William Emfinger

EDUCATION

2011-2015 **Ph.D.**, *Vanderbilt University*, Nashville, TN., *3.91*
Electrical Engineering

2007-2011 **B.E.**, *Vanderbilt University*, Nashville, TN., *3.66 (Electrical), 3.48 (Biomedical), 3.35 (Cumulative)*
Electrical Engineering and Biomedical Engineering

PhD Dissertation

Title *Network Performance Analysis and Management for Cyber-Physical Systems and their Applications*

Description Techniques for precise design-time analysis and run-time management of time-varying network resources in distributed CPS (fractionated spacecraft) using min-plus calculus and convolution.

RELEVANT SKILLS

Languages C/C++, Python, Javascript/TypeScript, C#, MATLAB, HLSL, Java

Software Unreal Engine, Unity, Fusion360/EAGLE, LaTeX, WebGME, Component-Based Software, Code Generation

OSes FreeRTOS, Linux, Android, iOS, Windows, uC/OS-II & III

Hardware ESP32 (ESP-IDF), ARM (ARM7, STM32, Cortex-M3), AVR (Mega,Tiny,USB)

Math Rendering, Simulation, Image Processing, Motion Processing

EXPERIENCE

2022–Present **Systems Engineer**, *Backbone Labs Inc.*, Atherton, CA
- Defined, developed, and managed next-generation firmware architecture for Backbone Pro (9/10 IGN). Managed firmware design and development, delivering $>= 1$ FW release per week for rapid deployment and testing in 12 month development cycle.
- Developed and managed cross-platform firmware architecture to allow compilation of firmware code into python-bound shared objects for use in custom-developed python tools used by firmware, user research, and production teams.
- Developing next-generation electronics and software architectures for cross-platform gaming experiences including BLE, WiFi, NFC, ESP-NOW (802.11), and WiFi Direct.
- Systems architecture, R&D of next-generation wireless communications and power transmissions technologies, firmware development, electrical design and development

2018–2022 **Director R&D**, *Permobil Inc. - Acquired Max Mobility LLC.*, Lebanon, TN
- Developing and coordinating R&D roadmaps and technology development for FDA Class II medical devices.
- Machine learning on edge devices for autonomous powered wheelchair navigation leveraging low-cost RGB cameras, NVidia Jetson, Monocular Depth Prediction, Optical Flow Prediciton, and Learned Visual Odometry for ML-based SLAM solution.
- In-house Unreal Engine-based simulation and data collection testbed to rapidly train artificial neural networks for intelligent sensing in indoor / outdoor autonomous navigation for powered wheelchairs.
- Design and implementation of next-generation software and electronics platform for power assist and powered wheelchair systems.
- Wireless data collection and neural network-based gesture control of medical devices from WearOS and WatchOS.

2017-2018 **Chief Technology Officer**, *Max Mobility LLC.*, Antioch, TN
- Developed technology strategy for a modular power assist device & powered wheelchair ecosystem.
- Developed and managed university partnerships and funded graduate student research into novel medical devices.
- Developed state-of-the-art autonomous powered wheelchair add-on concept using COTS hardware leveraging Hololens, Unity, and ROSMOD tool-suite.
- Investigated novel motor designs such as spherical induction motors and methods for power wheelchairs and manual wheelchair power assist devices.

2016–Present **Adjunct Assistant Professor of Mechanical Engineering**, *Vanderbilt University*, Nashville, TN
- Faculty advisor to the Vanderbilt Aerospace Design Lab, focusing on systems engineering, physical dynamics modeling and control, model-based engineering, and ground-based hardware in the loop test equipment.

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2016–2017 **R&D Engineer**, *Max Mobility LLC.*, Antioch, TN

- Coordinated software design, modeling, development, testing, and production for SmartDrive MX2+ and the PushTracker smartwatch. Included wireless reprogramming, inertial measurement, motor control, power management and display code.
- Developed and integrated collaborative, model-based software engineering into R&D team workflow with modeling language and code generators which produced target-executable code.

2015–2016 **Post-Doctoral Researcher**, *Vanderbilt University*, Nashville, TN

- Developed Hardware-in-the-Loop testbed (RCPS) and integrated it with distributed coordinated simulation platforms for testing and validation of resilience and security in distributed CPS.
- Integrated ROSMOD toolsuite into web-based, collaborative modeling platform (WebGME) to become integrated development environment for developing, deploying, and managing distributed CPS applications on RCPS testbed.

2011–2015 **Graduate Research Assistant**, *Vanderbilt University*, Nashville, TN

- Developed component model for Robot Operating System (ROS), with associated graphical model-driven development, analysis, deployment, and monitoring tool, ROSMOD
- Worked on DARPA F6 / DREMS Fractionated Satellite Project helping develop secure OS, Middleware, Analysis techniques, and Development & Deployment infrastructure with new methods for design-time network analysis and run-time network enforcement of applications in distributed systems with time-varying networks
- Published and presented research in RTSS@Work 2013 workshop, RTAS CyPhy 2014 Workshop, ISORC 2015, and RSP 2015

2009-2011 **Senior Electrical Engineer**, *Max Mobility LLC.*, Antioch, TN

- Worked 50+ hr/wk during summer, 30+ hr/wk **during school** while taking 18 hours of undergraduate classes
- Developed algorithms to classify IMU & propulsion data from Max Mobility's BioMobility Lab
- Designed, fabricated, and programmed IMU to detect pushes on manual wheelchair, *PushTracker*
- Transitioned *PushTracker* into autonomous power assist device for manual wheelchairs, *SmartDrive*

PROJECTS

2016-Present **WebGME HFSM**, *Open Source Model-Based Software Design Toolsuite*

Collaborative toolsuite for modeling, simulating, and generating executable c++ code using the hierarchical finite state machine (HFSM) formalism. Used to develop SmartDrive MX2+ and next-generation power assist devices. Available at *github.com/finger563/webgme-hfsm*.

2016-2022 **SmartDrive MX2+**, *FDA Class II Power Assist Device for Manual Wheelchairs*

Combining embedded c++, lithium ion battery, brushless motor, omniwheel, bluetooth remote control, WatchOS & WearOS smartwatch control, data collection to the cloud, and over the air firmware updates. Available at *https://www.permobil.com/en-us/products/power-assist/smartdrive-mx2*.

2014-Present **ROSMOD**, *Open Source Model-Based Robotics Toolsuite*

Collaborative toolsuite for developing, analyzing, deploying, and monitoring component-based ROS applications on distributed systems. Used to win NASA competition in 2015. Available at *github.com/rosmod/webgme-rosmod*.

2013-2015 **Vanderbilt Aerospace Design Lab**, *Club Project*

- (2013-2014) design and implement the landing-site hazard detection system for the *Star*CRAFT rocket: system design, image processing, data transmission and collection
- (2014-2015) design and implement the autonomous Martian sample detection and recovery system: system design, PCB design and manufacturing, ROSMOD component code, image processing.

2014-2016 **Multi-Domain Systems Simulation and Rendering Engine**, *Personal Project*

Goal: simulate in real-time multiple interacting physical systems at multiple scales using cutting edge GPU and GPGPU computing techniques, focusing on aerospace craft in the solar system and planetary atmospheres.

2013 **Software Rendering Engine**, *Class Project*

Networked first person video game utilizing a custom software rendering engine that I designed and implemented.

2010 **Wearable Transparent HUD**, *Class Project*

Developed transparent wearable HUD showing user's position/orientation and direction/distance to goal location.

AWARDS

2016 **AIAA Special Award**

Outstanding mentorship of the 2014-2015 Vanderbilt Student Launch Team

2015 **First Place NASA Student Launch Challenge**

Martian sample recovery system: **A**utonomous **G**round **S**upport **E**quipment

2014 **First Place NASA Student Launch Challenge**

*Star*CRAFT (rocket + ramjet + landing-site hazard detection) System

2011 **RESNA Student Design Competition Finalist (Highest award)**

PushTracker activity monitor and feedback for manual wheelchair users

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Publications

[1] D. Balasubramanian, W. Emfinger, P.S. Kumar, W. Otte, A. Dubey, and G. Karsai. An application development and deployment platform for satellite clusters, 2013.

[2] A. Dubey, W. Emfinger, A. Gokhale, G. Karsai, W. R. Otte, J. Parsons, C. Szabo, A. Coglio, E. Smith, and P. Bose. A software platform for fractionated spacecraft, 2012.

[3] W. Emfinger and G. Karsai. Modeling network medium access protocols for network quality of service analysis, 2015.

[4] W. Emfinger and G. Karsai. Analysis of routed networks with time-varying delays and capacities, 2016.

[5] W. Emfinger, G. Karsai, A. Dubey, and A. Gokhale. Analysis, verification, and management toolsuite for cyber-physical applications on time-varying networks, 2014.

[6] W. Emfinger, P.S. Kumar, A. Dubey, W. Otte, A. Gokhale, and G. Karsai. Drems: A toolchain and platform for the rapid application development, integration and deployment of managed distributed real-time embedded systems, 2013.

[7] P.S. Kumar, W. Emfinger, and G. Karsai. A testbed to simulate and analyze resilient cyber-physical systems, 2015.

[8] P.S. Kumar, W. Emfinger, G. Karsai, D. Watkins, B. Gasser, and A. Anilkumar. Rosmod: A toolsuite for modeling, generating, deploying, and managing distributed real-time component-based software using ros, 2016.

[9] T. Levendovszky, A. Dubey, W. Otte, D. Balasubramanian, A. Coglio, S. Nyako, W. Emfinger, P. Kumar, A. Gokhale, and G. Karsai. Distributed real-time managed systems: A model-driven distributed secure information architecture platform for managed embedded systems, 2014.

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