

Exponent®
Engineering & Scientific Consulting

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Professional Profile

Dr. Martens applies his expertise as an electrical engineer to the scientific investigation of electrical systems, industrial and machine controls, electronics, and software. With more than 30 years of experience, he has analyzed and investigated control systems, power generation and distribution equipment, electronics, and electrical installations. He has performed incident, fire, and explosion investigations, as well as analyses of intellectual property claims and of system-performance and construction-related claims, including claims arising in large international construction disputes. He is a committee member of several standards-making organizations (NFPA and ASME) and a member of IEEE, ISA, NFPA, ASME, NAFI, and SAE. Dr. Martens is accustomed to working in a dispute-resolution context and has provided testimony in a wide range of adjudicatory venues, including U.S. federal and state courts and international arbitration (SIAC, ICC, LCIA, and SCC).

Embedded Systems

Dr. Martens' work on microprocessor-based and microcontroller-based computer systems (embedded systems) encompasses a host of applications including automobiles, motorcycles, 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, evaluating, 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, Remote Terminal Units (RTUs), 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, and dryers. He has advised clients on the appropriate level of safeguards for safe operation and control, assisted in implementing them, audited installations, evaluated interface and alarm systems, extracted and analyzed historical SCADA/DCS data, and participated in Factory Acceptance Testing (FAT), Site Acceptance Testing (SAT), loop checks, and control-system commissioning. He draws on his accident-investigation experience and knowledge of industry standards to perform process hazard analyses (FMEA, HAZOP, PHA, What-Ifs, and LOPA).

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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 and Distribution

Dr. Martens' power-systems work spans generation, transmission, and distribution, including fossil-fuel, biomass, hydroelectric, pumped-storage, combined-cycle, and grid-connected battery energy storage (BESS) facilities. He has evaluated specifications, design, workmanship, construction, commissioning, maintenance, and failures of utility, industrial, and commercial systems and equipment. Among the systems and equipment he has evaluated are generators and their controls, e.g., automatic voltage regulators (AVRs) and exciters, turbines, transformers, switchgear, circuit breakers (and generator circuit breakers), motors, protection and relaying, arc-flash and power-quality/harmonics, and automatic transfer/switchover schemes.

Dr. Martens has managed facilities, supervised electricians and tradespeople, performed reviews and audits of electrical installations, and evaluated system design and completeness for facilities ranging from college campuses and high-rise buildings to mines, refineries, airports, and power plants across the United States, Australia, Central and Southeast Asia, the Middle East, Europe, and South America. He evaluates emerging power and energy technologies, including grid-connected battery energy storage systems (BESS), solar power and associated electronics, and wind power and their interconnection to the grid.

Fire and Explosions

Dr. Martens has experience assessing wiring, appliances, electrical products, power supplies, batteries, battery-operated equipment, and grid-connected energy storage in the context of evaluating failure modes, fires, and arc-flash events. He has conducted Consumer Product Safety Commission (CPSC)-related investigations for a variety of products, and he has been involved in complex domestic and international fire and explosion investigations, including switchgear fires and boiler/gas explosions. He has evaluated products and appliances in laboratory environments and performed forced-failure testing. Additionally, Dr. Martens has investigated the role of control systems in such incidents, applying his knowledge of hardware and logic (programming) to understand control system responses before and during fires and explosions.

Academic Credentials & Professional Honors

M.B.A., Business Administration, University of Michigan, Ann Arbor, 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, Case Western Reserve University, 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

Professional Engineer, Alabama, #PE51510

Professional Engineer ECEE, Florida, #85797

Professional Engineer, Illinois, #62058837

Professional Engineer, Kansas, #PE25630

Professional Engineer, Michigan, #6201057824

Professional Engineer, Missouri, #2010036256

Professional Engineer, New York, #86510

Professional Engineer, North Carolina, #37584

Professional Engineer, Ohio, #PE.65142

Professional Engineer Electrical, Texas, #105276

Professional Engineer, Washington DC, #PE.906421

Professional Engineer, West Virginia, #19078

IPAF Operator Training Certificate - Static Vertical (1a), Mobile Vertical (3a), Mobile Boom (3b), 06/11/2021 - 05/31/2026

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

Certified Fire and Explosion Investigator (CFEI)

Certified Vehicle Fire Investigator (CVFI)

National Fire Protection Association (NFPA) Hot Work Safety Certificate Program

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 Electronics 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

Klopp, R, Martens, J, and Sinenian, N. Today's Complex Mining and Minerals Disputes Favor Breadth Over Depth in Expertise, Mining Arbitration Report, Jus Mundi, March 2022.

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

Committee Member, Drivers Application Guidebook: Electric Motors – Guidelines for Applications, Installation, Maintenance, and Troubleshooting, Hydraulic Institute, August 2019.

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.

Subcommittee member of Center for Chemical Process Safety (CCPS), Guidelines for Safe Automation of Chemical Processes, 2nd Edition, December 23, 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

Electrical Power Generation, Transmission & Distribution

- Generator explosion analysis: analyzed a generator failure and explosion related to control valves failing to fully close when the generator became unloaded.
- Generator core failure: analyzed automatic voltage regulator (AVR) controls and breaker operation that improperly energized the exciter and damaged windings.
- Generator circuit breaker failure: analyzed a ~20 kV generator circuit breaker failure and the power-system response in an incident that led to an explosion at a power plant.
- Utility generator failure: root-cause analysis of a ~20 kV generator failure focused on stator end-windings and vibration.
- Turbine/generator controls: evaluated gas-turbine generator (GTG) control systems in connection with failures.
- Pumped-storage hydroelectric: evaluated the electrical system of a ~2.3 GW pumped-storage facility, including equipment installation and sizing, for reliability and construction quality.
- Hydroelectric protection: analyzed protection-system design and relay settings in relation to transmission-line protection.
- Arc-flash in high-voltage breaker: analyzed a 220 kV breaker arc-flash event during re-energization after a plant outage.
- Switchgear failures, fires, and arc-flash: analyzed 480 V-6.6 kV switchroom equipment failures, fires, and arc-flash events at multiple facilities.
- Combined-cycle gas-turbine (CCGT) switchgear failure: root-cause evaluation of an ~11 kV switchgear failure, including interlocking and control-signal paths that prevented proper grid disconnection.
- Wind-farm switchgear arc-flash: analyzed a ~12 kV medium-voltage switchgear arc-flash event at a wind facility.
- High-voltage transformer failure: evaluated high-voltage stress effects on 345/34.5 kV transformers supplying a steelmaking facility.
- Power-system design and power quality: evaluated a distribution system serving electric arc furnaces for design defects, including harmonics.
- Campus distribution completeness: evaluated a college campus electrical distribution design for percentage-of-completion and adequacy of design basis.
- 6 kV motor failures: analyzed premature motor failure related to internal insulation breakdown.
- Automatic transfer/tiebreaker failure: investigated an automatic transfer switch/tiebreaker failure that caused a complete industrial-plant shutdown.
- Grid-connected battery energy storage (BESS): evaluated multiple grid-connected battery energy storage systems for defects and performance, including SCADA-operated BESS.
- Backup generator sizing: evaluated backup generator sizing for a water treatment facility.
- Mining and processing plant electrical systems: assessed modular switchrooms, cable routing, terminations, junction boxes, local code compliance, defective switchgear, fire-suppression systems, small power & lighting, transport, maintenance, and the quality of factory- and site-acceptance testing for a mine and processing plant.
- Airport electrical distribution and building systems: assessed switchgear/switchrooms, transformers, uninterruptible power supply (UPS) systems, LAN infrastructure serving data and IT rooms, wireless access points, and IT outlets, and small power & lighting.

- Refinery electrical design and defects: analyzed miscellaneous electrical and instrumentation defects, including sensors, UPS systems, and switchgear, and assessed control-building electrical design.
- Power-plant motor defects: assessed defects associated with high-voltage, high-power motors critical to plant operation.
- Large-complex electrical drawing completeness: evaluated one-line and related electrical drawings for completeness and basis of design.
- Desalination-plant switchgear arc-flashover: performed root-cause analysis of a high-voltage switchgear arc-flashover, using damage patterns, laboratory test data, and the actions of electricians and plant staff leading up to the event.
- Water-treatment-facility switchgear after maintenance outage: assessed a high-voltage switchgear failure that occurred during startup after a maintenance outage.
- Hydroelectric plant construction quality: evaluated ongoing construction, workmanship, equipment installation, and related standards compliance at a hydroelectric generation facility.
- Utility surge claim analysis: analyzed power records and equipment for fire events associated with alleged power surges and related distribution-system events.

Systems and Controls

Dr. Martens has over 30 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, industrial processes, and machines ranging from consumer products to large industrial facilities 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 waterbed temperature regulation.
- Advanced driver assistance (ADAS) and automation systems: reviewed and evaluated forward-collision warning, automatic emergency braking, adaptive headlights, and camera systems.
- Vehicle networks and cybersecurity: evaluated controller area network (CAN) and Media Oriented Systems Transport (MOST) communications, on-board diagnostics (OBD-II) usage-based-insurance devices, and vehicle-hacking access methods.
- Supplemental restraint, transmission, and related vehicle systems: analyzed airbag electronics, transmission controls, tire-pressure monitoring, seat-heating, and wiper systems.

- Robotic vacuum cleaning devices: analyzed control systems and autonomy-related technology.

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 a 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 a 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 historical 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 historical Wonderware data to determine various operating conditions for plant operation.
- Once-through supercritical steam generator (meltdown): detailed evaluation of the control system for a once-through, supercritical steam generator that overheated during commissioning, including the PLC and SCADA logic and the chosen control algorithms.

- Turbine overspeed: evaluated a turbine overspeed event and associated control system in a power-station explosion.
- Multiple pulverized-coal boiler explosions and safety reviews: performed control-system analyses for numerous multiple-burner, pulverized-coal boiler explosion investigations and conducted stoker- and pulverized-coal safety-system reviews.
- Nuclear power plant instrumentation evaluation: performed instrumentation analysis for a nuclear power plant failure.
- Gas-turbine generator controls: evaluated gas-turbine generator control systems in connection with failures.
- SCADA/DCS historical data and logic analysis: extracted historical operating data and compared control narratives to implemented DCS/PLC logic (e.g., Ovation, Delta V, OSI PI, Wonderware) for boilers, pipelines, gas storage, iron-ore processing, and refrigeration systems.
- Emergency shutdown systems (oil refineries): analyzed emergency shutdown system design and function for oil refineries.
- Control-system hot-changeover feasibility (refinery): analyzed the feasibility of a hot-changeover of control systems for a refinery as part of a construction project and assessed defects in the control of major plant equipment.
- RTU electronic design analysis: analyzed the electronic design of remote terminal units (RTUs) used in distributed data-acquisition systems.
- Oil & gas operational analysis: performed operational and control analyses for offshore oil platforms, onshore oil-processing wells, and oil pipelines.
- Gas pipeline supervisory control and data acquisition (SCADA) design: assessed SCADA and programmable logic controller (PLC) system design and implementation against local and international standards.

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, Human Machine Interface (HMI), and historical 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 whether 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 machine data 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.
- Military access-point distributed control system: evaluated a distributed control system for military access points.
- Vision-based automated railroad inspection systems: evaluated automated track-inspection systems, including related algorithms.

Electronics and Circuitry

Dr. Martens has over 30 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 applications.
- 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 a 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 a multi-processor-based system.
- Power electronics and electromechanical device interfaces to control audio equipment using personal computer: designed and constructed an electromechanical interface 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 applications.
- 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-controlled nichrome heater system: designed and constructed a power amplifier/driver for a 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.
- Battery systems and battery-management circuitry: evaluated cells, packs, chargers, battery management systems (BMS), and related circuitry for consumer, medical, hobby, uninterruptible power supply (UPS), and grid-connected applications as part of fire investigations, failure analysis, design reviews, forced-failure testing, and factory audits.
- Consumer Product Safety Commission (CPSC) investigations: conducted CPSC-related investigations and forced-failure testing of consumer products and appliances.

- Electrical products in fire and explosion investigations: evaluated wiring, power supplies, appliances, battery-operated equipment, and control-system responses before and during fires and explosions.
- Printed circuit board manufacturing analysis: evaluated PCB quality of electronic boards experiencing field failures.