

Exponent®
Engineering & Scientific Consulting

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Professional Profile

Matthew Pooley, Ph.D., is a principal scientist in Exponent's Electrical Engineering & Computer Science practice with over 15 years of experience in semiconductor optoelectronics, software development, information science, and intellectual property consulting. He specializes in semiconductor electronics, optics and electromagnetics, software and computing systems, and IP litigation support.

Dr. Pooley has experience in a broad range of industries, including consumer electronics, imaging and signal processing, control systems, cloud and other distributed computing and communication systems, and numerical modeling and simulation. He frequently serves in an expert testifying role providing objective scientific analysis and opinions for litigation matters.

He provides a range of professional technical services to clients including:

- Scientific support and expert testimony for legal activities, such as intellectual property matters, international arbitration, software-related disputes, and other litigation.
- Source code review, ranging from local embedded firmware or self-contained applications to distributed and cloud-based systems comprising many components and API layers or other interfaces.
- Failure analysis relating to semiconductor electronics, optical devices, optoelectronics and display technology, and digital control systems.
- Advanced image processing, thermal (IR) imaging, and optical measurement techniques.
- Numerical analysis, such as finite element modeling, for engineering and product design matters.
- Technical advice relating to software development and data analytics.
- Providing objective scientific advice to senior management executives of a startup company.

Before joining Exponent, Dr. Pooley worked as a software developer for COMSOL Multiphysics, creating tools to model established consumer products such as transistors, LED lighting, photodiodes, and photovoltaic cells. He also has significant hands-on experience with semiconductor fabrication and processing techniques in a cleanroom environment, including sample cleaning and preparation, wafer cleaving, photolithography, metal deposition, etching, and device bonding/packaging.

Dr. Pooley completed his Ph.D. in the Semiconductor Physics Group at the University of Cambridge, in conjunction with Toshiba Research Europe Ltd. His work involved a range of novel experiments that led to seven publications in respected journals. In addition to his semiconductor fabrication skills, he has extensive experience in a range of spectroscopy, optical measurement, and material characterization techniques including, photoluminescence (PL), micro-PL, electro-PL, time-resolved PL, Fourier-transform infrared spectroscopy (FTIR), photon correlation measurements such as HBT and HOM interferometry, atomic force microscope (AFM) imaging, and scanning tunneling microscope (STM) imaging.

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Dr. Pooley also has a strong background in scientific programming and numerical simulation methods. He has developed systems for automatic data acquisition and processing, such as a piezo feedback system to stabilize alignment in optical measurements with long acquisition times and analysis tools for easily extracting figures of merit from large datasets using fits to mathematical models.

Academic Credentials & Professional Honors

Ph.D., Physics, University of Cambridge, England, 2013

M.Sci., Physics, University of Nottingham, UK, 2009

Professional Affiliations

IEEE, Senior Member (#93621352)

Publications

Scott GD, Pooley MA, Ocola PL. 2024. Quantum Computation: From Hardware Challenges to Software Engineering Tools and Technologies. In: Computer Engineering Applications in Electronic, Biomedical, and Automotive Systems, Nova Science Publishers; DOI: 10.52305/XATK7438

Scott GD, Pooley MA, Cotts BRT. Numerical and Analytical Modeling of Electromagnetic Fields From Offshore Power Distribution Cables. IEEE Transactions on Magnetics 2023; 59:5900105

Pooley M, Scott GD, Souri SJ. Practical Pitfalls of Regulating Technology, Exponent Thought Leadership. February 18, 2021

Scott G, Pooley M, Murphy P. Infrared Thermometry Amid the COVID-19 Pandemic, Exponent Thought Leadership. July 30, 2020

Kattamis AZ, Murphy PF, Pooley M, Soane A. "Water Infiltration in Common Residential and Commercial Power Cables Introduced by Capillary Action," 2020 IEEE Symposium on Product Compliance Engineering - (SPCE Portland), Portland, OR, USA, 2020, pp. 1-3, doi: 10.1109/SPCE50045.2020.9296167

Pooley M. Getting Your Head In The Cloud, Exponent Thought Leadership. April 30, 2020

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Pooley MA, Bennett AJ, Stevenson RM, Farrer I, Ritchie DA, Shields AJ. Energy-tunable quantum dot with minimal fine structure created by using simultaneous electric and magnetic fields. Physical Review Applied 2014; 1:024002.

Pooley MA, Bennett AJ, Farrer I, Ritchie DA, Shields AJ. Engineering quantum dots for electrical control of the fine structure splitting, Applied Physics Letters 2013; 103:031105

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states in a quantum dot, Nature Communications 2013; 4:1522

Pooley MA, Ellis DJP, Patel RB, Bennett AJ, Chan AKH, Farrer I, Ritchie DA, Shields AJ. Controlled C-NOT gate operating with single photons. Applied Physics Letters 2012; 100:211103.

Bennett AJ, Pooley MA, Stevenson RM, Farrer I, Ritchie DA, Shields AJ. Free induction decay of a superposition stored in a quantum dot, Physical Review B; 84:195401.

Boyer de la Giroday A, Bennett AJ, Pooley MA, Stevenson M, Skold N, Patel RB, Farrer I, Ritchie DA, Shields AJ. All-electrical coherent control of the exciton states in a single quantum dot, Physical Review B 2010; 82:241301

Bennett AJ, Pooley MA, Stevenson RM, et al. Electric-field-induced coherent coupling of the exciton states in a single quantum dot. Nature Physics 2010; 6:947-951.

Selected Conference Presentations

Pooley MA, Bennett AJ, Stevenson RM, et al. Coherent electrical manipulation of a quantum dot qubit. APS March Meeting, Boston, MA, 2012.

Pooley MA, Bennett AJ, Stevenson RM, Ward MB, Patel RB, Boyer de la Giroday A, Skold N, Farrer I, Nicoll CA, Ritchie DA, Shields AJ. Observation of anticrossings in the exciton state of single quantum dots via electrical tuning of the fine-structure splitting. Journal of Physics: Conference Series 2011; 286:012026

Project Experience

At Exponent, Dr. Pooley has applied his expertise to assist a diverse range of clients over a broad spread of industries.

Expert Litigation Support

Dr. Pooley has served in testifying and consulting expert roles for a wide range of litigation matters in venues including U.S. District Court, the High Court of Justice in England and Wales, the Unified Patent Court (UPC) in the European Union, the U.S. International Trade Commission (ITC), the Patent Trial & Appeal Board (PTAB), and global international arbitration forums.

He has served as a testifying expert for numerous intellectual property matters on behalf of IP/patent owners as plaintiffs in some matters and defendants accused of infringement, misappropriation, or other IP encroachment or violations in other matters. Such matters have included:

- Cases pertaining to semiconductor devices and their fabrication, such as transistors, memory, images sensors, interconnect layers, other integrated circuitry (IC), and photovoltaic technology including solar panels and photodiodes.
- Complex distributed computing and communication systems, such systems for interoperability between different communication technologies (e.g., Voice-over-IP, Land Mobile Radio, cable networks, fiber optics networks, satellite broadcast systems); control systems and Internet-of-Things (IoT) technology, such as smart sensors, smart thermostats, and cameras/security systems; and edge computing or other decentralized or autonomous computing/control/information systems.
- Comprehensive source code review of accused products for assessing allegations of IP infringement, including determining whether source code production is sufficient for the litigation

purposes, and identifying missing or additional required aspects of source code for investigating specific allegations. The scope of Dr. Pooley's source code investigations spans from self-contained embedded firmware or stand-alone applications through to distended, distributed, and interconnected multi-component cloud-based systems involving many vendors/parties.

- Image processing and optical sensing technologies, such as for manipulating images for display in different contexts from different viewing perspectives, and for use in security systems.

In addition to IP litigation, Dr. Pooley has served as a testifying expert for other disputes, including:

- Software development matters, such as disputes arising regarding the quality or performance of software created by third parties relative to specifications or technical aspects of contractual obligations.
- Semiconductor manufacturing quality and performance issues, such as technical aspects of contractual obligations and industry norms and best practices regarding agreements between the designers of semiconductor technology and the manufacturing foundries of corresponding products.
- Technical aspects of software-related transactions or other contractual agreements, such as technical considerations pertaining to transfer of application ownership using prominent third-party marketplaces (e.g., the Google Play store, Apple App store and the like), and analysis of timescales and delays in software development activities.

As well as serving in testifying roles, Dr. Pooley provides consulting services for litigation support, often as stand-alone services but also as a precursor to serving as a testifying expert, including:

- Product tear down and analysis, ranging from non-destructive imaging techniques to disassembly and reverse engineering of complex electronic devices. These activities often include creating bespoke analysis software tools or measurement investigation protocols, such as for quantifying surface topology of semiconductor layers/devices (e.g., for solar cells or sensors), numerical modeling/simulation of semiconductor device performance, and other advanced measurement techniques for quantifying material properties and circuit layouts, for comparison against allegations of infringement and corresponding aspects of asserted claims.
- IP landscaping and prior art analysis for supporting technical aspects of IP validity.

Source Code Review

Dr. Pooley has performed source code review in a range of contexts, including for both litigation matters and product development. He has assessed software for compliance with specifications to help ensure that third-party software vendors have satisfied performance and functionality requirements, and he has assessed whether software performs as intended. Example projects include:

- Review of embedded firmware within chipsets, e.g., systems-on-chips (SoCs), central processing units (CPUs), graphical processing units (GPUs), and microcontrollers. Assessment of whether firmware modifications enable dynamic adjustment of voltage and/or current characteristics or other performance metrics; assessment of whether firmware provides sufficient protections required by expert control restrictions.
- Review of firmware within power management modules for batteries and applications with highly varying current requirements. Extraction of the state engine used to control charging and activation of various different hardware with different power requirements.
- Review of firmware for driving integrated displays embedded within portable devices to assess user interface (UI) functionality.

- Review of applications including for mobile devices (e.g., apps available for download from well-known marketplaces) or for customer hardware solutions such as products that interact with vehicle computer systems for integrating after-market products (e.g., HVAC and backup power systems for long-distance truck/RV cabins).
- Failure investigation and root-cause analysis activities for complex software systems, including cloud-based or other distributed computing and communication systems.

Semiconductor Devices & Optoelectronics

Dr. Pooley has investigated various semiconductor devices within consumer electronics products for failure analysis and identification of root causes of various issues, and he has assisted in development activities of various electronic and optical products. This has included:

- Electrostatic discharge issues with printed circuit boards (PCBs).
- Electromagnetic interference issues.
- Automotive electronics, including control systems for accessories as well as aspects of core engine control functionality pertaining to emissions treatment systems.
- Manufacturing quality of semiconductor products.
- Development of custom optical solutions, such as laser projection systems, infrared imaging systems, and other optical sensing and measurement devices.

Dr. Pooley has a deep understanding of semiconductor technology down to the individual device-level scale through to component-level integration of modules within circuitry and products. This includes investigations into material properties and performance metrics of individual transistors, memory cells, or other integrated devices, through to assessment of how modules are included within overall products such as assessing power management, thermal solutions, and electromagnetic interference considerations for consumer products of all scales.

Electromagnetics & Numerical Modeling

Dr. Pooley has extensive experience with electromagnetic signals and associated communication and signal processing applications. For example, he has applied finite element analysis (FEA) for modeling the performance of antenna, ranging from long-distance communication applications (e.g., radio dipole arrays, microwave line-of-sight systems, satellite broadcast systems) to close range near-field communication (NFC) and radio frequency identification (RFID) applications (e.g., creating a simulation environment to model expected performance of NFC and RFID cards and products that integrate similar functionality).

In addition, Dr. Pooley has modeled electromagnetic emissions from utility-scale infrastructure, such as transmission lines, substations, and offshore wind farms.

Dr. Pooley’s services in this field include:

- Creation of bespoke FEA models and simulations of products including electronic, optical, and electromagnetic effects, e.g., antenna, photodiodes, light emitting diodes (LEDs), solar cells, and micro-electromechanical systems or MEMS devices.
- Measurement to quantify and assess electromagnetic interference considerations to capture such effects in numerical modeling and validate simulation results.
- Integration of numerical analysis and modeling methods into development of electromagnetic and optical products to increase efficiency of product development activities.

Control Systems

Dr. Pooley has assessed control systems of various types and applications in a range of contexts. This has included investigating control algorithms of firmware, and associated hardware considerations, within individual self-contained products (e.g., state engines defined in embedded firmware), through industrial-level control systems (e.g., proportional-integral-derivative, or PID, control systems for machinery), to distributed IoT solutions (e.g., remote sensing and security platforms for buildings with mesh networks of individual devices and cloud-based distributed infrastructure).

Dr. Pooley's services in this field include:

- Considerations of interoperability between devices, such as communication between different IoT devices (e.g., software compatibility through adoption of mutual protocols for communicating and for the information payloads of communications, hardware compatibility for transmitting/receiving various communications).
- Architectural considerations for implementing effective control (e.g., the degree to which edge computing is applicable and how autonomous distributed control aspects are integrated with centralized or cloud-based resources), as well as information considerations for effective and robust monitoring of control activities (e.g., logging infrastructure, data formatting for different purposes, development of unit testing and other quality assessment metrics).
- Considerations regarding Human-Machine-Interfaces (HMIs) and other UI elements (e.g., are appropriate features/functionalities exposed in effective locations to users of the system, is it clear and intuitive how a user should interact with the system, and is the current state of the system clearly conveyed by the interface).