



## Sports Medicine Testing and Rehabilitation Systems

### Background

Computer Sports Medicine takes used Cybex Humac, Norm and Biodex Active Testing and Rehabilitation Systems and retrofits them with new electronics and new software. These systems present preprogrammed and custom isokinetic and isometric resistance profiles to patients and provide real-time quantitative data to rehabilitation professionals. The equipment is large, heavy and expensive. Upgrading existing systems saves rehab centers significantly over buying new systems, and provides many new operational and database features.

Bolton Engineering designed the original retrofit electronics to work with Humac and Norm machines, and, several years later, designed add-on boards to allow the same electronics to operate with Biodex II and Biodex III systems. The original system boards were built in the late 1980's and early 1990's using discrete TTL and PAL logic. Each system had as many as 5 boards with a system total of more than 300 IC's. Bolton Engineering studied the original documentation and reversed engineered the critical design sections. Most of the logic was placed in a medium-size FPGA (Field Programmable Logic Array). The final system fit on a single 6" x 10" circuit board with fewer than 50 ICs.

The retrofit electronics communicated via USB to a host PC running Windows. The system had two redundant processors that continuously checked and cross-checked each other. Redundant hardware interfaces were implemented to monitor critical encoder channels. Hardware safeties were designed to halt the system and disable the motor servo amplifier under power supply and processor fault conditions.

For additional information, see [www.csmisolutions.com](http://www.csmisolutions.com).

### Project Scope

Bolton Engineering wrote the specification, designed the schematics and circuit board, developed a flexible FPGA-based I/O system, fabricated and debugged the hardware, and implemented the on-board control USB software and DSP software. Bolton Engineering also developed Windows driver software and created communication channel debug and demonstration software.