systems, blind spot warning systems, and intersection warning systems requires wide fields of view. In general, a wider field of view also helps with perception of vehicle speed and is preferred. Better quality images are represented by higher resolution enhances the detection of objects in the environment and the ability to detect changes in relative motion for other traffic and is preferred. The NADS provide quality visuals with 360-degrees of horizontal field of view.

Motion cueing provides a sense of acceleration to the driver which is a critical cue in vehicle handling for accelerating, braking, cornering, turning, and speed maintenance. The ability to provide realistic motion not only results in more realistic driving performance but also reduces simulator disorientation. Studies examining driver response to crash situations require sufficient motion cuing to provide continued feedback to the driver as they complete their crash avoidance response. During the evaluation of Electronic Stability Control Systems, the government used the NADS, which was the only simulator available that had sufficient motion cueing capacity.

The availability of multiple vehicles to for use in the simulator provides increased realism and allows for the testing of different types of vehicles without mismatches that can occur when a vehicle does not look similar to the vehicle dynamics being used. For example, when testing a higher profile SUV, it is important that the vehicle interior reinforce the idea that the vehicle is an SUV rather than looking like a car. Multiple cab capability is limited, but is present at the NADS.

Staffing to support the technical needs of the research is important for timely completion of projects. Many academic simulator facilities are staffed predominantly by students, who provide fresh ideas, but limit the speed at which research can be completed and tends to tie it to the academic calendar. Simulators that are predominately staff based are generally associated with corporate and government facilities. The NADS provides the benefits of having full time staff along with access to academic expertise through the University of Iowa.

Table 1 – A Comparison of Driving Simulator. The highest fidelity in each category is highlighted.

	Field of View (degrees)	Visual Acuity (arcmin/pixel) (Lower is better)	Motion Envelope Track Size (X by Y)	Motion dof	Publicly Available	Number of Full Size Vehicle Cabs	Automated Vehicle Proving Ground	Full-time Support Staff
NADS/UIowa	360x40	H: 1.3 V: 1.7	64'x64'	13	Yes	5 (2 Cars, SUV, Heavy Truck, Tractor)	Yes, 285 square miles	8
FORD Virttex	F: 180x40 R: 120x25	H: 2.3 V: 2.0	N/A	6	Yes	1 Car		5
Toyota/Lexus	360x40	H: 2.3 V: 2.0	100'x64'	9	No	1 Car		?
George Mason U.	180x20	H: 1.8 V: 1.1	N/A	2	Yes	0		1
FHWA HDS	150x40	H: 1.0 V: 1.0	N/A	6	Yes	1 Car		?
Montana St	240x38	H: 2.0 V: 2.0	N/A	6	Yes	1		1
Wisconsin	240x38	H: 2.0 V: 2.0	N/A	6	Yes	1		2
Ohio State	260x40	H: 2.0 V: 2.0	N/A	6	Yes	1		?

Sources

http://www.nads-sc.uiowa.edu/dscna/2001/Papers/Grant%20_%20Motion%20Characteristics%20of%20the%20VIRTTEX...pdf

http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.303.140&rep=rep1&type=pdf#page=71

http://drivesim.osu.edu/files/2015/08/Ohio_State-Driving_Simulation_Lab-handout.pdf

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http://humanfactors.gmu.edu/research/lab-equipment