Todd Muscat

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SUMMARY

Robotics and software systems engineer with deep experience across the full physical-computing stack: embedded firmware, real-time device interfaces, servo and motion control, electromechanical machinery, CNC automation, simulation, telemetry, visualization, and large-scale software architecture.

Hands-on technical leader with experience ranging from interrupt-driven firmware and board-level debugging through motion-control software, machine integration, robotics simulation, Unreal-based physical simulation, PyTorch/ OpenUSD simulation systems, and production software deployment.

Core technologies include C/C++, Python, RTOS, Linux, microcontrollers, CAN, SPI, I2C, Ethernet, USB, RS-485, PID/servo systems, Unreal Engine, JSBSim, OpenUSD, PyTorch, distributed systems, APIs, and telemetry.

EDUCATION

University of California, Los Angeles

Bachelor of Science, Physics

EXPERIENCE

Principal AI Researcher & LightStruc Developer, Architect and Director Aug 2024 - Present

Global Virtual Networks

- Develop agentic coding workflows using the Visual Studio Code extension framework.
- Research mechanistic interpretability in major large language models (LLMs).
- Develop instrumentation, UX, harnesses, and backend services for LightStruc AI.

Ongoing

Independent Robotics & Simulation Projects

- Build autonomous multirotor drone systems, integrating flight hardware, sensing, control software, communications, and autonomous behavior.
- Retrofitted a Bridgeport 3-axis milling machine for CNC operation, combining mechanical systems, electronics, machine control, and software.
- Built a PyTorch/OpenUSD autonomous-drone swarm simulator supporting 50 agents at 60 Hz on an NVIDIA RTX 4090 under Linux/Python.
- Designed the swarm simulator with explicit separation of simulation state, runtime motion, scene representation, identity, and visualization.
- Develop C++/Unreal physical-simulation systems involving procedural geometry, constraints, articulated assemblies, deformable systems, physical attachment frames, and simulation-state extraction.

Senior Software Architect & Flight Dynamics Model Aerodynamicist January–August 2024

iPerformX, Inc. - U.S. Department of Defense Contract

- Developed a production military flight simulator using C++, Unreal Engine, and the JSBSim flight-dynamics API.
- Developed and integrated flight-dynamics models for three military trainer aircraft (T-45, T-6, and T-38) during an eight-month DoD program.
- Maintained approximately 35 FPS with two networked aircraft operating concurrently in dogfighting, training, and flight-characteristics testing scenarios.
- Designed synchronization strategies for multi-aircraft mission scenarios used in student training.

- Helped build high-fidelity environments for three major U.S. Navy aviation bases using Cesium and Unreal Engine, contributing aviation realism, atmospheric behavior, and weather simulation.
- Integrated aerodynamic simulation, real-time systems, visualization, UX, and training requirements into a production simulator architecture.
- Prototyped an architecture for hosting multiple independent flight-dynamics models with separate CUDA/GPU execution resources before project funding concluded.

Director of Software Development Aug 2021 - Jun 2022
HID Global *Long Beach, California*

- Led a 14-person software and firmware engineering team responsible for HID's Mercury line of production physical-access controller boards, deployed at million-device scale worldwide, while remaining hands-on in embedded architecture, firmware implementation, debugging, code review, and hardware integration.
- Led a major supply-chain mitigation re-spin of the company's flagship Mercury physical-access control products, spanning MCU replacement, PCB/board-layout changes, firmware migration, hardware bring-up, and end-user software compatibility.
- Directed migration of a several-KLOC C++ embedded firmware application across 4 MCU architectures—one legacy Atmel/Microchip platform and three new targets from Renesas, NXP, and STMicroelectronics.
- Worked across the complete re-spin stack: schematic/PCB changes, microcontroller selection, firmware porting, peripheral integration, board bring-up, validation, and host/application software changes.
- Implemented and debugged low-level SPI, I2C, and RS-485 communications, ranging from interrupt-driven bit-banging and direct peripheral handling through vendor libraries and hardware APIs.
- Worked with Ethernet PHY/NIC hardware, embedded memory devices, DMA-based transfers, CAN, USB, 802.11 Wi-Fi, and BLE.
- Performed hands-on hardware bring-up and fault isolation using oscilloscopes, logic analyzers, breadboards, pin-level testing, and direct board-level diagnostics.
- Diagnosed timing, signal-integrity, peripheral, communications, and board-integration problems jointly with electrical and hardware engineers.
- Coordinated firmware and application compatibility with major third-party ecosystem partners, including Honeywell, whose software integrated with Mercury controller hardware.
- Worked directly with partner engineering teams to maintain end-user software behavior and compatibility across the hardware re-spin.
- Developed across RTOS-based embedded systems and Linux-hosted device infrastructure.
- Built and supported software spanning firmware, drivers, device communications, engineering/test tooling, and higher-level applications.
- Established CI/CD and engineering-quality infrastructure using Jenkins, Azure DevOps, and SonarQube.

Head of Software Engineering Aug 2018 - Apr 2019
Essentium, Inc. *Irvine, California*

- Led and directly contributed to software and firmware for industrial 3D-printing robotic systems.
- Worked hands-on with motion-control behavior, including machine limits and implementation of start/end motion and velocity-curve behavior.
- Developed software coordinating electromechanical motion, material delivery, machine state, scheduling, and operator commands.
- Built machine UX and material-management scheduling systems.
- Integrated I2C, CAN, USB, RS-485, Wi-Fi, BLE, RTOS, MQTT, and real-time telemetry.
- Worked across mechanical, electrical, firmware, application, visualization, and cloud engineering boundaries.

Vice President of Engineering / Engineer Feb 1984 - Dec 1999
Precision N/C, Inc. *Huntington Beach, California*

- Developed software for high-precision CNC and robotic aerospace manufacturing systems under U.S. Department of Defense and Boeing Aircraft contracts.
- Developed software supporting massive SNK 5-axis aerospace skin-milling systems with an approximately 2,000 × 400 × 40 in. XYZ working envelope, plus rotary-axis motion of approximately ±15° / ±30°.

- Wrote CNC post-processors translating manufacturing geometry and tool paths into machine-specific motion/control instructions.
- Developed DNC communications, machine interfaces, protocol software, and production job-spooling systems.
- Wrote 5-axis machine motion-control software, firmware, operator software, and engineering tools in C and Fortran.
- Developed servo diagnostic and PID-tuning software and worked directly with engineers on physical feedback-loop problems including stiction / stick-slip behavior.
- Worked across the complete control stack: electronics, board-level debugging, communications, servo systems, motion control, application software, and simulation.
- Developed a Complot robotic simulation/proofing system used to emulate 3D milling behavior before committing expensive production machine time.
- Developed 3D visualization and device-interface software for a Ford Aerospace robotic/machine-simulation project.
- Ported a substantial DARPA-sponsored Fortran engineering codebase to C on Intel architecture.
- Designed VisualAPT, a domain-specific programming environment for robotics/CNC motion programming.

CONSULTING ASSIGNMENTS (SOFTWARE ARCHITECT / ENGINEERING LEADER · 2019-PRESENT)

EntelMed: Developed biomedical IoT systems involving heart-rate, SpO2, and glucose telemetry, mobile applications, APIs, and cloud-connected patient systems. Worked with Python/R and Azure Cognitive technologies on feature extraction and AI/ML system design.

Ephesoft: Designed AI/ML software modules for handwriting and form recognition. Worked across C#/.NET, PostgreSQL, TypeScript, Angular, and Docker.

Edwards Lifesciences: Designed API and integration architecture connecting ERP, Salesforce, practitioner, and product-inventory systems.

SELECTED ENTERPRISE SOFTWARE ARCHITECTURE & ENGINEERING LEADERSHIP (1999-2018)

Senior engineering and architecture roles at Tallán, United Healthcare / Optum, Slalom Consulting, LPS/LSI, USRES, Arch Bay Capital, Nations Direct Title Insurance Services, and HomeSpace.com.

- Designed high-volume APIs, distributed systems, workflow platforms, integration architectures, and cloud applications.
- Led architecture and technical delivery for a $47M healthcare EDI initiative serving approximately 1.2 million lives.
- Directed engineering organizations of up to approximately 70 engineers, architects, analysts, and designers.
- Architected transaction and asset-management systems supporting portfolios exceeding $650M.
- Built high-volume operational systems processing approximately 100,000 system messages and more than 350 transactions per day.
- Maintained hands-on responsibility for architecture, proof-of-concept development, system design, code review, and technology selection.

TECHNICAL SKILLS

Skills

- Robotic design and physics simulation
- Actuator realization - selection and drive design
- Robotic mechanisms and transmissions
- Motion and force control & tuning
- Embedded robotics software and firmware
- Vision and sensor fusion for robotics and perception-guided motion & manipulation
- Military flight simulation
- Rapid hardware prototyping and system integration
- Expert in 5-axis machining, 3D printing, and CAD/CAM
- Expert in PCB design (ECAD) and layout; board bring-up and pin-level diagnostics
- Flight dynamics modeling
- Procedural geometry & 3D visualization
- Multithreading, telemetry & IoT
- Test automation & CI/CD
- OOP & distributed systems

Tools

- Visual Studio Code / Visual Studio
- IAR compiler; GCC; MSVC
- SEGGER J-Link
- Oscilloscopes / logic analyzers
- Altium / KiCad; breadboarding
- NVIDIA Omniverse; Unreal Engine
- Azure DevOps; gitFlow; AWS; SonarQube; Jenkins

Platforms

- Linux; Win
- RTOS; ROS2
- OpenUSD; NVIDIA Omniverse / Newton; Unreal Engine

Protocols

- CAN / CAN-Bus; EtherCAT
- I2C; SPI
- USB; RS-232; RS-485
- Ethernet
- 802.11 Wi-Fi; BLE

Languages

- C / C++ / C#
- Python
- JS; Fortran; SQL; APT

APIs

- OpenCV
- OpenUSD
- PyTorch
- JSBSim
- Qt / PySide / LightStruc
- MQTT
- Hardware APIs and libraries

Micros & Sensors

- Atmel / Microchip: AT91RM9200, ATmega2560
- ST: STM32 (F2, F4, F7, H, L/U families); STM32G0, STM32L4, STM32U; STM32WB, LSM6DSOX
- TI: MSPM0; MSP430; TM4C1294
- ADI Blackfin; ADXL345
- Silicon Labs EFM32
- PY32 / PY32F030 (LCSC)
- NXP: RW610; LP
- Renesas: various MCUs
- Freescale: various MCUs

Components

Development boards

- Raspberry Pi
- Arduino
- NVIDIA platforms
- ESP32
- Raspberry Pi Pico
- Vendor evaluation boards for the listed MCUs

Ethernet MAC / PHY / NIC

- STM32H Ethernet MAC
- WIZnet W5500; W6100
- TI DP83825IRMQR
- Microchip LAN8742A

Radio / wireless

- ST67W radio modules
- Infineon CY43439
- DA16200MOD-AAC4WA32 (chip antenna)

Switches & buffers

- TS3A27518E
- 74HC125
- PCA9548A I2C mux

Breakouts

- SOIC / SSOP / TSOP adapters
- microSD cards & breakouts