Fabio De Paola/PA Wire

Paul Newman's work led to the successful trialling of this driverless vehicle in a public space for the first time in October 2016 by Transport Systems Catapult in Milton Keynes.

The road to self-driving vehicles

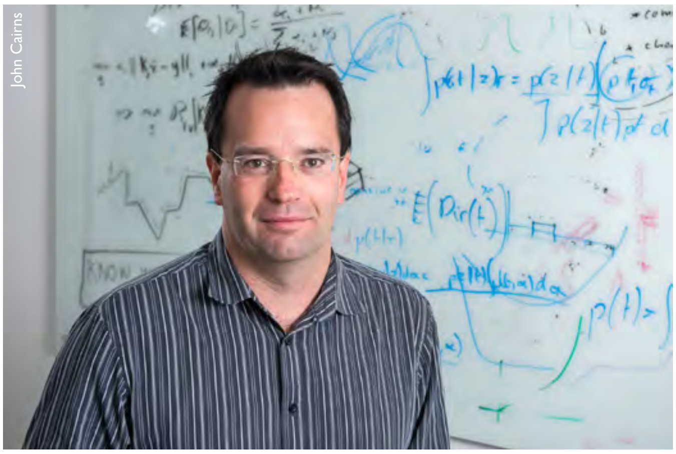
Engineering undergraduate **Andreea-Maria Onescu (2015)** talks to **Professor Paul Newman (1991)** about robotics

'Autonomous vehicle' is a new concept that is hard for most of us to understand. What does it mean, how does it work, and what is behind this concept in terms of programming? I went to find out from Paul Newman, BP Professor of Information Engineering and an EPSRC Leadership Fellow, who is currently head of the Oxford Robotics Institute within Oxford's Department of Engineering Science and restlessly working with his team to make self-driving vehicles a reality.

Paul started as an undergraduate engineering student at Balliol not so long ago, in 1991. He then moved to the University of Sydney, where he undertook a three-year PhD in autonomous navigation at the Australian Centre for Field Robotics. He really enjoyed his time there and describes himself as being 'the right guy, doing the right PhD, at the right time, with the right supervisor, in the right place'. After that, he came back to England and worked for a company in subsea navigation. Later he found out that the software he wrote during his time there was used to run the vehicles that were put in service to fix the Deepwater Horizon oil spill in 2010. Before coming back to Oxford as a young departmental lecturer in 2013, he attended MIT for three years. There he was a postdoc and then a research scientist doing a lot of underwater robotics.

Paul thinks he always knew he was going to work on robotics systems in the end. Explaining his choice, he says, 'There is something extraordinary about having a machine not do your will, but do your will in having its own will.' By writing software and equipping the machine with relevant sensors, 'you can have an agent work in the world in a way that was not pre-programmed'. He highlights the difference between automation and autonomy, the former referring to programming a machine to do the work you want and the latter meaning programming a machine to be able to make its own decisions later. It is really interesting to be able to create an autonomous machine which, after you have written several million lines of source code, is able to interpret the data received from sensors in order to decide, for example, whether it is safe to go through a red or green traffic light.

After publishing a lot of interesting papers, Paul decided that he wanted to bring everything that he knew together and apply it to a domain that really interested him, such as transport and cars.



John Cairns

‘There is something extraordinary about having a machine … do your will in having its own will.’

So he went to the UK funding agency for science (the Engineering and Physical Sciences Research Council) and told them that he really thought he could build a self-driving car. He was awarded a Leadership Fellowship grant, the biggest grant he could have got, and the work it funded led to the successful trialling of a self-driving vehicle in Milton Keynes in October 2016, the conclusion of the Transport Systems Catapult’s LUTZ Pathfinder project.

When asked about the part he played in the development of the autonomous car, Paul says that he made some big contributions to the field of robots knowing where they are. For instance, he worked on the structure of the SLAM (simultaneous localisation and mapping) project, which, he explains, enables a machine to ‘go into a place with no idea what that place looks like and build a map of it and simultaneously use that map to localise’. He is also happy to have worked with another Balliol alumnus, Mark Cummins (2001), on the loop closing problem, which is about making a robot realise if it has returned to an already visited place.

Then Paul started thinking about space and studying how a robot would represent the space around it and its journey through the environment: what information it would store and how it would store it. He has recently started a project with a DPhil student, Chris Linegar, which has the purpose of programming a machine to determine its location based on the weather. Another interest of Paul’s is the role of the huge amount of data for robotics. The goal of self-driving vehicles is to acquire data and then learn from their past experiences; the next goal is having a fleet of these vehicles, which will share information in order to become better. Unlike humans, vehicles can learn almost instantly about the experiences of another car – so, for example, being able to avoid making the same mistake, which can even turn into avoiding accidents. When it comes to the time taken by the car to make decisions, Paul says that each bit of software takes 1/50 of a second to give an answer to a main computer. If there is a completely new situation, then the computer decides it is safer to stop. There are still questions that need answering, however, before such a vehicle can be sold, since there can be a lot of unpredicted events on the road and the car must be able to interpret each of them and make the best decision in any situation: it might need to accelerate or to slow down, for example, depending on the nature of the event or the behaviour of the object encountered.

It will also be possible for this type of robotic system to be implemented in other domains, such as surgery and vehicles going to Mars – there is already a project for the latter in which Paul is involved. When will this happen? He tells me it is not going to be long.

Paul’s life would have been different if it weren’t for the fact that Balliol said yes when he applied to read Engineering Science as an undergraduate, he thinks. He remembers the friendships he formed at Balliol, spending time in the JCR communicating his ideas, having fun, playing with the new computers. He loved sports – he used to play for the cricket team – and he remembers singing. He loved the intensity of everything.

From his time studying, he learnt that all the subjects taught matter. There is one thing, though, that he thinks should change about the course and that is that it should include programming classes. He would also really like students to try to learn more than just the syllabus, by getting involved in various projects. He is open to getting students to work as interns for his company, Oxbotica (which integrated the autonomy software on to the self-driving vehicle), so that they can ‘get on the front foot’, as he puts it, because ‘everyone is doing the syllabus but it is all about the extra bits that you can do that really matter’. As an example of something extra, he remembers being in his second year and wanting to learn new things. So he decided to still go to the bar and socialise but not spend any money there. With what he saved, he took gliding classes and went to the cinema every Wednesday and Friday night at nine o’clock.

He also recalls loving the coursework modules he had to take in the Trinity Term of his second year. It was his first proper programming exposure and he really enjoyed it because it was challenging, it was not graded or timed, and the main purpose of the modules was to get you involved in real engineering. He believes he learned more during this time than in many other terms, since he had to learn how to split a complex problem into little bits. As for his tutors, he considers they made a huge impact on his career; he can still remember some of the tutorials he had with them.

When asked what advice he would give to young engineers, he says, ‘Do the thing that technically you find the most interesting at the time, and be unapologetic about it because it’s going to keep you happy.’ That is what he did, and his own career has shown what can be achieved by doing so.

The software developed by Paul Newman’s company Oxbotica, selenium, makes it possible for a vehicle to enter autonomous mode, using data from cameras and LIDAR systems to navigate its way around the environment.