

**Development of Instructional Procedure and Software for  
Microcontroller and Embedded Systems**

by

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## ABSTRACT

Microcontrollers have evolved drastically in recent years. The M68HC12 microcontroller was originally used for the undergraduate course *Microprocessor Systems (MPS)* at Rensselaer Polytechnic Institute. The HC12 featured an updated architecture to its predecessor, the HC11, which was used in *Laboratory Introduction to Embedded Control (LITEC)*. Originally introduced in the 1990s, the HC11 and HC12 microprocessors became outdated. A decision was made to convert the LITEC course from using the HC11 microprocessor, to the 8051. Since MPS was the follow-on course to LITEC, it needed to be updated to use the 8051 microcontroller as well.

The update required rewriting six laboratory exercises for MPS. The first lab introduced students to working with the ANSI terminal and basic I/O. In the second lab, students worked with interrupts and learned how to use timers on the 8051 microcontroller. Synchronous and asynchronous communication was covered in the third lab. This included working with the UART and SPI on the 8051 microcontroller. In the fourth lab, students learned analog to digital and digital to analog conversion using the 8051. Using the MAC to build a simple FIR filter was also covered. The fifth lab brought all of the previous labs together by having students write a simple interface for a Magic 8 Ball, and interfacing with a keypad and LCD screen. In the final lab, students learned how to interface with external memory. In addition to the updates to MPS, LITEC was updated to use the SDCC compiler instead of the Keil compiler. This allowed students to have larger source code files and enabled use of floating point operations.

The final result of this research was a successful implementation of the 8051 microcontroller. Each lab had the same functionality as the previous HC12 version, and some took advantage of the new features in the 8051 in order to teach students additional functionality. The author worked closely with the students as a Teaching Assistant in order to revise the labs for clarity. LITEC was successfully converted to the SDCC compiler, and all of the example source code in the course was updated to be compatible with SDCC. In addition to the work for MPS and LITEC, the author documented the differences between the Keil and SDCC compilers, as well as how to install and configure SDCC with the Silicon Labs IDE.