

# Automotive Motion Simulators for Testing Dynamic Stability Controls

**Robert W. Mitchell**  
**Ideal Aeromith Inc.**

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# Introduction

1. Automobiles have complex dynamic and stability controls due to regulations, competition, and safety concerns.
2. Many of the features originally designed for testing aircraft are now being incorporated into automotive test systems.
3. Motion simulation test equipment was originally designed for testing aircraft sensors as: gyroscopes, inertial navigation systems (INS), inertial measurement units (IMU), and attitude heading and reference systems (AHARS).
4. This same equipment is now used for testing: airbag fuse sensors, yaw rate sensors, roll rate sensors, vehicle stabilization systems, anti-skid braking systems, active suspension sensors, and navigation systems.

# Features Originally for Aircraft are Now in Vehicles

1. Engine Management Systems – Pollution, performance controls
2. FLIR – Forward IR, image enhancement for windshield heads-up display during inclement weather
3. Rate Gyro – For roll stability control, to prevent roll-over
4. Rate Gyro – For ABS control, maintain tracking on curves during braking
5. Radar – Forward/rear collision detection & avoidance
6. Navigation Systems - directional gyro to augment GPS systems

# Motion Sensor Applications

**Yaw Rate Gyro Sensors - Rate gyros are used to measure yaw motion, used in anti-skid braking systems**

**Roll Rate Gyro Sensors – Roll motion is used to sense excessive roll that may cause a rollover.**

**Vehicle Stabilization Systems - Use combined roll and yaw sensors to maintain vehicle stability**

**Navigation Systems – Yaw sensors are used with the GPS system to display vehicle direction.**

# AUTOMOBILE SAFETY STATISTICS IN USA

## LIVES SAVED PER YEAR

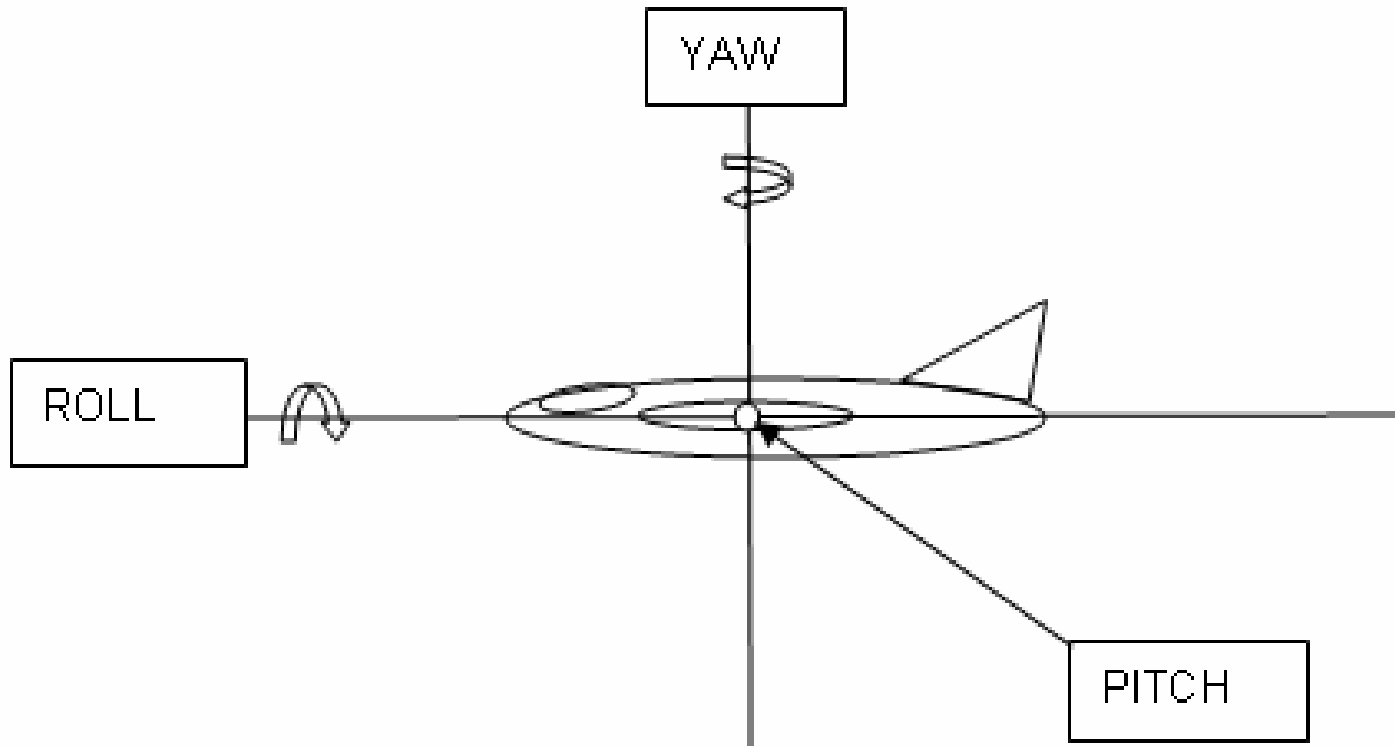
SEAT BELTS	15,000 LIVES
AIR BAGS	2,500 LIVES
ELECTRONIC STABILITY	10,000 LIVES

## ELECTRONIC STABILITY CONTROL

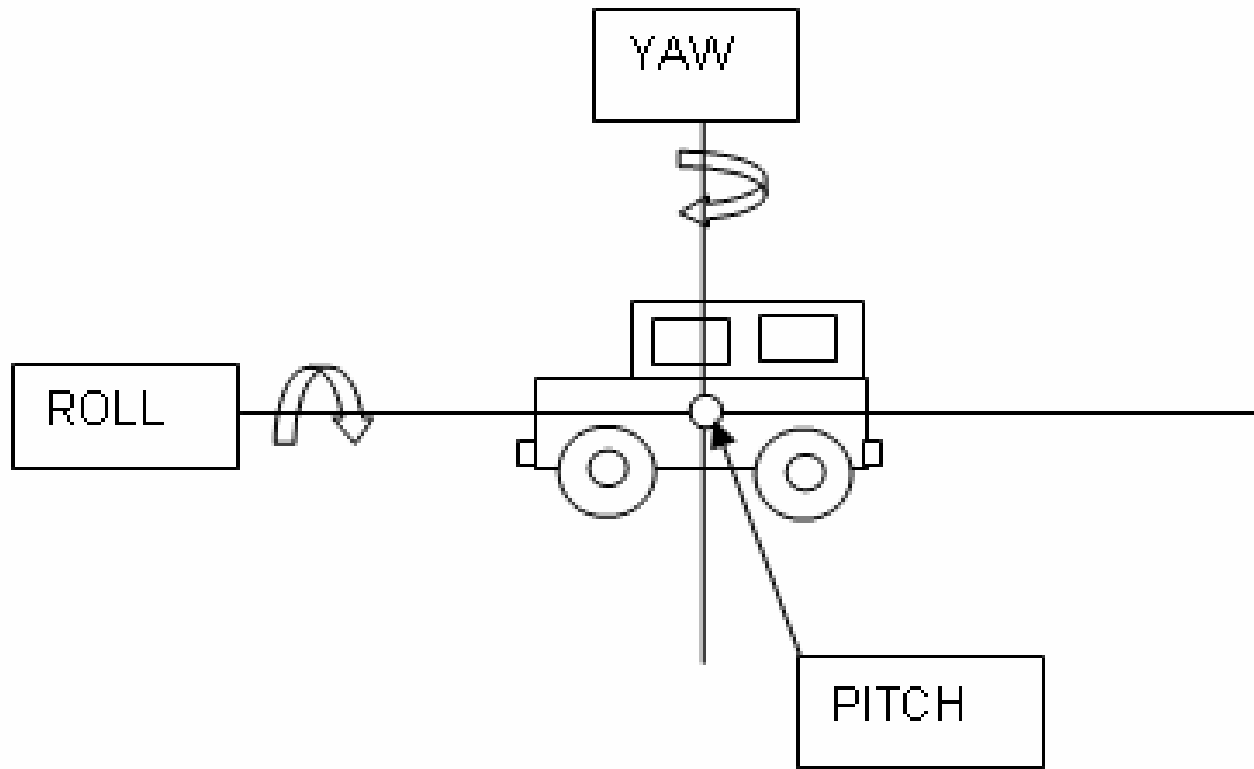
40% OF NEW CARS IN 2006

100% OF NEW CARS IN 2010 (MANDANTORY)

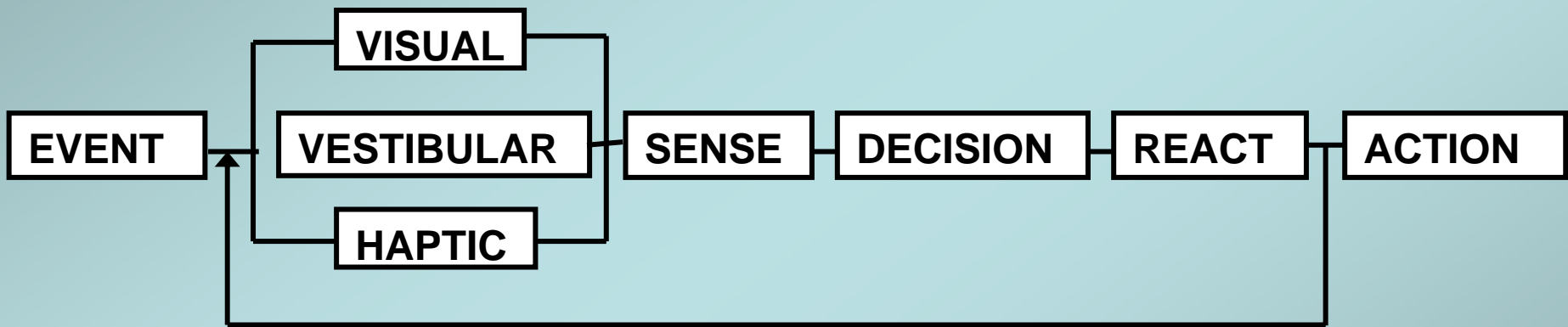
# Aircraft Axes Of Motion



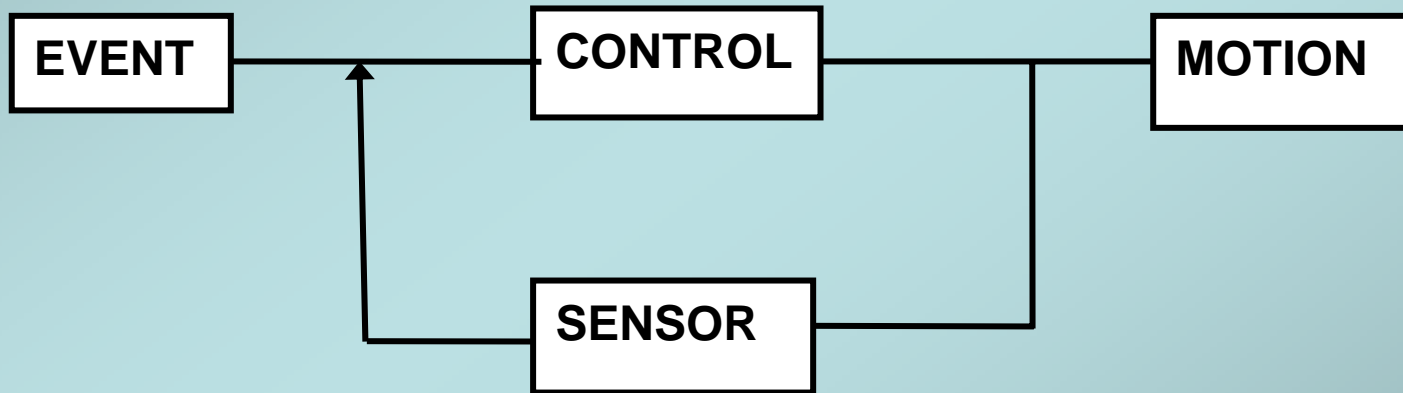
# Automotive Axes Of Motion



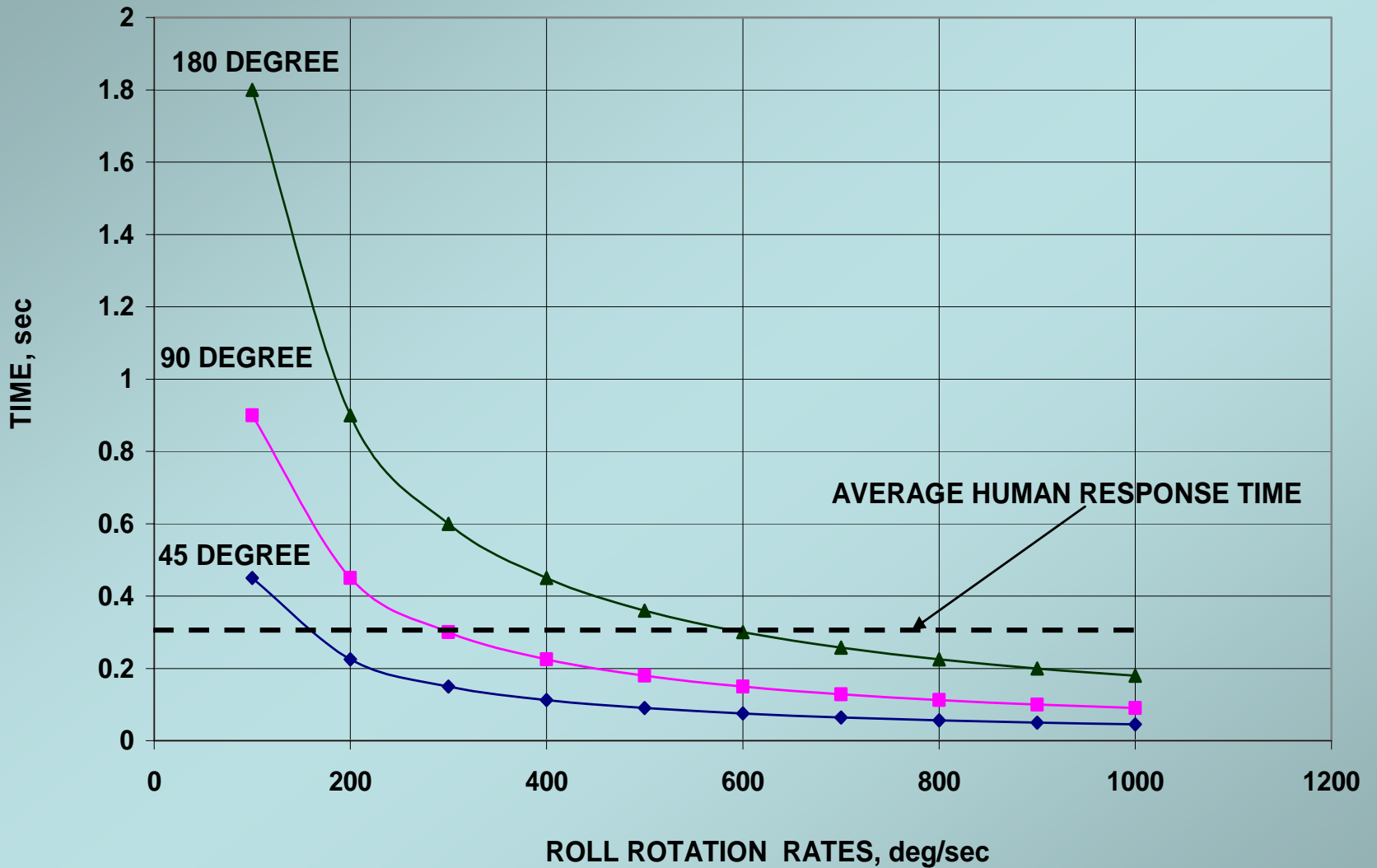
# Human Block Diagram



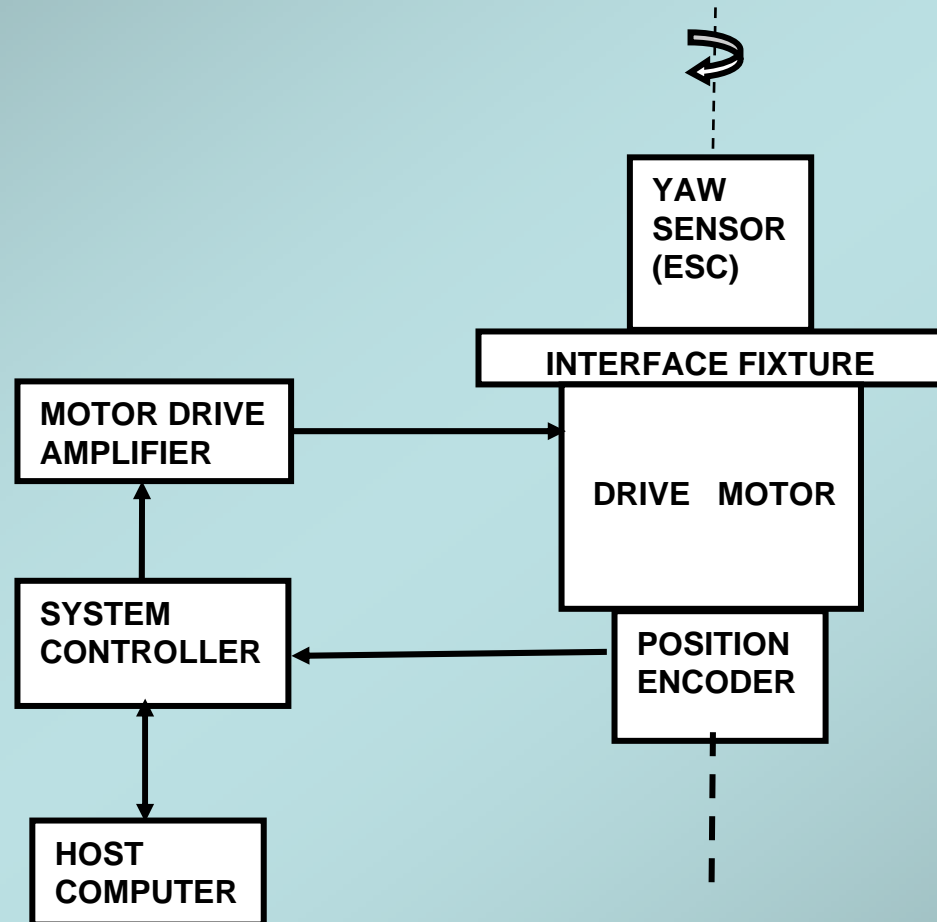
# Sensor Block Diagram



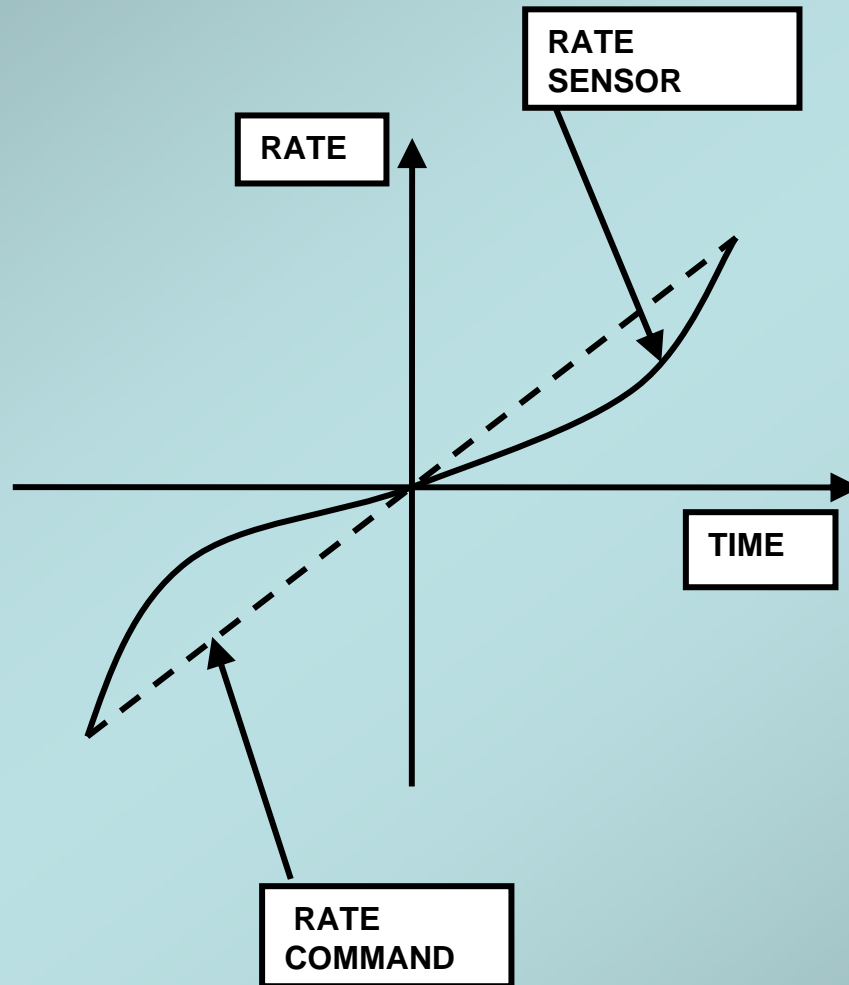
# Turnover Rates



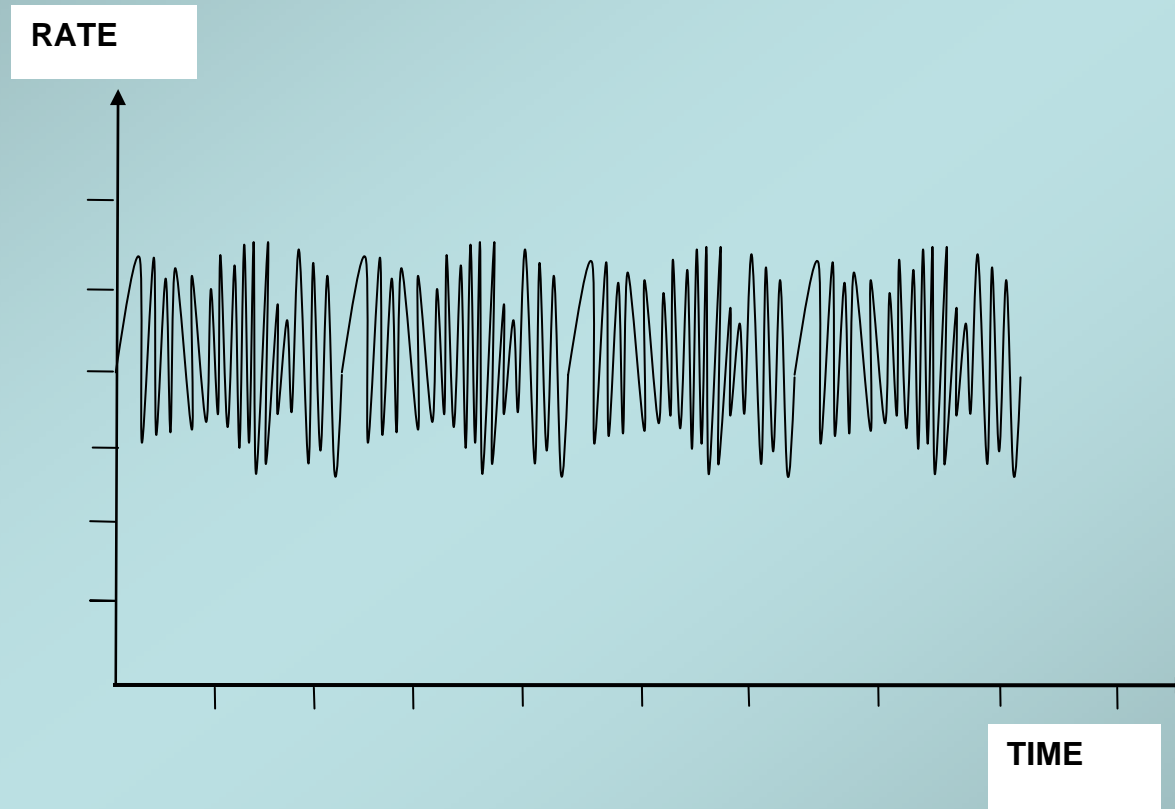
# Motion Simulator Block Diagram



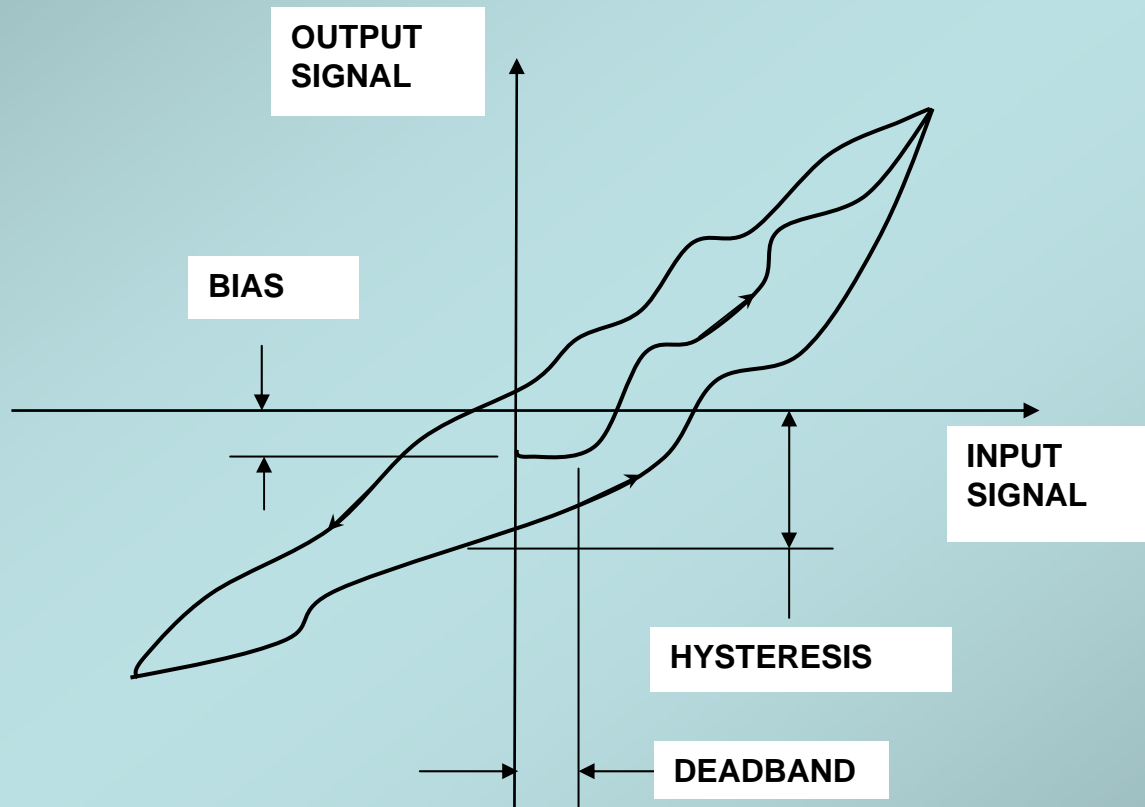
# Rate Sensor Linearity Testing



# Rate Sensor Stability Testing



# Rate Sensor Hysteresis Testing



# Vehicle Stability Control Intervention

CONTROL	SUSPENSION	STEER	BRAKE	ACCELERATOR	AUDIBLE WARNING
OBSTACLE		O	O	O	O
CRASH AVOIDANCE	O		X	X	X
SKID MITIGATION		O	X	X	
ABS - STRAIGHT			X	X	
ABS- CURVES			X	X	
ROLLOVER			X	X	
LANE DEPARTURE		O			X
	X = EXISTS			O = FUTURE	

# Advantages of Laboratory Sensor Testing

PARAMETER	TEST TRACK	LABORATORY
Inclement Weather	Limited Testing	No Effect
Safety	Dangerous at Times	Safety Interlocks
Operating Temperature Range	Weather Related	On-Board Temp Chamber
Motion Accuracy	Driver and Recorder Dependent	Precisely Controlled by Computer
Roll, Yaw, Pitch Rotation	Difficult or Dangerous	Parameters Controlled by Computer
Reliability	Variable, Low	10,000 Hours MTBF
Maintainability	High Maintenance	4 Hours MTTR

# Dual Axis Motion Table Specifications

	<u>Outer Axis</u>	<u>Inner Axis</u>
<b>Angular Freedom</b>	<b>Unlimited</b>	<b>Unlimited</b>
<b>Rate</b>		
<b>Maximum</b>	<b>+/- 500 deg/sec</b>	<b>+/- 1200 deg/sec</b>
<b>Minimum</b>	<b>+/- 0.00008 deg/sec</b>	<b>+/- 0.00008 deg/sec</b>
<b>Accuracy (over 360 deg)</b>	<b>0.0005%</b>	<b>0.0005%</b>
<b>Position</b>		
<b>Range</b>	<b>0.00000 to 359.99999 deg</b>	<b>0.00000 to 359.99999 deg</b>
<b>Accuracy</b>	<b>0.0005 deg (+/- 2 arc sec)</b>	<b>0.0005 deg (+/- 2 arc sec)</b>
<b>Acceleration</b>	<b>200 deg/sec<sup>2</sup></b>	<b>4000 deg/sec<sup>2</sup></b>

# Dual Axis Motion Table with Temperature Chamber



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## Contact Data

**Robert W. Mitchell**

**Ideal Aerosmith Inc  
232 Alpha Drive  
Pittsburgh, Pa 15238**

**Telephone: 412-963-1495**

**Email: [mitchell@idealaero.com](mailto:mitchell@idealaero.com)**