Table of Contents

Winery Overview .................................................................................................................... 3
   A very simplistic view ............................................................................................................ 3
   The facility ............................................................................................................................. 4
   Overview of the process ......................................................................................................... 6
   Wine Making Summaries ....................................................................................................... 11
   Last Harvest: 2018 ............................................................................................................... 16

Step #1: Assessing Grape Maturity ......................................................................................... 17
   Weather and soil humidity ................................................................................................... 17
   Sampling ............................................................................................................................... 18
   Chemical Analysis ............................................................................................................... 19
   Physical Analysis ............................................................................................................... 20
   Forecasting quality, date and volume of harvest ................................................................. 21
   Data Management ............................................................................................................ 22
   Tracking Results for the 2018 crop .................................................................................... 24

Step #2: Harvest, Sort & Destem ......................................................................................... 27
   Picking the Grapes ................................................................................................................ 27
   Sorting, Destemming & Crush ............................................................................................ 28
   Data Management ............................................................................................................. 29
   Tracking Results 2018 ........................................................................................................ 31

Steps 3-11: Upfront Wine Making Decisions ....................................................................... 34
   Step #3: Crush, Stomp or Full Berry Fermentation? .......................................................... 35
   Step #4: Saignée? ................................................................................................................ 36
   Step #5: Add Water? ............................................................................................................ 37
   Step #6: Adjust Acidity? ..................................................................................................... 37
   Step #7: Add Stems or Oak Chips? ..................................................................................... 39
   Step #8: Add SO₂ ............................................................................................................... 39
   Step #9: Add Enzymes? ..................................................................................................... 40
   Step #10: Add Fining Agents? ............................................................................................ 41
   Step #11: Cold Soak? .......................................................................................................... 41
   Data Management ............................................................................................................. 42
   Tracking Results 2018 ........................................................................................................ 44

Step 12: Primary Fermentation Phase 1 .............................................................................. 45
   Choice of Yeasts .................................................................................................................. 45
   Yeast Nutrient ..................................................................................................................... 46
   Process Steps for Primary Fermentation Phase 1 ............................................................... 47
   Dealing with Fermentation Problems ............................................................................... 49
   Data Management ............................................................................................................. 50
   Tracking Results for 2018 ............................................................................................... 50

Step 13: Primary Fermentation Phase 2 .............................................................................. 52
   Press before Fermentation is Finished? .............................................................................. 52
   Dealing with Fermentation Problems ............................................................................... 53
   Data Management ............................................................................................................. 53
   Tracking Results for 2018 ............................................................................................... 54

Steps 14-18: Extended Maceration to Press ........................................................................ 55
   Step #16: Extended Maceration .......................................................................................... 55
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steps #14-15 &amp; 17 Pressing Decisions</td>
<td>55</td>
</tr>
<tr>
<td>Finishing Primary Fermentation</td>
<td>57</td>
</tr>
<tr>
<td>Racking</td>
<td>57</td>
</tr>
<tr>
<td>Data Management</td>
<td>57</td>
</tr>
<tr>
<td>Tracking Results 2018</td>
<td>58</td>
</tr>
</tbody>
</table>

**Fermentation Batch Review (Steps 3-17)**

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Management</td>
<td>59</td>
</tr>
<tr>
<td>Tracking Results for 2018</td>
<td>67</td>
</tr>
</tbody>
</table>
Winery Overview

Winemaking is about transforming healthy and clean grapes into young, immature wine, a 3-4 month process. This is the step after growing quality grapes, an annual endeavour. The step after winemaking is cellaring, which is about maturing the young wine in barrels, bottling the wine and maturing the bottles – that takes 5-8 years.

This section is organised as follows:

- On this page, we explain the general concepts and processes used. We start with a simplistic view, then describe our winemaking facility and then summarise the 15 individual process steps. Then we conclude with a summary of how we made the wine in each of the 9 past years 2009 – 2017.
- On the following pages, we describe the process steps in more detail and how they apply in the last harvest (2018), what decisions we made and what we learned.

A very simplistic view

In a very simplistic view, making red wine has 4 distinct phases:

- Phase 1 - from grapes to sweet must:
  First we decide when we pick grape bunches in the vineyard. Then we sort out the bad bunches, destem the bunches, sort out debris and dirt and crush the grapes into sweet must. Must is a slurry of grape juice, grape skins and seeds. Phase 1 takes 6-8 weeks of monitoring grapes in the field and a few hours of picking and processing the grape bunches.

- Phase 2 - from sweet must to alcoholic must
  We ferment the sugar with the help of yeasts into alcohol. During this process a lot of valuable organic compounds are extracted from the skins, pulp and seeds – these compounds give the wine its characteristic odours, taste and mouthfeel. This step takes 2-3 weeks and is the most critical and difficult phase.

- Phase 3 – from alcoholic must to juvenile wine
  We separate the now alcoholic juice from the skins and seeds by pressing the must. This takes a few hours
The facility
To go through these four phases, we need a special-purpose facility: a winery. We built our facility on 4 levels, so we do not need to use pumps – we rely on gravity to move the product, and winches or lifts when required. The rationale is to prevent the rough physical treatment of juice, skins and seeds inside a pump. This graphic illustrates the sequence:

A brief explanation covering the entire wine-making and cellaring process:

- **On the Bunch Sorting Table**, we sort out the damaged bunches and leaves coming in from the vineyard
- **The Elevator** moves the sorted bunches to the mouth of the destemmer
- **The Destemmer** separates the grapes from the stems
- **On the Berry Sorting Table**, we pick out the "Material Other than Grapes" or MOG, mostly small stem and leaf pieces
- As the berries leave the Sorting Table and fall into the Fermenter; we have the option of inserting a **Crusher** which breaks their skin so valuable compounds can be extracted more efficiently during fermentation
- **In the Fermenter**, we convert Grapes into Fermented Must (i.e. sugar into alcohol). The fermenter is temperature controlled by a **Glycol Cooler** pumping cold or warm glycol through the walls of the Fermenter.
- **The Press** separates the juice (i.e. wine) from the grape skins and grape seeds.
The young wine is then dropped to a **Mixing Tank** in the cellar and moved back and forth between Barrels until it is mature and bottled. The mixing tank and barrels can be moved up or down to allow gravity flow between them. The temperature in the cellar is kept at 55-60° F by the **Glycol Cooler** pumping cold glycol through an air-conditioner.

To the left of the graphic is a picture of the physical layout. You can see the ground level outside through the window, and you can see cellar levels -1 and -2. Half the floor between level -1 and -2 is removable so that we can connect the fermenting tank with a bridge to the press. This is shown on the page explaining the press. Cellar level -3 is below. The wine is transported by a hose through holes in the floor to the mixing tank and barrels below.
Overview of the process

Here is the next level of detail: a closer look at the four phases described above. Note, this process has evolved significantly over the years; what follows is our process for the 2018 vintage and after. The flowchart on the right shows 18 steps and the decisions which link them:

1. Measure Berry Ripeness: We measure the progress towards grape maturity in the vineyard and then decide when to harvest.

2. Harvest, Sort & Destem: We pick the grape bunches, sort out the dirt, destem them, sort the berries end up with clean grape berries in a fermentation tank.

3. Crush or Stomp: We decide whether we want to break the skins of the grapes with rollers (crush) or with our feet (stomp), or not at all (i.e. Full Berry Fermentation)

4. Saignée? We decide whether we want to artificially increase the concentration of flavours in the wine. This is done by increasing the
“skins & seeds”-to-“liquids” ratio through syphoning off a percentage of the liquids. The juice that is syphoned off can be used to produce rosé wine.

5. Adjust Brix: We decide whether we need to lower the average Brix level by adding water.

6. Adjust Acidity: We decide whether we need to adjust the pH up (add carbonates) or down (add tartaric acid). We can make this adjustment now or delay until later. This adjustment can be made upfront (i.e. as step 6) or later (i.e. during fermentation or cellaring) in increments.

7. Add Stems or Oak Chips: We decide whether we want to add back some of the Stems into the must to adjust the flavour profile or add Oak Chips to adjust the phenolic extraction.

8. SO₂ or native Fermentation? We decide whether we want to ferment with yeasts and bacteria native in the vineyard and winery, or with cultured yeasts purchased from external providers. If we decide to use cultured yeasts, we add SO₂ to kill off all native non-saccharomyces yeasts and bacteria.

9. Enzymes? We decide whether we want to artificially increase the extraction of desirable components in the skin, pulp and seeds into the juice by adding enzymes which break down cell walls.

10. Add Fining Agents: We decide whether we want to add antimicrobial agents to bind and precipitate spoilage bacteria.

11. Cold Soak? We decide whether we want to extract desirable components of the skin and pulp into the grape juice before fermentation is converting the juice into alcohol. Again the idea is to get more aromas and flavours. We soak at a low temperature of around 50-55 °F to prevent spoilage.

12. Fermentation Phase 1: Now we raise the temperature of the must to 70 dF and decide whether to start fermenting with native yeasts living in the vineyard and the cellar, or industrial yeasts purchased from third parties. If we decide for native, we simply wait for the fermentation to start on its own, or we mix in a bucket of must which we had set aside a week or so earlier and started fermenting on its own. If we decide for industrial, we inoculate the must with cultured yeast. In either case, we consider adding nutrients for the yeast, the amount depending on the level of Yeast Available Nitrogen (YAN) in the must.

13. Fermentation Phase 2: After the fermentation accelerates and the sugar level has fallen by around a third, we have a few decisions to make. If we started with native yeasts, we might wish
to decide to finish with industrial yeasts and inoculate. Also, more yeast nutrients may be required. Because fermentation releases thermal energy, we may also need to cool the tanks, so the temperature stays below 90 °F. At the same time, we need to start watching the amount of phenolics extracted from the skins and pulp. If the tannins extracted exceed the anthocyanins extracted by more than 10-20% before the fermentation is complete, we decide to press the cap separately to limit further tannin extraction while completing the primary fermentation (steps 14 & 15). Alternatively, we proceed to step 16.

14. Press Cap Separately: We scoop out the cap (mostly skins floating on top of the must) and press it, then pour the resulting juice back into the fermentation tank.

15. Primary Fermentation Phase 3: we complete the primary fermentation, i.e. all the sugars have been converted to alcohol.

16. Extended Maceration: If the fermentation has completed before tannins have reached 110% of peak anthocyanins, we decide whether to extend the time the now fermented juice is exposed to the grape skins - and, more importantly, the seeds - to extract even more phenolics (i.e. mostly tannins).

17. Press: We separate the juice from the skins and seeds by first letting the juice flow out of the fermentation tank into the settling tank (called “Free Flow”) and then pressing the remaining wet must into the same tank and other containers (called “Press Run”). The remaining, now dry, skins & seeds are carted into the field to fertilise the soil.

18. Rack into Barrels: After letting the wine settle for a few days in the mixing tank and other vessels we rack the juice into barrels and topup tanks leaving the sediment behind.

Steps 1 through 18 takes between 10 and 30 days

Up to 2015, we followed this process for a single grape variety, Cabernet Sauvignon.

In 2016 we started dealing with 4 different grape varieties (Cabernet Sauvignon, Merlot, Petit Verdot and Cabernet Franc) each possibly reaching harvest maturity at a different date. So potentially we have 4 processes running simultaneously, slightly staggered time-wise. In 2018 we had 3 separate harvests, starting with Merlot and Cabernet Franc in the upper field, followed by Cabernet Sauvignon in the lower field and finishing with Petit Verdot in the upper field.

Following is a detailed flowchart of the process and the decisions taken for each of the 3 in 2018 harvest. The only purpose of showing this chart upfront is to illustrate how the steps and
decisions described in the following pages fit together. The bold arrows indicate the decisions taken. We describe the individual steps in the pages which follow.
Step #1: Measure Berry Ripeness
- Measure berry ripeness and tare with ICV method
- Measure berry ripeness and tare with ICV method

Step #2: Harvest, Sort & Destem
- Harvest grapes
- Sort grapes
- Destem

Step #3: Crush or Stomp?
- Crush Berries
- Stomp Berries

Step #4: Saignée?
- Yes
- No

Step #5: Add Water?
- Yes
- No

Step #6: Adjust Acidity?
- Yes
- No

Step #7: Add Stems or Oak Chips?
- Yes
- No

Step #8: Add SO2?
- Yes
- No

Step #9: Add Enzyme?
- Yes
- No

Step #10: Add Fining Agent?
- Yes
- No

Step #11: Cold Soak
- Yes
- No

Step #12: Primary Fermentation Phase 1
- Yes
- No

Step #13: Primary Fermentation Phase 2
- Yes
- No

Step #14: Press Cap
- Yes
- No

Step #15: Primary Fermentation Phase 3
- Yes
- No

Step #16: Extended Maceration
- Yes
- No

Step #17: Press
- Yes
- No

Step #18: Rack
- Yes
- No
Wine Making Summaries

The following table summarises how we made wine during the first 7 years, 2009 – 2015

During the first 3 years, I relied heavily on Aran Healy who helped me make decisions on what equipment to buy and taught me how to use it and make wine. We took relatively few measurements, relying mostly on Aran’s experience and tasting skills. The first year was about setting a benchmark: producing the wine with minimal additions and interventions in a 100% natural fashion. In the second and third year, we started experimenting with established wine-making techniques (like using commercial enzymes and yeasts). In the third year, we were particularly challenged by a bad harvest (low volume and quality of grapes)
### Wine Making Summary 2009-2015

<table>
<thead>
<tr>
<th>Year</th>
<th>Stage</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
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#### Berry Testing
- Harvested 10/29/09
- Titratable sugars: 22.0 Brix
- Non-volatile acidity: 1.5 g/L
- Malic acids: 5.0 g/L
- pH: 3.7

#### Press Cup Sensitivity
- Pressed all at 240 psi
- No malo!
- PYO potential: 19.5% of cap with ICV
- Tannin: 1.1 g/L
- Total anthocyanins: 100 mg/L

#### Complete Fermentation
- Dry ice, 0.15 cft
- Into mixing plant
- Pressed at 14 psi
- No malo!
- PYO potential: 19.5% of cap with ICV
- Tannin: 1.1 g/L
- Total anthocyanins: 100 mg/L

#### Final Press
- Pressed at 14 psi
- No malo!
- PYO potential: 19.5% of cap with ICV
- Tannin: 1.1 g/L
- Total anthocyanins: 100 mg/L

#### Malolactic Fermentation
- No malo!
- PYO potential: 19.5% of cap with ICV
- Tannin: 1.1 g/L
- Total anthocyanins: 100 mg/L

#### Calling-in decisions
- No malo!
- PYO potential: 19.5% of cap with ICV
- Tannin: 1.1 g/L
- Total anthocyanins: 100 mg/L

#### Summary
- Malolactic fermentation
- PYO potential: 19.5% of cap with ICV
- Tannin: 1.1 g/L
- Total anthocyanins: 100 mg/L

---

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snapshot: November 23, 2018
During the following 2 years, 2011 & 2012, after Aran left, we started to become more numbers oriented and collected data more diligently.

In 2013 David Fenyvesi joined, contributing his East European winemaking experience. We started to measure phenolics with the help of WineXray, a service that converts spectral absorbance measurements into estimates of phenolic compounds in the wine. This, in turn, allowed us to fine-tune the fermentation process. We also started to document the winemaking process with a detailed flow-chart and collected data diligently.

In 2014 we started to measure the phenolics in grapes after veraison to help to time the harvest, and we pressed the cap separately and before fermentation was finished to limit the uptake of tannins.

In 2015 we fermented the different clones separately in bins within the fermentation tank – this proved that the 337 clone was of much higher quality than the Rixford clone (in term of extractable Anthocyanin concentrations)

By 2016 the new Upper Vineyard started to produce and, because Merlot matures a month earlier, we started running two harvests and two rounds of fermentations in sequence. We introduced new smaller fermentation tanks to fit inside the large tank to handle smaller lots, and we built a small crusher because stomping in new tanks became infeasible. Nicolas Vonderheyden replaced David, adding his Bordeaux winemaking experience to the mix. This, and input from UCDavis encouraged me to return to the more natural approach we had used in 2009: no enzymes, no sulfur and no commercial yeasts.

The process became more complicated. The graphic illustrates the difference between 2015 and 2016. In 2015 we had one harvest (cabernet), split the grapes into three fermentation buckets (by clone) and combined the fermented juice at press into a single barrel. In 2016 we harvested and fermented the grapes the Upper Field (Merlot, Cab Franc & Petit Verdot) first in a single tank, used only the freeflow and set the wine aside. Then we harvested the Lower Field. The long row grapes (337 clones) were saigneeed and fermented in 4 separate fermentation tanks and their freeflow combined with the free flow from the Upper Field into 2 barrels. The grapes from the short rows (Rixford clone) received the saignee from the long row grapes, were fermented in 2 separate fermentation tanks, then pressed together with the remaining skins of the long row grapes and filled one barrel.
### Wine Making Summaries 2015 & 2016

#### Berry Testing
- Date: 15-Sep
- Analysis:
  - pH: 3.47
  - TA: 14.50
  - Lactic Acids: 3.47
  - Alcohol: 5.5
  - Press volume: 26-Sep
  - Brix: 25.20

#### Harvest
- Date: 6670
- Analysis:
  - pH: 3.32
  - TA: 75
  - Lactic Acids: 3.47
  - Alcohol: 7.5

#### Crush & Stump
- Date: 4275
- Analysis:
  - pH: 3.32
  - TA: 7.5
  - Lactic Acids: 3.47
  - Alcohol: 7.5

#### Punch & Open Glasses
- Date: 5090
- Analysis:
  - pH: 3.47
  - TA: 7.5
  - Lactic Acids: 3.47
  - Alcohol: 7.5

#### Primary Fermentation: Phase 1
- Date: 500
- Analysis:
  - pH: 3.47
  - TA: 7.5
  - Lactic Acids: 3.47
  - Alcohol: 7.5

#### Primary Fermentation: Phase 2
- Date: 600
- Analysis:
  - pH: 3.47
  - TA: 7.5
  - Lactic Acids: 3.47
  - Alcohol: 7.5

#### Extended Maceration
- Date: 1120
- Analysis:
  - pH: 3.47
  - TA: 7.5
  - Lactic Acids: 3.47
  - Alcohol: 7.5

#### Press Cap Separately
- Date: 1122
- Analysis:
  - pH: 3.47
  - TA: 7.5
  - Lactic Acids: 3.47
  - Alcohol: 7.5

#### Complete Primary Fermentation to Tank or Barrel
- Date: 1122
- Analysis:
  - pH: 3.47
  - TA: 7.5
  - Lactic Acids: 3.47
  - Alcohol: 7.5

#### Final Press
- Date: 1122
- Analysis:
  - pH: 3.47
  - TA: 7.5
  - Lactic Acids: 3.47
  - Alcohol: 7.5

#### Malolactic Fermentation
- Date: 1122
- Analysis:
  - pH: 3.47
  - TA: 7.5
  - Lactic Acids: 3.47
  - Alcohol: 7.5

#### Clustering & Bottling
- Date: 1122
- Analysis:
  - pH: 3.47
  - TA: 7.5
  - Lactic Acids: 3.47
  - Alcohol: 7.5

#### Comment
- Date: 1122
- Analysis:
  - pH: 3.47
  - TA: 7.5
  - Lactic Acids: 3.47
  - Alcohol: 7.5

The following text is included in the document:

- **Sampling error in berry testing led to late harvest and low phenolics.**
- **Chateau Hetsakais:** WINERY Pages
- **www.chateuhetsakais.com**
- page 14
- **snapshot: November 23, 2018**
In 2017 we replaced all spreadsheets with a database. This screenshot of the “REVIEW: Vintage” layout for 2017 summarises the vineyard and winery activities; the cellar activities are incomplete because the vintage is still in barrels. In 2017 we had two harvests, both poor in volume and quality: we harvested the 4 blocks (PetV, CabF, Me2 & Me1) in the upper field on October 3, the CSLR block on October 14 and abandoned the CSSR block. We fermented the Merlot blocks separately and combined the CabF and PetV blocks. We fermented the Cabernet Sauvignon block in 4 separate fermentation tanks. All fermentations completed with indigenous yeasts.

Then we pressed and filled one barrel with Cabernet Sauvignon, and a half barrel with a mixture of Merlot (55%) Cabernet Franc (25%) and Petit Verdot (20%). The third cellar batch was tiny and used as topup. We inoculated the two barrels with malolactic bacteria but have little success in converting the remaining malic acids to lactic acids.
Last Harvest: 2018

2018 was a much better year. Harvest quantity and quality were excellent. The fermentations all completed with indigenous yeasts, and we ended up with 3 full barrels and plenty of topup wine. We decided to use, for the first time, a dedicated topup container for each barrel to eliminate a potential source of cross-contamination.

The remainder of this section describes each of the process steps in more detail.

A pdf file of the Winery Section as of November 15, 2018, is available here.
Step #1: Assessing Grape Maturity

Picking the grapes at the right time is critical. Timing depends on the maturity of the grapes, the outlook for inclement weather and the availability of a picking crew. The most critical aspect is grape maturity assessment and takes weeks.

Ideally, all grapes reach the same final level of maturity at the same time. In reality, they do not. Proper pruning and canopy management can narrow the time window of final maturity so we can harvest all grape bunches at the same time. We sample the grapes in the vineyard every week and test them – when the average reaches specific characteristics we pick. There are four aspects to consider in getting to the picking decision:

1. **Weather and soil humidity**: how much sunshine have the grapes received over the growing season and how much water was added through irrigation to fine-tune the grapes’ condition during the last 4-5 weeks?
2. **Sampling**: How do we sample the grapes to be analysed, so the sample represents the range of maturity in the entire vineyard?
3. **Chemical Analysis**: what chemical measurements do we take to decide whether the grapes have reached maturity and how will the results affect our winemaking process?
4. **Taste Analysis**: how can we consistently evaluate the taste of the grapes during their final weeks of maturation?

Finally, we try to forecast, as we measure, when we will likely end up picking and what volume we can expect from the harvest. Quality, date and volume forecasts help us organise the picking crew/party and make decisions on the subsequent fermentation processes.

The following paragraphs explain what we do in detail.

**Weather and soil humidity**

We described on the last page in the vineyard section how we monitor weather conditions during the growing season. A critical weather-related leading indicator for maturity used throughout agriculture is Cumulative Growing Degree Days (“CGDD”). We track this number throughout the year and pay particular attention during the last 4 weeks. The goal is to reach around 2000 CGDDs before picking.
We can increase soil humidity with irrigation. We do not irrigate the vineyard except in very dry seasons and during the final weeks of maturation if we need to prevent sugar from shooting beyond our target of 24 Brix before the grapes have reached physiological maturity (as measured by Taste Analysis). As a consequence, we track CGDDs, temperature lows and highs, humidity lows and highs and irrigation amounts during the final weeks.

**Sampling**

The second task is to decide how we sample. The goal is to sample in the areas which provide the full range of berry maturities. The best time to easily spot degrees of berry maturity is during veraison when the berries turn from green to blue. So we look at

- The planting map to make sure we sample all the different clones
- The veraison map when 90% of the berries are blue to make sure the maturity differences are representative for the entire vineyard, and
- The projected crop load map to make sure we have enough fruit to sample

In 2017 we selected, as in 2016, six sample areas. In the Lower Field: the north-east corner of the long rows to sample the "Freedom" and "4453" roots with 337 cabernet clones. In the north-east corner of the short rows to catch the "110R" roots with "Dr Emmet Rixford" cabernet clones, and the boundary between the short and long rows to catch the 2009 replantings, i.e. clone 337 on 4453 roots. In the Upper Field: The first half rows for each varietal. The graphic below shows the three maps and the selected sampling areas. The assumption is that differences in the maturity levels now, near picking, would be similar to the differences which were readily observable during veraison.
In 2018 we changed the selection of sampling areas because, both in 2016 & 2017 the sample results did not match well with the observations at harvest (for one, the final projected Brix levels were 2-4 Brix lower than what we got at harvest). So, in 2018 we sampled each block in the lower field uniformly, and we sampled the middle row of each block in the upper field.

For each block, we collect weekly samples of 110 berries each, 100 berries for chemical analysis, 10 berries for taste analysis.

**Chemical Analysis**

We take a whole range of measurements and from them calculate sample averages.

- **Sugar content (Brix):** Sugar content of the grape juice is the most straightforward measure of maturity. Usually, wine is picked when the sugar level has reached 22-28 Brix depending on the style of the wine desired. Our target is 24 Brix.
- **Acidity (pH and TA).** At maturity, we expect a pH range of 3.3 to 3.5 and a TA range of 6 to 9 [g/L]. We also capture Tartaric, Malic & Gluconic Acids, but are not yet sure what we do with the numbers. Finally, we capture Volatile Acidity, to detect possible infestations.
- **Nutrients (Alpha Amino Acids and Ammonia which sum up to YAN, Yeast Assimilable Nitrogen).** These are vital benchmarks for nutrition available for yeasts during fermentation. We target YANs of 250 ppm, below that we need to add nitrogen during fermentation.
- **Projected Anthocyanin content (tANT):** Anthocyanins are responsible for the colour intensity and mouthfeel of the finished wine. We are experimenting with this measure. We press the berries, the expose the skins and seeds to an alcohol solution at 130 °F for 2 hours, then press again and measure the phenolic components extracted by the alcohol solution.

We describe the laboratory processes the Laboratory Section.
Physical Analysis

An alternative measure is to assess the maturity of the grapes by tasting their skin, pulp and seeds individually. L’Institut Cooperatif du Vin (ICV), a wine advisory cooperative in Montpellier, France, has developed a handy methodology which we use. It requires judgement for rating 18 different characteristics on a scale from 1 to 4. See table below for the form we used:

<table>
<thead>
<tr>
<th>ICV Detail Berry Sensory Analysis Scoresheet</th>
<th>Date:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Berry Softness</td>
<td>2. Elastic change of shape slightly under pressure</td>
</tr>
<tr>
<td>2. Skin Color</td>
<td>Pink, red</td>
</tr>
<tr>
<td>3. Stalk removal</td>
<td>Difficult</td>
</tr>
<tr>
<td>4. Pulp detachment &amp; juiciness</td>
<td>Split easily into pulp and juice</td>
</tr>
<tr>
<td>5. Sweetness</td>
<td>Lightly</td>
</tr>
<tr>
<td>6. Acidity</td>
<td>High</td>
</tr>
<tr>
<td>7. Herbs/coarseness</td>
<td>Very intense</td>
</tr>
<tr>
<td>8. Fruit Aroma</td>
<td>Absent</td>
</tr>
<tr>
<td>9. Disintegration</td>
<td>Very difficult</td>
</tr>
<tr>
<td>10. Tannin Intensity</td>
<td>High</td>
</tr>
<tr>
<td>11. Astringency</td>
<td>Between 6-9 o'clock</td>
</tr>
<tr>
<td>12. Skin Aroma</td>
<td>Strong</td>
</tr>
<tr>
<td>13. Herbs/coarseness</td>
<td>Intense</td>
</tr>
<tr>
<td>14. Fruit Aroma</td>
<td>Absent</td>
</tr>
<tr>
<td>15. Seed Color</td>
<td>Green or yellow-green</td>
</tr>
<tr>
<td>16. Seed Hardness</td>
<td>Soft &amp; elastic, can be rolled with fingers</td>
</tr>
<tr>
<td>17. Astringency</td>
<td>High</td>
</tr>
<tr>
<td>18. Antioxidant</td>
<td>Absent when tasted quickly</td>
</tr>
</tbody>
</table>

The process is:

- **Step 1: Visual Inspection.** Inspect the 4-5 berries and rate 1) the elasticity of the berry, 2) the colour of the skin around the stalk and 3) how easy it was to remove the stalk.
- **Step 2: Pulp Tasting.** Squeeze the pulp of the 4-5 berries into your mouth and separate out the seeds with your tongue and keep the seeds for the last step. While doing that evaluate 4) how easy the pulp detached from the skin, 5) the sweetness of the juice, 6) its acidity, 7) its herbaceousness (herbal aroma) and 8) its fruit aroma. This takes some experience as all the ratings have to be done within 10 seconds.
Step 3: Skin Tasting. Put the skins into the mouth and chew them hard 15 times or until they have entirely disintegrated into mush. Then evaluate 9) the level of disintegration after 15 chews, 10) the tannin intensity, 11) the astringency, 12) the skin acidity, 13) the herbaceousness and 14) the fruit aroma.

Step 4: Seed Evaluation. First, rate 15) the colour and 16) the hardness of the seeds. If the rating is 3 or 4, chew the seeds and rate 17) their tannin intensity and 18) their astringency.

As the berries mature, the ratings move from 1 towards 4. Often not all ratings reach 4 before the Brix level of the berries becomes excessive or the weather turns too cold to finish maturation, and the grapes need to be picked regardless. The final scores provide input to winemaking to adjust the fermentation and maceration styles. We used this ICV process from 2013-2016 and then concluded it was not appropriate for our situation. We have far too few samples to accurately benchmark our judgements. So in 2017, we returned to a more straightforward approach: we rate how berries look, feel and taste using a range of 1 to 4 (from immature to fully mature). Essentially, we use an abbreviated ICV process.

In summary: We endeavour to pick when the CGGD passed 2000, the sugar levels have passed 24 Brix, the average of average ICV scores passed 3.5, and the Anthocyanin levels are peaking.

Forecasting quality, date and volume of harvest

Our quality forecasts are based mainly on the physical appearance of the bunches (e.g. mildew damage, bird damage, shrivel) and the projected potential Anthocyanin levels.

Our harvest date forecasts are based on the observed Brix level and the historical experience on how fast Brix levels increase over time at given ambient temperatures. The graphic on the right shows that 2012-2015 the sugar levels have increased on average between 0.8 to 1.4 Brix/week. However, as shown on the right, there is no convincing correlation between that number and the average temperature during the week.
We also consider the observed evolution of potential Anthocyanin content and estimate when the peak will likely occur.

Our gross volume forecasts are based on estimates for each vine at veraison how big the current fruit load is as a percentage of estimated maximum load and averaging these numbers over each row. Then we estimate the maximum fruit load in pounds for each varietal and multiply it with the average observed fruit load to get to an estimated harvest volume per row.

The quality and date forecasts are updated every week as we take and analyse our samples.

Data Management

Before we can record berry test results, we need to create records in the BerryTestActions table for each harvest block. For each block, we create a record and enter the Test Date and the harvest block.

This screenshot shows, as example, the creation of the LFLR record on September 12, 2017

![Create Berry Test record](image)

We record observations for our six vineyard blocks in a single layout. This screenshot shows, for illustration, the recordings on September 10, 2018.
We monitor the progress of berry maturation and adjust the projected harvest dates after we enter the results of the berry tests. This screenshot shows the layout to review and adjust the dates on October 1, 2018:

<table>
<thead>
<tr>
<th>Berry Test Date</th>
<th>Available Berry Test Dates for 2018</th>
<th>Chateau Het sakais: WINERY Pages</th>
<th><a href="http://www.chateauhetsakais.com">www.chateauhetsakais.com</a></th>
<th>snapshot: November 23, 2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>September 10, 2018</td>
<td>Cabernet Sauvignon Long Stems</td>
<td>Cabernet Sauvignon Short Stems</td>
<td>Cabernet Franc</td>
<td>Merlot</td>
</tr>
<tr>
<td>LFLR</td>
<td>Oct 1, 2018</td>
<td>8 AM</td>
<td>Oct 1, 2018</td>
<td>8 AM</td>
</tr>
<tr>
<td>LFR</td>
<td>Sept 10, 2018</td>
<td>8 AM</td>
<td>Oct 1, 2018</td>
<td>8 AM</td>
</tr>
<tr>
<td>LPLR</td>
<td>Oct 1, 2018</td>
<td>8 AM</td>
<td>Oct 1, 2018</td>
<td>8 AM</td>
</tr>
<tr>
<td>LFR</td>
<td>Sept 10, 2018</td>
<td>8 AM</td>
<td>Sept 10, 2018</td>
<td>8 AM</td>
</tr>
<tr>
<td>LPLR</td>
<td>Oct 1, 2018</td>
<td>8 AM</td>
<td>Oct 1, 2018</td>
<td>8 AM</td>
</tr>
<tr>
<td>LFR</td>
<td>Sept 10, 2018</td>
<td>8 AM</td>
<td>Sept 10, 2018</td>
<td>8 AM</td>
</tr>
<tr>
<td>LPLR</td>
<td>Oct 1, 2018</td>
<td>8 AM</td>
<td>Oct 1, 2018</td>
<td>8 AM</td>
</tr>
<tr>
<td>LFR</td>
<td>Sept 10, 2018</td>
<td>8 AM</td>
<td>Sept 10, 2018</td>
<td>8 AM</td>
</tr>
</tbody>
</table>

We monitor the progress of berry maturation and adjust the projected harvest dates after we enter the results of the berry tests. This screenshot shows the layout to review and adjust the dates on October 1, 2018:
Tracking Results for the 2018 crop

In 2018 temperatures were high during the winter but significantly below average in March & April. Summer was characterised by slightly lower-than-average temperatures and no heat-spikes. Growing Degree Days never caught up to average by harvest. The result was an early bud-break but late harvest of high-quality fruit.

The layout “REVIEW; Weather and Berry Maturation” allows reviewing this. Here is a screenshot of the first tab in that layout. It shows the weather, the critical dates in maturation and the Brix and pH readings.

Note, the late maturation of the Petit Verdot block. The next screenshot shows the potentially extractable Anthocyanins, the berry composition and their size. Of note are the healthy Extractable Anthocyanin levels and the low YAN numbers, particularly in the lower field.
The following chart shows the Extractable Anthocyanin measurements over the last 5 years (3 years for the upper field). Note the rebound in the lower field after 3 years of decline.

In summary, our Grape Maturity Assessment led us to:

Pick the Merlot and Cabernet Franc in Upper Field on September 21 with Potential Anthocyanins peaking around 2000. We estimated sugars around 22.5 - 23.5 Brix and pH relatively high in the 3.4 - 3.7 range. With an estimated 100% fruit load on Merlot Uber at 10 lbs/vine, Merlot at 5 lbs/vine and Cabernet Franc at 7 lbs/vine, we estimated gross harvest yield at 380, 350 and 200 lbs respectively.

Pick the Lower Field on October 6 with Potential Anthocyanin levels having peaked 1 week earlier at a high 2600 ppm. One week before harvest, the sugar levels reached 22 - 23, and the pH remained low at 3.2 – 3.3. YAN levels very particularly low, below 100. With an estimated 100% fruit load yield of 18 lbs/vine, we estimated gross harvest yield at 2400 and 1200 lbs for the long and the short rows respectively.
Pick the Petit Verdot on October 21. Brix measured 18.5 and pH 3.2 3 weeks earlier. We estimated 100% fruit load yield at 9 lbs/vine to result in an estimated gross harvest yield of 170 lbs.

To estimate the size of the harvest, we estimated fruit load percentages for each plant on September 18 (at 50% veraison). This screenshot shows the estimated fruit loads.

The next page will show that some of these estimates were significantly off the mark: actual Brix and pH levels turned out almost 10% higher.
Step #2: Harvest, Sort &Destem

This page covers the harvesting of grape bunches in the field, sorting out bad bunches and debris, destemming the bunches and then sorting out remaining debris among the grape berries. The result is clean grape berries in fermentation tanks.

Picking the Grapes

A manual harvest involves organising a large enough picking crew so that all the grapes can be harvested during the morning hours before it gets too hot. Exposing picked grapes to sunshine and heat for more than 1-2 hours can severely reduce their quality. We usually organise a group of a dozen or so friends to show up in the morning, hand them 5-gallon buckets and clippers and get the job done within a few hours. The bribe is a good lunch.

In 2013 we started to record the crop volume [lbs] by row. In 2014 we estimated the crop load for each vine and then recorded the crop volume for each vine at harvest (except for low yielding vines which we combined into groups of 2, 3, 4 or 5 plants). In 2015 we recorded crop loads for each vine but in 2016 returned to recordings per row.

These charts show the harvest volumes over the last 20 years. For each block, we show the gross yield in the field and how much ended up in the fermentation tanks.
Three points of note. First, we only started making wine in 2009, before we sold all our grapes. Second, the yield in the Cabernet Sauvignon blocks dropped significantly after 2009 because we battled a self-inflicted Eutypa infection of the vines. It took us almost 10 years to recover from that mistake. Third, beginning in 2016 the 4 blocks in the upper vineyard start producing Merlot, Cabernet Franc and Petit Verdot.

Sorting, Destemming & Crush

Bunch sorting is a labour-intensive manual process taking as long as picking. We pour buckets of grape bunches one by one on a table and people sitting around the table sort out by hand all the irregular, infected or damaged bunches and berries. Good bunches and grapes are passed on to destemming. Bad material is discarded. The percentage of the discarded material varies between 2% in a good year (e.g. 2014) and >25% in a bad year (e.g. 2011, 2015, 2017).

For small harvest volumes, below 300 lbs, we use a single Bunch Sorting table from which we throw clean bunches into a Destemmer. The destemmer detaches the berries from the stems. The grape berries fall on a Berry Sorting grid from which we scoop the clean berries into a small fermentation tank. This is a two-person operation. We use a Delta E1 Destemmer from Bucher Vaslin (http://bvnorthamerica.com/wp-content/uploads/2013/07/Delta_E1_ang_avril_2007.p°F) which can efficiently process 1 ton of grapes per hour.

For medium-size harvests (300 – 1200 lbs) we add another bunch sorting table and a Grape Elevator which we use as platform for berry sorting, and we use a Crusher which crushes the berries before they fall into the Fermentation Tank. The grape elevator was manufactured by P&L Specialties, Santa Rosa, CA ( pnlspecialties.com ). The Crusher is a modified electric grape crusher from Williams Brewing, San Leandro, CA ( williamsbrewing.com ). This is a 5-8 person operation.
For larger harvests, we add another bunch sorting table, and we mount the destemmer on top of a TRV15 Vibration Table from Bucher Vaslin, (http://bvnorthamerica.com/wp-content/uploads/2013/07/TRV20-35-50_ANG_2006-11.p°F) on which we sort out bad berries and MOG (Material Other than Grapes). Under the sorting table, a pan collects juice from damages grapes and MOG. That juice can be filtered and poured into the fermentation tank, or it can be counted as part of the “Saignee” and used elsewhere or discarded. At the end of the sorting table, a Grape Crusher can be inserted to break the grape skins before the grapes fall into the Fermentation Tank. This is an 8-12 person operation.

Data Management

There are three tables involved in managing data for the harvest and crush: Vessels, FermBatchDefinitions and HarvestActions

The Vessel table contains a description and specifications of each container used in winemaking and cellaring. Before a vessel can be referred to in another table, it has to be defined here. This screenshot shows, for
example, the entry of a Mixing Tank. The following screenshot shows the listing of all vessels currently in use

Before we record the harvest, we need to first create new records for the Fermentation Batches in the FermBatchDefinitions table defining the different fermentation batches to which the harvest will be allocated. This screenshot shows, for example, how we defined the batch 2017CLS1R1

The HarvestActions table is used to record first the weight of bunches collected by 5-gallon bins for each row, and the estimated percentage of weight left on the vine or dropped in the vineyard for each row. This screenshot shows how the weights were recorded by row for the 2018 harvest of the lower field:
Second, the HarvestActions table is used to record the sorting losses (bunch sorting, destemming, berry sorting, unused saignee from the vibration table) and how the net yield is allocated to the different fermentation tanks defined earlier. This screenshot shows the losses and allocations for the same harvest.

This layout also summarises the grape quality as recorded in the berry tests, it provides an opportunity to record commentaries on the quality of each block and the harvest overall, and it shows the labour input (in total man-hours) accumulated to date for the must in each fermentation tank.

**Tracking Results 2018**

We scheduled three harvests in 2018:

- On September 21 we harvested the Merlot and Cabernet Franc blocks in the upper field and mixed the berries into two small fermentation tanks, around 750 lbs.
- On October 6 we harvested the Cabernet Sauvignon blocks in the lower field and put all together in the large fermentation tank, around 2,300 lbs.
- On October 26 we harvested the last block, Petit Verdot, around 120 lbs.
Overall the quality and yields were excellent. We had some minor losses due to an invasion of wild turkeys which picked berries through the net. The following screenshots show the key data:

### ALL: HarvestActions 2018 Friday, September 21

<table>
<thead>
<tr>
<th>Harvest Date</th>
<th>Harvest Name</th>
<th>Harvested Variety</th>
<th>Harvested Field or Parcel</th>
<th>Harvested Field or Parcel Details</th>
<th>Harvested Date</th>
<th>Harvested Field or Parcel Details</th>
<th>Harvested Date</th>
<th>Harvested Field or Parcel Details</th>
<th>Harvested Date</th>
<th>Harvested Field or Parcel Details</th>
<th>Harvested Date</th>
<th>Harvested Field or Parcel Details</th>
<th>Harvested Date</th>
<th>Harvested Field or Parcel Details</th>
</tr>
</thead>
</table>

**Total Yields:**

- **Total Yield:** 102.8 tons
- **Total Harvest:** 100.9 tons
- **Total Processed:** 100.9 tons
- **Total Crushed:** 100.9 tons
- **Total Pressed:** 100.9 tons
- **Total Delestage:** 100.9 tons
- **Total Fined:** 100.9 tons
- **Total Bottled:** 100.9 tons
- **Total Shipped:** 100.9 tons
- **Total Remaining:** 100.9 tons

**Yield Notes:**

- **Yield Notes:** 100.9 tons

**Harvest Summary:**

- **Harvest Summary:** 100.9 tons

**Harvest Comments:**

- **Harvest Comments:** 100.9 tons

---

### ALL: HarvestActions 2018 Saturday, October 6

<table>
<thead>
<tr>
<th>Harvest Date</th>
<th>Harvest Name</th>
<th>Harvested Variety</th>
<th>Harvested Field or Parcel</th>
<th>Harvested Field or Parcel Details</th>
<th>Harvested Date</th>
<th>Harvested Field or Parcel Details</th>
<th>Harvested Date</th>
<th>Harvested Field or Parcel Details</th>
<th>Harvested Date</th>
<th>Harvested Field or Parcel Details</th>
<th>Harvested Date</th>
<th>Harvested Field or Parcel Details</th>
<th>Harvested Date</th>
<th>Harvested Field or Parcel Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>2018-10-06</td>
<td>Chateau Hetsakais WINERY</td>
<td>Merlot</td>
<td>2018 Lower Field &amp; Cellar</td>
<td>2018 Lower Field &amp; Cellar Details</td>
<td>2018 Lower Field &amp; Cellar Details</td>
<td>2018 Lower Field &amp; Cellar Details</td>
<td>2018 Lower Field &amp; Cellar Details</td>
<td>2018 Lower Field &amp; Cellar Details</td>
<td>2018 Lower Field &amp; Cellar Details</td>
<td>2018 Lower Field &amp; Cellar Details</td>
<td>2018 Lower Field &amp; Cellar Details</td>
<td>2018 Lower Field &amp; Cellar Details</td>
<td>2018 Lower Field &amp; Cellar Details</td>
<td></td>
</tr>
</tbody>
</table>

**Total Yields:**

- **Total Yield:** 88.3 tons
- **Total Harvest:** 88.3 tons
- **Total Processed:** 88.3 tons
- **Total Crushed:** 88.3 tons
- **Total Pressed:** 88.3 tons
- **Total Delestage:** 88.3 tons
- **Total Fined:** 88.3 tons
- **Total Bottled:** 88.3 tons
- **Total Shipped:** 88.3 tons
- **Total Remaining:** 88.3 tons

**Yield Notes:**

- **Yield Notes:** 88.3 tons

**Harvest Summary:**

- **Harvest Summary:** 88.3 tons

**Harvest Comments:**

- **Harvest Comments:** 88.3 tons

---

### ALL: HarvestActions 2018 Sunday, October 21

<table>
<thead>
<tr>
<th>Harvest Date</th>
<th>Harvest Name</th>
<th>Harvested Variety</th>
<th>Harvested Field or Parcel</th>
<th>Harvested Field or Parcel Details</th>
<th>Harvested Date</th>
<th>Harvested Field or Parcel Details</th>
<th>Harvested Date</th>
<th>Harvested Field or Parcel Details</th>
<th>Harvested Date</th>
<th>Harvested Field or Parcel Details</th>
<th>Harvested Date</th>
<th>Harvested Field or Parcel Details</th>
<th>Harvested Date</th>
<th>Harvested Field or Parcel Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>2018-10-21</td>
<td>Chateau Hetsakais WINERY</td>
<td>Syrah</td>
<td>2018 PV</td>
<td>2018 PV Details</td>
<td>2018 PV Details</td>
<td>2018 PV Details</td>
<td>2018 PV Details</td>
<td>2018 PV Details</td>
<td>2018 PV Details</td>
<td>2018 PV Details</td>
<td>2018 PV Details</td>
<td>2018 PV Details</td>
<td>2018 PV Details</td>
<td>2018 PV Details</td>
</tr>
</tbody>
</table>

**Total Yields:**

- **Total Yield:** 52.5 tons
- **Total Harvest:** 52.5 tons
- **Total Processed:** 52.5 tons
- **Total Crushed:** 52.5 tons
- **Total Pressed:** 52.5 tons
- **Total Delestage:** 52.5 tons
- **Total Fined:** 52.5 tons
- **Total Bottled:** 52.5 tons
- **Total Shipped:** 52.5 tons
- **Total Remaining:** 52.5 tons

**Yield Notes:**

- **Yield Notes:** 52.5 tons

**Harvest Summary:**

- **Harvest Summary:** 52.5 tons

**Harvest Comments:**

- **Harvest Comments:** 52.5 tons
Right when the clean berries are ready to drop from the berry sorting table into the fermentation tank, nine decisions have to be taken. All of these decisions are taken depending on the quality of the berries coming out of the destemmer and the intended style of wine to be produced. Natural style wine-makers tend to stay away from using cultured yeasts and enzymes; interventionist wine-makers tend to use all available tools in the box.

- **Step #3: Crush or Stomp?** We decide whether we want to break the skins of the grapes with motorised rollers (crush) or with our feet (stomp), or not at all (resulting in Full Berry Fermentation)
- **Step #4: Saignée?** We decide whether we want to artificially increase the concentration of flavours in the wine. This is done by increasing the "skins & seeds"-to-"liquids" ratio by syphoning off a percentage of the liquids. The juice that is syphoned off can be used to produce rosé wine or discarded.
- **Step #5: Lower Brix?** We decide whether we need to lower the sugar level (Brix) by adding water.
- **Step #6: Adjust Acidity?** We decide whether we need to adjust the pH up (add carbonates) or down (add tartaric acid).
- **Step #7: Add Stems or Oak Chips?** We decide whether we want to add back some of the stems into the must to adjust flavour profile or add Oak Chips to adjust the phenolic extraction
- **Step #8: SO₂ or native Fermentation?** We decide whether we want to ferment with yeasts native in the vineyard and winery, or with cultured yeasts purchased from external providers. If we decide to use cultured yeasts, we need to add SO₂ to prevent spoilage of the fruit and to kill off any indigenous yeasts
- **Step #9: Enzymes?** We decide whether we want to artificially increase the extraction of desirable components in the skin, pulp and seeds into the juice by adding enzymes which break down cell walls.
- **Step #10: Add Fining Agents?** We decide whether we want to add fining agents to bind and precipitate spoilage bacteria (particularly important for musts with low acidity, when SO₂ is not as effective in controlling microbes).
- **Step #11: Cold Soak?** We decide whether we want to extract desirable components of the skin and pulp into the grape juice before fermentation is converting the juice into
alcohol. Again the idea is to get more aromas and flavours. Soaking needs to be done at a low temperature of around 50-55 °F to prevent spoilage.

This chart shows the detail process and the choices made in 2018

The following paragraphs describe the choices and actions in detail

**Step #3: Crush, Stomp or Full Berry Fermentation?**

At this juncture, the pulp and juice in the grapes have the colour of white wine. It turns red during cold soak and fermentation as phenolic compounds from the skin and seeds are dissolving into the juice. This transfer can be accelerated by breaking the skins of the grapes before they are dropped into the fermentation tank, a process called crushing or stomping the grapes:
Crushing is usually accomplished by passing the berries between two rollers spaced at a distance slightly smaller than the diameter of the berries. Care must be taken, not to crush the seeds inside the berries in the process because that would release unwanted chemicals into the juice.

We built our crusher to sit on top of a fermentation tank in 2016 based on components salvaged from hobby-winery crushers sold by Williams Brewing.com. An electric motor drives two rollers over a set of external gears. A funnel guides the grapes to be crushed to fall between the rollers, and the crushed berries fall into the fermentation tank. The picture shows the crusher over a fermentation tank and fed by buckets.

Stomping is accomplished by a person stepping into the fermentation tank and on the grapes. This is the old-fashioned way, and the job is usually reserved for virgin maidens when available [increasingly difficult to find given the weight required!]. The alternatives are grown-ups in wet-suits or stainless steel robots. Stomping is considered somewhat gentler on the grapes than breaking the cell-walls with rollers.

If the grapes are very ripe, they tend to break open during destemming and crushing, or stomping may not be necessary at all.

If the grapes are left whole then, during subsequent fermentation, the yeast will need to enter the berry through the small hole created when the berry stem was removed. This takes longer and is called Full Berry Fermentation.

Step #4: Saignée?

Saignée (from French, meaning “bleeding”) is one of the methods for producing rosé wine. It started though with the intent to remove liquid from the grape must before the juice gets exposed to skins. The idea is to increase the “skin-to-liquids” ratio by removing liquids upfront so that the remaining liquids get more exposure to the colour and tannins that are extractable from the skins and seeds. The purpose is to increase the flavour and colour density of the wine.
Saignee is often used in a bad-weather-year when the grapes did not get enough warmth and sunshine to fully mature. The juice is either separated as fallout from the vibration table or syphoned off within 1-2 hours after destemming. The slightly pink juice is either discarded or fermented separately to produce rosé wine.

Using a vibrating berry sorting table, as we do, automatically diverts some juice before the berries reach the fermentation tank. This juice, if filtered to eliminate MOG, can be poured back into the fermentation tank, discarded or used elsewhere.

**Step #5: Add Water?**

We pick the grapes when they are ripe. Simplistically ripeness is measured by the amount of sugars accumulated in the berries. A good guideline is: berries are ripe when sugars reach 23-25 Brix (i.e. grams of sucrose per 100 grams of juice). A better way to evaluate ripeness is to taste the juice, skins and seeds or to measure accumulating Anthocyanins.

Particularly in a year with heatwaves, it can happen that Brix levels at harvest reach 26-27. This amount of sugar, if left to ferment, will lead to alcohol levels of close to or over 16% which will negatively affect the taste of the wine. Therefore it is advisable to reduce the sugar concentration before fermentation or to limit the alcohol level later. The easiest way to reduce sugar concentration is to add distilled water – the rule of thumb is: a 10% reduction in Brix or projected alcohol is accomplished by adding 10% of water. In most countries, commercial wineries are not allowed to add significant amounts of water to must, but since we do not sell our wine, we can do what we like.

**Step #6: Adjust Acidity?**

Acidity affects the wine’s microbial, protein tartrate stability, malolactic fermentation, its colour, flavour and ageing potential. Adjusting the acidity is an integral part of the winemaking process and is advisable when the must has a pH below 3.2 or above 3.7 or a Titratable Acidity (TA) of above 7.5 or below 5.0.

Also see: [http://winemaking.jackkeller.net/acid.asp](http://winemaking.jackkeller.net/acid.asp)
Increasing acidity: The addition of acid to grape juice, must or wine decreases the pH and increases TA of the wine. The low pH will make SO₂ more effective against oxidation and bacterial infections, and it will increase the colour intensity and ageing potential of the wine. The amount of acid needed to correct the acidity deficiency depends on the total acidity, the pH, and the buffer capacity of the juice, must or wine. The choice is between adding tartaric, malic or citric acids as they will affect the pH, TA and taste of the wine differently. The general guidelines are

- g/L addition of Tartaric acid will increase the TA by about 1.0 g/L and will decrease the pH by 0.1 pH units.
- g/L addition of Malic acid will increase the TA by about 1.12 g/L and will decrease the pH by 0.08 pH units.
- g/L addition of Citric acid will increase the TA by about 1.17 g/L and will decrease the pH by 0.08 pH units.

Adding acid can result in some precipitation of potassium tartrate (KHT) which will affect both pH and TA. It is highly advisable to do acid additions in small steps or do a bench test with the must at hand before making any additions.

Decreasing acidity: Red wine is usually put through a “malolactic fermentation” (see Cellaring section) after the fermentation of sugars into alcohol. In that step malic acid is converted to lactic acid which increases the pH by around 0.2 and decreases the TA by around 2 and also softens the mouthfeel of the acid. If that projected reduction is not substantial enough, deacidification with precipitation agents may be necessary at this juncture. The deacidification agents precipitate some tartaric acid in the form of insoluble salts.

- Calcium Carbonate CaCO₃ forms carbon dioxide and precipitates calcium tartrate (CaT). However, this introduces a risk of calcium tartrate instability. Simple deacidification with CaCO₃ is used against high tartaric acid content, mainly on grape juice/must; it can be utilised on young wines as well.
- Potassium Bicarbonate (KHCO₃) and Potassium Carbonate (KH₂CO₃) are used for deacidification of grape juice, must or wine for improving quality or rounding off off-flavours. They both form carbon dioxide and precipitate potassium bitartrate. With the double salt method, we can reduce tartaric and malic acid. Double salt deacidification is a particular technique in which we take up to 20% of the volume to be treated and add
all the CaCO3 calculated needed for the total volume. The goal is to precipitate tartaric and malic acid in roughly equal parts. The high pH over 4.5 produced in this fraction is to facilitate this.

To avoid over-adjustment, a bench trial should be performed before any intervention.

**Step #7: Add Stems or Oak Chips?**

Do we want to add some of the stems (removed in the destemmer) back into the must? This is often done with Pinot grapes that are low in phenolics, but less with other varietals. The goal would be to add more tannins to the wine. We have not added any stems back to date.

If desired, a small amount of specially treated oak chips can be added to the must to improve the projected flavour profile of the wine. Purveyors of these oak chips claim they can enhance the binding of anthocyanins and round out the mouthfeel; others can mask green flavours. Some argue oak chips are a substitute for soaking and fermenting in oak barrels. The jury is still out on the effectiveness of oak additions.

**Step #8: Add SO₂**

Most winemakers add Sulfur Dioxide, SO₂, repeatedly during wine-making and cellaring in small doses to prevent spoilage. It degrades certain types of enzymes which spoil the wine by oxidising phenols; this is its role as an antioxidant. SO₂ also kills bacteria and non-Saccharomyces yeasts by entering through their cell walls.

There are 4 different instances when SO₂ is added to must and wine:

1. Right after grape sorting and before cold soak - if fermentation will be done with commercial yeasts (i.e. this Step #8). The purpose here is to kill off all native non-saccharomyces yeasts and bacteria upfront and protect the wine from accidental spoilage
2. After malolactic fermentation has finished, to protect the wine during cellaring
3. During cellaring whenever we top up or rack a barrel (every 1-2 months).
4. Just before bottling to protect the wine in the bottle
SO$_2$ is added to most wine made today’, but there is a clear tendency to reduce the amount used – particularly for the very high end and artisan wines. The less SO$_2$ is used, the higher the risk of spoilage, thus very clean grapes and winery/cellar equipment become even more critical. Details on how to measure SO$_2$ concentrations and how much to add are provided in the Laboratory section.

The first opportunity to reduce the use of SO$_2$ is right up front: before fermentation.

- SO$_2$ is usually added to kill off all bacteria and spoilage material that is carried into the winery from the vineyard with the grapes or have over-wintered in the winery. At this juncture, SO$_2$ also kills off any native non-saccharomyces yeasts. This is desirable in high volume operations when laboratory grown yeasts of known origin and characteristics are used to ensure consistent fermentations and wine quality. These cultured yeast are derived from samples collected in the most prestigious highest quality vineyards in the world. Since different yeasts applied to the same grapes produce wines with different taste profiles, yeast selection is an important decision for the winemaker.

- On the other hand, native yeasts that arrive with the grapes provide “terroir” or individuality/uniqueness to the wine produced – that is what makes native fermentations attractive to artisanal winemakers. Their use also increases the risks of stuck fermentations, a major production headache. One way around this conundrum is to extract yeast cultures in the vineyard and grow selected strains in the laboratory, then clean the grapes when they come in with SO$_2$ and subsequently inoculate with the in-house grown cultures thus preserving the “terroir”. This, however, is only economically viable for very high-end wineries.

So, if the intention is to do a native fermentation, it is better not to add any SO$_2$ at this juncture or at least limit the addition to less than 20 ppm (parts per million, or grams per metric ton).

Step #9: Add Enzymes?

Enzymes are catalysts for biological reactions. Enartis Vinquiry (www.enartisvinquiry.com) and Laffort (www.laffort.com) are the leading developers and producers of enzymes for the wine industry. Some of their enzymes are used before and during fermentations to accelerate the break down the grape cell walls so that preferred tannins from cell walls (as compared to less preferred tannins from the seeds) are more readily released into the juice. The result is improved colour stability of the wine and softer tannins.
Step #10: Add Fining Agents?

SO2 does not work well to control bacterial infections when the acidity of the must is low (i.e. pH above 3.7). In this case, we may decide whether to add a fining agent to bind and precipitate spoilage bacteria. For an example and more detail, see the Enartis video http://www.enartis.com/us/focus-on/webinars/high-ph-red-winemaking_5744.htm.

Step #11: Cold Soak?

A further technique to increase the release of colour (and to a lesser extent tannins) from the grape walls into the juice is to let the crushed or stomped grapes soak in their juice at around 50°F for a few days before fermentation starts. The low temperature prevents spoilage and an accidental onset of fermentation. During cold soak the must has to be covered with a blanket of Argon or CO₂ to prevent oxidation and the grapes need to be agitated and punched down daily. There are two ways to achieve this: either by adding a daily dose of dry ice (which reduces the temperature and releases CO₂) or by cooling down the fermentation tank with glycol. We limit the use of dry ice because we felt it might be too harsh on the grapes (effectively flash freezing at the contact points). In 2013 we switched to an insulated fermentation tank with a cooling jacket which is fed with glycol from a refrigeration unit. The fermentation tank was built by Santa Rosa Stainless Steel (www.srss.com) on specification; the refrigeration unit is a Kreyer Chilly Max (www.kreyer.com) bought from MoreWinePro (www.morewinepro.com).

As the skins separate from the juice they start forming a cap – this is because skins are less dense than the liquid. This cap dries out unless the liquid is pumped over, or the cap is punched down regularly. We prefer to punch down as it does not involve pumps. The following picture illustrates the concept (adapted from a presentation by Prof. Jim Habertson) and the actual punch-down.
In 2016 we introduced 4 new smaller fermentation tanks which were designed to sit inside the glycol cooled larger tank in a water bath. The first purpose was to allow fermentations in smaller batches. The second purpose was to allow early removal of skins and seeds before the fermentation is finished by introducing a basket sieve at the bottom of each tank. The third purpose was to allow for better temperature management during cold soak and fermentation.

The tanks were custom-built again by Santa Rosa Stainless Steel.

The twice-daily cold soak/punch-down process is:

- Lift the tank cover
- Punch down the must to the extent possible.
- Measure the chemical properties of the must to track progress.
- Squeegee and wipe down the inside walls of the tank with disinfectant (KMBS solution on a paper towel), cover the must with a new blanket of Argon or CO2 and lower the tank cover.

To measure the chemical properties we take two 2 ml samples and centrifuge them for 4 minutes at 13,500 rpm. Then we use one sample for the OenoFoss instrument to measure Brix, Density, pF, VA, TA, Tartaric Acids, Gluconic Acids, Malic Acids, Alpha Amino Acids and Ammonia. We use the second sample to measure its transparency at various wavelengths in the ultraviolet-to-visible spectrum and transmit the spectral data to wineXray.com which instantly returns the phenolic results (Free and Total Anthocyanins, Anthocyanins Bound to Tannins, Protein-Precipitable Tannins and Total Iron-Reactive Phenolics). For a more detailed description of the process and the meaning of these measures read the Laboratory section.

**Data Management**
We use the FermActions table to record data during the winemaking process. The table has a record for each set of measurements and actions in each fermentation tank. The table is described in the Data Management section. Before we record any measurement or action, we need to create the respective FermActions records. This is accomplished with the “CREATE: Fermentation Action record” - layout. The following screenshot shows, as example, the record for the 2017CSLR1 fermentation batch on October 23, 2017, at 4 pm.

We record data for all fermentations running simultaneously for a given harvest date with the “INPUT: Fermentation Actions by Harvest” layout. It can accommodate for up to 8 simultaneous fermentation batches. This layout has five tabs: the first to input actions, the second to input measurements of chemical properties, the third to set the boundaries for the “MUF” (Must under Fermentation) calibration and the fourth and fifth to review results graphically.

This screenshot shows the “Actions” tab of the input layout on October 14, 2017, at 6 pm, when we re-allocated the saignee on the vibration/berry sorting table from fermentation tanks 1, 2 & 3 to fermentation tank 4.

This screenshot shows the “Juice Analysis” tab at the same time.
Note, we only have “Must” readings in the chemical analysis because the fermentation had not started yet.

The other three tabs are irrelevant at this juncture.

**Tracking Results 2018**

We made the following choices in 2018:

- The crusher failed mechanically, so we went for full-berry fermentations for the Merlot, Cab Franc and Petit Verdot batches and we stomped the Cabernet Sauvignon batch.
- We made no additions of any sort,
- We discarded the juice falling off the berry sorting tables – effectively a 7% saignee.
- Except for the Petit Verdot batch, we used dry ice to cool down the berries as they fell into the fermentation tank, equivalent to a 1-day cold soak.
Step 12: Primary Fermentation Phase 1

Fermenting grape juice into wine is about transforming sugar into alcohol with yeast. This happens in a complex web of chemical reactions which are not yet fully understood. The level of Brix measured in grape juice translates linearly into the percentage of alcohol the wine will have: 24 Brix in must yields around 13.5% alcohol in wine.

Fermentations can be divided into 2 successive phases:

- **Phase 1: Lag & Exponential growth phase.** First, the yeast microbes need to adjust to the environment (temperature, pH etc.). As soon as the adjustment is complete, the yeast cells divide and grow in number exponentially while at the same time converting sugar. This takes a few days during which significant energy is dissipated in the form of heat, and rising temperatures and oxygen is consumed. Berries start to disintegrate, and skins start to float up to create a cap which needs to be broken up and submerged with regular punch-downs.

- **Phase 2: Stable & Exponential Decline Phase.** This is when the yeast cells systematically convert sugar into alcohol. CO₂ is generated, and temperatures tend to fall because the energy generated is dissipated by the fermentation tank into the environment. The cap of skins needs to be punched down regularly. The yeast cells start to die off when the sugar and other nutrition get scarce when the alcohol level gets too high, or the temperature falls too low.

A fermentation is called successful when all the sugar is consumed by the time the yeasts have died off. The opposite is a stuck fermentation when sugars are still present after the yeasts died and new yeasts need to be added to restart the fermentation. This is cumbersome and can be prevented by managing temperatures and yeast nutrients and selecting the appropriate yeast strains for the grape variety at hand and style of wine-making.

**Choice of Yeasts**

Different yeast strains produce different tasting wines even when applied to the same grapes. There are thousands of different yeast strains, many naturally available concurrently in the environment. So the challenge for the wine-maker is to decide on what yeast to use:
1. Fermentation with Indigenous Yeasts: We rely on the mix of yeast strains that happen to be attached to the berry skins brought in or survived in the winery from previous fermentations. This choice creates wines which genuinely reflect the local terroir, but there is a risk that the fermentation may not complete successfully.

2. Fermentation with Industrial Yeasts: We kill the indigenous yeasts with SO$_2$ in Step #8 above and inoculate the must with a known, commercially available yeast or a yeast-derived from the own vineyard and propagated. This choice reduces the risks of stuck fermentations but adds uniformity to the wine produced.

3. Fermentations with both: We start with Indigenous Yeasts but then, in phase 2, introduce Industrial Yeasts to make sure the fermentation finished without a hitch.

For our first vintage (2009) we decided to go with a native fermentation to establish a benchmark for what happens without interventions. In the subsequent 6 years, 2010-15, we used commercially propagated yeasts to reduce the risks of stuck fermentations and have a record on which yeasts were actually doing the fermentation. As we gained more confidence in our ability to control the fermentation process we came back to native fermentations starting in 2016.

**Yeast Nutrient**

The most important yeast nutrient is Nitrogen which is metabolised by yeast to synthesise proteins. Nitrogen stimulates yeast multiplication, keeps yeast metabolism active, prevents H$_2$S and mercaptan formation and stimulates aroma production. Nitrogen is provided as Yeast Assimilable Nitrogen (YAN). YAN is composed of ammonium ions and amino acids. Ammonium ions are the favourite ‘food’ of yeast. Easy and fast to use, ammonia impacts mostly yeast growth and population. Amino acids are harder to be assimilated. They represent the qualitative, healthy and delicate ‘food’ for yeast, which impacts their growth, health and efficiency through the fermentation as much as aroma production.

Berries contain YAN naturally. The optimal concentration for a healthy fermentation is between 150 and 350 mg per litre of must depending on its sugar content. The rules of thumb are:

- For good population growth of yeast, we need at least 150 mg/L of YAN
- For converting sugars to alcohol, we need 10 mg/L/Brix of YAN (e.g. for must with a sugar concentration of 25 Brix we need 250 mg/L of YAN
• Too much YAN (>350 mg/L) increases stress conditions, produces off-flavours or leads to stuck fermentations.

Artisan winemakers prefer to minimalise the use of additives of any sort, including nutrients. We used no nutrients in 2009, then used them 2010 through 2015 as suggested by commercial yeast manufacturers. In 2016 and 2017 we used nutrients sparingly, only when fermentations showed signs of stalling. In 2018 we added significant amounts of nutrients because the level of YAN in the must was very low, below 100 for the Cabernet Sauvignon blocks.

**Process Steps for Primary Fermentation Phase 1**

When we use commercial yeasts and nutrients, we need to hydrate the yeast in a nutrient solution. Here are the steps we go through:

• We make sure the must has an adequate concentration of nitrogen – food for the yeast. We measure YAN (Yeast Assimilable Nitrogen) and adjust yeast nutrient in the next step as required.
• We hydrate the required amount of additional yeast nutrient in 2 litres of 104°F tap water as specified by the supplier.
• We carefully hydrate the yeast in the solution; this process is essential to ensure that the yeast cells assimilate to the environment: We add the yeast, stir gently and let the suspension stand for 20 minutes. Then we mix in 2 litres of grape juice and let the solution stand until it cools down to the temperature of the must in the fermentation tank + 15°F
• We pour the acclimated solution into the fermentation tank and start the punchdowns.

When we go for native fermentation, we may set a bucket or two of crushed grapes aside a week earlier, punch it down daily and observe whether fermentation starts indigenously. The bucket is ready to be used to inoculate the main fermentation tanks when the fermentation is active (i.e. producing enough CO2 to form a 1-2 inch cap in the bucket). The alternative is to simply wait until the fermentation starts on its own; this creates a “Warm Soak” waiting period of 3-4 days.

Here is the process chart:
At inoculation, we may want to add nutrients, mainly if the YAN level measured in Step #6 above is below 120 mg/L. Punchdowns in the primary fermentation tanks should start 12 hours later.

The punchdown process is:

- Three times a day, take the tank cover off and blow off the Argon or CO2 blanket with a fan.
- Punch down the cap making sure not to crush seeds at the bottom of the tank (picture on the right). Decide whether to further increase the oxygen supply in the must. If yes, macro-oxygenate once a day during the first 3 days: Inject 10-40 ppm of pure oxygen through a diffusion stone into the must (equipment - the picture on the right). The advantage of O2 diffusion is that we can measure the amount of oxygen injected, but not the amount that bubbles up and is not absorbed.
- An alternative to punchdown is delestage, but here there is no measurement at all of the oxygen supplied. Delestage requires draining the
fermentation tank into a holding vessel, leaving the remaining skins exposed to air for 20 to 100 minutes and then pouring the contents of the holding vessel back over the skins into the tank. Delestage should not be repeated more than 3 times and should be followed by a punchdown at least 16 hours later. (see this article for a good description https://winemakermag.com/237-delestage-fermentation-techniques).

- Take another tasting sample and comparison taste.
- Take two 2mL samples for chemical analysis once a day. Enter results into new records of the FermentationActions table.
- Squeegee and wipe down inside walls of the tank with disinfectant (KMBS solution on a paper towel), cover the must with a new blanket of Argon or CO2, if the fermentation is not yet producing enough CO2 itself, and put the tank cover back on.
- Adjust heating or cooling to keep the temperature in 70-80 °F range.

Around 3-4 days following inoculation we expect to see a peak in the level of Free Anthocyanins (hopefully above 1,000) and sugar levels having dropped 1/3rd in Brix. At this point, we move on to Fermentation Phase 2.

**Dealing with Fermentation Problems**

A long lag phase or abrupt stop in the conversion of sugars to alcohol indicate a problem. An abrupt stop in fermentation activity can happen as a consequence of a severe temperature drop – no longer an issue for us since we can control the temperature in our fermentation tank. A problematic delay in the onset of fermentation activity is indicated when the lag phase is longer than 5 days. This can happen when:

- A native fermentation is attempted with indigenous yeasts. It may help to raise the temperature, but it is safer to switch to inoculation with industrial yeast instead.
- The yeast used for inoculation did not develop properly. This can be confirmed by counting the density of viable yeast cells under a microscope. It should have reached 10 to 100 million cells / mL - an analysis better left to a commercial lab (e.g. Enartis). The remedy is to re-inoculate.
- There is a nutrient deficiency as indicated by low YAN levels relative to the Brix level of the must. The remedy is to add more yeast nutrition.
- There are toxins or spoilage microbes in the must. This can be confirmed by lab analysis of the must revealing excess SO2, pesticides, copper or iron residuals or spoilage.
microbes. If the analysis indicates Lactic Acid Bacteria as spoilage microbes, then the must should be treated with Lysozyme and SO2. If the analysis indicates non-microbial toxins then fining is recommended with Bentonite, yeast hulls or an industrial product like Enartis Cellferm.

When restarting a fermentation, it is advisable to use a special yeast which ferments vigorously and can adapt to high alcohol, high volatile acidity and has low nutrition needs.

**Data Management**

Data management is identical to what we described in Steps 3-11, with one exception. We measure the chemical properties twice, using both the “Must” and the “MUF” settings on the OenoFoss equipment. This is because the measurements for MUF (Must Under Fermentation) are not calibrated and need to be interpolated to calibrated Must-measurements. The following screenshot shows the “Juice Analysis” tab for October 19, 2017, at 10 am.

**Tracking Results for 2018**

We made the following choices in 2018.
We had 4 fermentation batches, two for the Merlot-CabFranc mixes, one large one for the Cabernet Sauvignon must and 1 small one for the Petit Verdot must. We waited 2-4 days until the fermentations started on their own, but had to add significant amounts of nutrition 500 -1500 ppm) to compensate for the low YAN levels (85 – 175 ppm). We used Nutriferm from Enartis and Microessentials from Gusmer. We reached one third sugar depletion in 2-3 days before the Anthocyanins peaked. We occasionally heated the must, so temperatures stayed in the 75 – 82 dF range. We infused between 15 – 27 ppm of pure oxygen.

We will review the results at the end of Step 17.
Step 13: Primary Fermentation Phase 2

Phase 2 of the Primary Fermentation represents the steady state and the rapid decline in the yeast population. We may need to add more nutrient supplements, and we reduce the number of daily punch-downs to 2. We also need to reduce oxygen exposure (stop macro-oxygenation). When the temperature drops we switch to heating, to keep temperature 75-85 °F. Now we watch Tannins and Bound Anthocyanins rise. The target for the Tannins is 110% of the Anthocyanin peak. The target for the Bound Anthocyanins is 20% of the Anthocyanin peak.

Here is the detail process graphic

The phase 2 punch-down process is:

- Take the tank cover off and blow off the accumulated CO2 with a fan
- Twice ad day, punch down the must while making sure not to crush seeds at the bottom of the tank.
- Take tasting sample and measure chemical properties and temperature once a day.
- Squeegee the inside walls of the tank and wipe with a paper towel soaked in KMBS solution, and, if sugar depletion is above 90%, cover the must with a new blanket of Argon because CO2 production has diminished.

Press before Fermentation is Finished?

The critical decision for the winemaker in this phase is whether to remove the skins & seeds before the fermentation is finished. Early pressing is advised when the tannin levels get too high for the desired style of wine. So we watch out for Tannin levels to rise above 110% of the previous Anthocyanin peaks. If this happens before fermentation is complete, we consider to

- either scoop out the bulk of the skins, press them separately, pour the extracted juice back into the fermentation tank, and let the fermentation finish in the fermentation tank,
• alternatively, press the entire must before the fermentation is finished and then finish the fermentation in the barrel without further skin and seed contact.

If Tannin levels stay below 110% of the previous Anthocyanin peak, we continue the punch-downs until fermentation is complete, i.e. Brix at -2. At that point, we will decide whether to look for further tannin extraction by extending the maceration or to go to pressing.

Dealing with Fermentation Problems

A sluggish fermentation is indicated when the daily reduction in the sugar level slows down before reaching 8 Brix or when the sugar reduction stalls entirely before reaching -2 Brix within 3 weeks of inoculation. The causes of a sluggish fermentation are the same as discussed on the previous page covering Phase 1: lack of nutrients due to the exhaustion of available supplies, toxins, volatile acidity or spoilage microbes. For these causes the remedies are the same: adding nutrients, fining with bentonite or adding Lysozyme. Alternatively a fermentation can turn sluggish in phase 2 if the fructose/glucose ratio of the remaining sugars are out of balance; in this case, reinoculation with a special yeast capable of handling fructose is recommended.

Data Management

Data Management is identical to the process in Step 12 with one exception. We measure the chemical properties twice, using both the “MUF” and the “FinW” settings on the OenoFoss equipment. The following screenshot shows the “Juice Analysis” tab for October 24, 2017, at 9 am.
Tracking Results for 2018

In 2018 we made the following choices: We did not apply a second batch of nutrients at the beginning of Phase 2 because we had used Microessentials which has a delayed availability. All fermentations completed except the Petit Verdot batch which stalled at -1 Brix, despite heating the musts to keep temperatures in the high 70's. Tannin extractions never exceeded the Anthocyanin peaks, so there was no need for pressing early. We decided to delay any addition of Tartaric Acid despite the low acidity levels (pH remained over 3.6 in all 4 fermentations)

We will review the results at the end of Step 18

Previous page: Step #12: Primary Fermentation Phase 1
Next Page: Step #14 - 18: Extended Maceration to Press
Last updated: November 10, 2018
Here is the detail process chart, the thick lines indicate the path taken in 2018:

**Step #16: Extended Maceration**

On completion of Primary Fermentation, we can consider extending the maceration to further extract Tannins and increase the level of Bound Anthocyanins. Because the alcohol level is now high, Extended Maceration will extract relatively more seed tannins which can be beneficial if seeds were very ripe and the addition of nutty/almondy taste is desired. We keep the temperature at 70 °F and continue with 1 punch-down per day for up to 5 days (depending on taste).

The Extended Maceration punch-down process is:

- Take the tank cover off.
- Punch down the must while making sure not to crush seeds at the bottom of the tank.
- Take two 2mL samples for chemical analysis.
- Taste sample and decide whether to continue or end extended maceration.
- Wipe down the walls of the tank with disinfectant (KMBS solution), cover the must with a new blanket of Argon or CO2 and put the tank cover back on

**Steps #14-15 & 17 Pressing Decisions**

Pressing is initiated when
• Primary Fermentation (step #13) was incomplete when Tannin levels reached 2000 or 110% on previous Anthocyanin peak, or
• Primary Fermentation (step #13) was completed in the fermentation tank, and tannin levels were high enough to skip extended maceration, or
• the must had been subjected to extended maceration, and that is complete (step 16)

If pressing is initiated before Primary Fermentation is complete, we press the cap only: we scoop the cap out of the fermentation tank into the press, then press and return the pressed juice to the fermentation tank where the primary fermentation is completed.

The side-by-side pictures show the two alternatives. When we press the entire must (when the primary fermentation was completed), we first drain the juice through a thief into the press and then move the must over a steel channel into the press. When we press the cap only, we scoop out the cap into 5-gallon buckets, empty the buckets into the press, press and return the pressed juice to the fermentation tank by buckets.

We use a 1.5-ton bladder press: Bucher Vaslin XPro 5 ([http://www.buchervaslin.com/en-bucher-France-bucher-pneumatic-presses-16-22-26.html](http://www.buchervaslin.com/en-bucher-France-bucher-pneumatic-presses-16-22-26.html)) which, we now realise, is overkill for our requirements. We extract the additionally required juice at very low pressure (0.2 to 0.3 bar only) from the must in multiple rounds. This is called the Press-Run. The remaining pressed must (now called pomace) is scooped out and distributed in the vineyard as fertiliser for the next season.

For small fermentation batches, we don’t use the big bladder press. Instead, we use a small manual press which saves in setup and cleaning efforts. There are two types. In modern manual bladder presses, water pressure fills a bladder which presses the must outside against a
stainless steel sieve. In old-fashioned screw presses, a wood lid is pressed down by a big screw, and the juice escapes laterally through a vertical wood lattice. We have used both types for the small lots from the upper vineyard. The picture on the right shows the two types.

**Finishing Primary Fermentation**

If the fermentation was not completed before pressing due to high tannin extraction during Phase 2 of the Primary Fermentation, then the fermentation now needs to be completed either in the barrels and the variable-top steel tank or the fermentation tank. The process is:

- Take test samples, stir and then recover with Argon blanket
- Taste and measure (OenoFoss & WineXray)
- Keep temperature at 70 °F and continue the daily process until Brix reaches -1.5.

If the fermentation is finished in the barrels, then the barrels need to be heated, and the temperature kept at around 70 degrees. This is accomplished with heating mats built into the barrel dollies.

**Racking**

The juice from pressing is held for a few days to a few weeks in steel tanks to let dead yeast cells and other solid material sink to the bottom as sediment before we syphon the clear young wine off to barrels or topup tanks for cellaring. We use this racking step also to mix juice from different fermentations and press-runs. We protect the young wine in the settlement tanks with an Argon gas cover to prevent oxidation and growth of microbes on the surface.

**Data Management**

Data Management for Steps 14 to 16 is identical to Step 13. For the final press and the allocation to barrels and topup tanks (i.e. Cellar Batches) we need to first define the batches and then specify the allocation of fermentation batches to each new cellar batch. This is done in
the “ALL: CellarBatchComposition” – layout. The picture shows a screenshot of the layout for the 18CSMeCFPV1 cellar batch

**Tracking Results 2018**

In 2018 we made the following decisions:

- We did not press any of the fermentations early, nor did we extend the maceration periods after the fermentations were complete. The tannin and anthocyanin levels were adequate without.
- We pressed the two Merlot - Cabernet Franc fermentations in the old-fashioned manual screw press and combined the juice for settlement into a single stainless steel barrel.
- We pressed the Cabernet Sauvignon ferment in the large bladder press and settled the juice in the large Settling Tank.
- We free-flowed the Petit Verdot ferment into two glass carboys for settlement.
- Finally, we mixed, at varying ratios, the different settlement tanks into 3 French barrels (one new, two neutral) and five topup tanks. The goal was to get one barrel of 100% Cabernet Sauvignon, two barrels of different Bordeaux-style mixes and separate topup tanks which reflect these mixes.

The following spreadsheet shows the allocations to barrels (green) and topup tanks (white):

<table>
<thead>
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<th>Cellar Batch Name</th>
<th>18CS</th>
<th>18CS1a</th>
<th>18CS1b</th>
<th>18CSMeCFPV1</th>
<th>18CSMeCFPV1T</th>
<th>18CSMeCFPV2</th>
<th>18CSMeCFPV2T</th>
<th>18CSMeCFPV3T</th>
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<td><strong>FINAL COMPOSITION</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| CS | 50 | 50 | 50 | 50 | 46.60 | 61 | 4.05 | 81 | 4.25 | 12
| CSLF | 29% | 29% | 29% | 24% | 81% | 24% | 12 | 12
| Me1 | 0% | 0% | 0% | 4.81 | 5% | 0.40 | 8% | 12.98 | 22% | 1.05 | 22% | 3.76 | 28%
| Me2 | 0% | 0% | 0% | 3.60 | 5% | 0.30 | 5% | 9.71 | 16% | 0.76 | 16% | 2.81 | 11%
| CaSF | 0% | 0% | 0% | 2.02 | 5% | 0.17 | 3% | 5.44 | 22% | 0.62 | 22% | 1.57 | 12%
| PV | 0% | 0% | 0% | 0.00 | 2% | 0.08 | 3% | 2.52 | 8% | 0.10 | 8% | 0.87 | 7%
| **TOTAL** | 60.00 | 5.00 | 5.00 | 60.00 | 5.00 | 5.00 | 60.00 | 5.00 | 60.00 |
| **FINAL IMPLIED COMPONENTS** | | | | | | | | |
| CS | 60 | 5.00 | 5.00 | 5.00 | 46.60 | 61 | 4.05 | 81 | 4.25 | 12
| Me1CabF | 0% | 0% | 0% | 0.00 | 0% | 5.26 | 5% | 44 | 9% | 14.20 | 24%
| Me2CabF | 0% | 0% | 0% | 0.00 | 0% | 5.16 | 5% | 43 | 9% | 13.99 | 24%
| PV | 0% | 0% | 0% | 0% | 1.00 | 5% | 0.00 | 2% | 2.52 | 8% | 0.10 | 8% | 0.87 | 7%
| **TOTAL** | 60.00 | 5.00 | 5.00 | 60.02 | 5.00 | 5.00 | 60.00 | 5.00 | 60.00 | 13.26 |

Previous page: Step #13: Primary Fermentation Phase 2
Top of Page: Go
Next Page: Fermentation Batch Review (Steps 3-17)
Last updated: November 12, 2018
Fermentation Batch Review (Steps 3-17)

Data Management

To review each Fermentation Batch, we designed a layout which pulls all berry tests and fermentation actions data together. The goal is to provide a context to explain the actions taken and the results achieved in a uniform format across all fermentations all vintages. The “REVIEW: Fermentation Batch” layout has 7 tabs:

- MUF Calibration: is used to review the calibration and adjustments made to the OenoFoss “Must-Under-Fermentation” measurements
- Phenolics: is used to correct the results from WineXRay’s phenolic component estimates which tend to show aberrations due to sampling errors in the spectral analysis
- Acidity: is used to review the different measurements of acidity and comment on the effect of acidity adjustments
- Actions: is used to review and comment on all actions taken during fermentation
- Fermentation: is used to review and comment on the progress of the fermentation
- Source Detail: is used to review and comment on the quality of harvest blocks which made up a fermentation batch
- Overview: sums up all the commentaries and data in the previous 6 tabs.

In the following paragraphs, we show the screenshots for each tab using the actual data for the 2017CSLR1 fermentation batch
MUF Calibration tab

This tab shows the OenoFoss measurements of the chemical properties and the adjusted values. An adjustment has to be made to the raw “MUF / MustUnderFermentation”-measurement because OenoFoss only provides calibrated measurements for “Must” and for “Finished Wine”. Note, we need to input the boundary conditions in this table for the adjustments to happen. An explanation of how the adjustment is calculated can be found in the Laboratory section.
The Phenolics tab reviews the phenolic results provided by WineXray based on the measured spectrum of each sample. Impurities occasionally distort the measured spectra in the sample. As a consequence, the phenolic results are distorted. We use this layout to make manual adjustments to the phenolic results by inspecting the graphs and eliminating outliers. Again, we input the yellow fields during the review to summarise the results.
The Acidity tab shows the evolution of the OenoFoss-based measurements of pH, TA, VA, Tartaric Acid, Gluconic Acid and Malic Acid, and the timing of the Tartaric Acid additions, if any. Note, the table shows the adjusted values described in the MUF-Calibration tab. We complete the yellow fields during the review to summarise the results.
The Actions tab reviews the actions taken during winemaking. The steps include saignee, additions of water, enzymes, yeasts, nutrition, sulfur, oxygen, tartaric acid oak chips and the removal of skins and seeds in pressing. This tab allows reconciling the batch weights throughout all steps. Again, we enter summary data in the yellow fields during the review process.
The Fermentations tab reviews the progress of the fermentation in terms of fermentation step and conversion of sugars to alcohol as measured by completion %, Brix, density, glucose, fructose and alcohol. This tab also lists all the action comments. Again, we enter summary data in the yellow fields during the review process.
Source Detail tab

This tab shows the berry test results of the components making up the fermentation batch. In this instance, the 2017CSLR1 batch consisted of only one component, grapes from the CSLR block. In other instances, we would see multiple rows of graphs in this layout – one for each component.
Overview tab

The Overview tab pulls together all the information added in the yellow fields in the previously discussed tabs. The goal of the fermentation batch review is the write a Batch Commentary which summarises all the information collected.
Tracking Results for 2018

Currently, the “REVIEW: Vintage” layout provides the best overview of what we did with the 2018 vintage. We described it already in the Winery Overview page. Note, in 2018 we started tracking manhours spent in the vineyard, winery and cellar. So for each step and batch, we can now show cumulative manhours spent.

If we want to drill down more into what happened in the vineyard during 2018, we look at the “REVIEW: Weather and Berry Maturation” layout.

The first tab shows the weather conditions during the year and the evolution of sugar accumulation (Brix) and acidity (pH) during the final weeks of berry maturation for each of the 5 blocks. The second tab shows more details on berry maturation. Overall, the weather conditions throughout the season were favourable, a bit cool but no heat spikes. Consequently, the harvests were good, both in terms of volume and quality.
The following screenshots show the Overview tab of the “REVIEW: Fermentation Batch” layout for each of the 4 fermentations, all indigenous.

We first harvested the Merlot and CabFranc blocks and fermented in 2 tanks which we combined into single settlement tank.
Then we harvested the Cabernet Sauvignon blocks and fermented both in a single large tank
Finally, we harvested the small Petit Verdot block and fermented in a small tank

On completion of all fermentations, we allocated the young wine from the 3 settlement tanks into 3 oak barrels at different Cabernet Sauvignon – Merlot – Cabernet Franc – Petit Verdot combinations and we saved topup wine in small topup tanks dedicated to each barrel.

Previous page: Step #14-17: Extended Maceration to Press
Top of Page: Go
Next Page: Cellar
Last updated: November 14, 2018