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Engineering & Scientific Consulting

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Professional Profile

Dr. Martens applies his expertise as an electrical engineer to the scientific investigation of electrical engineering systems, controls, and software; he has experience with a multitude of technologies centering on electricity, electronics, and controls. He has analyzed control systems, electronics, and electrical equipment as part of incident investigations, intellectual property claims, fires and explosions investigations, system performance analysis, and construction-related claims. Dr. Martens is a committee member of several standards-making organizations (NFPA and ASME), and is a member of IEEE, ISA, NFPA, ASME, NAFI, and SAE. Dr. Martens has provided testimony in various adjudicatory venues such as federal and state court and international arbitration.

EMBEDDED SYSTEMS

Dr. Martens' work on microprocessor-based and microcontroller-based computer systems (embedded systems) encompasses a host of applications including automobiles, robotic systems, appliances, power wheelchairs, and other mechatronic systems. Dr. Martens' expertise includes system-level analysis, sensor evaluations, electronics and circuit design review, components and component failure analysis, software, and firmware (source code) analysis, internet-based system design (IoT), control philosophy and algorithm development.

Dr. Martens has experience developing and testing electronic automotive systems. Prior to joining Exponent, Dr. Martens managed the embedded control systems group at Delphi Corporation, a leading global supplier of mobile electronics and transportation systems, where he developed several systems for improved vehicle performance.

INDUSTRIAL PROCESSES AND MACHINE CONTROL

Dr. Martens is active in the field of industrial process control and applies his knowledge of Programmable Logic Controllers (PLCs), Supervisory Control and Data Acquisition (SCADA) systems, and Distributed Control Systems (DCSs) to industrial machine and process control analyses and investigations. He has analyzed industrial process systems and components, including boilers, burners, generators, turbines, water treatment, mills, pipelines, incinerators, dryers. He has advised his clients regarding the appropriate level of safeguards necessary for the safe operation and control of their systems, assisted them in implementing those safeguards, audited their installations, evaluated interface and alarm systems, and participated in Factory Acceptance Testing, Site Acceptance Testing, and control system commissioning. He draws from his accident investigation experience and his knowledge of industry standards to perform process hazard analyses.

Dr. Martens has analyzed machine controls for cranes, lifts, mining equipment, amusement park rides, robotics, computer vision-based systems, construction equipment, packaging systems, agricultural and

farming equipment, food processing equipment, and more. In addition to system-level design philosophy, he has analyzed wiring, sensors and switches, actuators, and control logic.

ELECTRICAL POWER SYSTEMS

Dr. Martens' work on electrical power systems has encompassed a wide range of technologies including fossil fuel-based and biomass-based electric power generation and hydroelectric generation. He has evaluated specifications, installations, workmanship, construction, maintenance, and failures of industrial, commercial, and utility power generation and distribution systems and components. He has experience managing facilities, working with electricians, analyzing electrical systems and switchgear equipment failures and fires in a variety of environments, including utilities, industrial settings, underground and surface mining, water treatment facilities, and more.

FIRE AND EXPLOSIONS

Dr. Martens has experience evaluating wiring, appliances, electrical products, power supplies, batteries, battery-operated equipment and more in the context of evaluating failure modes and fires. He has conducted Consumer Product Safety Commission (CPSC)-related investigations for a variety of products. He has been involved in complex domestic and international fire investigations. Further, he has experience evaluating products and appliances in laboratory environments and performing forced-failure testing. Additionally, Dr. Martens has investigated and explored the role of the control systems in such incidents. He applies his knowledge of hardware and logic (programming) to understand control system responses prior to and during fires and explosions.

Academic Credentials & Professional Honors

M.B.A., University of Michigan, Ann Arbor, with high distinction, 2003

Ph.D., Electrical Engineering and Computer Science, Case Western Reserve University, 2000

M.S., Electrical Engineering and Applied Physics, Case Western Reserve University, 1993

B.S., Electrical Engineering and Applied Physics, Case Western Reserve University, summa cum laude, 1993

Tau Beta Pi Engineering Honor Society

Eta Kappa Nu/IEEE's Award for Outstanding Senior in Electrical Engineering

Ohio Aerospace Institute Fellowship

Centerior Energy Fellowship

General Motors Scholarship

Case Alumni Association Scholarship

Dean's High Honors

Licenses and Certifications

Licensed Professional Engineer, Illinois, #062-058837

Licensed Professional Engineer, Michigan, #6201057824

Licensed Professional Engineer, Missouri, #2010036256

Licensed Professional Engineer, North Carolina, #037584

Licensed Professional Engineer, Ohio, #E-65142

Licensed Professional Engineer, Texas, #105276

Licensed Professional Engineer, West Virginia, #19078

Licensed Professional Engineer, District of Columbia, #PE906421

Licensed Professional Engineer, New York, #086510-1

Licensed Professional Engineer, Kansas, #PE25630

Licensed Professional Electrical and Computer Engineer, Florida, #85797

Certified Fire and Explosion Investigator (CFEI), #17603-9653

Crash Data Retrieval Technician Levels 1 & 2, Collision Safety Institute

Prior Experience

Manager, Embedded Control Systems, Delphi, Brighton, MI, 2004-2005

Project Manager, Active Chassis Systems, Delphi, Brighton, MI, 2000-2004

Research Assistant, Electrical Engineering and Applied Physics, Case Western Reserve University, Cleveland, OH, 1997-2000

Project Manager, CAM-LEM, Inc., Cleveland, OH, 1996-1997

Advanced Chassis Control Engineer, Delco Chassis, Division of General Motors, Dayton, OH, 1995-1996

Advanced Facilities Engineer, Delco Chassis, Division of General Motors, Dayton, OH, 1994-1995

Laboratory Facilities Manager, Center for Automation and Intelligent Systems Research (CAISR) Mechatronics Laboratory, Case Western Reserve University, Cleveland, OH, 1992-1993

Intern, Delco Chassis, Division of General Motors, Dayton, OH, 1991

Intern, Delco Chassis, Division of General Motors, Rochester, NY, 1990

Repair Technician, Affiliated T.V. Shops, Eastlake, OH, 1988-1989

Professional Affiliations

Institute of Electrical and Electronic Engineers — IEEE (senior member)

Subcommittee Member for Guidelines for Safe Automation of Chemical Processes, 2nd Edition. Center for Chemical Process Safety, American Institute of Chemical Engineers, Wiley, 2017

International Society of Automation — ISA (member)

National Fire Protection Association — NFPA (member)

Principal Member: Technical Committee on Single Burner Boilers, NFPA 85 Boiler and Combustion Systems Hazards Code, National Fire Protection Association, effective August 2015

Alternate Member: ASME CSD-1 Standard, Controls and Safety Devices for Automatically Fired Boilers, effective June 2017

Alternate Member: ASME Board on Safety Codes and Standards, effective March 2018

American Society of Mechanical Engineers — ASME (member)

National Association of Fire Investigators — NAFI (member)

Society of Automotive Engineers International — SAE (member)

Patents

Patent 6,789,002 B1: Determination of Vehicle Payload Condition, September 7, 2004 (with A. Hac).

Patent 6,804,594 B1: Active Steering for Handling/Stability Enhancement, October 12, 2004 (with T. Brown, A. Chandy, H. Chen, and C. Gryczan).

Patent 6,862,506 B2: Method for Automatically Adjusting Reference Models in Vehicle Stability Enhancement (VSE) Systems, March 1, 2005 (with E. Bedner, K. Boswell, H. Chen, and B. McDonald).

Patent 6,879,896 B2: System and Method for Using Vehicle Operator Intent to Adjust Vehicle Control System Response, April 12, 2005.

Patent 6,926,114 B2, Assist Modification in Active Front Steering, August 9, 2005 (with F. Bolourchi, K. Boswell, J. Dickinson, and E. Bedner).

Patent 6,942,057 B2: Feel Control for Active Steering, September 13, 2005 (with K. Boswell and F. Bolourchi).

Patent 7,083,025 B2: Method for Implementing Vehicle Stability Enhancement Reference Models for Active Steer Systems, August 1, 2006 (with E. Bedner and K. Boswell).

Patent 7,213,675 B2: Method and System for Anti-Static Steering for Vehicle Steering Systems, May 8, 2007 (with C. Gryczan).

European Patent EP 1357013B1: System and Method for Using Vehicle Operator Intent to Adjust Vehicle Control System Response, June 6, 2007.

European Patent Application 02078139.9: Method for Automatically Adjusting Reference Models in Vehicle Stability Enhancement Systems.

European Patent Application 02079498.8: Feel Control for Active Steering.

Publications

Martens, J., Arora, A. Functional Safety & Your Product. 2020 Association of Equipment Manufacturers Product Safety & Compliance Seminar, Live Webinar, August 26, 2020.

Martens, J., Kuykendal, M., Bracher, D., Arora, A. Functional Safety That Your Boss Will Understand. 2019 Association of Equipment Manufacturers Product Safety & Compliance Seminar, Des Moines, IA, May 1, 2019.

Prigmore J, Bishop J, Martens J. Electrical Investigations: Case studies, common electrical safety mistakes, and lessons learned. 2018 IEEE IAS Electrical Safety Workshop (ESW). pp. 1-5, 2018.

Bobbitt B, Garner S, Cox B, Martens J, Fecke M. Manual vs. automatic boiler controls: A historical perspective from relevant codes and standards. Proceedings of the ASME 2017 Power and Energy Conference 2017. (Accepted).

Fecke M, Martens J, Cox B, Bishop J. Codes, standards, and guidelines for plant steam utilities. Exponent Electrical Engineering & Computer Science Newsletter, Volume 4, 2016.

Martens J, Sinenian N. Usage-based insurance devices. Exponent Electrical Engineering & Computer Science Newsletter, Volume 1, 2015.

Arora A, Martens JD. Energy storage for BEV's: An engineering perspective. IEEE Transportation Electrification Conference and Expo (ITEC' 13), Dearborn, MI, June 16-19, 2013. (Half-day tutorial).

Martens JD, Arora A. Understanding the role of software in product failures. IEEE Symposium on Product Compliance Engineering, Portland, OR, November 5-7, 2012.

Morrison DR, Fecke M, Martens, JD. Migrating an incident reporting system to a CCPS process safety metrics model. Journal of Loss Prevention in the Process Industries 2011.

Martens JD, Fecke, M, Ogle, RA, Bishop, JA. Functional testing for industrial control systems. Proceedings, ASME 2011 International Mechanical Engineering Congress & Exhibition IMECE2011, Denver, CO, November 11-17, 2011.

Arora A, Martens JD, Babic D. AC & DC adapters safety considerations. IEEE Symposium on Product Compliance Engineering, San Diego, CA, October 10-12, 2011.

Fecke M, Martens JD, Cowells J, Morrison DR. A guide to developing and implementing safety checklists: Plant steam utilities. Process Safety Progress 2011; 30(3):240-250.

Ramirez JC, Fecke M, Morrison DR, Martens JD. Root cause analysis of an industrial boiler explosion (and how hazard analysis could have prevented it). Proceedings, ASME 2010 International Mechanical Engineering Congress & Exhibition IMECE2010, Vancouver, Canada, November 12-18, 2010.

Morrison DR, Fecke M, Martens JD. Migrating an organizational incident reporting system to a CCPS process safety metrics model. 2010 Annual Symposium, Mary Kay O'Connor Process Safety Center, Texas A&M University, College Station, TX, October 26, 2010.

Fecke M, Morrison DR, Martens JD, Cowells JT. A guide to developing and implementing safety checklists: Plant steam utilities. American Institute of Chemical Engineers, 2010 Spring National Meeting, 25th Center for Chemical Process Safety International Conference, San Antonio, TX, March 22-24, 2010.

Morrison DR, Martens JD, Ogle RA, Cowells JT. Root cause analysis of a cryogenic refrigeration system explosion. American Institute of Chemical Engineers, 2009 Spring National Meeting, 43rd Annual Loss

Prevention Symposium, Tampa, FL, April 26-30, 2009.

Morrison DR, Martens JD, Ogle RA, Cowells JT. Accident investigation using process control event diagrams. American Institute of Chemical Engineers, 2009 Spring National Meeting, 24th Annual CCPS International Conference, Tampa, FL, April 26-30, 2009.

Martens JD, Johnson G, So P. Design considerations for consumer products utilizing high voltage. Presentation, 2006 IEEE Symposium on Product Safety and Compliance Engineering, IEEE Product Safety Engineering Society, (PSES), Irvine, CA, October 23-24, 2006. Also approved for publication in the IEEE PSES 2006 Conference Proceedings.

Martens JD, Hac A, Brown T. Detection of vehicle rollover. 2004 SAE World Congress, No. 04-Annual-848, Detroit, MI, March 2004 (Book SP-1869, paper number 2004-01-1757).

Martens JD. Lyapunov-based, on-line identification for backstepping control. Department of Electrical Engineering and Computer Science, Ph.D. Dissertation, Cleveland, OH, Case Western Reserve University, 2000.

Martens JD, Newman WS. Stabilization of a mobile robot climbing stairs. 1994 IEEE Proceedings and IEEE Video Proceedings of the International Conference on Robotics and Automation, San Diego, CA, p. 2501-2507, May 1994.

Martens JD. Enhanced teleoperation of a mobile robot. CAISR Technical Report #93-111, Master's Thesis, Case Western Reserve University, 1993.

Doctoral Thesis

Martens JD. Lyapunov-based, on-line identification for backstepping control. Case Western Reserve University, Cleveland, OH, 2000.

Project Experience

Systems and Controls

Dr. Martens has over 25 years of experience specifying, designing, constructing, and analyzing control systems. A representative sampling of projects is listed below. These projects have involved control systems for products, processes, and machines ranging from office equipment to industrial processes with project scopes ranging from design and design reviews to accident investigation and failure analysis. Control systems generally consist of sensors, controllers, and actuators and Dr. Martens' work in design and analysis of control systems has ranged from detailed reviews of individual components to analysis of complex integrated systems.

Control Systems for Products

- Academic test grading system: evaluated control system for an academic test grading system (card scoring) used in schools to determine potential issues with ability to read scoring sheets.
- Automatic racquetball serving machine: designed and constructed an automatic racquetball serving machine with variable speed and pitch.
- Automatic revolving and sliding doors: analyzed control system for their potential role in various accidents related to automatic doors.
- Automotive antilock brake system: analyzed control system for antilock brakes and compared operation to industry standards and practices.
- Automotive stability control: designed, implemented, and obtained patents on several vehicle stability, rollover, and steering control methods.
- Business card scanner accuracy: analyzed accuracy of control system used to scan business cards and

perform optical character recognition.
- Computer-controlled telephone answering machine: designed and constructed a computer-controlled telephone answering machine, including interface circuitry and programming.
- Computer hard disk drive control method: analyzed control algorithm for head seeking and compared to teachings of a patent.
- Electric rear steering for automotive applications: designed and implemented control algorithms for electric rear steering to improve safety and performance of automotive systems.
- Electrically-powered four-wheel recreational vehicles: analyzed control system for electrically-powered four-wheel recreational vehicles that were experiencing faults and evaluated potential solutions.
- Espresso machine temperature control system: designed and constructed an analog temperature control system for an espresso machine.
- Hand-activated liquid dispenser: analyzed electronics and control system for an automatic soap dispenser.
- Home automation and security control system: designed, constructed, and programmed a home automation and security system with internet-based access.
- Hospital-grade sterilizer accident: analyzed control system for a hospital-grade sterilizer, reviewed incident data, and performed testing to evaluate control system responses.
- Ice maker system fires: analyzed control system for commercial ice making machines that were experiencing fires.
- Microprocessor-based robotic paint nozzle controller: analyzed and redesigned a paint head controller for an automatic robotic painting machine.
- Microprocessor-based stepper motor controller: designed and constructed a stepper motor controller, including power electronics and controller logic.
- Mobile robot control: retrofitted OEM control system with multi-processor based control system for automatic stair climbing.
- Oven controls: analyzed oven control systems to determine potential mechanisms for faulty burner operation.
- Paint dispensing control method: analyzed control system method for achieving high accuracy color paint dispensing and compared to teachings of a patent.
- Paper shredder control: analyzed and tested anti-jam algorithms for commercial office paper shredder.
- Sonar sensor-based control system for mobile robotics: designed and constructed a sonar sensor hardware driver and control system to perform obstacle avoidance for a mobile robot.
- Variable low-speed feedback controller for radio control car: designed and constructed PWM-based feedback velocity controller for low-speed (crawl speed) control of radio control car and interfaced to computer control system.
- Vision-based mobile robot tracking control system: designed and constructed multi-processing control system to use real-time vision processing for object tracking.
- Waterbed temperature control system: designed and constructed an analog temperature control system with discrete over-temperature control for water bed temperature regulation.

Control System for Processes

- Gas burner for thermal oxidizer safety consulting: analyzed control system implementation for several thermal oxidizer burners and advised client on safety considerations.
- Grain processing facility fire: analyzed the role of the control system in an accident involving the processing of grain.
- Grain storage facility fire: analyzed the role of the control system in an accident involving the storage of grain.
- Incinerator control system safety analysis: analyzed the control system for an inert-atmosphere incinerator and developed list of considerations.
- Incinerator explosion: analyzed the control system for an inert-atmosphere incinerator that experienced an explosion.
- Laminator treating system explosion: analyzed process data and control system for an industrial, continuous processing, board laminating process.
- Natural gas and pulverized coal boiler explosion: analyzed the process data and logic for the burner

management and combustion control systems for an industrial boiler that experienced an explosion.
- Nuclear control rod height control system: evaluated rod height control system in a nuclear power plant to determine potential failures.
- Phenol processing plant fire: analyzed control system response to a power outage at phenol processing plant.
- Pulverized coal, gas, and stoker boiler safety consulting: analyzed control system implementations for several pulverized coal, gas, and stoker boilers and advised clients on safety considerations.
- Sheet roll treating facility: analyzed control system for a sheet roll treating system involved in an explosion to determine sequence of operation.
- Steam-powered generator explosion: analyzed the control system response to an out-of-normal condition that led to an explosion at a power generating station.
- Steel processing plant fire: analyzed the control system used to process steel at a facility that experienced a major fire.
- Train monitoring and control system: analyzed control systems including Human Machine Interfaces (HMIs) used for monitoring and controlling a commuter rail system that experienced a collision.
- Underground salt cavern gas storage facility accident: analyzed control system and historic process data to determine storage capacity and production rate for a natural gas storage facility.
- Water treatment facility flood: analyzed control system response when a downstream valve lost communication with the control system for the main processing facility.
- Wonderware Data Analysis: evaluated historic Wonderware data to determine various operating conditions for plant operation.

Control Systems for Machines

- Airplane service lift accident: analyzed the control system for a service lift that damaged the wing of a commercial airplane.
- Amusement park ride stoppage investigation: investigated the design of a drive control system for a Ferris wheel that experienced a stoppage.
- Brick palletizing station accident: analyzed the control system for an industrial brick palletizing control system in which a worker was injured when the machine was put into motion.
- Continuous miner control system: evaluated control system and associated remote control for a continuous miner involved in an injury.
- Continuous long-wall miner: analyzed control system and available process data for a continuous long-wall miner involved in a fatal mining accident.
- Crane control system: analyzed crane control system for potential faults that could lead to unexpected motion.
- Elevator control system: evaluated control system that had experienced flooding to determine potential problems associated with water intrusion.
- Height Control Module (HCM) performance test system: designed, constructed, and programmed functional test system for automotive automatic leveling Height Control Modules (with Tech 2).
- Industrial press control system accident: analyzed control system for an industrial press in which a worker was injured.
- Lyophilizer accident: analyzed control system and Human Machine interface (HMI) and historic process data for a pharmaceutical freeze-dryer that exploded.
- Mining shuttle car drive analysis: evaluated performance of DC drive for a shuttle car.
- Remote control for construction equipment: analyzed remote control system for construction equipment to determine if potential faults could lead to unexpected motion.
- Remote control for lift system: analyzed remote control system for a lift for potential faults that could lead to unexpected motion.
- Scissor lift accident: analyzed hard-wired control system including sensors for a lift involved in a tip accident.
- Speed detection and control system for fan clutch test system: designed and constructed a speed detection and control system for audit and performance testing for fan clutches.
- Sports lighting control system failures: analyzed control systems for remote-controlled sports lighting equipment when manufacturer was experiencing unacceptably high failure rates.

- Vision-based robotic laser cutting control system: developed control system to perform laser cutting of materials and vision-based verification of parts.
- Vertical lathe accident: evaluated control system and available data in machine to determine potential accident scenarios.
- Wiper audit and performance test stand: programmed a multi-station automotive wiper testing system to exercise wiper motors and collect data.

Electronics and Circuitry

Dr. Martens has over 25 years of experience specifying, designing, constructing, and analyzing digital and analog electronic circuits for a variety of applications including sensing, control, battery charging, radio control, electromechanical interfacing, and embedded systems. Many of the projects listed above include electronics and circuitry evaluation. An additional representative sampling of projects related to electronic circuits is listed below.

- Analog and digital interface circuitry for personal computer: designed and constructed specialized input/output interfacing circuitry to provide full optical isolation.
- Battery charging circuitry: designed, constructed, reviewed, and analyzed battery charging and battery-powered circuits for various battery chemistries and applications.
- Burn hazard analysis: analyzed various devices for potential to cause burns.
- Car audio equalizer system: designed and constructed a multi-band equalizer system for audio application.
- Custom LED-based encoder for mobile robot actuators: designed and constructed a custom encoder system for articulating mobile robot.
- dSPACE interface electronics: designed and constructed isolation and interface circuitry for automotive instrumentation.
- Failure Mode and Effects Analysis: employed FMEA and other techniques to evaluate the reliability of various circuits and systems.
- Fan clutch speed monitoring circuitry: designed and constructed an optical counting and speed detection system for measuring speed of fan clutches in test system.
- Home security system: designed and constructed a web-enabled security system for monitoring and controlling sprinkler system, lights, garage door, and security.
- Industry Standard Architecture (ISA)-based Analog-to-Digital, Digital-to-Analog, and Digital Input/Output data acquisition and control board: designed and constructed a multi-channel input/output data acquisition and control board.
- Interface circuitry for radio control car to Versa Module Europa (VME)-based multiprocessor system: designed and constructed circuitry to interface input/output boards to radio control system.
- Medical devices: analyzed various battery-operated medical devices for potential single-point failures that could create potential ignition sources during ethylene oxide sterilization.
- Optical sound transmission: designed and constructed a transmitter and receiver system for transmitting sound using light.
- Portable VME-based multiprocessor system and power electronics for autonomous mobile robot: retrofitted a teleoperated mobile robot with multi-processor-based system.
- Power electronics and electromechanical device interfaces to control audio equipment using personal computer: designed and constructed an electromechanical interfaces to control audio equipment using computer control.
- Printed Circuit Board (PCB) Failure: evaluated and tested printed circuit boards and components for failure for a variety of applications.
- Radar detection circuitry: designed and constructed a radar detection system for automotive application.
- Radio control transmitter/receiver link w/ DTMF (Dual-Tone Multi-Frequency) transmission: designed and constructed radio control transmitter and receiver system to interface to computer.
- Real-Time Damping module performance test stand: designed and constructed a customizable, multi-channel control and data logging system to test various generations of RTD control modules.
- Sixteen-channel, computer-controller nichrome heater system: designed and constructed a power

amplifier/driver for computer-controlled heating system.

- Wave generator: designed and constructed a custom multi-frequency sine-wave generator and special timing circuitry for MTS test equipment.
- Wiper delay circuitry for automobile: designed and constructed an adjustable automotive wiper delay system.