Case study

SWITCHING DYNAMIC WEIGHING TO DIGITAL

Bringing *life* to technology.

Measure

Our client had always used analogue PLL circuits in their vibrating element load cells. But we encouraged them to shift to digital for greater accuracy and flexibility.

The challenge

At first, the client didn't see a problem with the analogue PLL circuits they had always used – they simply wanted to create a new generation load cell that was capable of weighing huge objects more accurately.

However, we believed that an analogue circuit load cell was inferior to a digital one, as it could only weigh the object it was designed for. This meant it wasn't as flexible or as useful as it could be.

The brief

We were asked to develop an electrical amplifier for a vibrating element load cell for use in dynamic weighing. It needed a PLL circuit to drive the mechanical transducer in a closed loop.

The aim of the amplifier was to track the output and by phase shifting the output by 90° should bring the output and input into phase to keep the sensor in continuous oscillation. As the transducers are loaded, the resonant frequency is maintained. The frequency output has a defined relationship with the load applied so measurement can be effected.

Phase-locked loops, whose structure is shown below, mainly contained three elements: a digitally controlled oscillator (DCO), a phase detector (PHD) and a low pass filter (loop filter).

Our response

The client was originally expecting an analogue solution, using a particular Integrated Circuit (IC), with the performance fixed by specific values of capacitors and resistors. But we encouraged them to move to digital.

As all of the elements above can be built in software, we used a processor to implement a digital PLL. It allowed us to apply compensation and linearisation, and temperature and pressure compensation, based on ambient conditions. In effect, the PLL became the measurement system as well.

The hardware comprised:

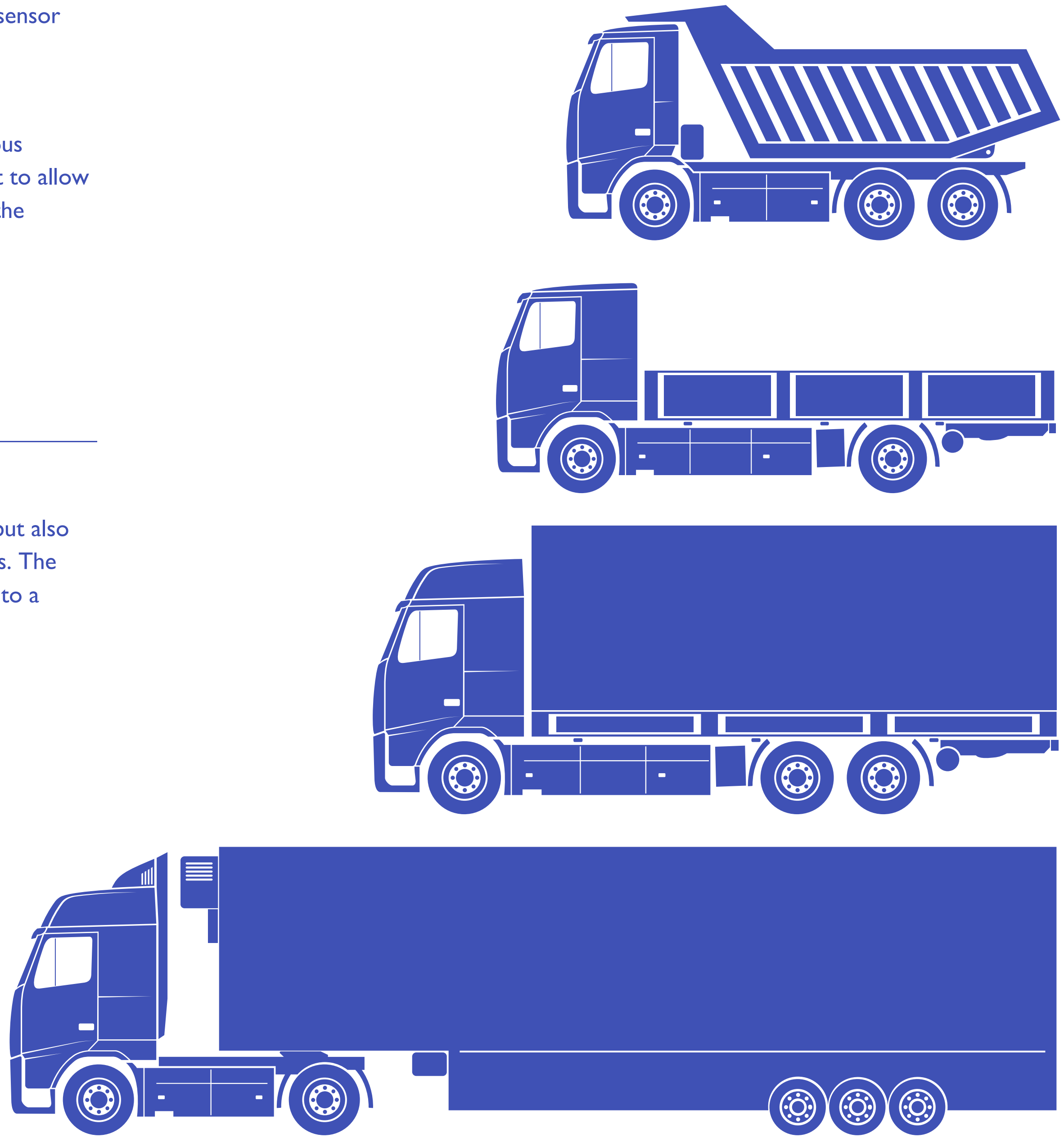
1. Low pin count ARM processor, which has internal RAM and Flash, with two channels of counter/timer (>=16bit), A/D and D/A, SPI, I2C and USB.
2. 24V input power supply.
3. 24V power amplifier to drive excitation piezo.
4. Charge controlled amplifier to improve the linearisation of the sensor piezo.
5. USB interface for control/programming of the parameters (or calibration parameters).
6. SPI interface for dual function pressure/temperature sensors for compensation.

This resulted in a compact, encapsulated design, as it only required sensor inputs, piezo driver outputs, a USB and DC power input.

The USB output provided a simple Windows-based software, which communicated with the board and allowed us to configure the various software parameters. This was used extensively during development to allow the parameters to be optimised. Once the client was satisfied with the performance of the board, we could freeze the values in the code.

The result

The client now has a digital load cell that's not only more accurate but also capable of weighing a range of objects – from HGVs to pallett trucks. The increased flexibility and precision has made it much more attractive to a wider range of customers.



Final words

Sometimes you have to go with your instincts. This client had a particular design in mind and talked only of analogue, no mention of digital. But I just felt that they were ready for something different, particularly the owner of the business. The beauty of this approach is the range of possibilities it opens up. This was used in one product but it is possible that the approach could be built as a platform and this would be cost-effective.

I guess the interesting thing here is that they had already made the decision in their own minds. It was as if they were waiting for us to legitimise it.

Jeff Graham