

Exponent®
Engineering & Scientific Consulting

Adam Cardi, Ph.D., P.E.

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Professional Profile

Dr. Cardi is an experienced mechanical engineer who advises clients on complex problems in design, manufacturing, product testing, and failure analysis. He leverages his prior experience developing various electromechanical systems for the military to provide a wholistic assessment of the technologies of interest in each of his engagements–from the mechanical performance of systems to their underlying software and control. Dr. Cardi has provided consulting services regarding product recalls, product defect litigation, intellectual property litigation, national defense, and insurance disputes.

Dr. Cardi has applied his engineering expertise to projects involving consumer products (e.g., kitchen appliances, pressure washers, hoverboards, and heated blankets), construction equipment (e.g., excavators, bulldozers, boom lifts, and cold planers), hydraulic systems (e.g., pumps, valves, and actuators), and fluid handling components (e.g., valves, fittings, and piping). He has extensive experience performing investigations at industrial facilities in the context of workplace accidents as well as performance assessment of manufacturing lines.

Dr. Cardi helps clients navigate all stages of the product/concept development process–from problem identification, to background research, requirements definition, preliminary design, detailed design, prototyping, testing, and design verification. He facilitates knowledge transfer that enables clients to address future challenges and improve their development pipeline. Dr. Cardi utilizes a combination of simulation and experimental techniques to provide timely and accurate answers to clients' problems. He has extensive knowledge of fabrication processes including milling, turning, injection molding, welding, and waterjet. Dr. Cardi also possesses an extensive understanding of the capabilities and limitations of many machine shop tools developed through firsthand experience. He utilizes his knowledge in electrical design, software, and motion control to build robots in his home workshop and has developed embedded software for six (6) microcontroller platforms.

Prior to joining Exponent, Dr. Cardi was a Senior Research Engineer at the Georgia Tech Research Institute (GTRI) where he worked on the mechanical design and precision alignment of high-power radar systems. He also conducted research on the modeling and prediction of chatter (unstable cutting) in metal turning operations, as well as estimating the amount of residual stress in a workpiece after milling.

Academic Credentials & Professional Honors

Ph.D., Mechanical Engineering, Georgia Institute of Technology, 2009

M.S., Mechanical Engineering, Georgia Institute of Technology, 2008

B.S., Mechanical Engineering, Purdue University, 2005

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Licenses and Certifications

OSHA 30 Hour Outreach Training Program - General Industry

Academic Appointments

Adjunct Instructor, Mechanical Engineering, Georgia Institute of Technology, 2017

Prior Experience

Senior Research Engineer, Georgia Tech Research Institute, 2015-2017

Senior Engineer, Exponent, 2009-2014

Publications

Cardi AA, Bement MT, Liang SY. Workpiece dynamics during stable cutting in a turning operation. International Journal of Machine Tool Research 2008; 3(4).

Cardi AA, Firpi HA, Bement MT, Liang SY. Workpiece dynamic analysis and prediction during chatter of turning process. Mechanical Systems and Signal Processing 2008; 22:1481-1494.

Cardi AA, Kosbab BD, Overly TG, Schultze JF, Bement MT. Damage assessment through control feedback expansion of modal space. Proceedings of the 24th International Modal Analysis Conference (IMAC-XXIV), Saint Louis, MI, 2006.

Cardi AA, Adams DE, Walsh S. Locating and quantifying ceramic body armor impact forces on a compliant torso using acceleration mapping. Proceedings of SPIE - Health Monitoring and Smart Nondestructive Evaluation of Structural and Biological Systems 2006; V, 6177:617714.

Cardi AA, Adams DE, Walsh S. Ceramic body armor single input force identification on a compliant torso using acceleration response mapping. Structural Health Monitoring - An International Journal 2006; 5(4), 355-372.

Project Experience

Consumer Products

o Evaluated over 10 pressure cooker designs using FEA simulations and experiments

o Performed analysis of centrifugal juicers to determine the root cause of basket separation during operation

o Analyzed the electrical system in various toaster ovens to understand if certain conditions could cause the devices to turn on without user input

o Assessed bearing failures, acoustic issues, and the performance of capacitive touch user interfaces in various blenders

o Analyzed four different espresso/coffee machine models to improve fluid flow characteristics and identify the root cause of polymer degradation

o Examined multiple heated blanket designs to determine causes of overheating events

o Assessed the likelihood of high strength magnets fracturing due to unintended contact with one another

o Evaluated the performance of various retractable awnings

o Examined failures of furniture (e.g., wooden couches and chairs), shower stools, and glass shower doors

Heavy Equipment

o Quantified and interpreted loading on a forklift's occupant restraint system during a frontal collision

o Investigated tip over events in various scissor lifts and boom lifts to understand the interaction between site conditions, operator commands, and machine dynamics

o Assessed the performance of the braking system on a telehandler-style forklift

o Examined the control system on a boom lift alleged to have stalled/stopped without user input

o Evaluated the performance of a hydraulic trash compactor

o Investigated a large electric shovel and its associated switchgear

o Analyzed the performance of various construction equipment including bulldozers, skid steers, excavators, cold planers, and pavement grinder/grooving machines

Product Development/Evaluation

o Designed a hydraulic system to erect a 5-ton space-fed radar antenna array and maintain pointing accuracy

o Developed a hydraulic system to position antennas in two different ground penetrating radar systems

o Designed an electro-mechanical apparatus for deploying and stowing components for a radio frequency (RF) feed in a space-fed phased array radar system

o Designed a battery adapter with an injection molded enclosure and custom circuitry that allowed soldiers to operate a handheld IED detector from conventional military batteries

o Developed a quadruped robot consisting of custom CNC machined parts, printed circuit board assemblies, and embedded firmware

o Designed a sensor kit for ground robots to enable semi-autonomous operation and support dismounted operations for soldiers

o Designed over 10 electronics enclosures against military requirements covering electromagnetic interferences (EMI), shock and vibration, temperature, and moisture

o Performed design reviews on various downhole tools used in the oil and gas industry to determine their efficacy, safety, and reliability in deep-water applications

o Performed Monte Carlo simulation and live fire experiments to evaluate the operational benefit of measuring an indirect fire projectile (e.g., a M795 155 mm projectile fired from a howitzer) with a passive optical camera to improve the accuracy of follow-on shots

o Evaluated the effectiveness of a small Unmanned Aerial Vehicle (UAV) to support squad level unit operations

o Developed an extreme high voltage IED countermeasure system that demonstrated the ability to pre-detonate IEDs and detect command wires in a wide variety of environmental conditions.

o Managed the development of a rapidly deployable mobile "3D printing" engineering laboratory for the US Army capable of operating in remote environments

o Designed and assembled a 3D printer using open-source hardware and software

o Spent six months traveling throughout southern Afghanistan working as an engineer in the US Army's Rapid Equipping Force (REF) Forward Laboratory developing dozens of technologies for military personnel engaged in active combat operations, which included covert/overt surveillance, tagging/tracking/locating, dismounted power solutions, and counter IED enhancements to route clearance packages

Health Monitoring and Control Systems

o Developed signal processing and health monitoring techniques for journal bearings in an internal combustion engine using onboard sensors

o Developed a custom testing apparatus and signal processing techniques to non-destructively assess the health of heart pumps using vibration measurements

o Performed a patent infringement analysis concerning methods to monitor performance and control hydraulic fracturing (fracking) fleets

o Developed an active control system and evaluated algorithms to non-destructively evaluate damage in a beam

o Tuned a motion controller for a 3D printer using stepper motor drives

o Developed a custom motion controller for a quadruped robot

o Developed a control system for pumping hot and cold fluid into a custom test setup to achieve a desired temperature profile

Plumbing/Fluid Systems

o Analyzed failures in various brass valves associated with water losses

o Analyzed fire hydrants involved in high pressure testing and motor vehicle accidents

o Performed analysis of a direct spring safety valve to understand its performance and potential for failure due to dynamic instability (chattering) in a power plant

o Analyzed the performance of corroded black pipe in residential homes to determine fitness-for-service

o Designed three (3) different hydraulic systems to position various radar antenna arrays, each consisting of pumps, valves, hoses, and actuators

o Analyzed fluid dynamics during a diving incident at a hydroelectric power plant involving differential pressure

o Evaluated the performance of various camlock-style fluid couplings to understand how component wear could contribute to unintentional separation

o Analyzed a failure in a showerhead mixing valve associated with a water loss

Industrial Facilities

o Analyzed winder equipment in an artificial turf facility and its associated control system

o Assessed the performance of a large vertical machining center

o Analyzed the performance of a conveyor belt system that included a belt scale to measure crushed aggregate

o Evaluated the performance of a turret lathe in a machine shop

o Analyzed the performance of a web handling line that manufactured various laminated products consisting of paper, polymer films, foil, and scrim

o Examined the performance of pneumatic adapters for mounting printing plates in high-speed offset printers

Locks

o Assessed the likelihood that a door lock in an apartment building could be defeated by lockpicking techniques

o Investigated a window lock in an apartment building that was alleged to have been defeated

o Analyzed the performance of door locks in a college dormitory

o Evaluated the capability of an electronic deadbolt to secure an apartment unit’s door

o Evaluated the performance of a door and door lock during a fire

o Examined controlled access door locks at apartment complexes and hotels

Vibration/Acoustics

o Performed vibration measurements and fatigue life estimation on a residential power meter to determine the likelihood of insulation breakdown and arcing between conductors

o Assessed vibration levels on large (8 foot diameter) fans in a subway system

o Developed a technique to estimate the location and magnitude of a ballistic impact in body armor using acceleration measurements

o Performed Finite Element Analysis (FEA) on an electronics enclosure subjected to random vibration

o Analyzed sources of noise in a blender due to vibration

o Evaluated vibrations in nearby structures during a car race to estimate the likelihood for damage

o Developed signal processing techniques to non-destructively assess the health of heart pumps using vibration measurements

Software

o Performed a source code review for infringement analysis of two patents concerning health monitoring and control systems for hydraulic fracturing (fracking) fleets

o Developed signal processing techniques and machine learning-based classifiers for radar data collected by ground penetrating radar systems to detect Improvised Explosive Devices (IEDs) in Iraq and Afghanistan

o Wrote embedded software for six (6) different microcontroller platforms and implemented various communication protocols such as SPI, I2C, and UART

o Developed a simulation of a metal turning process in MATLAB, ported the code to FORTRAN 95, and deployed it on a computer cluster

o Wrote embedded firmware for a low power (~20-microwatt average power) Bluetooth Low Energy (BLE) module to simulate a medical device application