

# Extrusion Machine Testing

## using the DaqBook

Industrial

Application Note #69

### Application Summary

Aluminum extrusion machines often spend too much time loading a fresh billet and performing some “house-keeping” tasks. Although this dead time is necessary, it limits the number of billets that can be processed. Machine owners strive to minimize the dead time by fine-tuning the control system. Specialists who fine-tune the machines are expert in balancing a number of critical parameters to ensure smooth operation of the hydraulic ram, minimize system pressure spikes, and guarantee a safe machine.

Harold Baker of Harold Baker Consulting, Bartlette, Ill., has a lot of experience fine-tuning the best machines used by the Aluminum Company of America, Morris, Ill., as well as other aluminum-extrusion manufacturers. Baker monitors system hydraulic pressure in several locations while adjusting time delays, ram position sensors, pressure sensors, pump commands, and flow control valves. The data acquisition system he uses must be able to accommodate up to 15 inputs, record hours of data without interruption, and work reliably on the factory floor. In addition, the data must be easily recalled in a graphic format to be included with customer reports.

### Possible Solution

Baker had been using a well-known brand of data acquisition system since the middle 1970’s. He upgraded to their newer models in the early 1990’s, but had to work around its limit of four input channels

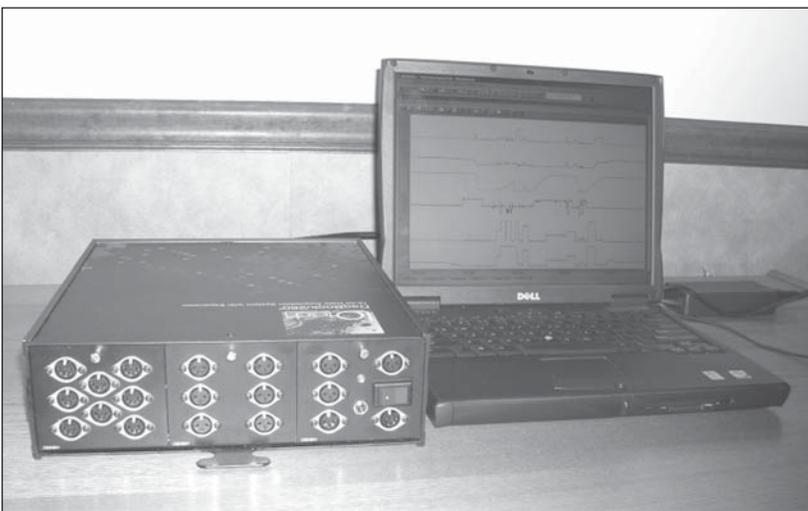
for pump signals and pressure sensors. “I always had to compromise my choice of measurements,” says Baker. “I was really frustrated that I could not monitor every pressure and pump signal that I thought was important — simultaneously. I had to run several tests repeatedly with different combinations of sensors to establish the time and pressure profile I needed.” Another drawback was the weight of the instrument, about 76 pounds. This made it extremely difficult to transport between various sites.

### IOtech’s Solution

The equipment’s strict limitations prompted Baker to investigate another data acquisition system that provided more measurement channels, was more portable, and had the robustness to operate without failure in the rather harsh factory environment. He evaluated the IOtech **DaqBook**® and was pleasantly surprised to find more than he had expected. Says Baker, “The nice thing about the **DaqBook** is that I can put it in my roll-around computer case and carry it on the plane with me, so I don’t have to check it in with baggage. By comparison, sometimes the old system didn’t survive the plane trip, in spite of it being packaged in a foam-padded travel case. Too many times I arrived at a site with a dead instrument that had to be returned for repair.”

Besides portability, Baker likes the **DaqBook**’s ability to play back the data he needs for including in reports for his customers. Says Baker, “It’s easy to log onto any portion of the recorded data stream and select the chart of interest with a simple “copy screen” command and insert it directly in my Microsoft® Word document.” This makes a very professional-looking report. The old system used a 3.5-inch disk and could store only a few seconds of data. The **DaqBook** stores hours of data.

The larger number of input channels on the **DaqBook** also makes Baker’s job easier. He can monitor 8 transducer inputs and 6 pump command inputs and watch the system’s response while adjusting the variable volume pumps and fine-tuning the valves. Moreover, during the cycle, he can record the pressure at the end of an extrusion while the system decompresses, the ram retracts, the container opens, and the butt shears. The next part of the cycle is just as critical to record, that is, when the container closes, the loader moves up, the ram travels forward and crushes the billet, and then extrudes. “The dead time is when nothing is being extruded,” says Baker. “So I examine the dead cycle to see where I can find delays. Timers and pump commands can be adjusted to speed up the dead cycle but not shock the system.”



Baker uses the **DaqBook** to monitor hydraulic system pressure on aluminum extrusion machines while adjusting variable-volume pumps to minimize dead time. He customized the rear panel of his **DaqBook** to accommodate three and five-pin connectors used with unique pressure sensor and pump signal cables.

When running 30 billets per hour, and fine-tuning takes from one to five seconds per charge off the press in dead-cycle time, at the end of the day, week, or month, it amounts to a huge amount of time saved. Several more billets could be processed, but the press is effectively just sitting there. "A prime example is a 7300-ton UBE press that Alcoa owns," says Baker. "It processes 18-inch diameter by 54-inch long billets weighing more than 1,000 pounds. So at the end of the month, you can often push through more than one additional billet by reducing the dead cycle." It's quite an art, claims Baker, and for the longest time, people did not worry about dead cycle. "But when you start looking at a second here and another second there, it adds up quickly," continues Baker. "I removed multiple seconds from numerous machines, caused by such things as air in the main ram. When loading a new billet, the ram crushes it against the die and builds pressure on the side cylinders. This commands the system to close the main ram prefill valve, which in turn prevents the ram from running at extrusion speed. When the full pump commands are present at the same time, air in the main ram is under compression, and you can see it on the recording. The **DaqBook** just puts everything in front of you. You don't have to guess what the problem is."

Dead-cycle time depends on the size of the machine and where the dead cycle is measured. This has always been debatable, but for Baker, a cycle is pressure off, pressure on. The machine should have a short dead cycle, but operate without components banging and slamming. Says Baker, "I fixed an extrusion machine that had such a huge spike that the pressure was knocking the pipes off the butt shear. Every clamp on the butt shear piping was broken." He connected the **DaqBook** and found that the original program contained a full-pump command, but as the shear passed a slow-down proximity switch, the pump was supposed to destroke. The proximity switch logic was not sealed for slow down, so it just ignored the switch and

returned to commanding full stroke. The shear was slamming at full pump volume generating a huge spike in the hydraulic system. But by spreading out the command with the **DaqBook**, Baker could see that the slow-down command was present for only a few milliseconds, and then returned to full command. So he changed the program to respond to the slow-down switch, and sealed the command until it reached the top of the shear. That took out the spike that shot clear off the scale, past the 5000-psi pressure transducer limit.

## Conclusion

The IOtech **DaqBook** helps Harold Baker, an extrusion-machine consultant, fine-tune the variable volume pumps and the program steps controlling cycle times. Reducing the dead-time part of the cycle, that is, when hydraulic system pressure is off, is critical for increasing aluminum extrusion throughput. The **DaqBook** lets Baker monitor and record pressure and pump control commands, print charts for his reports, and store hours of data for future performance comparisons.

## DaqBook/2000 Series

The DaqBook/2000® series of portable data acquisition devices are available with either a built-in Ethernet interface (model /2000E), or a parallel-port interface (model /2000A or /2000X). The Ethernet-based DaqBook/2000E can attach directly to the Ethernet port of a PC, or to an installed Ethernet network. The DaqBook/2000E also contains three parallel expansion ports, which can attach to an additional three parallel DaqBooks, thereby quadrupling the channel capacity of a single Ethernet link to the PC.

### Features

- Analog input, frequency input, timer output, digital I/O, and analog output; all in one compact and portable enclosure
- Available with either an Ethernet PC connection, or a parallel port which can link directly to a PC parallel port, or with an interface to PCI bus, PC-Card slot, or ISA slot
- 16-bit, 200-kHz A/D converter
- Synchronous analog, digital, and frequency measurements
- 8 differential or 16 single-ended analog inputs (software selectable per channel)
- Expandable up to 256 analog input channels, while maintaining 200-kHz (5  $\mu$ s per channel) scan rate
- Expandable up to 1024 analog inputs with DaqBook/2000E plus three slave parallel DaqBooks
- 512 location channel/gain FIFO, capable of scanning all channels, including expansion channels and digital/counter channels, at 5  $\mu$ s per channel
- Trigger modes include analog, digital, & software, with <5  $\mu$ s latency
- Virtually infinite pre-trigger buffer
- Optional four channel, 16-bit, 100-kHz analog output card installs internally
- 40 digital I/O lines scanned synchronously or asynchronously with analog inputs
- Digital I/O is expandable up to 272 lines, including isolation and relay closure options
- Four cascadable counter/pulse input channels scanned synchronously or asynchronously with analog inputs
- Two timer/pulse output channels
- Digital calibration — no potentiometers
- Multi-unit scan synchronization
- Vehicle network interface option



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