



Embedded Software Consultant

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JACOB W. BENINGO, CSDP

JACOB@BENINGO.COM

CELL: 248-719-6850

Objective:

Seeking to drastically improve the condition of my clients and the embedded software industry by decreasing development costs, time to market, and increasing product robustness through architecture design and review, application and driver frameworks, process improvement, coaching, training and other methods.

Professional Experience:



President / Consultant
Employed: July 2008 – Present

As **President / Consultant**, I am responsible for innovatively developing embedded software that is of high quality, well documented and scalable. I serve clients in automotive, defense, medical and space industries in addition to the embedded software industry as a whole as a blogger, technical content creator, educator and speaker. I am also responsible for business activities such as marketing, strategy and career development. Below are a few highlights of my experiences during this period.

Beningo Engineering Project Highlights

- Expert Firmware Analysis
 - Performing software analysis on safety critical software as part of expert witness cases
 - Setup, configuration and analysis of firmware using static analysis tools
 - Review of software development processes and adherence to industry best practices
 - System failure analysis with unit test harness development
 - MISRA C compliance analysis
- Automotive Firmware Review and Testing
 - Code review of module firmware with recommendations for improvement
 - Setup and performance of static code analysis
 - Complexity analysis and recommendations for system testing and prove-out
 - Real-time constraint and performance analysis
 - Architecture review and recommendations
- Fly-by-wire Transmission Control Module
 - Software architecture design
 - Firmware development of primary MCU and safety MCU
 - MCU driver development
 - Start-up system integrity checks
 - RTOS setup and configuration
 - Real-time system safety checks, stack overflow, memory integrity, CRC checking, etc



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- Microcontroller Driver Framework
 - Scalable Hardware Abstraction Layer Design and implementation
 - Human readable configuration layer
 - Static code analysis using Klocworks and PC-Lint
 - MISRA C:2004 Compliant Framework for safety critical applications
 - Development of documentation using Doxygen
 - Deployed in automotive, defense, medical and space systems.
- Microcontroller Bootloader Framework
 - “Toolkit” design with templates for requirements, design, implementation and testing
 - API and components developed to improve reuse and decrease time to market
 - Reusable/Layered Software Architecture Design
 - Robust, multi-image flashing with fall back fail-safe
 - Multiple communication interfaces such as UART, I2C, CAN, TCP/IP, etc
 - Remote update capabilities deployed for defense, medical and space systems
 - Image encryption
- CubeSat OS
 - Software architecture design and modeling in UML
 - Core OS components for small satellite flight software
 - BSP, SD w/ file system, command scheduling and exception handling
 - API components for watchdog, advanced debugging, satellite subsystems
 - Deployed at NASA, University of Michigan, Astrodev, etc
- Sleep Apnea Wearable IoT Device
 - Hardware design for ECG/EKG, EMG, EOG, EEG and nasal pressure sensors
 - Hardware design and layout for SPO2 sensing module
 - Embedded software architecture, design and implementation
 - Bluetooth interface for data offloading to mobile device
- Medical Health Care Sanitation Monitor Wearable Device
 - Composite USB host and device (MSD & CDC)
 - Hand Sanitation sense algorithm
 - Power savings modes (14 hour battery life with 680 mAh battery)
 - Zigbee Mesh Networking communications
 - Infrared detection and decoding
 - Distributed server bootloader model
- Connected HVAC Monitoring System
 - System requirements and specification
 - Embedded software design and architecture
 - System monitor including use of a TCP/IP stack, wifi, email capability, sensor monitoring and data communication protocols.
 - Analytics reporting for filter status, voltage and current monitoring



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- Infotainment Future Concepts Research and Development Consulting
 - Design of Hardware interfaces for multi-display output on Android
 - Modification to Linux kernel for multi-display system and external input devices for R&D platform development
 - Development of test fixtures and simulators for interface latency testing
 - Android toolchain build, development and porting for TI OMAP 5432
 - Design and development of python scripts, java and misc applications
 - GUI integration using web tools and communication such as JSON
- Embedded Software Testing and Validation
 - Gathering of Requirements for Validation to Automotive OEM Software Specs
 - Development of Requirements Traceability Matrix
 - Develop of Software Requirements Specification
 - Development of Test Cases and Unit Tests
 - Perform testing of software system including static analysis and complexity reporting
 - Development of simulation platform for hardware input simulation
- Low Power Test Bench
 - Evaluation of ARM Cortex-M parts for energy minimization
 - Software architecture and operating system impact analysis
 - Low power mode, sleep-on-exit, clock throttling, etc experimentation
 - Best Practices, presentations at ESC and course development



Southfield, Mi 48076

Senior Embedded Engineer
Employed: November 2010 –
November 2011

As **Senior Embedded Engineer**, I was responsible for developing a scalable firmware architecture and robust embedded software for embedded products such as the BEARS blast-sensing unit. I developed innovative solutions for problems facing the defense industry. I was also responsible for developing remote firmware update capabilities and multi-processor algorithms. Below are a few highlights of my experiences during this period.

Badenoch Project Highlights

- Blast Event Analysis Recording System (BEARS)
 - Detected blast events in military vehicles and recorded the blast profile for later analysis
 - Design and implementation of device drivers and task scheduler
 - Design of multi-core software algorithms and shared communications buffer
 - Development of CAN, SPI, UART, FLASH, EEPROM drivers and communication protocols.
 - Design and implementation of custom filtering algorithm
- Software Development Process



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- Implementation of software development procedures such as version control, project management and bug tracking.
- Development of requirements tracking and traceability procedures
- Development and implementation of design cycle improvement such as CMMI and implementation of Agile development techniques.
- J1939 CAN Boot-loader
 - Architecture design and modeling of the bootloader using UML.
 - Development of detailed design and implementation documents
 - Creation of C style and best practices guidelines
 - Design and development of a robust CAN J1939 based boot-loader which included S-Record parsing and assembly, flash writing, application checksum, application present detection and ability to secure and un-secure the flash system.



Farmington Hills, Mi 48076

Embedded Software Engineer

Employed: November 2009 –
November 2010

As an **Embedded Software Engineer**, I was responsible for the design and development of embedded software architectures and low level firmware for SMPS and power control software within the defense industry. I brought to bear world class embedded software design techniques and procedures which drastically improved the state of the art. Below are a few highlights of my experiences during this period.

Global ET Project Highlights

- Embedded Software Design
 - Turret Control Module
 - Design and implementation of device drivers and task scheduler.
 - Interfaced to motor control module and implemented motor control routines.
 - Implemented fault tolerant error code
 - Idle and power savings modes (<1 mA)
 - Development of CAN and LIN drivers and communication protocols.
 - Software Architecture Design, Implementation and Testing.
 - Vehicle to Grid Software Development
 - Development of device drivers
 - Development of DC to AC Control Algorithms
 - Development of DC to DC SMPS Control Algorithms
 - Design of module communication protocols



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University of Michigan
Ann Arbor, Mi 48109

As an **Embedded Software Engineer**, I was responsible for the design and development of embedded software architectures and low level firmware for flight software in small satellites. The embedded software framework I developed formed the base code for all small satellites developed by the University of Michigan from this point forward. Below are a few highlights of my experiences during this period.

Embedded Software Engineer

Employed: May 2009 – May 2010

University of Michigan Project Highlights

- RAX Flight Software
 - Day-to-day operational management and coordination of flight software architecture design
 - Flight Computer ICD updates and documentation
 - Participated in hardware reviews and troubleshooting of subsystems
 - Development of flight software in C, including software interfaces to S-Band and UHF Radios, GPS, Payload Integration Module, Attitude Determination and Instrument Data Processing Unit.
 - Subsystem Integration, testing and validation
 - Development of system drivers for the TI MSP430F1611, 16bit Risc Processor to include startup code, Task Scheduler (Salvo RTOS), UART, I2C, SPI, custom radio packet interface, and interfaces to additional spacecraft subsystems.
 - Development of a Smart Watchdog Processor capable of monitoring spacecraft health functions and ground communications.



Grand Blanc, Mi 48451

Lead Systems Engineer

Employed: August 2007 – April 2009

As a **Lead Systems Engineer**, I was responsible for the entire design and development of both embedded software and hardware architectures. I coordinated multiple engineering teams spread across the globe to bring together the first computer based infotainment system used in the Automotive Industry. I was responsible for the entire design cycle from concept to production. Below are a few highlights of my experiences during this period.

Azentek Project Highlights

- Project Management



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- Day-to-day operational management and co-ordination of product development
- Coordinating with internal and external engineering and manufacturing teams
- Lead the preparation of engineering quotes and proposals to include the development of Project Budgets, SOW's, WBS's and Requirements Documents
- Managing BOM, Tooling and Program Costs
- Leading project updates and meetings
- Product Concept Development
 - System Architecture Design
 - Engineering Feasibility Studies
 - Development of Design Specifications
 - Supplier and component selection



Grand Blanc, Mi 48451

EMC Engineer

Employed: June 2003 – August 2007

As an **EMC Engineer**, I was responsible for the design and development of control software and data acquisition systems. Test data was recorded into databases where reports were then generated for analysis. Developed a number of small-embedded systems to assist in the testing of full vehicle EMC testing including fiber-optic link and robotic arm for camera position and control. Below are a few highlights of my experiences during this period.

Jacobs Engineering Project Highlights

- Maintaining and developing SQL Server and Access databases.
- Design of a Fiber-Optic Bus Communications tool which communicated with the Ford vehicle bus (CAN, ISO/KEYWORDS and SCP)
- Development of Embedded software and hardware

Education:



University of Michigan
August 2005 – May 2010

Masters of Engineering in Space Systems Engineering

Completed course work in project management, system design, instrumentation, embedded controls, computational engineering and firmware with a 3.72 GPA. Core focus was on the development of robust and quality flight software with a secondary emphasis on sensor design and integration to software systems.



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Central Michigan University
August 2000 – December 2004

Bachelor of Science in Electronics Engineering Technology

Completed standard coursework for EE with additional emphasis in Embedded Systems. GPA 3.22. Focus on embedded software development and design, assembly language and CPUs, object oriented design techniques. Completed a number of projects including an 8088 motherboard, internet controlled sensor network and motor system.



Central Michigan University
August 2000 – December 2004

Bachelor of Science: Physics and Mathematics

Completed coursework in Electricity and Magnetism, Mechanics, Thermodynamics, Quantum Mechanics and Experimental Physics. Completed 16 additional hours of astrophysics courses. GPA 3.22. Worked as a tutor teaching the basic first year physics and mathematics with the occasional second year electromagnetics course.

Technical Expertise:

Hardware:

- 8/16/32 –bit Embedded Controllers (ARM, Atmel, Microchip, NXP, ST Microelectronics, Texas Instruments, etc)
- Peripheral devices (ADC, DIO, CAN, DAC, I2C, LIN, PWM, SPI, UART, USB)
- External Devices (Bluetooth, Displays, GPS, SD cards, Sensors, Wi-fi, etc)
- Instrumentation (Emulators, Logic Analyzer, Oscilloscope, Protocol Analyzers, etc)

Languages:

- C/C++, C#, Assembly, Java, Python.

Software:

- IDEs (Code Composer, Code Warrior, Eclipse, IAR Workbench, Keil uVision, MPLAB X, Slick Edit, Sublime Text, Understand)
- Static Code Analysis (PC-LINT, Polyspace)
- OS (Embedded Android, Embedded Linux, FreeRTOS, Micrium OS II/III ,Salvo)
- General Tools (Altium, Doxygen, MS Office i.e. Word, Excel, Power Point, Visio, Matlab (including Simulink and Stateflow), Visual Studio .Net)



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Publications:

- (2015 – Present). DesignNews.com blog
- (2012 - Present). Embedded Basics. Blog on EDN.com.
- (2013 – Present). Embedded Bytes Newsletter
- (2013 - 2014). Blog on All Programmable Planet
- (2012). Developing Reusable Device Drivers for MCU's. Embedded Systems Conference.
- (2012). Boot-loader Design for Microcontrollers in Embedded Systems. ESC
- (2011). Startups and Small Businesses – A baptism by fire. IEEE GOLDRush, September, 18.
- (2011). Differentiating Yourself as an Engineer. IEEE GOLDRush, March, 14.

Presentation, Speaking Engagements and Webinars:

- (2015). Boot-loader Design for Microcontrollers. ESC-Boston (April)
- (2015). Squeezing the Battery Life out of an ARM Cortex-M MCU. ESC-Boston (April)
- (2015). Mastering the ARM Cortex-M Processor (5 Sessions). DesignNews / Digikey CEC (May).
- (2015). Baremetal C Programming (5 Sessions). Design News / Digikey CEC (February).
- (2014). Software Architecture Design (5 Sessions). Design News / Digikey CEC (November).
- (2014). ARM Techcon. Squeezing the Most out of Battery Life using the ARM Cortex-M Processor (October)
- (2014). Python for Embedded Systems (5 Sessions). Design News / Digikey CEC (August).
- (2014). IEEE Computer Society Embedded Workshop on Boot-loader Design Techniques (October)
- (2014). Mastering the Embedded Software Design Cycle (5 Sessions). Design News/ Digikey CEC (Feb)
- (2013). Microcontroller Design Techniques with ARM Cortex-M4. EDN/ST Webinar (Dec)
- (2013). Fundamentals of Embedded Software Design (5 Sessions). DesignNews/Digikey Continuing (Nov)
- (2013). Squeezing the Battery Life out of an ARM Cortex-M MCU. Doulos/ARM Webinar (Nov)
- (2013). Meeting the Challenges of Embedded Systems Design for Automobiles. IEEE Spectrum Webinar (May)
- (2013). Embedded Software Basics. Embedded Systems Conference / Design West
- (2012). Developing Re-usable Device Drivers for MCU's. Embedded Systems Conference / Design East
- (2012). Boot-loader Design for Microcontrollers in Embedded Systems. Embedded Systems Conference / Design East and West



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Workshops and Training:

Boot-loader Design Techniques for Microcontrollers (1 Day Hands-on Course)
Squeezing the Battery Life out of an ARM Cortex-M (1 Day Hands-on Course)
Fundamentals of Embedded Systems using C (4 Day Hands-on Course)
Real-time Software using Micro Python – The Basics (5 Sessions Hands-on)
Engineering Resume Workshop (1 Day Course)
Career Growth and Management Workshop (1 Day Course)

Other Special Experiences:

(2013 – Present) South Eastern Michigan IEEE Consultant Affinity Group Chair
(April 2013) Co-Founded South Eastern Michigan IEEE Consultant Affinity Group
(April 2013) Completed business planning through Michigan Small Business Development Center
(December 2010) Certified Software Development Professional through IEEE Computer Society
(September 2009) Completed 2 week course in Patent Law for Engineers
(April 2005) Completed 40 hours of Visual Basic .Net Training through New Horizons
(December 2005) Completed 16 hours of Access Database training through New Horizons
(May 2005) Completed 16 hours of MathCAD training through Mathsoft
(Summer 2003) Completed 16 hours of CAN training through SAE



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Testimonials:

“Jacob was everything I could hope for in a software consultant. He was very easy to work with, and communication was excellent and easy. He made sure he fully understood my needs and my design, and helped me write a lot of the documentation required by the customer. He also helped me restructure my code to have a more efficient architecture. I would recommend him and plan on using him for future projects.”

Alex Chou
Electrical Engineer
AGM Automotive, Inc.

"When we came up with the concept for the OneConnect home sleep study device we had exactly that, a concept. Jacob helped change that by taking our idea and turning it into a reality. He worked with us to flush out the design and developed a hardware and software architecture that will be our flagship platform. In addition to performing the actual design, Jacob also provided us with his insights into the development cycle and business which greatly helped us get our product to market. Jacob was easy to work with and I look forward to working with him on my next project."

Chris Gillette
OneConnect, LLC

"Jacob was everything we could hope for in an embedded systems consultant. His understanding of the entire design process from requirements gathering, system architecting, implementation to testing and production was of great value to us. Jacob's layered software architecture design allowed us to quickly adapt to changing customer requirements saving both time and cost. He is easy to work with and has a knack for taking a complex technical topic and explaining it in easy to understand terms. I would recommend him and look forward to working with him again."

Larry Roy
Vice President, Development
Embedded Logix

"Designing a robust and functional system starts with a good architecture design. Jacob worked with us to improve our embedded software architecture designs and helped us to implement a layered software architecture with clear and defined API's. His method for documenting software and adhering to software standards was phenomenal. We recommend and look forward to working with Jacob on future embedded software projects."

Ron Shelby
C&S Engineering

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