

Advanced Winemaking
Pinot Noir Cold Soak Group
Summary Report

Agriculture 270
Fall Semester 1999
Viticulture & Winery Technology Program
Napa Valley College

6 Dec 99

Prepared by:
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Introduction

Students in Agriculture 270 Advanced Winemaking were subdivided into four groups to undertake winemaking experiments under the leadership of the instructional staff: Clark Smith, Michael Murtaugh, and Bob Broman

This report chronicles the activities and results—including errors of commission and omission—of one of these groups—the *Pinot Noir Cold Soak Group*:

Group 4: Pinot Noir Cold Soak Group		
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The experiment lasted from late August 1999 to mid-December 1999 and comprised several phases:

1. Pre-Harvest Vineyard Monitoring
2. Harvest & Crush
3. Cold Soak Maceration
4. Alcohol Fermentation
5. Malolactic Fermentation
6. Racking
7. Blending

These phase descriptors are used as section headings.

The Pinot Noir Cold Soak experiment was organized into two trials—Early Harvest and Late Harvest.

The purpose of the experiment, according to the protocol, was:

After all wines are fermented and clear, proceed with sensory evaluation, difference testing and descriptive taste evaluation. Summarize the effects of the treatments. Prepare a blend using the lots within the group to produce a “best” blend and explain why you made the blend.

Clark Smith’s dictum—*Thought is born of failure*—was vigorously put into practice by the Pinot Noir Cold Soak Group. By this measure, the group could be considered very *thoughtful*.

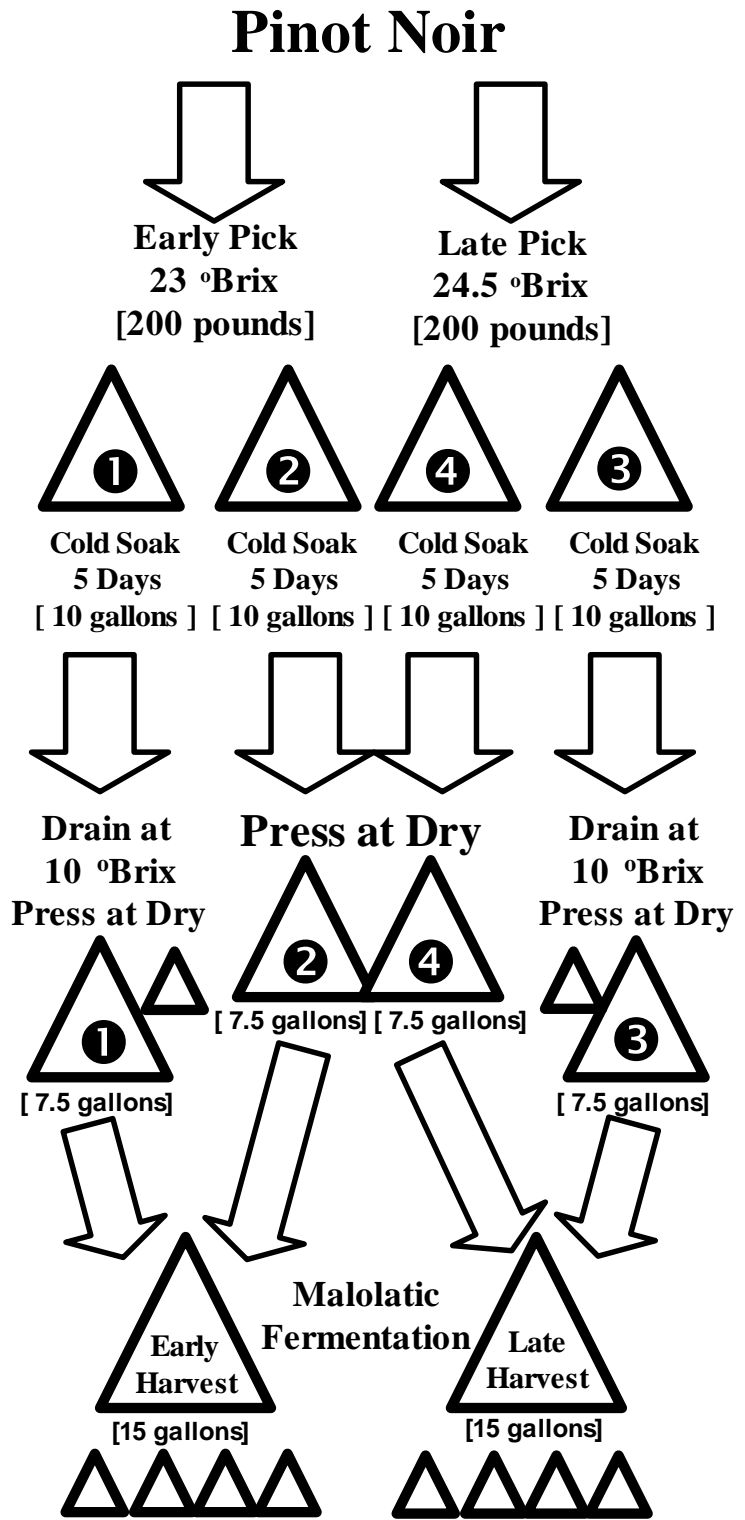
Pinot Noir Cold Soak Group Protocol

The Pinot Noir Cold Soak Group, one of four groups in *Agriculture 270 Advanced Winemaking*, implemented the experimental procedure shown to the right.

Using the *juice yield planning factor* of 150 gallons wine/ton grapes, each 200-pound pick was expected to yield 15 gallons of wine.

Milestones included:

1. Early pick, 2 Oct 99; 200 pounds, 24.4 °Brix.
2. Late pick, 9 Oct 99; 186 pounds, 24.5 °Brix.
3. Early pick cold soak ended, inoculation 7 Oct 99.
4. Late pick cold soak ended, inoculation 14 Oct 99.
5. Early pick drain, 7 °Brix, 11 Oct 99
6. Late pick drain 4.5 °Brix, 17 Oct 99
7. Early pick dry (0 °B) press, 14 Oct 99
8. Late pick dry (0 °B) press, 23 Oct 99
9. Early pick MLF complete, gross lees racking 5 Nov 99
10. Late pick MLF complete, gross lees racking 8 Nov 99
11. Early pick wine volume after MLF = 12 gallons for Lots 1 & 2 Combined
12. Late pick wine volume after MLF = 6+ gallons for Lot 1 Free-Run and 5+ gallons for Lot 2 Hard-Press



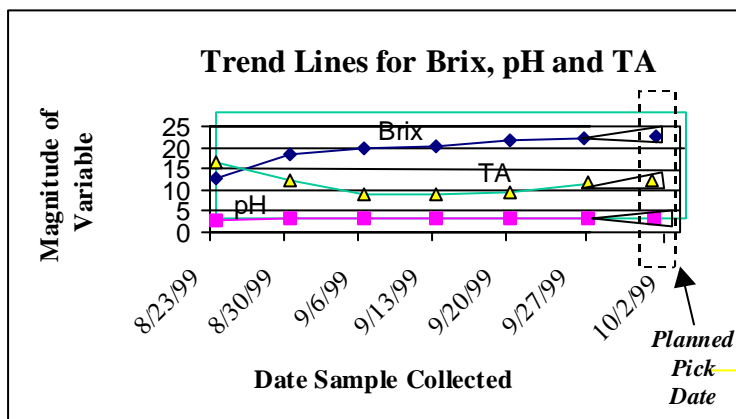
Pre-Harvest Vineyard Monitoring

Vineyard sampling of Pinot Noir was accomplished by five or so two-person teams. Each team collected 100 berries and measured the weight per berry as well as °Brix, pH, and titratable acid (TA).

Samples were collected Monday evenings during the early part of the class.

The data to the right was developed by one of the two-person teams.

Each of the n pre-harvest berry (or cluster) samples are analyzed in the lab. Analytical results used to generate the chart are summarized below:



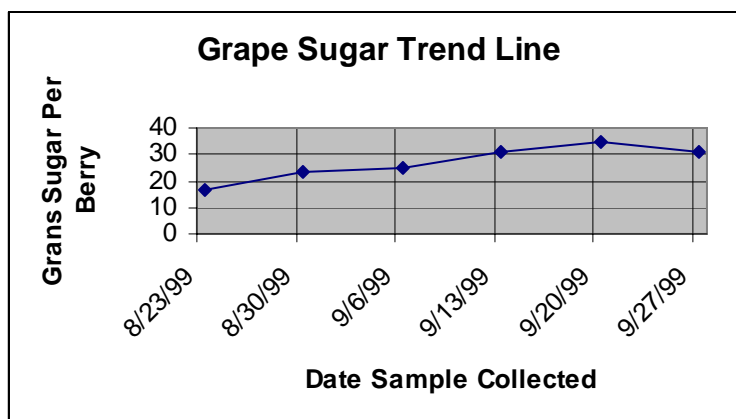
Var/Date	23-Aug-99	30-Aug-99	6-Sep-99	13-Sep-99	20-Sep-99	27-Sep-99
Brix	12.6	18.6	19.8	20.2	21.6	22.2
pH	2.93	3.17	3.33	3.23	3.33	3.18
TA	16.6	12.5	9	9.1	9.4	11.5

It should be noted that although the °Brix trend line looked good (for a 23.0 °B target), the 27 Sep 99 pH decreased when it should have increased and the TA increased when it should have decreased.

The average weight of the sugar per berry—the product of multiplying °B and average berry weight—also trended down as shown to the right.

The average weight per berry (100 berry sample) was 1.62 grams on 20 Sep 99 and 1.41 grams on 27 Sep 99 due to:

- (a) Non-representative sample,
- (b) Berry dehydration caused by the hot weather coupled with no irrigation, or
- (c) Both.



Most likely, dehydration concentrated the acid and increased TA and decreased pH.

Given the 22.2 °B on Monday 27 Sep 99, the pick for the Early Harvest was schedule for Saturday 2 Oct 99 pick date when the °B was expected to be very close to the target 23.0; a few hot days moved this to 24.5 °B.

As it turned out, the Early Harvest and Late Harvest °Brix readings were nearly identical at 24.4 °B and 24.5 °B, respectively, thus eliminating or badly compromising a major experimental variable.

Harvest & Crush

Protocol Procedure 1—Pick early harvest grapes at 23.0 brix, late harvest grapes at 24.5 brix. At each harvest date pick 200 pounds of grapes for fermentation.

Early Harvest	Activity/Measure	Late Harvest
24.4°Brix ¹	°Brix	24.5°Brix
Saturday 2 Oct 99, 7 a.m.	Pick Date	Saturday 9 Oct 99, 7 a.m.
604.1 pounds after sort ²	Group 3 & 4 Pinot Noir harvest	354.5 pounds after sort ³

Notes:

1. The early pick was scheduled at the Monday 27 Sep 99 class when the °Brix was 22.2 with a good change of hitting the target of 23.0°Brix. However, a few hot days increased the Brix dramatically.
2. Pinot Noir Group 3 Immediate Inoculation and Pinot Noir Group 4 Cold Soak joined forces to harvest 400 pounds of grapes. The planning factor of 35 pounds per bin suggested 11.4 bins. 13 bins were picked to be on the safe side. This resulted in an over-pick. This resulted in a new planning factor of $600 / 13 = 46$ pounds per bin.
3. Pinot Noir Rows 4, 5, 6, and 7 yielded less than 400 pounds as secondary growth was avoided in an attempt to achieve the highest °Brix feasible and differentiate the early and late harvests. This result was not achieved—the °Brix were nearly identical.

Protocol Procedure 2—All grapes are destemmed and crushed just enough to break open the berries. The Cold Soak group will add 40 ppm SO₂. Assume a juice yield of 150 gallons per ton.

Early Harvest	Activity/Measure	Late Harvest
200 pounds ¹	Pounds in Lots 1 + 2	88 pounds + 88 pounds
4.45 grams SO ₂	SO ₂ grams added	2.0 g SO ₂ + 2.0 g SO ₂
15 gallons	Juice Estimate	6.6 gallons + 6.6 gallons

Notes:

1. Mistake 1: The early pick crush was put into one 30-gallon container—Lots 1 and 2 commingled. This must was divided into two lots later (see below).

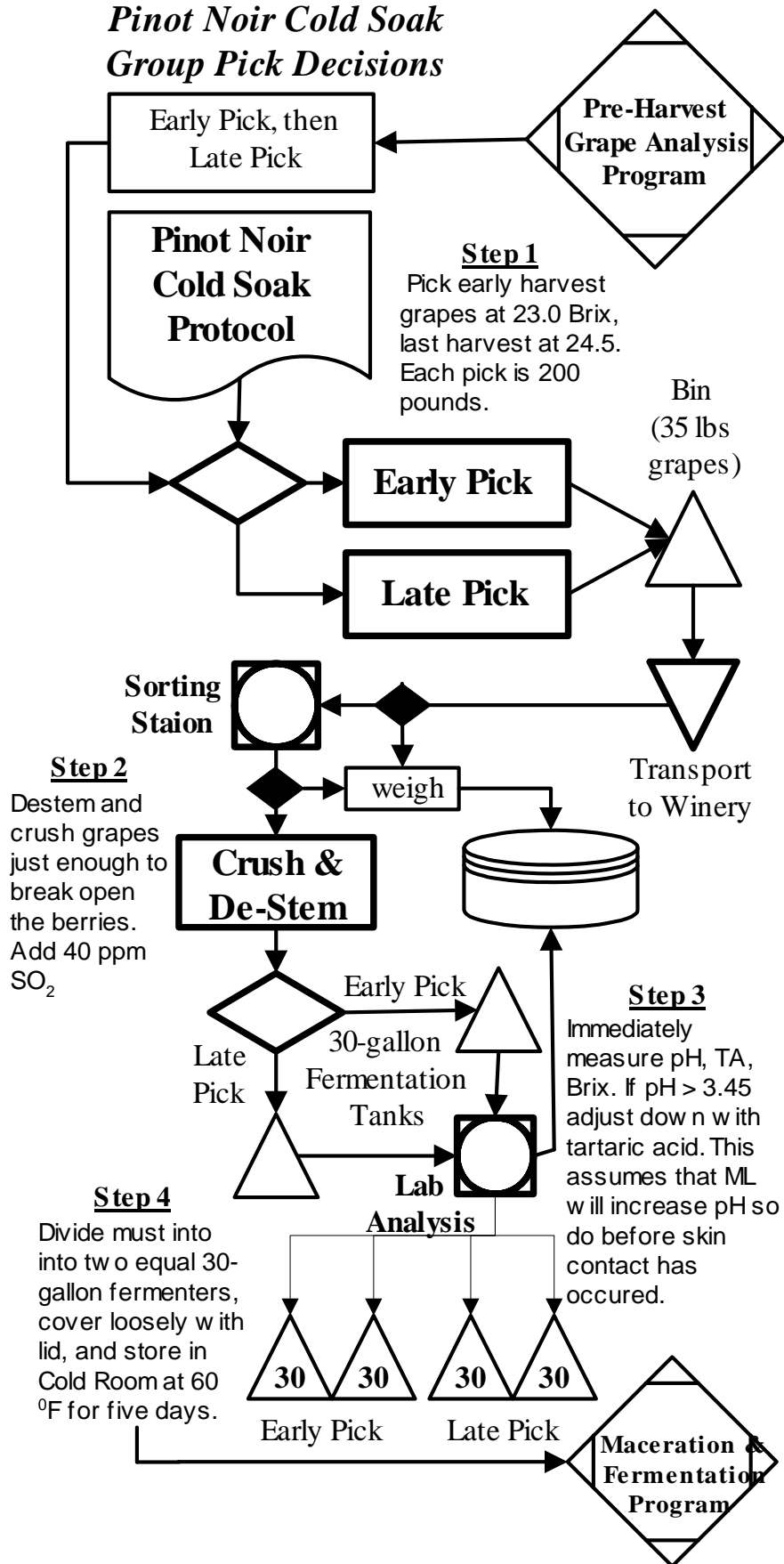
Protocol Procedure 3—Measure the pH, TA, Brix of the juice immediately after crushing. Adjust the pH down to 3.45 with tartaric acid if needed. NOTE: This assumes skin contact and ML will move us to high pH range, so do not wait until skin contact has occurred to make this addition!

Early Harvest	Activity/Measure	Late Harvest
3.38 pH	pH	3.32 pH
8.1 TA	Titratable Acid (TA)	8.8 TA
24.4 °Brix	°Brix	24.5 °Brix

Notes:

1. As pH for the early and late harvests was under 3.45, no tartaric acid was added.

**Pinot Noir Cold Soak
Group Pick Decisions**



Cold Soak Maceration

Maceration

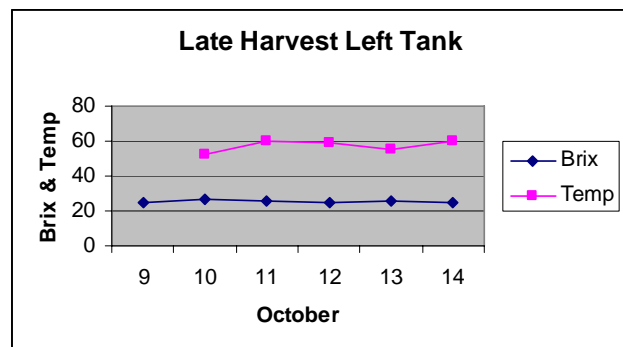
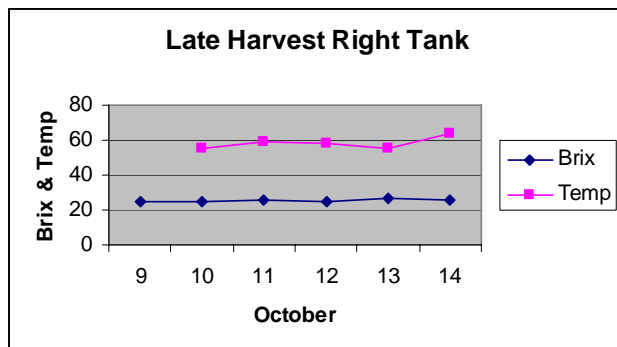
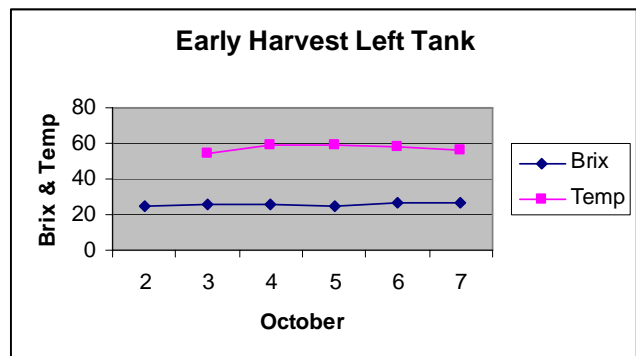
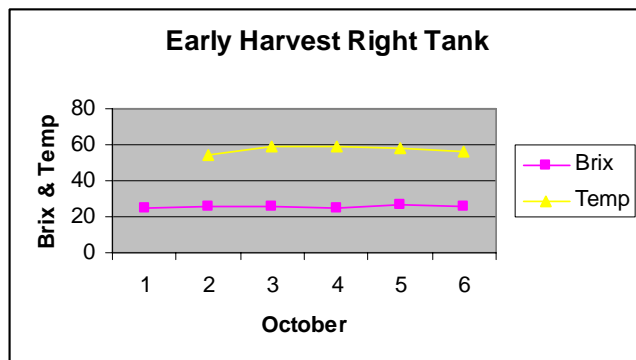
The period when the grape juice and skins (and seeds) are in contact and color, aroma, flavor, tannins and other favorable (or unfavorable) attributes are imparted to the juice as it is converted to wine.

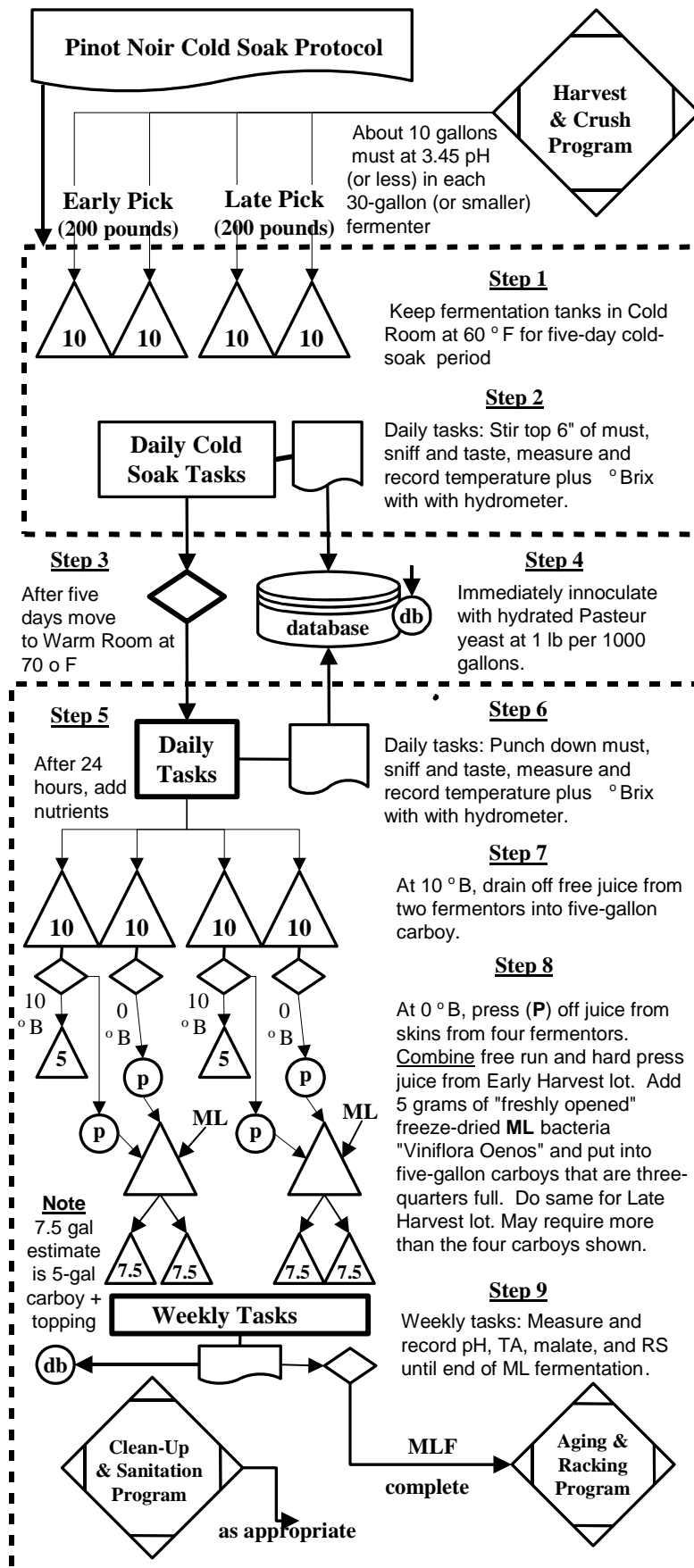
Protocol Procedure 5a—The Cold Soak group will divide the crushed grapes into two equal 30-gallon fermentors, cover loosely and move into the Cold Room at 60 degrees for 5 days. Mix the surface 6 inches daily to reduce molds and aerobic yeast.

Early Harvest					Late Harvest				
Date	Right Tank		Left Tank		Date	Right Tank		Left Tank	
October	Brix	Temp	Brix	Temp	October	Brix	Temp	Brix	Temp
2	24.4				9	24.5		24.5	
3	26.1	54	26.1	54	10	25.2	55	26.3	52
4	26	59	26	59	11	25.5	59	25.5	60
5	25	59	24.8	59	12	24.5	58	24.7	59
6	26.5	58	26.5	58	13	26.5	55	25.5	55
7	26	56	26.4	56	14	25.5	64	24.5	60

Notes:

1. The early harvest crush of 200 pounds (15 target gallons) was put into one fermenter instead of two on Saturday 2 Oct 99; this mistake was caught on Monday 4 Oct 99 when the approximately 20 gallons of must was subdivided into two 30-gallon fermentation tanks.
2. Mistake 2: The 6 Oct 99 readings for the Early Harvest Left Fermenter were missed.

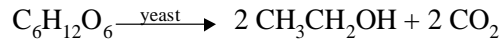




Alcoholic Fermentation

Alcoholic Fermentation

The process whereby living yeast cells convert grape sugars—
glucose and fructose—to ethyl alcohol (ethanol) and carbon dioxide:



Protocol Procedure 5b—After 5 days move both fermenters into the warm room at 70 degrees. Inoculate with hydrated Pasteur Red yeast at 1#/1000 gallons when moved. 24 hours after yeast inoculation add nutrients of 2#/1000 Superfood and 2#/1000 DAP during a punch down. Monitor fermentation with Brix, temperature, smell and taste daily from the beginning of the cold soak to dryness.

Early Harvest Lots 1 + 2	Activity/Measure	Late Harvest Lots 1 + 2
100 pounds + 100 pounds	Pounds Grapes after sort	88 pounds + 88 pounds
7.5 gallons + 7.5 gallons	Target Gallons Wine	6.6 gallons + 6.6 gallons
7 Oct 99: 3.4 g + 3.4 g PRY	Add Pasteur Red yeast	14 Oct 99: 3.0 g + 3.0 g PRY
8 Oct 99: 6.8 g + 6.8 g SF	Add Superfood	15 Oct 99: 6.0 g + 6.0 g SF
8 Oct 99: 6.8 g + 6.8 g DAP	Add DAP*	15 Oct 99: 6.0 g + 6.0 g DAP

* Diammonium phosphate (DAP)

Protocol Procedure 6—One of the two fermenters will be drained of free run juice at 10 Brix. Insert a 1" siphon hose below the fermenting cap before punching down and remove free run juice into glass carboy(s), leaving the cap wet. Fermenting carboys should be 3/4 full. Continue to punch down skins. Monitor Brix and temperature in all fermenters.

Early Harvest Fermentation					Late Harvest Fermentation				
Date	Left Tank		Right Tank		Date	Left Tank		Right Tank	
October	Brix	Temp	Brix	Temp	October	Brix	Temp	Brix	Temp
7	26.0	56	26.4	56	14	25.5	64	24.5	60
8	26.1	68	25.8	66	15	24.5	64	24.5	60
9	24.5	68	25.0	68	16a	23.7	69	23.6	68
10	15.2	65	22.0	78	16p	21.0	70	21.0	70
11a	7.0	70	13.8	77	17a	14.1	74	14.1	74
11p	3.0	70	7.0*	84	17p	11.2	76	11.0	76
12a	3.1	70	3.3	74	18	4.5**	67	3.0	76
12p	2.5	68	2.0	68	19	1.0	67	0.0	70
13a	1.2	62	1.0	66	20a	1.1	58	0.9	58
13p	0.5	75	0.6	74	20p	0.6	62	0.2	62
14a	0.2	68	0.2	68	21a	0.8	60	0.1	60
14p	-2.0	69	-1.3	68	21p	0.7	64	0.0	64

Notes:

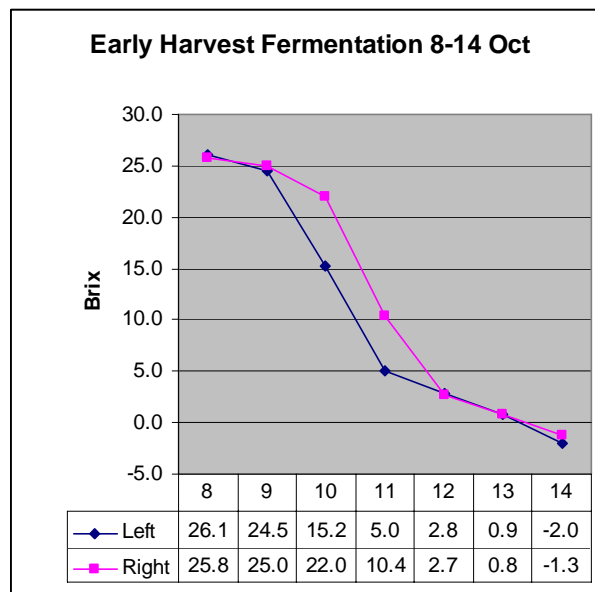
1. During the Bouchaine field trip, winemaker Dave Stevens said that the ideal fermentation temperature for Pinot Noir is “hot” or over 90 °F but less than 95 °F. Our temperatures were much lower, probably due to much less must mass.
2. * Free-run was drained of off the Early Harvest Right Tank at 7.0 °B on 11 Oct 99.

3. ** Free-run was drained off the Late Harvest Right Tank at 4.5 °B on 18 Oct 99.
4. The Late Harvest was pressed on Saturday 23 Oct 99 with °B readings slightly above 0.0.

For the Early Harvest lots, upon inoculation, the °Brix slowly decreased during 8-9 Oct 99 and then headed south during 10-11 Oct 99 when it decreased more slowly to 14 Oct 99 when it went negative (because alcohol has a lower specific gravity than water, the hydrometer used to measure °Brix floats a bit high and gets a reading lower than the actual).

Note that when two readings were obtained in a single day, they were averaged for purposes of the graph shown to the right. This was necessary to make the day grids of equal size.

The plots for the two lots are more congruent at the start and finish of alcoholic fermentation than during the steeply declining middle period from about 23 to 3 °Brix when Right lagged Left.

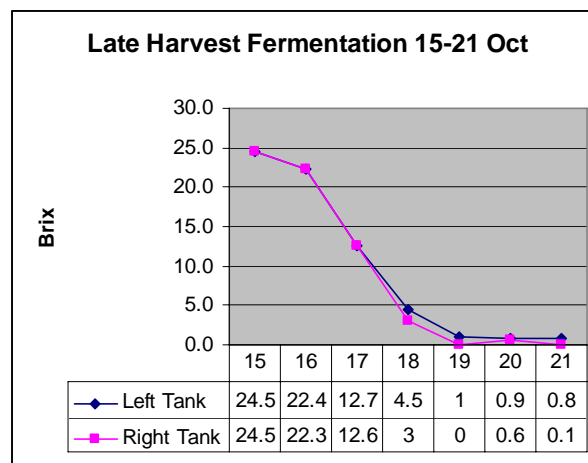


The Late Harvest plots are shown to the right.

The pressing of Late Harvest Lot 1 (Left Tank) and Lot 2 (Right Tank) actually occurred on Saturday morning 23 Oct 99 when 5-gallon carboys and the “freshly opened” freeze dried ML bacteria “Viniflora Oenos” was available. At this time the Left tank was 0.4 °Brix @ 59 °F and the Right tank was 0.2 °Brix @ 58 °F.

The two plots to the right are nearly congruent.

The juice and skins were generally in contact for five cold soak days and seven alcoholic fermentation days. This has helped to impart a deep red color to the Pinot Noir.



Protocol Procedure 7a—When fermenting skins, in both separated and whole musts, reach 0 brix press off the skins. Combine free run and hard press juices of each trial into one container to make it uniform.

Early Harvest Lots 1 + 2	Activity/Measure	Late Harvest Lots 1 + 2
About 15 gallons*	Combine free run & hard press	About 6.6 & 6.6 gallons*

Notes:

1. * Using the 150 gallons wine per ton grapes
2. Mistake 3: With Early Harvest, the two tanks of must and the carboy of free run wine were combined into one 30-gallon container prior to initiating the ML fermentation. This action was based on the thought that Early Harvest was the Trial, not that Right and Left Tanks were each a Trial.
3. The Early Harvest was pressed with force; the Last Harvest was pressed with little force.

Malolactic Fermentation

Malolactic Fermentation

Bacterial fermentation whereby malic acid is converted to lactic acid and carbon dioxide, often adding complexity to the wine.

Protocol Procedure 7b—Add 5 grams of “freshly opened” freeze dried ML bacteria “*Viniflora Oenos*” to each trial lot. Transfer into $\frac{3}{4}$ full carboys with fermentation locks. As bubbling slows, top up as soon as possible.

Early Harvest Lots 1 + 2	Activity/Measure	Late Harvest Lots 1 + 2
5grams VO added combined lots	Add 5 grams ML Bacteria	0.5 grams added to each lot
Three 5-gal and three 1-gal	Transfer to 5-gallon carboys	Four 5-gal carboys, 2 per lot

Notes:

- As noted on the previous page, the interpretation of “trial lot” was open to question. The result of pressing was three lots: an Early Harvest Combined Lot, a Late Harvest Free-Run Lot, and a Late Harvest Hard-Press Lot.
- Mistake 4: The protocol called for 5.0 grams of ML bacteria when it should have been 0.5. Note that the Early Harvest Combined Lots 1 & 2 received the 5.0 gram inoculation.

Protocol Procedure 8—Keep all fermentation lots in the 70-degree warm room. Measure pH, TA, Malate, and RS weekly until the end of the ML fermentation.

The MLF records are included below:

Pinot Noir Cold Soak Group Malolactic Fermentation												
	Early Harvest Combined				Late Harvest Free-Run				Late Harvest Hard-Press			
Date	pH	TA	M	RS	pH	TA	M	RS	pH	TA	M	RS
10/15	3.53	8.2	—	—	—	—	—	—	—	—	—	—
10/21	3.60	5.6	Yes	0.05	—	—	—	—	—	—	—	—
10/28	3.82	4.9	Some	0.02	3.82	6.2	Yes	0.05	3.84	6.0	Yes	0.0
11/4	3.72	5.1	No	0.0	3.75	6.0	Some	0.025	3.73	7.3	Some	0.025
11/5	Racked off the gross lees											
11/8	Re-Racked				Racked off the gross lees				Racked off the gross lees			

Notes:

- It should be noted that the measurements above are subject to errors. The pH readings of 28 Oct 99 seem to be high, perhaps because the pH meter was not calibrated. The 4 Nov 99 readings are more accurate; the 3.72 reading for Early Harvest was corroborated by a new lab reading of 3.716 on a precision instrument.
- Note that TA readings are all over the map. In fact, a 6.1 reading for the Early Harvest in the old lab was contradicted by a 5.1 reading in the new lab.
- Mistake 5: Hydrogen sulfide aroma graced the Early Harvest and copper was added on 6 Nov 99.
- Mistake 6: Note that not all members of the Pinot Noir Cold Soak Group were overly concerned with sanitation procedures. This could have contributed to the H₂S.

Racking

Protocol Procedure 9—At the end of ML fermentation rack off of gross lees, adjust the pH down to 3.70 if needed with tartaric acid, add 50 ppm SO₂ and store in the cold room in topped up containers to clear.

For the Pinot Noir Cold Soak Group, the early harvest combined lots completed MLF (per the 4-5 Nov 99 paper chromatography results), the pH was 3.72 (as of 4 Nov 99), the TA was 5.1 or 6.1 (as of 4 Nov 99), the free sulfur was 0.0 (as of 4 Nov 99). As of 4 Nov 99 at 4:15 pm, the early harvest combined lots had an H₂S aroma and it was decided to add copper salts.

The Early Harvest Lots 1 & 2 combined was racked off of the gross lees on 5 Nov 99 (and re-racked on 8 Nov 99 after the addition of chemicals). The Late Harvest Lot 1 Free-Run and Lot 2 Hard-Press were racked off of the gross lees on 8 Nov 99.

Pinot Noir Wine after Racking (but before Bottling)			
Lot	Early Harvest 1 & 2	LH 1 Free-Run	LH 2 Hard-Press
Gallons in 5-Gal Carboys	10	5	5
Plus Topping Wine	2 gallons	1 gallon	1/3 rd 750 ml bottle
pH after 1 st Racking	3.72	3.75	3.73

Notes:

1. The decision was made not to add tartaric acid and to leave the wine at just over 3.70.
2. Mistake 7: 30 ppm SO₂ was added to the early harvest combined lots and 50 ppm was added to the late harvest lots (this low ppm for the early harvest may have been recommended by one of the instructors, perhaps because copper was also added).
3. Mistake 8: 50 ppm SO₂ KMBS equates to 1.89g/5gal if the strength is 50% as one instructor says; if the strength is 85% as another instructor says, then we add 1.11g/5gal.

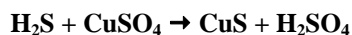
Sulfur Dioxide Additions (6Nov 99)			
Lot	Early Harvest 1 & 2	LH 1 Free-Run	LH 2 Hard-Press
SO ₂ Additions in ppm	30 ppm	50 ppm	5 ppm
SO ₂ Additions in gr / 5 gal	1.4 grams/5 gallons	1.9 grams/5 gallons	1.9 grams/5 gallons

Copper Addition (6Nov 99)¹			
Lot	Early Harvest 1 & 2	LH 1 Free-Run	LH 2 Hard-Press
CuSO ₄ Additions (1% sol)	3.5 ml / 5 gallons*	none	none

* 3.5 ml / 5 gallons of 1% copper solution (0.01 N) is equivalent to about 0.035 ml / 5 gallons of 1 N solution—0.035 ml is more than the 0.02 mg (or ml) suggested in the book. [Note that 1 milligram (mg) is approximately equal to 1 milliliter (ml).]

¹ **Hydrogen Sulfide & Copper**—From *Wine Analysis and Production* (WAP):

WAP states (p. 176): “Some winemakers remove objectional H₂S and mercaptans by direct contact with copper. Upon addition, copper reacts with hydrogen sulfide accordingly:



.... Addition of 4 g of cupric (II) sulfate (CuSO₄·5H₂O) per 37.85 hL (1,000 gal) raises the copper content by 0.2 mg/L. U.S. governmental regulations permit additions of up to 0.5 mg/L (as copper); residual levels in the wine cannot exceed 0.2 mg/L (as copper).”

For each 5 gal carboy, WAP suggests adding 4g/1,000gal or 20mg/5gal. WAP (p. 173): “...addition of SO₂ reduces the disulfides back to mercaptans, which can be removed by copper treatment....” If copper is added before our SO₂, the SO₂ could create mercaptans (e.g., skunk) that require more copper.

On Monday 15 Nov 99, all seven members of the Pinot Noir Cold Soak Group participated—with Clark Smith—in a rudimentary sensory evaluation of the three lots. Addition of ascorbic acid to the Early Harvest Lot and copper to all three lots immediately after racking off the fine lees was suggested.

Protocol Procedure 10—*After 2 weeks, when wines have settled clear, rack off of fine lees and adjust free SO₂ to 20-30 ppm without reference to molecular.*

To the PNCSG’s surprise, the pH had risen well above 3.7 and it was decided to add tartaric acid—at 0.10 grams per 100 ml (Wine Lab sheet)—to bring it back down:

pH Adjustments (20, 21 Nov 99)			
Reading/Adjustment	Early Harvest 1 & 2	LH 1 Free-Run	LH 2 Hard-Press
Sat 20 Nov 99	Racking off of Fine Lees	Racking off of Fine Lees	Racking off of Fine Lees
pH Reading (20 Nov 99)	3.816	3.924	3.925
Tartaric acid added	23.7 grams/5 gal	23.7 grams/5 gal	23.7 grams/5 gal
pH Reading (21 Nov 99)	3.575	3.587	3.704

On Sunday, 21 Nov 99, it was decided to add a small amount of copper to the Late Harvest Free-Run only (note that 0.9 is about ½ of the 2.0 recommended in WAP):

Copper Addition (21 Nov 99)			
Lot	Early Harvest 1 & 2	LH 1 Free-Run	LH 2 Hard-Press
CuSO ₄ Additions (1% sol)	none	0.9 ml/5 gal	none

The objective of the second SO₂ Addition—after racking off of the fine lees and before post-MLF topping—is to achieve 20 – 30 ppm free SO₂.

Sulfur Dioxide Additions after Racking off of Fine Lees (21 Nov 99)			
Lot	Early Harvest 1 & 2	LH 1 Free-Run	LH 2 Hard-Press
SO ₂ Additions in ppm	40 ppm	40 ppm	40 ppm
SO ₂ Additions in gr / 5 gal	1.514 grams	1.514 grams	1.514 grams
Free SO ₂ Achieved	Unknown	Unknown	Unknown

Notes:

1. Mistake 9: Even though access to the new lab was gained, attempts to measure Free SO₂ were not successful due to lack of time.
2. The PNCSG decided to consider SO₂ adjustment during the bottling process.

Note that the PNCSG was also attempting to organize a sensory evaluation scheduled for Monday 22 Nov 99.

A generalized flow chart for “blending and finishing” that includes racking, topping, fining, blending, and oak aging is included on the next page.

Blending & Finishing Program

Process Flow Chart	Description
<p>The flowchart illustrates the Blending & Finishing Program. It begins with 'Winemaker's Quality & Style Objectives' which informs the 'Maceration & Fermentation Program'. The process then moves to 'Rack Off of Gross Lees' (containers C₁, C₂, C₃, C_n) and 'Rack into different containers'. A 'database' (db) provides input to 'Actual Measures', which leads to an 'Adjustment Plan'. 'Actual Measures' also leads to 'Chemical Additions' (other, copper, SO₂, tartaric). The 'Adjustment Plan' leads to 'Topping' (Top & Bung all Containers, C₁, C₂, C₃, C_n) and 'Finishing' (Fining, Blending, Oak Aging, C₁, C₂, C₃, C_n). 'Finishing' leads to 'Records' (db) and 'Bottling & Aging Program'. A 'Cleanup & Sanitation Program' is shown as 'as appropriate'.</p>	<p>Planning & Management—After fermentation is complete (including malolactic fermentation if appropriate), several activities may take place. Of those listed below, only racking and topping are mandatory. Chemical additions, fining, blending, and oak storage are all optional.</p> <p>Racking—The first step after fermentation is usually racking the wine off of the gross lees. However, this may be done before fermentation is complete if, for example, hydrogen sulfide is detected and aeration is deemed useful.</p> <p>Racking off of the fine lees is accomplished after the particles have sufficiently settled (the Pinot Noir Cold Soak Group protocol calls for this second racking after two weeks).</p> <p>Chemical Additions—The addition of chemicals to help achieve the quality and style objectives of the winemaker combined art and science—a very complex subject area in theory and in practice.</p> <p>After the first racking, SO₂ is usually added. If the pH is above 3.7 (or other wine style threshold), tartaric acid can be added to bring it down.</p> <p>If H₂S develops, copper may be added (even if fermentation is not complete).</p> <p>Topping—After fermentation it is essential to top off the storage containers (e.g., carboys, barrels, tanks) and to continually add wine to replace any lost through evaporation or leakage. The presence of oxygen will cause oxidation that detracts from the quality of the wine.</p> <p>Fining—Impurities may be eliminated or mitigated through addition of fining agents.</p> <p>Blending—At some point prior to bottling, wines from different lots and/or varietals may be blending together to better achieve the winemaker's style and quality objectives.</p> <p>Oak Aging—Wine may be placed into oak barrels before or after malolactic fermentation, or before of after blending.</p> <p>Evaluation & Improvement—Results achieved by the Blending & Finishing Program are compared to objectives and improvements are made to the program (and related programs) on an on-going basis (to the degree feasible).</p>

Blending

Protocol Procedure 11—After all wines are fermented and clear, proceed with sensory evaluation, difference testing and descriptive taste evaluation. Summarize the effects of the treatments. Prepare a blend using the lots within the group to produce a “best” blend and explain why you made the blend.

General Discussion—According to the protocol:

1. The purpose is to produce a “best” blend from the lots of wine made by the Pinot Noir Cold Soak Group (PNCSG).
2. The rationale for this “best” blend should be based on knowledge of the effects of treatments.
3. This knowledge should be derived from sensory evaluation, difference testing, and descriptive taste evaluation of the lots and blends.

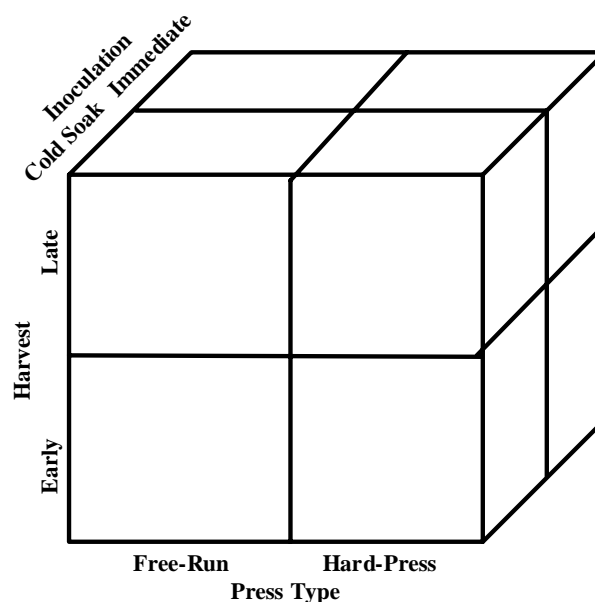
Lots—The PNCSG (Group 4) ended up with three lots:

- Lot 1—Early harvest free-run/hard-press combined (picked at 24.4 °Brix)
- Lot 2—Late harvest free-run (picked one week later than Lot1 at 24.5 °Brix)
- Lot 3—Late harvest hard-press (picked with Lot 2 at 24.5 °Brix)

These comprise the inputs for the “best” blend.

Treatments—The protocol defined an experiment with three principal treatments:

- Harvest—Early pick vs. Late pick (as noted the °Brix was nearly identical thus largely eliminating this “treatment from serious consideration).
- Press Type—Free-run vs. Hard-press (Group 4 mistakenly combined these for the early harvest).
- Inoculation—Cold soak vs. Immediate (this required comparison with the wine produced by the Group 3 Pinot Noir Immediate Inoculation Group who inoculated the day of each pick—i.e., no cold-soak-maceration period prior to inoculating for alcoholic fermentation).



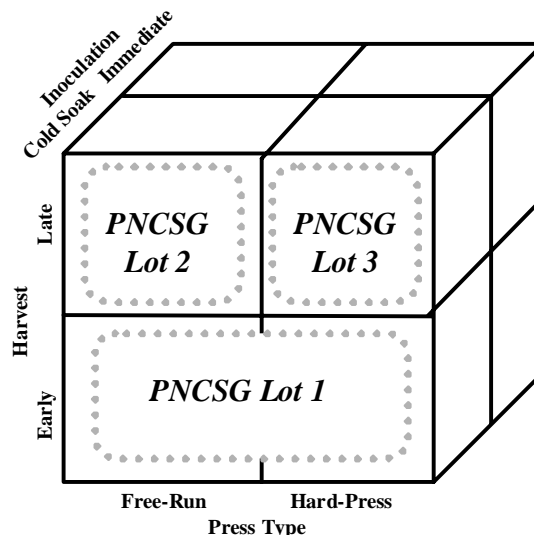
Ideally, Pinot Noir Groups 3 and 4 would have produced eight lots differentiated by the three “treatments” illustrated above.

Evaluation Tools—Three types are suggested by the protocol:

- Sensory Evaluation—Tools and techniques associated with Sensory Evaluation of Wine (some members of the PNCSG have taken the two formal courses offered by Napa Valley College).
- Difference Testing—Directional paired-comparison, duo-trio, and triangle described in the *Sensory Techniques Handbook*.
- Descriptive Analysis—Quantitative descriptive analysis, flavor profile, texture profile, etc.

Group 4 Candidate Questions & Hypotheses—The Pinot Noir Cold Soak Group (PNCSG) considered the following questions [and hypotheses] as candidates for *sensory evaluation, difference testing, and descriptive taste evaluation* during the 22 Nov 99 Advanced Winemaking class session where all 23 students comprised a panel for Pinot Noir experiments (all refer to the PNSG lots unless otherwise specified):

1. Is there a difference between Lot 1 and combined Lots 2 and 3 or, worded differently, is there a difference between the early and late harvests? [Hypothesis: There is no difference between the two harvests because the picking^oBrix was nearly identical.]
2. Is there a difference between Lot 2 and Lot 3? [Hypothesis: There is a difference because Lot 2 should have more tannins and more color as the must was concentrated after the free-run was drained off.]
3. Is there a difference between a PNCSG lot and the corresponding lot from the Immediate Inoculation Group? [Hypothesis: There is a difference because each Cold Soak should have more tannins and more color than the corresponding Immediate Inoculation lot.] Note: Group 3 Late Harvest Free-Run is preferred.
4. If equal parts of Lot1, 2, and 3 are blended to create a reference and if sensory evaluation techniques are employed to describe selected characteristics (e.g., cherry-berry aroma, astringency, bitterness), do any of the lots have greater or lesser intensity compared to this reference? [Hypothesis: Yes, but which?]
5. Same as 4, above, but without the reference.



Group 4 Experimental Design—The two Pinot Noir Groups were given approximately one hour each to accomplish their tests. The final racking of the fine lees and the final chemical adjustments were accomplished on Saturday evening 20 Nov 99 and Sunday morning 21 Nov 99, and the tests were performed on Monday evening 22 Nov 99. This meant that the experimental design had to be finalized, prepared, and implemented in a very short period-of-time. Additionally, the PNCSG would have to have the time and ability to analyze test results. Accordingly, the experimental design is somewhat modest in scope and expectation:

It was decided to have six samples of Pinot Noir: (a) PNCSG Lot 1, (b) PNCSG Lot 2, (c), PNCSG Lot 2, (d) PNCSG Lot 3, (e) PNCSG Reference (Blend of Lots 1, 2, and 3), and (f) an Immediate Inoculation lot that corresponds to one of the cold soak lots. These six samples would be put into 750 ml bottles that, in turn, would be labeled A, B, C, D, E, and F (with the contents unknown to the panel). The following tests would be run:

1. Directional Paired-Comparison—F (Immediate Inoculation) vs. A or B (Cold Soak): Using the Directional Paired-Comparison Test, “Which is the most bitter?” Null hypothesis: There is no difference between A or B and F. Alternative hypothesis: There is a difference. We would expect the null hypothesis to be rejected and the alternate accepted by virtue of tannins added during the cold soak
2. Duo Trio—B (Free-Run), C (Free-Run), and D (Hard-Press): Using the Duo Trio Test with B as the Reference, “Which of C and D is the same as B? Null hypothesis: The panel will not be able to tell the difference?. Alternative hypothesis. The panel will be able to tell the

difference. . We would expect the null hypothesis to be accepted as the Free-Run and Hard-Press lots are quite similar.

3. Quantitative (e.g., Scaling)—The final test should address selected characteristics of the PNCSG’s wine to provide inputs to help produce a “best” blend.

These three parts were incorporated into the form illustrated on the next page. The three parts were administered to a panel of 19 judges (many untrained and unskilled in the sensory evaluation of wines suggesting that the results are suspect).

Part 1 Directional Paired Comparison—The panelists were asked to compare B and F.

<p><u>Part 1: Directional Paired-Comparison</u></p> <p>Taste Sample B and Sample F. Circle the one that is most bitter:</p> <p>B or F</p>
--

It was thought that the null hypothesis would be rejected and that Sample B PNCSG Late Harvest Free Run would be more bitter than the Sample F Immediate Inoculation Late Harvest because of the five-day cold soak period and the acquisition of more tannins.

However, 10 selected B as most bitter and 8 selected F as most bitter. At the 5.0% level, 13 responses were needed to reject the null hypothesis.

It was concluded that there was no statistically valid difference in bitterness between the cost soak and immediate inoculation Pinot Noirs.

Part 2 Duo-Trio—The panelists were asked to compare B and D with C (which was identical to B).

<p><u>Part 2: Duo-Trio</u></p> <p>Taste Samples C ref, B, and D in that order. Circle either B or D to identify the one that is the same as C.</p> <p>B or D</p>

It was thought that the null hypothesis would be accepted because the Sample B (and C) PNCSG Late Harvest Free-Run (or Australian method) would be fairly close to the Sample D PNCSG Late Harvest Hard Press.

This proved to be the case with 10 panelists selecting B and 9 selecting D. To reject the null hypothesis and conclude that a statistically valid difference existed between B and D, 14 of the 19 would have had to select B.

Part 3A: Maturity/Intensity—The panelists were asked to evaluate Samples A, C, D, and E in an order that was different for each one-quarter of the class and mark the **maturity** and/or **intensity** of each aroma or taste attribute by entering the identifying Sample ID on the 10-interval scale, with the least intense to the left and the more intense to the right.

Sample A was PNCSG Early Harvest Combined, C was PNCSG Late Harvest Free-Run, D was PNCSG Late Harvest Hard-Press and E was the PNCSG Reference Blend of Lots 1, 2, and 3 in equal proportions.

Group 4: Pinot Noir Cold Soak

Part 1: Directional Paired-Comparison

Taste Sample B and Sample F. Circle the one that is most bitter:

B or F

Part 2: Duo-Trio

Taste Samples C ref, B, and D in that order. Circle either B or D to identify the one that is the same as C.

B or D

Part 3: Quantitative Sensory Evaluation

Part 3A: Intensity—Taste Samples A, C, D, and E in any order and mark the **intensity** of each aroma or taste attribute by entering the identifying ID on the 10-interval scale, with the least intense to the left and the more intense to the right.

Part 3B: Rank—Now rate Samples A, C, D, and E in **order** and enter into a 1, 2, 3, and 4 in the “rank” box to the right with 1 for the “most preferred” and 4 for the “least preferred.”

Sensory Evaluation Intensity Scale

	<i>cranberry</i>	<i>strawberry</i>	<i>cherry</i>	<i>raisin</i>											
Berry Aroma					<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: center;">rank</th> <th style="text-align: center;">score</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">A</td> <td style="text-align: center;">_____</td> </tr> <tr> <td style="text-align: center;">C</td> <td style="text-align: center;">_____</td> </tr> <tr> <td style="text-align: center;">D</td> <td style="text-align: center;">_____</td> </tr> <tr> <td style="text-align: center;">E</td> <td style="text-align: center;">_____</td> </tr> </tbody> </table>	rank	score	A	_____	C	_____	D	_____	E	_____
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Berry Taste					<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: center;">rank</th> <th style="text-align: center;">score</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">A</td> <td style="text-align: center;">_____</td> </tr> <tr> <td style="text-align: center;">C</td> <td style="text-align: center;">_____</td> </tr> <tr> <td style="text-align: center;">D</td> <td style="text-align: center;">_____</td> </tr> <tr> <td style="text-align: center;">E</td> <td style="text-align: center;">_____</td> </tr> </tbody> </table>	rank	score	A	_____	C	_____	D	_____	E	_____
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Astringency					<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: center;">rank</th> <th style="text-align: center;">score</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">A</td> <td style="text-align: center;">_____</td> </tr> <tr> <td style="text-align: center;">C</td> <td style="text-align: center;">_____</td> </tr> <tr> <td style="text-align: center;">D</td> <td style="text-align: center;">_____</td> </tr> <tr> <td style="text-align: center;">E</td> <td style="text-align: center;">_____</td> </tr> </tbody> </table>	rank	score	A	_____	C	_____	D	_____	E	_____
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Color (Hue)	<i>rose</i>			<i>purple</i>	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: center;">rank</th> <th style="text-align: center;">score</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">A</td> <td style="text-align: center;">_____</td> </tr> <tr> <td style="text-align: center;">C</td> <td style="text-align: center;">_____</td> </tr> <tr> <td style="text-align: center;">D</td> <td style="text-align: center;">_____</td> </tr> <tr> <td style="text-align: center;">E</td> <td style="text-align: center;">_____</td> </tr> </tbody> </table>	rank	score	A	_____	C	_____	D	_____	E	_____
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Part 3A consisted of six tests that used the 10-interval scale:

1) **Berry Aroma: Maturity** (Standards for cranberry, strawberry, cherry, raisin were available to the panel)—The results of the analysis of variance were:

A	C	D	E
7.2	5.4	5.4	6.7
4.3	2.3	7.3	8.5
9	3.5	8	10
4.5	2.7	7.4	9
3	8	7	4
8	2	5	2
9	3	4	7
2.5	5.5	7	9.5
5	2	1	4
3	1	5.5	8.3
7	6	8	5
7.5	1.5	1	6
3.8	5.5	9.7	7.2
9	6	8	4
6.8	8.5	10	6.2
3	8	7	2
8	9	7	8
8	9	5	7
5.5	10	8	1.3

Anova: Single Factor (at 5% level of confidence)

SUMMARY

Groups	Count	Sum	Average	Variance
A	19	114.1	6.005263	5.267193
C	19	98.9	5.205263	8.566082
D	19	121.3	6.384211	5.952515
E	19	115.7	6.089474	6.872105

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	14.48421	3	4.82807	0.724449	0.540679	2.73181
Within Groups	479.8421	72	6.664474			
Total	494.3263	75				

In order for a Sample to differ statistically from the others, the F value = 0.724449. had to be greater than the F critical value = 2.73181 and *it was not*. Therefore the null hypothesis must be accepted that all four wines had the same berry aroma: maturity.

2) **Berry Aroma: Intensity**—Again the null hypothesis was accepted—no difference in aroma among the four samples—because the F = 2.27 was less than F crit = 2.73.

A	C	D	E
8.4	3.3	3.3	4.2
9	10	4	3.5
8.8	4.6	3.3	5.3
4	2.5	7	9
4	8	6	5
6	2	4	1
9	3	4	7
5	3	3.8	8.6
5	2	1	4
10	8	4.3	1
8.4	3.3	7	5.7
4.8	4	6.8	8
8.7	7.2	4	5.7
9	3	4	5
5.5	8.8	4	7
3	9	7	5
10	8	7	9
5	6	6	5
3.8	7	5	2.5

Anova: Single Factor

SUMMARY

Groups	Count	Sum	Average	Variance
A	19	127.4	6.705263	5.707193
C	19	102.7	5.405263	7.352749
D	19	91.5	4.815789	2.794737
E	19	101.5	5.342105	5.71924

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	36.79724	3	12.26575	2.27418	0.08721	2.731809
Within Groups	388.3305	72	5.39348			
Total	425.1278	75				

3) **Berry Taste: Maturity** (Standards for cranberry, strawberry, cherry, raisin were available to the panel)—Again, no difference was detected by the panel of judges.

A	C	D	E
7.7	4.2	2.7	9.2
3.3	4.6	10	8.8
9.1	7.7	4.4	10
5	3	4	2
9	3	4	7
8.8	7.3	3	1.6
6	5	4	7
9	1	3.5	5
4	3	3	6
9.6	5.9	8.5	4
5.5	2.2	2.4	9
3	6	8	2
8.8	5	7.5	5

Anova: Single Factor

SUMMARY

Groups	Count	Sum	Average	Variance
A	13	88.8	6.830769	5.975641
C	13	57.9	4.453846	3.929359
D	13	65	5	6.513333
E	13	76.6	5.892308	8.524103

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	42.39904	3	14.13301	2.266501	0.092709	2.79806
Within Groups	299.3092	48	6.235609			
Total	341.7083	51				

Here some panelists did not perform the test completely (or at all).

4) **Berry Taste: Intensity**—Again, no difference.

A	C	D	E
8.9	3.3	3.6	7.8
10	8.5	3.4	2
8.7	3.7	4	9
2.4	6.7	4	8.5
4	8	6	9
5	3	4	2
9	3	4	7
9.3	8.2	4.4	6
6	5	4	7
9.8	2	3	4.5
8	3	5	4
8	4	9.8	9
5.3	4.3	8	2.5
4.5	5	8	5
2.8	6.8	6.2	7.8
3	8	6	2
10	8	7	9
8	7	7	3

Anova: Single Factor

SUMMARY

Groups	Count	Sum	Average	Variance
A	18	122.7	6.816667	7.174412
C	18	97.5	5.416667	4.915588
D	18	97.4	5.411111	3.724575
E	18	105.1	5.838889	7.456634

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	23.63819	3	7.879398	1.35436	0.264174	2.739498
Within Groups	395.6106	68	5.817802			
Total	419.2488	71				

The fact that no statistically valid differences were detected relative to aroma and taste was not surprising given the fact that the early harvest and late harvest °Brix were almost identical. The draining of the free-run juice—the Australian method—at 7.0 °Brix for early harvest (that was mistakenly combined with the hard-press lot) and 4.0 °Brix for late harvest did not make much difference compared to the hard-press.

Additionally, the panel of judges were not well trained.

5) **Astringency**—Here $F = 4.2$ was greater than $F_{crit} = 2.7$. *The panel detected statistically valid differences.*

A	C	D	E
6.2	3.1	6.8	7.3
3.7	6.9	4.4	5.8
4.9	8	9.5	5.8
2.4	4.2	6.8	9
4	7	8	6
5	4	3	6
3	8	6	4
3	6.7	9	8
3	4	5	7
2.2	6	4	4
2	9	4	7
7	4	3	2
4	5.5	7.5	2.7
5	6	9	8
5.1	8.3	7.2	6.3
4	7	9	3
4	7.5	3	3.5
4	8	7	5
6	3	2	8

Anova: Single Factor

SUMMARY

Groups	Count	Sum	Average	Variance
A	19	78.5	4.131579	1.912281
C	19	116.2	6.115789	3.582515
D	19	114.2	6.010526	5.765439
E	19	108.4	5.705263	4.130526

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	48.52987	3	16.17662	4.204243	0.00848	2.731809
Within Groups	277.0337	72	3.84769			
Total	325.5636	75				

Sample A Early Harvest Combined had a mean intensity score of 4.131579 with the other three samples higher on the scale.

6) **Color (Hue)**—Again, *the panel detected differences* with $F = 4.6 > F_{crit} = 2.7$.

A	C	D	E
7.3	3.2	3.7	6.3
6.6	3.7	5.4	7.3
9.4	5.6	4.5	9.8
8	2.8	4.8	9.5
3	9	8	5
7	5	6	8
8	6	7	9
2.8	8	4.4	10
4	7	3	9
8.5	3	3	3
7	5	5	5
8	6	7	7
7.3	4	3	5
2	4	7	8
6	4	4	5
4	8	9	6
8	2	2	6
5	3	4	6

Anova: Single Factor

SUMMARY

Groups	Count	Sum	Average	Variance
A	19	116.9	6.152632	4.685965
C	19	90.3	4.752632	4.720409
D	19	93.8	4.936842	3.745789
E	19	130.9	6.889474	3.857661

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	58.87092	3	19.62364	4.61466	0.005213	2.731809
Within Groups	306.1768	72	4.252456			
Total	365.0478	75				

Samples C with a mean of 4.75 and D with a mean of 4.94 were less intense in hue than A (6.15) and E (6.89).

A color comparison of PNCSG Late Harvest Hard-Press (Sample D) was compared to the Immediate Inoculation Late Harvest Free-Run and the Special 31-Day Extended Maceration lot.

Colors were measured at Charles Krug on Friday 19 Nov 99 with the following results:

Pinot Noir	Abs	Abs	Intensity	Hue (Bk*)	Hue (MB*)	Comments
Sample	A ₄₂₀	A ₅₂₀	A ₄₂₀ + A ₅₂₀	A ₄₂₀ / A ₅₂₀	A ₅₂₀ / A ₄₂₀	Days on Skins
1 Immediate Inoculation	0.287	0.376	0.663	0.763298	1.310105	7
2 Cold Soak	0.188	0.193	0.381	0.974093	1.026596	12
3 Extended Maceration	0.284	0.357	0.641	0.795518	1.257042	31

* The book (Bk) has Hue = A₄₂₀/ A₅₂₀ and Michelle Bowen (MB) thinks it might be A₅₂₀/ A₄₂₀ .

It is interesting to note that the Cold Soak had a lighter hue than either the Immediate Inoculation or the Extended Maceration which were fairly close in hue.

Part 3B: Preference Ranking—A somewhat easier-to-analyze approach asked the judges to order or rank the wines for each of the four attributes:

Now rate Samples A, C, D, and E in **order** and enter into a 1, 2, 3, and 4 in the “rank” box to the right with 1 for the “most preferred” and 4 for the “least preferred.”

The tabulations:

Number of Responses by Sample and Rank				
Rank	A	C	D	E
1 (most preferred)	9	5	0	4
2	3	4	5	7
3	3	3	7	3
4 (least preferred)	4	4	6	4
Rank Total	34	47	55	43
Preferred Sample	Preferred	—	—	—

As noted above, the sum of the ranks for each of the four PNCSG samples was (all 19 judges completed all entries):

- Sample A Early Harvest Combined Lots—Rank total = 34
- Sample C Late Harvest Free-Run (Australian Method) Lot—Rank total = 47
- Sample D Late Harvest Hard Press Lot—Rank total = 55
- Sample E Blend of A, C, and D Lot—Rank total = 43

In order for a sample to be significantly more preferred or less preferred the rank total must be outside of the Range 37 – 58 (for n = 19).²

Because Sample A with rank total of 34 falls outside of this range and is on the low end, it was preferred by the panel of judges (at the 0.05 level).

Although the Early Harvest Combined was preferred over the other samples, it must be reemphasized that the lack of training of the panel makes all results suspect.

However, the conclusion drawn from the ranking is that A is preferred and there is no difference among C, D, and E.

² From the Critical Differences Between Rank Sums, p = 0.05 Table in the Agriculture 173 Sensory Evaluation of Wine syllabus.

Group 4 Sensory Evaluation Results—To summarize:

- No difference in bitterness detected between PNCSG Sample B and Immediate Inoculation Group Sample F.
- No difference in Samples B or D compared to C which was the same as B.
- No differences between the four PNCSG samples A, C, D, and E for the following Attributes:
 - a) Berry Aroma: Maturity
 - b) Berry Aroma: Intensity
 - c) Berry Taste: Maturity
 - d) Berry Taste: Intensity
- Sample A was less astringent than Samples C, D, or E.
- Samples A and E had a deeper color (hue) than Samples C and D.
- Sample A was preferred over Samples C, D, and E.

Code	Pinot Noir Sample
A	PNCSG Early Harvest Combined Lots
B	PNCSG Late Harvest Free-Run
C	PNCSG Late Harvest Free Run
D	PNCSG Late Harvest Hard Press
E	PNCSG Equal Blend of A+B+D
F	Immediate Inoculation Group

The “Best Blend—Using Sample A “Preferred” as the base wine, a panel consisting of five of the seven PNCSG members tasted the following blends of Samples A, C, and D:

PNCSG Blending Trials (4 Dec 99)			
Sample	Trial Blend 1	Trial Blend 2	Trial Blend 3
A Early Harvest Combined Lots	100 ml	100 ml	125 ml (62.5 %)
C Late Harvest Free-Run Lot	50 ml	75 ml	50 ml (25.0 %)
D Late Harvest Hard Press Lot	50 ml	25 ml	25 ml (12.5 %)

The panel quickly rejected Trial Blend 2 and were torn between Trial Blends 1 and 3, but selected Trial Blend 3 as preferred as it was somewhat crisper than 1 but not outright sour like 2.

Blend 3 was judged to be the best balanced and integrated of the three. It was agreed that a hint of oak would be added using a French oak tea “brew” that had been prepared.

The oak brew was made on 30 Nov 99 and was added on 6 Dec 99 prior to the final presentation of the PNCSG Project to the Advanced Winemaking instructors and students.

The oak brew concentrate consisted of 1 lb French oak chips per 2 gallons wine plus 300 ppm SO₂.

Two 750 ml bottles of brew of this 1N concentrate were prepared.

The French oak tea was diluted to a 2% solution—this equates to 0.21 grams SO₂ and 1.6 oz French oak chips. This tea was added to the Pinot Noir Blend 3 wine along with PVPP (4 lbs per 1000 gal) and gelatin (1/4 lb per 1000 gallons).

The Pinot Noir “Best” Blend was poured to those present at the presentation. It was generally well received by the masses and adulated by the sophisticates—many expressed a wish to purchase a bottle for \$100. Fat chance!

Conclusions & Observations

Advanced Winemaking Class—The class provided valuable knowledge on winemaking and, more importantly, valuable hands-on experience.

Ad Hoc Organization & Management—The Pinot Noir Cold Soak Group comprised seven students who participated to varying degrees in the activities chronicled in this report. In addition to spotty participation, there was no recognized leader. As a result, everything was sort of ad hoc, somewhat disorganized, and not managed too well. Yet nearly all of the tasks specified in the winemaking protocol were implemented.

Winemaking Objective—One basic mistake made by the group was not to clearly understand the final objective expressed in Protocol Procedure 11:

Prepare a blend using the lots within the group to produce a “best” blend and explain why you make the blend.

Time should have been taken by the group to fully understand the entire protocol when the project was initiated. Terms like “trial” and “lot” should have been understood and agreed to.

Sanitation & Safety—Some felt that sanitation procedures should have received greater emphasis. Ditto for safety procedures. Not all members of the PNCSG carefully observed basic sanitation procedures.

Lab Access—Students did not have ready access to the new laboratory. This made implementation of the various measurement tests difficult, for example, the determination of Free SO₂ and the addition of KMBS to achieve a 23-30 ppm level.

