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Viewpoint

Though many writers are happy to put a date on the day a Japanese (or was it a Finn?) coined this rather ungainly word, mechatronics has been around in spirit for many decades.

My first brush with industry nearly half a century ago involved designing autopilots. Their early computing circuits used analogue magnetic amplifiers rather than the digital microcomputer we would expect today. But a machine that trundled through the sky, obeying commands computed from a multitude of sensor signals that enabled it to make a perfect automatic landing must surely be worthy of being called a robot.

By the early 1970s, we could buy 'budget' single-board computers for a thousand British pounds. Although these had a mere sixteen kilobytes of memory, their potential for mechatronics was immense.

One of my Cambridge researchers took on the task of revolutionizing the phototypesetter. The method is now commonly found in the laser printer. A spinning mirror scans a laser beam across the photosensitive film, letter shapes are held in computer memory and the entire mechanical design is greatly simplified.

I consider this trade-off between mechanics, electronics and computing power to be the guiding principle of mechatronics.

The research team were soon knitting similar computers into a variety of real-time applications, including an 'acoustic telescope' to build the signals from 14 microphones into an image of the sound source. Hydrofoils were simulated, violins were analysed for their 'Stradivarius-like qualities' and music was synthesized. A display for a colour television, novel in those days, depended on a minimum of electronics and a wealth of software.

But computing power soon came in ever smaller packages.

In 1979, planning started for holding the Euromicro conference in London. The chairman wanted an added showpiece and his mind was on "The Amazing Micromouse Maze Contest" that had just been announced by IEEE Spectrum. I put my hand up to organize the contest.

Then I started to follow the news from the USA. Blows were nearly exchanged when the "dumb wall followers" sprinted through the maze from the entrance at one corner to the exit at the other, much faster than their brainier rivals. How could the rules be massaged to give brains the edge?

The solution was to give the mouse-builders more specific information that could be designed into the logic of their machines. Our maze was specified as sixteen squares by sixteen, with the target at the centre, not on the edge. In that way, paths could circle the centre to form 'moats' that no mere wall-follower could cross.

A preliminary run was held in Portsmouth in July, with results that literally gave me nightmares. Of the six mice that competed, only one could make any attempt to follow a passageway, let alone find the centre. At the conference in September, fifteen mice competed. The winner was a clanking contraption, cobbled together around a brilliant maze-solving algorithm that has remained relevant to this day.

The contest went from strength to strength, being held in Paris, Tampere, Madrid and

Copenhagen, but for these first few years something struck me as strange. Not one of the winners was trained as an engineer. Great machines came from mathematicians, computer maintenance staff, programmers for manufacturing industry, but formally qualified engineers were notable by their absence.

So what is it that defines a mechatronic engineer? What is the special aptitude that singled out these champions? What had they learned from their endeavours that was not to be found in a formal engineering course?

They were able to put together a concept in which strategy, computing hardware, sensors, electronics and motors were blended together in harmony, not as a cobbled assembly of diverse technologies.

So what of the next generation of mechatronic engineers? How do we give them skill and ability with the essentials, without deluging them with the entire contents of the textbooks of at least three diverse disciplines? We must distil the 'good bits' from the diverse range of specializations that make up engineering as a whole.

The Micromouse experience suggests that hands-on experimentation is an essential ingredient. While learning, software must be 'crafted' by the student, rather than being ladled into the project as a bought-in commodity. The student must be prepared to deal with hydraulics or electro-mechanics, treating them as two sides of the same coin.

Mechatronics is special. It is no more a mere mixture of electronics, mechanics and computing than a *Chateau Latour* is a mixture of yeast and grape-juice.

This has been edited from the introduction to "Essentials of Mechatronics", published by John Wiley & Sons, Inc, ISBN: 0-471-72341-X, see www.essmech.com for details.