

Ten years of transformation

Reflecting on the technical advances in the wine industry over the past decade

By Dr Peter Godden and Dr Dan Johnson

The Australian Wine Research Institute, PO Box 197, Glen Osmond, Adelaide, SA 5064, Australia



With the current challenges faced by the Australian wine industry, it is easy to lose sight of the extraordinary technical advances that have been made in the last 10 years. Since 2002, many practices have changed markedly; from a technical perspective, there has been a transformation in how we do many things, with grapegrowers and wine producers working smarter and more efficiently.

This article explores some of those changes, the science and technology behind them and the technical support necessary for that practice change to have occurred. Investments made in the AWRI and other agencies by grapegrowers and winemakers via their investment agency, the GWRDC, have been instrumental in the development of these game-changing processes.

Australia's growers and winemakers have experienced a technical transformation, doing many things very differently now, compared with 10 years ago. What have been the drivers of that extraordinary rate of advancement?

When it celebrated its 50th anniversary in 2005, the AWRI had cause to read through a lot of old literature when preparing the review papers published in the AWRI's *Advances in Wine Science* commemorative book. Many in the industry were surprised at how rapidly groundbreaking science becomes part of the industry's 'assumed' or even general or basic knowledge bank. After all, Australian winemakers are renowned for rapidly adopting more efficient and effective technologies and processes, while respecting the more traditional side of the winemaking craft. For those of us who studied grape and wine science, it was particularly striking to see how far things had progressed since we had completed our studies.

This is a graphic illustration of science at work; a continual quest for new knowledge, building on an existing base and constantly testing and challenging what had gone before.

When one considers the rate of technological advancement in previous decades, a look at what has happened in the last 10 years is mind boggling; it is as though the rate of change has become exponential by comparison.

Yeast tailored to deliver desired characteristics; extraordinary degrees of practice-change in our use of closures and control of *Brettanomyces*; greater

confidence in fermentation management; understanding of tannin and colour in grapes and wine, and the ability to measure these parameters rapidly and put the results into context; fewer wine stability problems through better understanding of their causes and the implementation of improved quality control (QC) systems; understanding sensory characteristics, our own palates, and the preferences of our consumers; oxygen management; agrochemical use; an exhaustive list of new analytical methods; far greater understanding of the relationship between wine and, and social responsibility issues; and being able to measure wine style. The list is impressive. We highlight just a few of the major changes in this article.

ENSURING THAT WINE TASTES OF WINE, AND NOTHING ELSE

Scientific explanation of the causes of wine contamination and tainting has resulted in a dramatic reduction in the amount of spoiled wine over the last 10 years, saving the industry millions of dollars.

The value of that research cannot be underestimated: it reduced the risk of further contamination; protected the reputation of the Australian wine sector and of Brand Australia; and provided unequivocal evidence of the possible points of contamination along the supply chain. That science drove significant practice change, including widespread introduction of often simple, systematic QC checks both within supply companies and by grape and wine producers.

It resulted in many such problems being largely eliminated, and reduced the associated costs of stock write-downs, the endless stream of legal claims, and the huge amount of time wasted.

In one case alone, millions of dollars of wine were affected by plastic-like taints from a source unidentified until scientists got involved. A number of wineries experienced the problem, ranging from one or a few tanks in some locations, to virtually an entire vintage in another. Methods to identify the contaminants were developed, and used to track the source and the mechanisms by which the taint compounds were released into wine.

There are many other examples: reduction problems caused by high concentrations of elemental sulfur in potassium metabisulfite (PMS) were common 10 years ago, and there was no guarantee that one batch of additive or processing aid would perform the same as another. Quality processes implemented in wineries today provide the highest chance of elimination of issues relating to additives and processing aids.

A decade ago, wine additives and processing aids were commonly packaged in plastic or cardboard containers, and transported in conditions conducive to them becoming contaminated. However, scientific demonstration that many taint compounds are common in the environment and extremely mobile, moving readily through plastic and cardboard packaging, resulted in major international supply companies changing

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The range of commercial yeast strains available today is much larger than it was 10 years ago with yeast strain development now tailored to deliver specific desired characteristics through the understanding of genetics. These new strains give winemakers opportunities to lessen reductive characters, enhance various flavour and sensory properties, and produce lower levels of alcohol in response to consumer demand.

to barrier packaging. Transportation, storage and QC systems were also transformed.

By 2002, most winemakers knew of *Brettanomyces*, but would have been shocked to know that it had left its mark in their wine. Far less than 10 years later, working in partnership with researchers, Australian winemakers were pretty much on top of this troublesome yeast, achieving a dramatic drop in the volume of wine produced with Brett's unmistakable sensory characters. In a single decade alone, this is estimated to have saved the Australian wine industry \$500 million dollars.

At the end of 2011, a new tool was added to the industry's ongoing fight against Brett, with advanced technologies being used to unlock its genetic code. This painstaking work has been heralded as a world-first for wine research: opening the door to new strategies and treatments that could combat super-strains if they were to develop.

Improved sulfite use remains central to Brett control, and getting it right was a major theme of extension programs, resulting in significant cost savings for the industry. Winemakers have far greater knowledge than 10 years ago, understanding that they obtain

maximum benefit from sulfite when it is used effectively and not necessarily in larger quantities. After conducting many investigations of faulty wines and Brett, scientists developed the ratio of free to total SO₂ as a simple indicator of how successfully sulfite is being used; a measure subsequently introduced into many wineries' QC systems.

Grapegrowers also benefited, in dollar terms, from taint research. Over the past 10 years, the AWRI has become well established as the objective 'expert witness' in countless insurance claims: often named in contracts (for a range of purposes, not only insurance) as an arbiter of evidence in cases of smoke taint or other contamination, such as from hydraulic oil. Without such advice and undisputable evidence, many growers would have been refused payouts or faced the prospect of long legal battles to recover the compensation owed to them.

Work on smoke taint has also provided much-needed guidance throughout the wine production process. New measurement tools will reveal the scale of smoke contamination clearly, using objective assessment criteria, so that grape and wine producers can choose whether to blend affected grapes or lodge an insurance claim.

TAKING CONTROL OF FERMENTATION

As a leader in wine yeast research for decades, it was appropriate that the AWRI was the first to sequence and assemble the genetic code of wine yeast. That achievement gives Australian winemakers a competitive advantage in understanding how yeasts function to produce particular wine styles and flavours; a leap forward of incalculable potential impact and value.

A decade ago, commercial yeast strains were common in industry but, today, the range is much larger and yeast strain development is now tailored to deliver specific desired characteristics through the understanding of genetics. These new strains give winemakers opportunities to lessen reductive characters (by producing less hydrogen sulfide), enhance various flavour and sensory properties, such as tropical fruit characters and enhanced mouthfeel, and produce lower levels of alcohol in response to consumer demand. Scientists have also painstakingly built a yeast genome deletion library, creating from the single sequenced strain a collection of more than 3000 different strains, each with a single gene 'deleted'. They are now working to understand

the role and importance of every gene individually; a powerful tool by any standards. In terms of where the greatest impacts on wine sensory characteristics will come from in coming decades, therefore, it is hard not to put yeast at the top of the list.

'Stuck' and sub-optimal fermentations remain a priority, with stock write-downs associated with 'problem' fermentations costing the industry millions of dollars per year. In addition to helping winemakers when fermentation problems arise, researchers have been proactive in elucidating the causes. One discovery is that low juice pH with low potassium concentration is a key factor, with some yeast more affected than others. By building a juice bank, and testing fermentation performance of various wine yeasts, scientists have been able to help winemakers make better choices about the yeasts they use for particular ferments – substantially reducing losses and providing greater control of the process.

Nitrogen management has also been identified as a 'key player'. Winemakers have access to essential information about the 'how' and 'why' of nitrogen supplementation to provide greater control of fermentation, wine sensory profile and wine style. A simple yeast assimilable nitrogen (YAN) spectral assay has already been used by some producers during its development phase to monitor nitrogen levels in juice and during fermentation, and has been demonstrated to save money by cutting analysis costs, while reducing the risk of 'faulty' aromas in the wines.

THE BIRTH OF ONLINE TOOLS

A decade ago, using the internet was becoming the norm for many grapegrowers and winemakers; but when the first 'trouble-free winemaking' online tools became available, the internet speeds available to users in regional Australia remained a major consideration. Few could have imagined the paradigm shift in delivery systems that has occurred, which not only allow producers to operate more efficiently, but also in ways that were not even possible 10 years ago.

For instance, few people measured either tannin or grape colour in 2002; the measurement of both being cumbersome and slow. However, winemakers know that tannin and colour are important; wine writers discuss tannin using terms such as 'iridescence' or 'tightly wound coils', and research shows that consumers look for colour, linking its intensity to quality. The launch of the methyl cellulose precipitable (MCP)

tannin assay in 2005 delivered a rapid and robust method that was superior to what had previously been available. However, it was not until the Tannin Portal was launched, allowing measurement of a suite of phenolic compounds simultaneously, that unlocking the importance of these compounds as a driver of wine value became practical for most wine producers.

The potential of web-based tools seems virtually limitless and, with them, the ability to pool and share data for collective understanding of what is happening in our vineyards and wineries, in real time. The roll-out of broadband internet and adoption and development of smart-phones will continue, and the development of smart-phone apps tailored to vineyard and winery use is well under way.

THE VALUE OF INFORMATION

Ten years has seen an information technology boom, bringing with it access to more information than we often know what to do with. Online, targeted information delivery has been a priority via a comprehensive range of media: factsheets, e-bulletins, e-newsletters, regular technical reviews and websites, from the AWRI and many other sources. The online environment has increased the speed and frequency of information sharing and improved its value.

That hasn't meant that person-to-person contact has diminished in the last 10 years; quite the opposite. There are now more roadshows, practical workshops and contributions to other seminars and conferences, and it is still common for grapegrowers and winemakers to seek advice by phone. A staggering 36,000 requests for information were serviced by AWRI's specialist winemakers, viticulturists, library staff, and wine and society experts between 2005 and 2011; perhaps demonstrating that for many grapegrowers and winemakers, the resources provided are the first port of call when technical information and advice is required. The so-called 'Dog Book', in particular, has given grape and wine producers up-to-date information regarding maximum residue limits (MRLs) year after year. In late 2010 and early 2011, researchers took their expertise in MRLs to another level, working alongside other industry peak bodies to lobby successfully for grapegrowers to have access to alternative methods to combat outbreaks of downy mildew; a fine example of the value of comprehensive information networks and scientific expertise, delivering grape and wine producers the support they needed at a critical time. ▶



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Graeme Little

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Dan Eggleton

Mobile: +61 (0)438 824 493
deggleton@seguinmoreau.com.au

SEGUIN MOREAU AUSTRALIA
Post Office Box 5
Hindmarsh, South Australia 5007
Tel.: +61 (0)8 8340 5400
Fax: +61 (0)8 8340 5401
admin@seguinmoreau.com.au



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TREADING LIGHTLY

Both production costs and uncertainty surrounding water availability have dramatically increased in the last 10 years, making the development and promotion of practical tools and process engineering solutions a key priority. Many wine businesses have streamlined their processes, thereby increasing their environmental and business sustainability. Case studies from industry demonstrate improvements in areas such as refrigeration, wastewater treatment, wine stabilisation and fermentation management. Reliable data have also been produced, which demonstrate how value can be added to winery waste streams through renewable energy technologies, such as biomass production and anaerobic digestion.

UNLOCKING SECRETS INSIDE THE BOTTLE

'Winemaking continuing after bottling' is a term and concept widely used today, but would have sounded far-fetched to most people 10 years ago. The term was coined as a result of work on wine bottle closures, which demonstrated the potential of bottling variables, particularly closures, to influence the development of wine in the bottle in a predictable way.

Put simply, little was known about what happened to wine after bottling 10 years ago, and there were few tools with which to begin exploration of this major frontier of wine research. How things have changed.

Oxygen management, for example, is

now far better understood and practised than 10 years ago, providing wine producers with greater control over the shelf-life of their product, and greater understanding of the role of oxygen in the development of particular wine styles.

Elucidating understanding of what happens after bottling as a result of oxygen has been a huge (yet, for many, 'under the radar') advancement of the last decade. It has resulted in dissolved oxygen (DO) best practice levels falling by a factor of three or four, and has been a key driver for the industry changing the closures it uses for 80-90% of all wine bottled; by any standards, in any industry, a staggering rate of practice change.

Introduction of the concept of total package oxygen (TPO) continues to progress industry knowledge and understanding of this important area. TPO demonstrates that at packaging, oxygen can reside in wine itself (DO), in the headspace above it, and in the closures used. TPO correlates better than DO with how wines change after bottling, and many wineries and bottling service providers have now implemented a range of strategies – developed as a direct result of research – to manage oxygen more effectively.

This is a paradigm shift from 10 years earlier, and the value generated for industry has been enormous; not only in avoidance of spoiled product and the need to deal with closure testing and customer complaints, but also in the enhancement of product integrity and brand reputation.

A decade ago, most wine producers would have laughed at suggestions that by 2010, they would be able to measure wine parameters in bottles without even opening them. However, that is the reality with in-bottle spectroscopy now available to all Australian wine producers. This technique is also a great research tool, continuing to provide new information about the 'hidden' components of wine.

IT'S ALL ABOUT THE TASTE, THE SMELL, AND THE MOUTHFEEL

Flavour chemistry and sensory science have seen major advances in the last 10 years; proving the link between minty characters in some wines to eucalyptus trees, for example. Who would have thought that the black pepper character so often described in Australian Shiraz is actually the most potent aroma compound found in black pepper? Both discoveries provide scientific backing for Brand Australia's marketing strategy: Australian wines are distinctive, and science is able to explain why.

Australian winemakers have improved and validated their sensory threshold for many taints, reductive characters and even the 'black pepper' compound compared with 10 years ago. This has been achieved

through staging 'threshold testing' workshops on roadshows, through the Advanced Wine Assessment Course, and as part of the enormous contribution made by the industry's premier technical event, the Australian Wine Industry Technical Conference. Sensory science is now meshed into the majority of research projects.

A GLIMPSE AT THE FUTURE: WHERE WILL THE NEXT MAJOR IMPACTS OCCUR?

Measuring a wine's style by taking its fingerprint

The concept of 'measuring' wine style hadn't even been thought of 10 years ago and, yet, it is now a reality. The PinotG Style Spectrum – a scale used on labels of Pinot Gris and Pinot Grigio wines, is a fully-developed example of the application of spectral fingerprinting technology; in this case, it is used to inform consumers of the style of wine in the bottle at point of sale in a simple, graphical way. However, the potential applications of fingerprinting technology throughout grapegrowing and winemaking seem boundless.

A world without bentonite

The dream of replacing bentonite, and all its associated costs, is approaching reality with discovery of a protease enzyme that removes heat-unstable protein, potentially saving the industry tens of millions of dollars a year.

Meeting the expectations of Chinese wine consumers

Being proactive in seeking a better understanding of consumer preferences in China is already paying dividends, and the importance of those studies cannot be underestimated. Australia's wine exports to China are currently worth more than \$141 million, making it Australia's fourth largest export market and, clearly, a major part of all of our futures.

WHAT ABOUT 10 YEARS FROM NOW?

Industry investment in research, development and extension has generated a huge return over the last 10 years, delivering solutions to industry that save time and money, while also providing opportunities to make money. The current rate of technological development must continue if we are to stay competitive and provide the products that markets demand. In partnership with the GWRDC, the AWRI will continue to be at the forefront of that technological advancement, with benefits flowing to producers of small, hand-crafted, boutique wines, all the way through to our largest wine producers, creating a dynamic and sustainable future.