This document is subject to protective orders in the cases of:

Johnson v. Ford Motor Company - Case 99C0509 in the United States District Court in Northern District of Illinois, Eastern Division;

Baker v. Ford Motor Company - Civil Action 01-SV-5869 in the state court of Liberty County, Georgia;

Northern Trust Co. v. Ford Motor Company - Case 98L4154 in the Circuit Court of Cook County, Illinois, County department, Law division.

STATE OF MICHIGAN	}	
	} **SS:**	**<u>AFFIDAVIT</u>**
COUNTY OF WASHTENAW	}	

DR. THOMAS J. WIELENGA, being first duly sworn on oath, deposes and states as follows:

1. My name is Thomas J. Wielenga. I have a Bachelor of Science degree in Mechanical Engineering, a Master of Science degree in Computer Aided Design, and a Ph.D. degree in Mechanical Engineering. I am a registered professional engineer in the state of Michigan (#34054). I am a member of the Society of Automotive Engineers where I am a member of the Vehicle Dynamics Committee and the Automotive Dynamics, Stability and Control Conference planning committee. My Curriculum Vitae is attached as Exhibit A.

2. I am the owner and president of Engineering Insight, LLC, 411 Huronview Boulevard, Suite 200, Ann Arbor, Michigan 48103, which is engaged in the business of reconstructing and simulating rollover accidents and other loss-of-control accidents and in analyzing the design of vehicles involved in these accidents.

3. I am the inventor of the Anti-Rollover Braking System and hold patent 6,065,558. This system is licensed to Continental TEVES (a tier-one brake supplier) for worldwide use of the system. This system can help prevent rollovers by applying the front brakes of the vehicle when the vehicle encounters a maneuver severe enough to make it roll over. It helps to stabilize the vehicle both directionally (keep it heading down the road) and in roll (preventing it from rolling over).

4. I am experienced in the reconstruction and physically accurate computer simulation of vehicle accidents, including loss-of-control, rollovers and off-road events. I have extensive experience in the creation of complete computer models of specific vehicles, and in modeling tires and suspensions and the scenes of accidents. For this I have used the ADAMS (Automated Design of Articulated Mechanical Systems) program, which is also used by Ford in their vehicle design process. I have created models for the Chevrolet Astrovan, the Chevrolet S-10 Blazer, the Nissan Pathfinder, the Suzuki Samurai, the Jeep Wrangler, the Toyota 4Runner, the Isuzu Rodeo, and the Ford E-350 15 passenger Super Club Wagon.

5. I have examined the ADAMS models created by Ford in their design process and used by them in their rollover guideline. These vehicle models include: the Ford Aerostar, the Ford Bronco II, the Ford Explorer, and the Ford E-150 Club Wagon.

6. I worked for five years at Mechanical Dynamics, Inc. improving the ADAMS program, maintaining it, and training others in the use and theory of the ADAMS program.

7. On December 11, 2002 I received documents relating to testing and ADAMS modeling done by Ford relative to the Ford E-350 15 passenger Super Club Wagon. These documents are Bates numbered 7825 102458 - 102598. These documents are labeled "1999 Ford E-350 Van (301W193) Steering/Handling/Braking/VIMF. Sept 1998." Based on my education, training and experience the graphs on pages 102459 – 102462 and 102468 – 102479 reflect correlation of the ADAMS model with a VN127 E-350. Correlation refers to comparing the performance of the computer model with an actual vehicle's performance in the same maneuver. Specifically the vehicle is a 1999 model year vehicle equipped with Goodyear Wrangler HT LT245/75R16 tires (see Bates number 7825 102482).

8. There are four maneuvers in which the performance of the ADAMS model is compared and correlated against test data:

a. Constant speed, slowly increasing steer (Bates7825 102459 – 102462). Speed of 48 mph. Good correlation on Steer, Speed, Lateral Acceleration, Yaw Rate, and Body Roll. Acceptable correlation on Sideslip velocity (the ADAMS model shows slightly more plowing behavior than the test vehicle). Good correlation on suspension deflection, with the ADAMS model giving somewhat more deflection than the test on the Right Rear wheel.

b. Constant speed, slowly increasing steer (Bates 7825 102476 – 102479). Speed of 48 mph – done in the opposite direction of that in a. Similar correlation to a. The ADAMS model gives somewhat less deflection than the test on the Right Rear wheel.

c. Constant speed, step steer (Ford Ramp Steer) (Bates 7825 102468 – 102471). Speed 65 mph and steer to 55 degrees. Good correlation on Steer, Speed, Lateral Acceleration, Yaw Rate, and Body Roll. The ADAMS model is slightly low on Lateral Acceleration and Yaw Rate. Good correlation of suspension deflection, with the ADAMS model giving somewhat less deflection than test on the Right Rear wheel.

d. Constant speed, step steer (Ford Ramp Steer) (Bates 7825 102472 – 102475). Speed of 48 mph and steer to 85 degrees. Excellent correlation.

Taken together, the ADAMS model and test data show excellent correlation to high g levels in both a quasi-static situation and in dynamic situations. The model works well from low g to high g maneuvers with slow steers and in moderately high g maneuvers with quick steers.

9. Among the graphs provided in the documents I have specifically examined the page numbered 7825 102463, which is entitled "J-Turn." This is attached as Exhibit B. I am quite familiar with these types of graphs. Based on my education, training and experience, it is my opinion that on or about March 19, 2001, Ford ran ADAMS simulations of a VN127 E-350 van in a set of J-turn maneuvers with steering wheel angles of 90 degrees, 180 degrees, 270 degrees, and 360 degrees in both the right and left turning directions. This would be consistent with the Ford Motor Company Safety Segment Design Guidelines for Rollover Resistance with which I am also familiar.

10. In examining the plots produced by the ADAMS simulation of the J-turns described above, it is my opinion that the ADAMS modeled vehicle experienced one rollover and at least two simultaneous 2-wheel lifts. Ford's Rollover Resistance Guideline requires the vehicle not lift two wheels simultaneously for any of these steer angles. Ford claims this requirement only applies to vehicles having a GVWR not exceeding 8500 lbs. However, if this protocol had been applied to this vehicle it would have failed.

11. Also within the plots produced as described in paragraph 9 are plots of sideslip angle of the vehicles with respect to time. In these plots we see that in six of the eight simulated maneuvers the vehicles had increasing sideslip angle. In other words, the vehicles "spun-out," or the vehicle's "rear end came loose." This is sometimes called transient oversteer. This behavior is considered to be undesirable by engineers throughout the industry. The vehicle should "plow" (the front comes loose first) instead of "spin-out" (the rear comes loose first). These plots show that the vehicle spun out of control in relatively simple steering maneuvers. In my opinion, this represents defective behavior of the vehicle. This behavior makes the vehicle much more difficult for a driver to control, especially in emergency situations. The fact that the vehicles "spun-out" is also shown by the relatively high yaw rates in the Yaw Rate vs. Time plot.

12. Throughout my experience in using ADAMS software to model vehicles, Ford and other automotive companies have criticized my work through their retained experts by criticizing any data that might be inaccurate in some way. This receives great emphasis by quoting the commonly known phrase "Garbage in, Garbage out." However, in engineering modeling, this does not apply in the same way as it does in other aspects of computing. Engineers must always make simplifications and estimates to model real systems and even to measure real systems. Computer models can still correlate well with actual systems even though the modeled system is simplified in some way. In fact, my models do correlate well with the performance of actual vehicles. These kinds of criticisms would be rendered useless to Ford if I were given complete access to Ford's own ADAMS model. I would then be able to demonstrate, without any potential for criticism of my data input, specific vehicle behavior under various dynamic conditions. To date, Ford has refused to completely produce its ADAMS model of the E-350 Super Club Wagon and all of the attending preprocessors, subroutines, software and other files that are needed to make it work. This refusal prevents me from using their data to examine the vehicle's behavior and any possible changes or improvements to the vehicle.

13. Until recently Ford has denied the existence of ADAMS models of the Ford E-350 Super Club Wagon. In particular, they have claimed that the tires could not be tested and that the vehicle body's flexibility could not be accurately modeled.

14. I received in February of 2002 a model of the Ford E-150 Club Wagon (which is very similar to the E-350). In November of 2002 I received a set of FORTRAN subroutines that are required in order to use a Ford ADAMS model. In December of 2002, I finally received models of the Ford E-350 Super Club Wagon. However, the FORTRAN subroutines produced were obsolete with respect to the E-350 model. To my knowledge Ford has never produced for any of their vehicles a complete, working set of data and subroutines to someone involved in litigation. Ford has, however, in the past fully and completely supplied the necessary ADAMS models, preprocessors, subroutines and data files to their tire suppliers for their use in qualifying particular tires on Ford vehicles.

FURTHER AFFIANT SAYETH NAUGHT.

THOMAS J. WIELENGA

SWORN TO BEFORE ME and subscribed in my presence this 13 day of January, 2003.

Regina G. Lockridge

NOTARY PUBLIC

REGINA G. LOCKRIDGE
Notary Public, Wayne County, MI
Acting in Washtenaw County, MI
My Commission Expires 11-8-2006

Engineering Insight, LLC

411 Huron View Blvd. Suite 200
Ann Arbor, MI 48103
(734) 913-8520
(734) 913-8521 Fax

Curriculum Vitae of

THOMAS J. WIELENGA

President

PhD dynamicist, traffic accident reconstructionist, and registered professional engineer. Experienced in the reconstruction and physically accurate computer simulation of vehicle accidents including rollovers, and in creating graphic depictions for courtroom use. Experienced in creating complete computer models of specific vehicles and in modeling tires and suspensions.

EDUCATION

UNIVERSITY OF MICHIGAN, Ann Arbor, Michigan.
Ph.D. in Mechanical Engineering, 1979-1984. Thesis: *Simplifications in the Simulation of Mechanisms Containing Flexible Members.* Developed a computer application to analyze mechanical systems containing flexible members, capable of linking with computer applications in finite element and modal analysis. Devised a new second-order DAE (differential algebraic equation) integrator and simplified the calculation of equations of motion; developed a new method of using Euler parameters; applied vector-dyadic derivation throughout the analysis. Committee chairmen: Milton A. Chace, Joseph Whitesell.

MSE in Computer-Aided Design, 1979.

MICHIGAN STATE UNIVERSITY, East Lansing, Michigan.
BSE in Mechanical Engineering (Honors College), 1974-1978. Teaching and research assistant in dynamics for 3 years. Wrote portions of ENPORT, a system dynamics program.

PROFESSIONAL

Registered professional engineer in Michigan #34054
Became fully accredited traffic accident reconstructionist (ACTAR #425) in1994.

EXPERIENCE

ENGINEERING INSIGHT, LLC, Ann Arbor, Michigan, 1999 - present.
President of a company specializing in the simulation and analysis of rollover accidents. Expert in the dynamics of vehicles and the reconstruction, simulation and prevention of rollover accidents.

DYNAMOTIVE, LLC, Ann Arbor, Michigan, 1998 - present.
President of a company dedicated to preventing rollover in unstable vehicles. Creator of a system to prevent rollovers in vehicles susceptible to on-road rollovers. The system, called the Anti Rollover Braking (ARB) system, prevents rollovers by braking the front wheels of a vehicle when it is near rollover. By braking the front wheels the system prevents lateral forces from becoming large enough to roll a vehicle over. The system is the subject of an SAE paper (see list below) and has been granted US patent number 6,065,558.

CHACE AND ASSOCIATES ENGINEERING, INC., Ann Arbor, Michigan, 1992 — 1999.
Vice President of Engineering for an engineering consulting firm specializing in the reconstruction of accidents and analysis of failures involving vehicles, industrial machinery, and other mechanisms. Has created computer models of the Suzuki Samurai, Jeep Wrangler, Toyota 4Runner and Chevrolet S10 Blazer. Authored the protocol for measuring the physical characteristics of tires and created the computer model of tires that accurately represents lateral friction, aligning torque, vertical deflection and track change of tire. Created an algorithm that accurately simulates the crush of a vehicle experiencing rollover, including interaction with complicated terrain profiles. Created a library of suspension types and steering mechanisms that can be utilized quickly to build accurate vehicle models. Also directed the development of an animation program that creates graphic depictions of the behavior of vehicles in their simulated maneuvers. Created a method to solve for the CG and mass moments of inertia of a vehicle's sprung mass as it varies with occupant loading.

APPLIED COMPUTATIONAL TECHNOLOGY, INC., Ann Arbor, Michigan, 1991—1992.
Designed and implemented an advanced mechanical system analysis program based on an interactive object-oriented programming approach. Devised methods for computer integration of differential and algebraic equations of arbitrary order without loss of accuracy and stability.

SIMULATION SPECIALISTS, INC., Ann Arbor, Michigan, 1988 — 1991.
Founder and principal systems designer for an engineering consulting and software applications development company. Devised and implemented software-based methods for evaluating derivatives and partial derivatives of expressions suitable for the numerical integration of non-linear dynamics equations. Designed and implemented an advanced object-oriented programming language suitable for general programming and for engineering simulation applications. Responsible for day-to-day operations.

MECHANICAL DYNAMICS, INC., Ann Arbor, Michigan, 1983 — 1988.
Principal research engineer for analysis products for a computer-aided engineering company. Aided the development and maintenance of ADAMS, a multibody dynamics software program used in the simulation of vehicles, vehicle subsystems, spacecraft, aircraft, and mechanisms. Provided advice and problem solving to the in-house consultants. Created a tire model. Designed and implemented a DAE integrator; modified sparse matrix routines; added new capabilities, including joint primitives, gears, and couplers; and modified the input language. Represented MDI in mechanical system simulation contest and was uniquely successful in modeling all contest problems. Taught courses in theory of ADAMS. Acted as principal investigator in research projects for next-generation multibody dynamics analysis program, and for a real-time dynamic simulator of automobiles; managed the development of an ADAMS postprocessor for the Silicon Graphics workstation; managed the development a 3D preprocessor; analyzed and simulated car crashes and lift-truck turnovers for litigation.

UNIVERSITY OF MICHIGAN, Ann Arbor, Michigan, 1979 — 1983.
Teaching assistant in dynamics controls laboratory course. Performed general research in the field of multibody dynamics, especially relating to flexible bodies. Assisted in the development of a hardware and software system for digitizing TV images; analyzed a conveyor system using principles of dynamic simulation.

MASSEY FERGUSON, Livonia, Michigan, 1981.
Performed stress analysis of load-bearing tractor parts, using methods of finite element analysis.

INDEPENDENT CONSULTANT, Ann Arbor, Michigan, 1979 — 1983.
Acted as an independent analyst and consultant for various engineering clients. Analyzed a trailer suspension and aided re-design to achieve uniform load distribution; analyzed a ski-lift accident to help determine causation for litigation; analyzed the mechanics of manipulator arm for design of the spring tensioner.

BOEING COMMERCIAL AIRPLANE CO., Seattle, Washington, Summer, 1978.
Developed a thin-skin analysis module for an existing section properties computer software application; developed the software's user interface.

MICHIGAN STATE UNIVERSITY, East Lansing, Michigan, 1975 — 1978.
Designed and implemented a causal assignment procedure for the ENPORT IV bond-graph dynamic simulation software application.

PATENTS

Anti-Rollover Brake System. US Patent # 6,065,558 (May 23, 2000)
Rotating Shuttle Engines with Integral Valving. US Patent # 5,517,952 (May 21, 1996)

AFFILIATIONS

Society of Automotive Engineers:
  Vehicle Dynamics Standards Committee;
  Automotive Dynamics and Stability Conference Committee.
American Society of Mechanical Engineers
Institute of Electrical and Electronic Engineers
Society for Industrial and Applied Mathematics

PAPERS AND PUBLICATIONS

Wielenga, T.J., "A Study in Rollover Prevention Using Anti-Rollover Braking," Society of Automotive Engineers -SAE 2000-01-1642 (May 2000)
Wielenga, T.J., "A Method for Reducing On-Road Rollovers – Anti-Rollover Braking," Society of Automotive Engineers -SAE 1999-01-0123 (March 1999)
Chace , M.A. and Wielenga, T.J., "A Test and Simulation Process to Improve Rollover Resistance," Society of Automotive Engineers -SAE 1999-01-0125 (March 1999)
Wielenga, T.J., "Tire Properties Affecting Vehicle Rollover," Society of Automotive Engineers -SAE 1999-01-0126 (March 1999)
Wielenga, T.J., "New ADAMS Elements," *MDI Confidential Report* (March 1988).
Wielenga, T.J., "Wstiff — A New Stiff Integrator for ADAMS," *Proceedings of the 4th ADAMS News Conference*, TEDAS Gmbh, Marburg, Germany (September 1987).
Wielenga, T.J., "Analysis Methods and Model Representation in ADAMS" (ADAMS Theory Seminars), *MDI Report No. 41* (September 1987).
Wielenga, T.J., "The Effect of Numerical Stiffness on Mechanism Simulation," 1 *Proceedings from the 1986 International Computers in Engineering Conference* 376-378 (New York: American Society of Mechanical Engineers, 1986).
Wielenga, T.J., *Simplifications in the Simulation of Mechanisms Containing Flexible Members* (Report RSD-TR-6-84), (Ann Arbor: University of Michigan Center for Robotics and Integrated Manufacturing, March 1984).

PANELS, PRESENTATIONS, CONFERENCES

Organizer for the Simulation Session and Rollover Session of the 2000 SAE Automotive Dynamics & Stability Conference, May 7-9, 2002.

Organizer and Moderator for the Vehicle Stability and Control Panel at the 2000 SAE Automotive Dynamics & Stability Conference, May 15-17, 20000.

Organizer for the Simulation Session of the 2000 SAE Automotive Dynamics & Stability Conference, May 15-17, 2000.

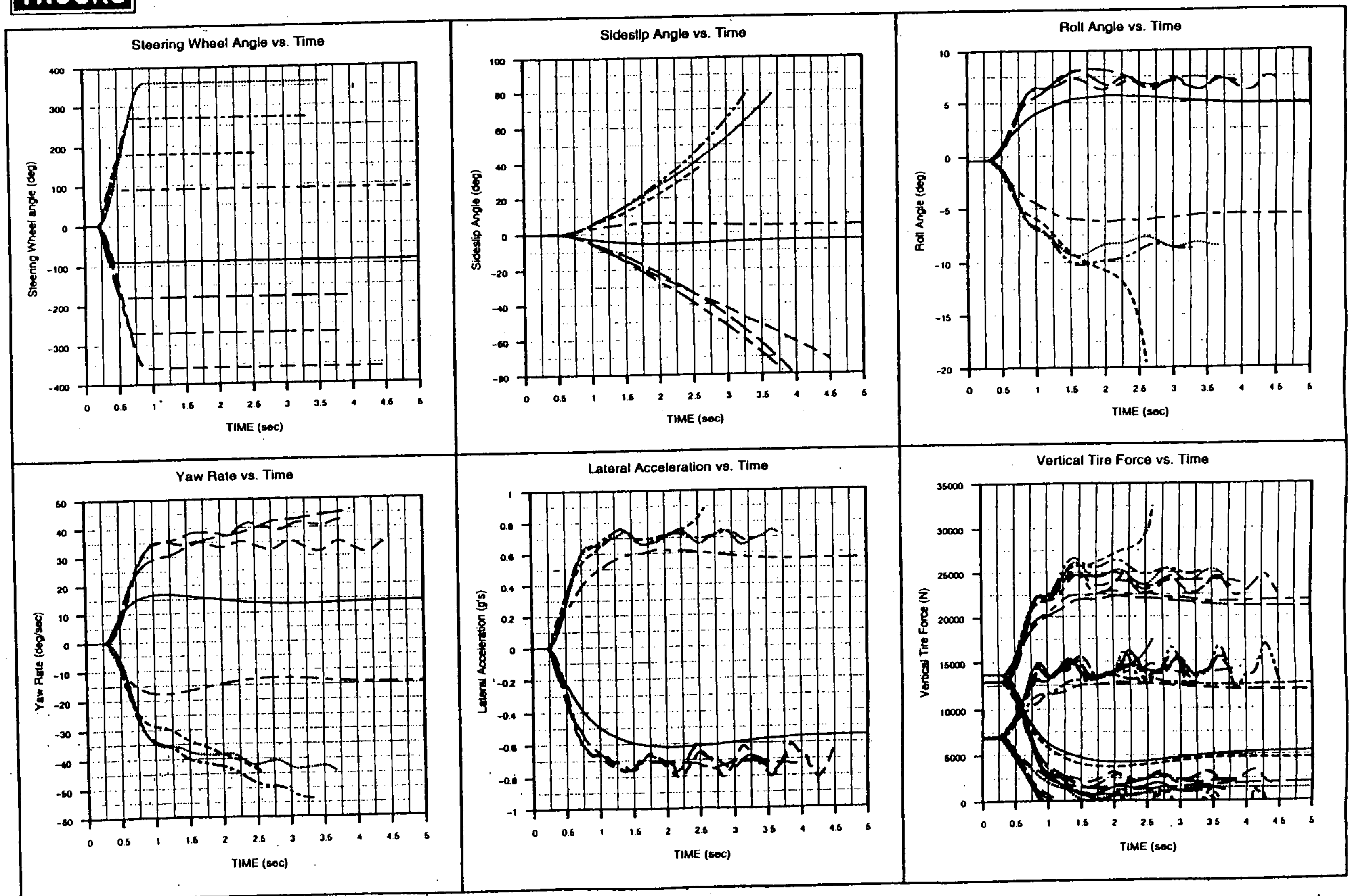
Presented "The Tire's Role in Rollover Safety" at the Clemson 2000 Tire Industry Conference March 2, 2000.

Panelist on the topic: "Future Directions and Challenges for Java Implementations of Numeric Intensive Industrial Applications." at the 5th NASA Symposium on Large-Scale Analysis and Design and Intelligent Synthesis Environments. October 15, 1999.

Truck Vehicle Center CAE
Vehicle Dynamics Section

TRUCKS

J–Turn



/ford/lu5333/u/ggordon/adams/vn127/e350/meplot.mvw
03/19/01 – 11:56:58 AM

G. Gordon – 84x51029 – ggordon
Page 1 of 1

7825 102463