Why use PLDs in teaching electronics?

Recently we have been looking at Programmable Logic Devices and programming tools. We believe these are relevant in teaching electronics for several reasons:

- PLDs are useful components in electronic systems
- The use of 74 series devices is in decline
- PLD technology has greater prominence in the new BTEC Higher syllabus
- PLD programming skills are a useful precursor for FPGA development

This article explains these points further.

**Background**

First some history: In the 1980’s, when PLDs first came onto the market, the development path for microcontrollers was very inegalant: a microcontroller was a high volume high commitment item with even One Time Programmable (OTP) devices not yet available. The use of PLDs at this time was easy to justify. PLDs were based on relatively low cost One Time Programmable PROM technology and as the average designer sought to mop up several 74xxx ‘glue logic’ devices in a system into one chip. This increased the reliability of a design, shortened the design cycle, reduced component count, PCB area and cost. At this time devices like the 22V10 – containing 10 flip flop macrocells and associated combinational logic elements – became very popular with designers.

An 84 pin 128 macrocell CPLD from Altera

These days in new designs low cost reprogrammable microcontrollers are the preferred choice for many of the applications that PLDs used to perform for a number of reasons: microcontrollers operating at speeds of 40MHz are pretty commonplace, the development path for microcontrollers is deemed to be easier than for PLDs and most electronic devices will already contain a microcontroller with, perhaps, excess processing power and spare pins. However PLDs still have one great advantage over microcontrollers: speed. Propagation times through a PLD are of the order of only a few nanoseconds which makes them about 100 times faster than the average microcontroller which would typically take several instruction cycles to complete even the simplest operation. This makes PLDs still useful in applications where timing is critical such as bus control or data multiplexing.

So my *first reason* for using PLD technology in teaching electronics is that the devices – even the humble 22V10 - still have their uses in modern electronic systems.

**Death of the 74 device**

When anything electronic comes into our office one of the first things I do is to take it apart to see what is inside. I have been like that since I was young (my first timex watch on my 7th birthday lasted 3 hours) and the downside of this habit is that many times I have not been able to get things back together. The upside is that I tend to have a good feel for the devices used in modern electronic systems. In the last few years I have only really seen 74xxx used for buffering signals and for clock generation. The days of using discrete 74 devices to build up a combinational or sequential logic circuit in modern electronic systems are virtually over.

So my *second reason* for using PLD technology in teaching electronics is that 74xxx series combinational and sequential chips are now rarely used, and it makes sense to teach at least this part of a modern digital electronics course using PLDs.

**It’s in the syllabus**

This is an easy one: in the new BTEC Higher National Electronics syllabus, which comes into effect in 2004, PLD technology gets mentioned in three units (Digital and Analogue design, Electronic Computer Aided Design, and Combinational and Sequential Logic.) So my *third reason* for using PLD technology in teaching electronics is that they are in the syllabus.

**Complex PLDs**

Even though devices like the 22V10 allowed designers to mop up ‘glue’ logic in the form of 74xxx ICs, there are applications where more complex logic blocks are needed and hence Complex PLDs were developed. CPLDs are basically a number of PLDs in a single package with an even larger programmable interconnect block between the internal PLDs themselves. Combining PLDs into one package has the advantage of even fewer components on a circuit board, increased reliability and increased speed of the overall circuit.

To give you an idea of where this technology has led us, today CPLDs are available with up to 512 flip flop macrocells in packages of up to 208 pins and a massive interconnect and combinational logic array connecting the flip flops together.

On our development system we use a device that contains 128 flip flop macrocells. It is hard to say what this is equivalent to in terms of a number of 74xxx series devices, but I suspect this will be more than adequate for traditional combinational and sequential logic projects.

**Complex PLDs as a precursor to FPGA development**

The System On Chip concept allows higher levels of integration and reduced design time.

The initial reasons for using PLDs in the ‘80s were that they increased reliability, shortened design cycles, reduced PCB area, and lowered cost. The same factors are now persuading high value low volume systems to shift to FPGAs as the entire hardware and software design can be contained in a single FPGA device. This new design concept is called System On Chip (SOC).

As far as teaching is concerned there is a downside to FPGA technology - the technology is relatively expensive, FPGA’s need ‘loading’ with the data by a slave EEPROM or microcontroller each time the power is turned on, and FPGA’s are packaged in high density (100 pin minimum) surface mount packages which are not ideal for education.

So my *fourth reason* for using PLD technology in teaching electronics is that it is a precursor to the skills needed for FPGA development and this is a skill that industry increasingly needs and values.

I would very much like to hear your views on this article – please email me at john@matrixmultimedia.co.uk.

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