Managing micro-oxygenation and other maturation techniques on a large scale: fine tuning, away from the recipe. The example of Caves de Rauzan - Bordeaux wines

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Introduction
In the early 1990s in order to mimic the effect of ageing in old barrels, the technique of micro-oxygenation was developed in Madiran, a south-western French appellation. The technique consists of continuously bubbling small amounts of oxygen in the wine, slower than the rate of consumption so that there is no accumulation of dissolved oxygen. An apparatus capable of achieving this has been created (Ducournau and Laplace 1993) and described (Moutounet et al. 1995).

Since its inception, the technique has commercially spread throughout the winegrowing world and is now systematically used in some wineries' entire winemaking process.

A number of uses for this technique have been proposed, such as sulfide and herbaceous flavour mitigation. However, micro-oxygenation is mainly used as a way of "structuring" and stabilising red wines (Lemaire 1995).

A part from the effect on colour which has been described (Atanasova 2002), the reactions also affect the final molecular weight of the phenolic compounds in the wine and therefore certainly change the colloidal chemistry as well as the sensory chemistry.

When large amounts of monomeric phenolics (anthocyanins, catechins) are present, the tannin reactions lead to low molecular weight species. For example, acetaldehyde-induced polymerisation stops when both ends are occupied by anthocyanins (Cheynier et al. 2000).

It is apparent that the initial content of the wine (in particular procyanidins/anthocyanidins) has a dramatic affect on the type and proportion of products formed.

Keeping this in mind, it appears that applying the technique in a winery requires more than just adding a dose of oxygen via a diffuser. It will involve raw material quality assessment, possible blending, final product definition and proper monitoring.

This is all time consuming and requires certain skills.

The bigger the winery, the more challenging this technique becomes. In fact, in most cases wine ageing in big tanks is closer to the environment of storage than it is to maturation or 'raising' (actual translation of the French term 'élevage').

Outlined below are some of the specific challenges a big winery may face when maturing its wines. Following this the case study of the Caves de Rauzan (2 million cases) will be presented.

2. Large winery challenges in ageing wine
2.1. Big tanks
In large wineries, besides the number of tanks, the first noticeable thing is usually their size. Anything from 50,000L to 1,300,000L can be considered as a big tank in terms of wine maturation.

The problems encountered are:
- Heterogeneity in temperature (gradient between top and bottom).
- Heterogeneity in turbidity.
- Difficult settling due to height and convection streams.
- Pressure on the lees due to height which results in high tendency to sulfides.
- Difficulty in applying certain extraction and maceration methods (punching down, rack and return...).
- Requires specific equipment (extraction, oxygenation, lees stirring devices, representative sampling method ...).
- Neutral material requiring, in some cases, oak addition by barrel alternatives; it is however, difficult to incorporate the whole range of toasted oak (from untoasted to heavy toast) at the right moments.

2.2. Complex organisation
In a small, family-owned winery the same person often acts as vine grower, winemaker, marketer, salesman and decision maker. Although it may appear impossible for the same person to have all the necessary skills, it gives the business an extraordinary coherence. The information is centralised and constantly available and the connections between the different roles are permanent.

In large wineries, we are more likely to find different teams working together. Each team has its own priorities and constraints and doesn’t necessarily understand the constraints of others. Communication and management is the key to success of a project, just like in any other business. However, the inherent complexity of the wine as a product makes it more critical.

Indeed, wine is a living product, constantly changing and strongly dependent on its unique raw materials which are the grapes and maybe the oak.

In addition, it is extremely difficult to define a wine precisely in terms of rational figures. The analyses are insufficient and tasting reports are based on cultural references which are never universal. Therefore, communication between different teams becomes impossible if no common platform of reference is built.
In addition to this, the quantity of information and experience on which traditional winemaking usually relies becomes enormous in large wineries where details are extremely difficult to record in a way they can be retrieved smartly. We know that making wine is all about details. In particular, micro-oxygenation is a technique based almost exclusively on empirical observations. This is due to the extreme complexity of the reactions which occur when applying it. Despite a great deal of research carried out on phenol chemistry, it may take years before there is a complete understanding of the effects and the methods to control them.

Nevertheless, the empirical models developed over 12 years of experience along with a strong commitment to a high level of attention has allowed the technique to be used successfully and safely in large wine companies. The cooperative group Les Celliers de Saint-Cricq and the Cave de Rauzan in particular is one of them.

3. Example of La Cave de Rauzan
La Cave de Rauzan is the biggest cooperative winery of the Bordeaux area, producing about 2 million cases a year for 30 million litres of storage capacity.

3.1. History of acceptance
An extension of the Chambre d’Agriculture is located in the facility and conducts experiments such as micro-vinifications.

Harvest 1996
In 1996, in order to experiment with the still-new technique of micro-oxygenation, the Chambre d’Agriculture purchased six units and treated six tanks of 60,000L each with their controls.

The trials were tasted once a month by a panel of winemakers. However, the lack of calibration made the results unclear. Rauzan’s winemaker, although intrigued by some of the effects, did not find them of sufficient interest to get started.

By chance the wines were tasted again two years later, and the winemaker was surprised by the amount of fresh fruit remaining in the treated samples as well as an increased fullness, compared to the controls.

Harvest 1998
The winery then bought its first 15 units.

Harvest 1999
A new group of tanks was equipped with 40 units.

Harvest 2000
A new group of tanks was equipped with 60 units. A further 10 units are intended for treating the whites.

For maturity assessment and quality control, an Infra Red Fourier Transformation IRFT analyser (FOSS) was purchased.
An expert panel was trained including winemakers and assistants as well as the director. A consulting contract was signed with Oenodev.

Harvest 2001
40 units completed the equipment.
A second IRFT analyser was purchased.
Two 25,000L tanks were designed (by SICOE and Oenodev) and bought specifically for lees handling. The vessels have temperature control and in-place stirring.

Harvest 2002
Some people from Sales & Marketing were included in the tasting panel.

3.2. Goals
The initial goals were:
• Decreasing herbaceous characters
• Stabilising colour and fruit
• Obtaining fuller mouthfeel

But above all conferring better longevity on the weak wines was the major issue.

The latest development has seen a close review of the style of Rauzan wines compared to those of Lugon (part of the same group). This was based on tastings by the expert panel and resulted in a clearer idea of where the technique should lead.

Figure 1 shows a principal composition analysis of tasting results on finished wines of Lugon (identified by LG) and Rauzan (identified by RZ). The two styles of these two wineries are clearly visible. The arrows show the changes hoped for by the board of directors.

Having this clearly defined helps a lot when the time comes to deciding which technique should be used and how.

3.3. Strategy of production
Rauzan sells most of its wines on the bulk market to wine merchants. The dates of sale and delivery depend on the state of the market and the prices may change significantly.

To capitalise on the market fluctuation it is crucial to have the right wine available at the right time. The decision to sell or not should be made using strategic parameters and should not be imposed by losses of quality of the wines in tanks or in bottles.

The decision makers can take the risk of waiting for better market conditions only if they don’t double the risk by losing quality.

In order to illustrate this, the wines produced can be sorted into three quality levels:
• Premium: aged in barrels, sold in bottle, ability to age in bottle.
• Medium: fruity, balanced with a medium concentration.
• Weak wines: lack of colour, lack of balance, drying tannins, green characters.

The lower end of the range is becoming more and more difficult to sell. In the past it used to be sold easily if the price was low enough. Nowadays, it is becoming difficult to find a market whatever the price.

Although the lowest quality level of wine represents a small percentage of the overall production, it is seriously threatening the profitability of the winery. Indeed, the longer it remains unsold, the more it needs to be blended with good wine in order to reach an acceptable (marketable) quality.

Improving the vineyard management and harvesting at the right time are certainly the most effective ways of improving the situation and decreasing the volume of problematic wines. However, it is a long-term process which requires the full support of the growers.

Micro-oxygenation was considered as an alternative for short-term improvement.

Figure 2 shows schematically the effects expected by using the technique on existing wines. In this case, the premium wines (balanced and concentrated) would entirely benefit from the technique, obtaining more tannic structure and fullness.

The medium wine may gain some fruit and weight but would lack enough concentration to be substantially improved.

Most of the lesser wines would be too unbalanced or dry to be treated without drying out. These wines tend to gain some dry vegetal aromas such as hay. Only a small portion may benefit from herbaceous character mitigation, revealing fresh fruit flavours.

In either case, no significant improvement can be expected in terms of longevity. The situation after 12 months may be worse for the lesser wines than it would have been without treatment.

Figure 3. Shows the evolution of the range of wines treated with micro-oxygenation after re-organisation by early strategic blending.
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Blending small portions of concentrated wines with lower quality wines doesn't make them good but, if done properly, can improve their balance enough for them to benefit from maturation techniques such as oak additions (barrel ageing in the case of Rauzan), oxygenation, lees management, etc. This type of blending is somewhat different from the usual final blending well known by winemakers and wine consultants. There is no need to find the perfect blend of aromas, acidity, fullness, etc., but just enough of the characteristics required for the techniques which are about to be used.

In the case of micro-oxygenation, the following criteria are necessary:
- Ratio between tannins and anthocyanins of 1:4 or more. The more free anthocyanins the better.
- A little as possible of dry vegetal, degraded fruit and dry tannins in the blend.

This method of blending is now widely applied in Rauzan and has been profitable in the past two years. However, it requires a thorough understanding of the wines available, their possible changes during maturation and the techniques applied by the winemakers and the decision makers. This explains their active implication in the tasting panel.

3.4. Equipment and procedures

The 165 units used in Rauzan are spread over five different cellars. Each one has a master box including one PLC (Programmable Logic Controller). They can work independently. Nevertheless, all five master boxes communicate with one PC. All doses and treated wine volumes are entered through the PC, which tracks the history of treatment and links it to the general production software.

As explained earlier, being able to build experience by linking together analysis, tasting results and treatment data is the key to success.

Rauzan uses standard Oenodev equipment based on separate interchangeable dosing units (one per tank) in boxes of 20. All tanks are equipped with one oxygen pipeline and one standard diffuser.

A starting, stopping and cleaning procedure has been developed and employees properly trained. Any decision about micro-oxygenation should be taken in consideration of wine requirements, not labour or machinery problems.

The winery purchased an oxygen meter (WTW Oxy 330) as well as a turbidity meter. It has a centrifuge, and two lees tanks so red wines can be racked off lees. This helps avoid competition for O₂ between the lees and the phenols. The lees, kept separate and properly treated, can be reincorporated later on for macro-molecules release and an increase of viscosity.

3.5. Monitoring

Arguably not as important as the initial strategic and technical decisions, monitoring is a key element as each wine is slightly different from the others and the reactions cannot be entirely predicted.

3.5.1. Analysis

Only basic analyses are available at the winery. More refined measurements are done by Oeno-Conseil laboratories in Preignac (33).

A nalysis recorded at starting point:
- Total phenols
- Total anthocyanins
- Laccase activity (if applicable)
- Total acidity
- Volatile acidity

Monitoring:
- Dissolved oxygen (DO)
- Turbidity
- Free SO₂ (when applicable)
- Malolactic fermentation (paper chromatography)

In the future, more analysis will be taken routinely through the IRFT equipment.

Microbiology:
- Brettanomyces populations are monitored extensively to avoid any oxygenation contributing to population growth. It has been proposed that high DO significantly
increases the growth of Brettanomyces populations (Gilis 2002).

Figure 4 is an example of one tank treated with micro-oxygenation before SO₂ addition. The chart shows a usual decrease of turbidity and DO remaining very low despite some significant doses of oxygen (40 to 70 mL/L/month during the first 10 days after alcoholic fermentation completion). The peak of DO corresponds to the post malolactic aerated racking, after the micro-oxygenation has been turned off.

Figure 5 shows that the preferred conditions for micro-oxygenation were well respected in the 70 tanks represented here. No high DO is found while micro-oxygenation is applied. All peaks of DO are at a micro-oxygenation dose of 0 and are related to regular racking.

### 3.5.2. Steering Tasting

As explained in the introduction, tasting is necessary along with DO measurement to control micro-oxygenation, to adjust the dose and decide when to stop.

In particular, during the early stages tasting should be performed daily. As it is an extremely busy period, finding time is difficult. A good compromise should be found between accuracy, data collection and the time involved.

The method being used, although not yet completely functional, is:

- 2 to 3 tasters
- Proper training
- 4 to 6 straightforward descriptors
- Tasting in the winery is OK
- Using scannable tasting sheets (one per wine and per 30 days)

Prior to SO₂ addition, the descriptors typically used are: fruit intensity, vegetal intensity, aldehyde, weight (viscosity, fullness), tannic intensity, type of tannins.

### 3.5.3. Evaluation and Decision Tasting

The group Les Celliers de Saint Cricq developed its own expert panel including winemakers from both wineries, sales and marketing personnel and the director. Frequent tastings take place from January through August with several purposes:

- Defining the goals
- Early and late blendings
- Result evaluation
- Competition evaluation...

Some of the elements of the method being used are:

- 5 to 10 tasters
- Proper training
- 10 to 25 descriptors
- Tasting room
- Real-time feedback

The real-time feedback has been found to be extremely important for faster and better calibration of the tasters, faster and more reliable winemaking decisions, judges' enjoyment and therefore motivation.

### 3.6. General Organisation

Increasingly, tasting becomes the centre of the organisation in the group. Having all major functions, from winemaking to sales and marketing, in the same expert panel is very challenging but appears to be very effective. Indeed, the communication around technical facts is eased significantly and therefore more general communication is improved.

The main expert panel involves people from management, sales and marketing, winemakers and assistant winemakers. The consultant helped to put this in place and participates on a regular basis so that it doesn't lose viability. As a matter of fact, it requires continuous motivation to keep going. The daily activities of all judges have the tendency to overtake the importance of the panel.

All participants in the panel are continually calibrating and training due to their participation. On the other hand, the panel benefits from the experience and the information being shared by the judges.

Not all technical or commercial decisions can be made by the full panel, so each team organises its own tasting for its own purposes, but when the time comes for consolidation a common language can be used.

From the micro-oxygenation point of view, the general blending decisions as well as the intermediate results evaluation are made by the main panel. Day-to-day monitoring is conducted by informal panels including the winemakers so that, again, a common language can be used.
4. Conclusions and perspectives
No great wine can be made without taking some risks, without some gamble on the future. But this can only be acceptable if the risks and their controls are well understood. In a large winery, an awareness of major issues and small details alike is a real challenge. Only a good organisation including good management of information will allow the managing team to succeed.

This is the direction that the Celliers de Saint Cricq took a couple of years ago, by accepting the costs of this technology. This included investing in production software capabilities, consulting and training. More importantly, some employees have been hired to give the winemakers more time to participate in tasting and think in terms of the overall picture.

The process is certainly still developing but has already borne results. For instance, micro-oxygenation is now perfectly integrated in the winemaking scheme and is used as well as one could expect in the conditions of a coop.

Consequently, the two last vintages have been sold at an average price of 15€/HL more than the market price and earlier than most of the competitors.

The remaining challenges are in the vineyard, in harvesting at the right time and in selecting precisely the lots of wine for the different quality levels.

The importance of tasting increased with the advent of this technique and it is now done more logically; however, it will always remain challenging and time consuming. Any analysis or automatic monitoring as an aid to decision making will be welcome.

Concerning micro-oxygenation, the areas requiring research are:
- Finding an analytical way to assess a wine's ability to age and benefit from oxygen. Defining its needs for a better balance.
- Having an easy and reliable measurement of redox potential.
- Having an easy method of aldehyde assessment.
- Automation of all DO, turbidity and all new measures.

Bibliography