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JUDGES' REPORT

WINE INDUSTRY

SMART MACHINE - OXIN

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INTRODUCTION

The Smart Machine Company invented OXIN, an autonomous vineyard tractor, to improve efficiency, reduce environmental impact and help solve labour shortages for winegrowers and orchardists.

OXIN does the work of several tractors at once - spraying, mowing, plucking leaves and mulching - as it goes down the rows with no driver on board. It saves fuel, reduces chemical use, reduces compaction of the ground and can work around the clock.

The Blenheim-based Smart Machine team of software developers, product designers and engineers have created a machine based on real-life vineyard conditions.

The aim is to do more with less: More tasks, more efficiency, more environmentally friendly, with less engineering materials, staff and overheads.



GENERAL INFORMATION

Smart Machine launched in 2018 and the OXIN, developed and manufactured in Marlborough, is their first project.

OXIN was borne out of the industry-wide problem of getting skilled labour and is designed to mimic the skills of the best human tractor driver. It has been developed in collaboration with Pernod Ricard Winemakers (PRW).

Smart Machine's three founders – Walter Langlois, Andrew Kersley and Nick Gledhill - had previously worked together in industrial automation and product development in Auckland and Hawkes Bay. When engineer Walter retired to a 4ha vineyard property in Renwick, Marlborough, he soon discovered the potential for automating more tasks in his vineyard. He developed new machinery, including a vine stripper, and started working with Pernod Ricard Winemakers. As technology advanced and became more affordable he saw the time was right to manufacture an Autonomous Vineyard Tractor.

He linked up with Andrew and Nick who brought their product development and manufacturing design expertise. Together the three founders created OXIN (the name reflects doing hard work in the field, with intelligence), which is designed, engineered and built at their workshop in Burleigh, Blenheim. Their staff of 21 includes software developers, an R&D team, engineers and mechanics, and more than half have moved to Marlborough to work for the company.

As at November 2022, 14 OXIN automated tractors had been made with another five in production. The company is up to a third-generation design incorporating improvements to functionality, materials, cost and health and safety based on the experience of each season.

There is a high level of collaboration with PRW. The OXIN developers interact with vineyard staff and use their feedback for improvements.

The OXIN is equivalent to a 130 Horsepower tractor and can be adapted for multiple vineyard tasks:

- Mowing and mulching attachment at the front.
- Arms at the side that extend and adjust to the canopy for leaf removal or trimming.
- Spraying attachment at the back. The OXIN system removes the need to pre-mix chemicals. The herbicide concentrate is held in a separate tank and is injected out through a water unit at the required dose for undervine spraying. Their next generation of sprayer will switch on and off between plants to further reduce chemical use. There is no left-over pre-mixed spray to hold or dispose of.
- Capacity to carry the Cropsy Technologies imaging and artificial intelligence system to monitor crop health and missing vines.



The OXIN is designed for a 2.4m row width and weighs 4T when stacked with implements (5T if using the spray unit). Its maximum speed is 6km/h and the compact design is half the length of a standard tractor with defoliator.

It takes about a month to build one OXIN unit. The steel components are manufactured in the South Island and sent to the Blenheim factory for fabrication and assembly. The circuit boards are designed by the Smart Machine team and made in Taiwan and China. The rubber tracks also come from China.

A LiDAR (Light Imaging, Detection and Ranging) unit on each OXIN uses laser beams to detect gaps in rows, look for obstacles, and ensure implement arms are in the right place. On-board sensors gauge pressure and levels of water and spray. They automatically stop if there is an issue.

Tracks rather than tyres distribute weight evenly over the ground, reduces compaction which affects plant growth and drainage, and can negotiate steep, wet, slippery ground.

At this stage the OXIN is powered by a Cummins diesel engine but the plan is to progress to a hybrid model (diesel/electric) and finally all-electric.

Safety is at the forefront of operations, with careful mission planning using GPS points to program the area of work and set exclusion zones, such as frost fans and pumpsheds.

One person in the vineyard can operate up to four OXIN at once, via a tablet.

Benefits of using OXIN include:

- Reduced soil compaction and rutting between rows (rubber tracks rather than tractor tyres).
- Up to 30% saving in fuel due to fewer passes.
- Reduced herbicide spray and more targeted application.
- Improved precision and efficiency with operations up to 20 hours a day.
- Reduced staff and risk of personal injury with only one person on the vineyard to monitor four tractors.
- 30-50% reduction in the number of tractors needed on a vineyard. (A 1000ha vineyard currently has about 20 conventional tractors. A fleet of six to 10 OXIN would do the same work, depending on block size and management).
- Designed to last. Strict maintenance programme to be followed by refurbishment after five years.

The up-front cost per machine is higher than a tractor, but the total capital cost for the equivalent fleet size is lower and the payback time is relatively quick due to better productivity, reduced staffing, and fuel savings.


Smart Machine is a private business with a board of members selected for their range of business, engineering and marketing skills. Pernod Ricard is an early investor. The company has also received around \$3m in funding from the Ministry for Primary Industries and Callaghan Innovation.

THE JUDGES WERE IMPRESSED BY:

- The high level of innovation by Smart Machine.
- The commitment shown by PRW to be involved at the research and development stage.
- The continuous improvement and evolution of OXIN, season by season, resulting in a product tailored for the wine industry.
- The environmental benefits of a multi-tasking vehicle - reduced diesel use, soil compaction and herbicide applied - as well as the business benefit of easing labour issues.
- Having the goal to be electric but the realism to develop in stages.
- The safer approach to chemical handling.

- The ability to collect vineyard data that will enable better crop management and monitoring for climate adaptation.
- The high priority given to safety on the vineyard as part of the development of OXIN.
- The commitment to sourcing components within New Zealand as much as possible.

PROBLEMS AND HOW THEY HAVE BEEN TACKLED

- Safety is the top priority. Areas of operation in the vineyard are blocked out by logging “geo fences” to keep the OXIN within boundaries. It is programmed to detect people, vehicles and obstacles. There are also on-board sensors to stop the machine if any leaks or other problems arise. A person on-site monitors up to four machines via a tablet, watching progress, checking on mission and implement settings, and intervening when required.
 
- The original intention was to produce a fully electric AVT. However, battery technology and charging infrastructure is lagging behind what is required for the heavy loads and hours of operation. Instead, effort is being put into perfecting on-board technology for doing the vineyard tasks. The next step will be a hybrid diesel engine to charge the battery to drive the OXIN, working up to the final stage of all-electric or hydrogen cell power.
- Finding staff with the skill set to develop and run the technology. Smart Machine are looking internationally for the right staff and have recently employed a robotics expert from Argentina.
- Supply chain risk. Rising costs and reliability of delivery of components from overseas has been an issue. In response to steel prices rising by 40%, design changes were made to reduce the amount of steel. All metal components are sourced in the South Island, which avoids the uncertainty of international freight delivery.
- Intellectual property. To avoid infringing patents, searches have been carried out to ensure international freedom to operate. Their own IP is their on-field experience.
- Making sales. When working with large corporates, there is a long lead-time for replacing tractor fleets. Sales negotiations need to start early and emphasise the long-term savings of an AVT fleet.

SUMMARY

The OXIN Autonomous Vineyard Tractor was conceived to help solve labour shortages and it has environmental benefits as well.

The judges were impressed at the integration of complex technologies to enable different and simultaneous actions in the vineyard. The ability to do several tasks at once reduces the number of passes down a row, saving fuel, chemical use and reducing soil compaction.

The collaboration with Pernod Ricard Winemakers means the OXIN has been developed in the vineyard, not in the lab. This is a powerful point of difference and provides a model for further technology, progress and business co-operation.

SUGGESTIONS

- The Smart Machine website is focused on vineyard management and production. There is room to do more on your website and marketing to promote the potential of the technology for the benefit of the environment.
- Research in Europe shows a strong move away from herbicide use. Pursue the idea of adding mechanical undervine cultivation to OXIN's capability.
- Increased marketing is the next step and climate change is the big issue. Look at promoting OXIN with this in mind, such as reduction in diesel use and data collection to cope with seasonal fluctuations and disease pressure.
- Promote what you're doing with a session at NZ Winegrowers' grape days.
- To help cover the skills shortage, provide a position for a PhD student at Smart Machine – there may be [Callaghan Innovation funding](#) available for this.
- Your level of collaboration with PRW would make a good feature in [NZ Winegrower magazine](#) and [NZ Story](#) and a Country Calendar programme.