Virginia 2010

Editor's note: I am reporting as accurately as my hands could scribble notes from the speakers. These are rough notes that are not reviewed. Readers should research any viticulture or wine making practices suggested in this article.

Since I arrived in the region ten years ago I never viewed neighboring wine industries in Maryland, New Jersey, New York, Virginia or Ohio as competitors for attention and business but rather as partners in establishing the East and Mid-Atlantic as successful and respected wine regions. However, that doesn't mean one cannot peek over the fence occasionally and see how a neighbor is doing, just as a point of reference to measure progress (or the lack of it).

I attended the Virginia Vineyards Association annual conference recently. My perception over the past 10 years is that the Virginia wine industry has moved significantly past Pennsylvania, demographically as well as in the popular perception of wine quality. Here are some facts:

- If quality is driven by research (and I believe it is), Virginia is home to two of the best in the business. Tony Wolf and Bruce Zoecklein each have over 20 years of service to their wine industry and are among the most respected in their fields of viticulture and enology. Extension educators in wine growing counties help them to disseminate their knowledge.
- The Virginia Wine Board has almost $800,000 of legislative funds to devote to viticulture and enology research and extension education, and marketing and promotion efforts. Look at www.virginiawine.org to see the quality of the promotion work. There is a Virginia wine newspaper and magazine, advertisements in major food and travel magazines. That's how a wine industry gets noticed.
- Ten years ago Pennsylvania had more wineries than Virginia. Today, Virginia is closing in on 200 wineries and 3000 acres of vines, well ahead of Pennsylvania. Some of the wineries represent significant capital investments, far greater than any that exist in Pennsylvania. If number of wineries and vineyard acreage are any indication of success and excitement about a wine industry, Virginia is on the move.
- There are many more professionals working in the Virginia wine industry than in Pennsylvania. These are individuals who are trained to grow grapes and make wine, many of them come from the Virginia Tech program. As much as I admire the self-taught wine maker or grape grower, sound fundamental skills and knowledge must be foundation of any wine industry.

I say all of this rather matter-of-factly. It is not incumbent upon Pennsylvania's wine industry to keep pace with its neighbors. But if we are to compete in the arenas of wine quality and agri-tourism, it stands to reason that we do not want to fall too far behind. Virginia is an easy drive from the Philadelphia metropolitan area. It would be a shame if any Gen X-Y-Z couple or friends decided to drive to northern Virginia for a wine experience rather than visit wineries at home.

When I arrived ten years ago I was told by industry leaders that one of their main goals was to define a regional variety identity for southeast Pennsylvania. It's only natural for a wine industry to strive for popular associations like Napa Cab, Oregon Pinot, German Riesling, Rhone Syrah, etc. It turns out, of course, that the state has a diverse varietal landscape but the southeast is the warmest region that is suitable for Bordeaux varieties. Over the decade from Virginia to Long Island, the Bordeaux red grape varieties have quietly moved to center stage for red wines and if events directed at the improvement of these varieties, such as this VVA seminar, the Cabernet Sauvignon workshop held last year in Pennsylvania or the upcoming Bordeaux terroir symposium offered by the Outer Coastal Plain Association in southern New Jersey, it's pretty clear that there is some agreement that Bordeaux varieties are in our future. The challenge for everyone has been Cabernet Sauvignon which is on the outer edge of our growing season and also quite cold tender. Merlot seems to have settled in nicely and, while I am still not persuaded that Cabernet Franc can be at the core of any varietal or blend, it is certainly showing improvement. We understand so much more about the site selection and vineyard design, viticulture and wine making practices that will help to consistently bring these varieties to full maturity and extract all the goodness from the grapes, even in our challenging climate (see '03, '04, '09).

The Virginia Vineyards Association hosts a wonderful 3-day conference each year. I attended the Bordeaux varietals vintner/grower discussion panel and a presentation by Dr. Markus Keller from Washington State University on the physiology of fruit ripening.

Dr. Tony Wolf began by describing the viticultural characteristics of the Bordeaux red varieties. He has observed that there is typically a five degree difference in the winter injury threshold between CS and CF. He suggested that 1.5 lb/ft is a good yield expectation for Bordeaux red varieties.

The following are Dr. Wolf's comments about Bordeaux red grape varieties:

- Cabernet Sauvignon: late bud break, generally tolerant of some rain during ripening, good rot resistance, high wine quality potential, cold tender, demanding site requirements, late ripening can be a problem in short season (<170 days) areas.
- Cabernet franc: a parent of CS, good rot resistance, occasional poor set, superior cold hardiness to CS.
- Merlot: excellent fruit quality, extremely cold-tender, susceptible to bunch rot
- Petit Verdot: late ripening, best as a blending variety, greater cold hardiness than CS, rot resistant, high wine quality potential, tender shoots, can be very fruitful (4/shoot).
- Malbec: tendency for poor set (coulure), cold tender, often blended.

Viticulture issues facing the Bordeaux red varieties include leafroll virus, late season bunch stem necrosis, berry shrivel (as discussed later by Markus Keller) and getting the fruit to full maturity. To optimize quality, Dr. Wolf recommends obtaining clean and healthy planting stock, keeping existing vineyards free of infected vines, select a water limiting site (excellent internal and surface drainage features), practice crop control, especially with young vines, manage fruit exposure for enhanced color development and practice adaptable canopy management, training systems and vineyard floor management practices. The research that Dr. Wolf and graduate students Gill Giese and Tremain Hatch have done on vigor control methods with cover crops, root pruning and restriction have yielded good data that demonstrate opportunities to control vine vigor.

Dr. Bruce Zoecklein recalled a Bordeaux wine seminar in an earlier very snowy winter in1993, and some unpleasant but probably accurate memories of the wines, which he described as having excessive tannins, bitterness, vegetal aromas and at times, microbiological spoilage. In the 17 years since then a lot has changed for the better in red wines in Virginia but he acknowledged the limitations of enology as a science to produce fully-formed great wines – modern wine making often solves the easy problems leaving the more difficult ones behind. We need to start by understanding the balance between the science and the art and craft of making a wine. A simple sequence of events from vineyard to cellar in wine production: vine balance > fruit composition > co-extraction (color and tannin) > structure/texture integration > color-aroma-flavor-mouth feel balance. Wine quality should be pushed past technical competence and move towards excellence. Enology has fundamental limitations in how far it can take wine quality. Wine is a colloidal matrix, not simply a solution, whose qualitative features are as important as the quantitative. Anthocyanins (color compounds) are influenced by pH, oxidation, structure, age and cofactors, and affect the degree of tannin polymerization. Bordeaux wine making practices can influence tannin pigment polymers that affect mouth feel. The ratio of anthocyanins to tannins will impact the quality of wine. Grape color is a barometer of ripening and other variables that determine wine quality. Infra-red devices are being used to separate grapes by color at the crush pad, sorting table, etc.

Dr. Zoecklein's own notes from his presentation may better illuminate his ideas and are printed here with his permission. I am very grateful to him for letting me include them in this newsletter:

Bordeaux-Variety Red Wines: Where are we? Where do we need to be? Most premium wine crafters have established a winemaking philosophy and practices which reflect how they believe they can best reveal the expression of their vineyard sites each season. The goal is usually to create wines that delight, impress and/or intrigue (Smith 2010).

Where are we with regard to our understanding of crafting fine Bordeaux-variety red wines? What do we need to do to improve?

A look at some of the important viticultural and enological considerations reminds us of both the kaleidoscope of decisions required, and how rapidly our philosophy and practices have changed in the last 10 years, 5 years, or even the last 3 years.

Vineyard Issues

- Soil composition
- Drainage/water management
- Clone
- Rootstock
- Canopy architecture
- Crop balance, components of yield
- Rate of maturity
- Maturity date
- Degree of berry shrivel
- Extent of berry and cluster variation
- Potential alcohol

Winemaking Issues

- Fruit sorting
- Degree of berry breakage
- Destemming
- Post-destemming sorting
- Pumping methods
- Cold soak temperature and duration
- Yeast strain/co-fermentations/uninoculated fermentations
- Vessel size
- Vessel type
- Heat management
- Oxygen management
- Sulfur dioxide management
- Inoculated vs. non-inoculated MLF
- MLF strains
- Timing and duration of MLF
- Effect of pH adjustment on volatiles
- Cap management type, duration
- Timing of dejuicing
- Press fractions
- Lees management

For Bordeaux wines, the above variables can be distilled down to impacts on the following:

- Vine balance
- Fruit composition
- Effect on co-extraction
- Structural/textural stabilization

Each of these has an influence on component parts, including color, aroma/flavor, mouth feel and overall balance. The epistemology of our knowledge brings us to certain conclusions, as outlined by Smith (2010):

- Enology has fundamental limits.
- Wine is a colloidal matrix, not simply a solution.
- Qualitative features may be as important as quantitative.

Traditional enology has been useful in recommending how to make wines with few defects. However, it has done less to advance the understanding of how to promote excellence. As is frequently the case, modern winemaking has solved the easy problems and left behind the more challenging ones (Smith 2010).

We no longer look at color, aroma, and flavor as the sum of their pieces. That is, we view wine not as an analytical sum of its parts, but as a complex colloidal matrix, the components of which act synergistically and antagonistically. The colloidal nature of wine suggests that particles of different sizes and shapes interact to integrate aroma/flavor and mouth feel. The knowledge that wine acts like a colloidal mixture has promoted our understanding of processing impacts, including juice extraction, fining and filtration.

Within limits, the properties of wines depend less on their composition and more on their structure. That is to say, there are both quantitative and qualitative features. This is notably evident when it comes to the impact of phenols on mouth feel.

a. Color. What have we learned about wine color of Bordeaux-variety red wines? Anthocyanins are phenolic compounds which, when extracted from grape skins, help provide red wine color. Water deficiency increases anthocyanins and lowers malic acid, while the effect on sugar concentration may be variable.

We know that visible color is a function of an entire constellation of factors listed below (Figure 1), not simply the amount of anthocyanins extracted from the fruit.

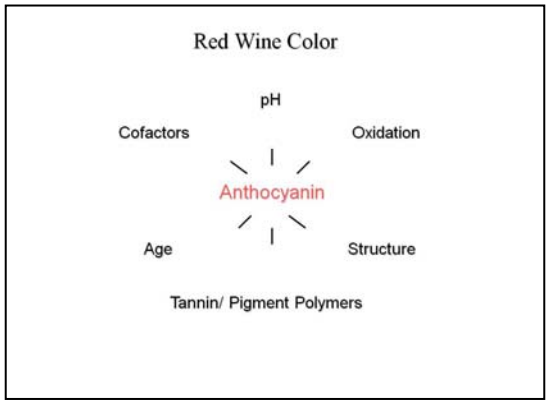

Figure 1. Factors influencing red wine color.
(Adapted, in part, from Kennedy 2008.)

Humans are very visually oriented. As such, wine color adds a bias to our evaluations. A classic example of this bias is to change the hue of a wine by adding varying concentrations of food coloring. If the red hue is diminished, the resultant wine will show a different sensory rating red or fullness, body and complexity. People believe that deep, rich-colored wines will have high volume/body and softer tannins. Conversely, it is assumed that a wine with less red color will have so-called 'green' or 'harsh' tannins.

Anthocyanins are critical to good red wine mouth feel. These compounds act as the "book ends" on the polymerization process, binding with tannins and limiting the degree of polymerization. As such, the ratio of tannin to anthocyanins is important (4 to 1). Anthocyanin polymers impact color, color stability, and wine mouth feel.

Colorless cofactors (Figure 1) create more color than would simply result from the anthocyanin concentration. This co-pigmentation phenomenon is perhaps more important for low-colored varieties than Bordeaux wines (see *Enology Notes* index).

What is on the horizon? While anthocyanins relate to subsequent red wine color, measurement in the fruit may best be used as a means of determining vineyard lot uniformity (see *Enology Notes #151*). Currently, we have sensors that can be used in the vineyard for measuring berry color. We have sorters that can take pictures of bins and segregate based on color. In the near future, we will have sorting tables that will separate destemmed berries based on color.

b. Tannins. What have we learned about tannins? There are several important positive correlations.

- Red wine quality (however defined) is correlated to total phenols.
- Red wine quality is more strongly correlated to skin tannins and, specifically, a certain group of skin tannins.

The global issue is balance, and how much tannin can be supported by the fruit perception in the wine. Tannin production proceeds prior to véraison, and maturation effects qualitative changes. Sugar accumulation rate is important to tannin development. Tannins are also influenced by a number of additional factors, including:

- Low nitrogen
- Low soil moisture
- Low soil fertility
- Moderate crop size
- High sun exposure

Tannin perception is a function of a number of features, including those listed (Figure 2).

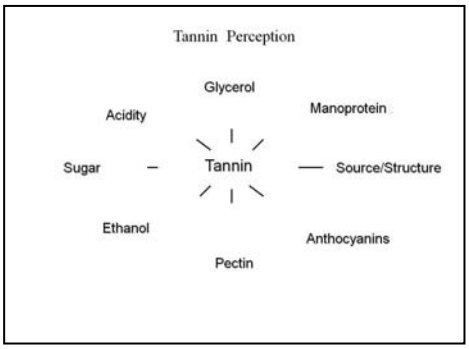

Figure 2. Factors influencing tannin perception. (Adapted, in part, from Kennedy 2009.)

As a function of processes such as délestage and controlled oxygenation, we have learned the art of building structure through controlled oxidative polymerization. The complete package has been our understanding of the advanced use of lees and completely re-thinking the role of barrels.

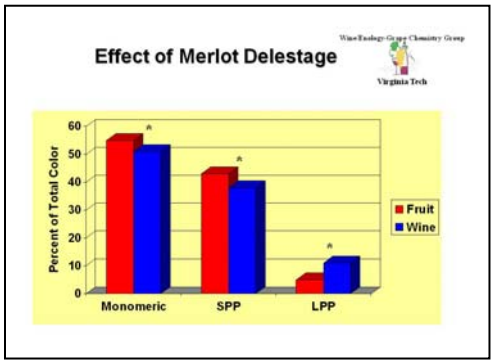

Figure 3. Polymeric pigments in Merlot.

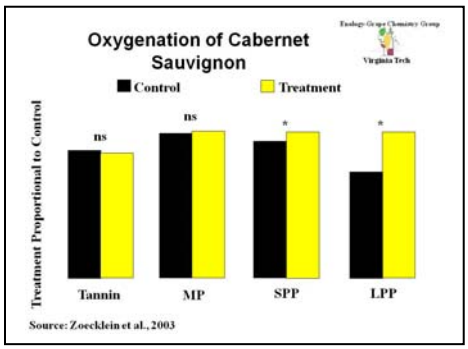

Figure 4. Tannins and polymeric pigments in Cabernet Sauvignon.

Figures 3 and 4, from research conducted in my lab, illustrate the impact of processing (délestage and oxygenation) on the association of monomeric anthocyanins (MP) with tannins to create small and large polymeric pigments (SPP and LPP). Color caps off the tannin polymerization, producing wines with finesse (see *Enology Notes* index for additional information).

What is on the horizon? To many, the Holy Grail is to have a tannin assay that is simple and that could be done at the winery. Such a measure could be of value in increasing our understanding of the relationships between grape growing, wine processing, and tannins (Kennedy 2010). A simple test that differentiates tannins, based on size and structure (including tannin-pigment polymers), would be ideal. It should be noted, however, that the perception of astringency is not simply a function of the qualitative and quantitative nature of tannin phenols, but each of the factors in Figure 2.

c. Aroma. What have we learned about red wine aroma? We no longer seek to simply pump up the positive attributes of the wine Aroma Wheel, and suppress the negative ones. Instead, we try to merge all the wine's aroma/flavor into a coherent whole. High-vigor vines and high yields can result in poor fruit chemistry, including high methoxypyrazines. We need to control growth by limiting water (when possible) and nitrogen, both of which can impact grape aroma.

Aroma measurement has been difficult for several reasons, including the complexity and variety of compounds and their concentrations. For example, while color and tannins are in concentration levels of parts per thousand to parts per million, aroma/flavor volatiles are often present in parts per trillion. This has made it difficult for winemakers to evaluate them. Currently, we use sensory evaluation techniques such as BSA (berry sensory analysis). These are subjective and, therefore, not easily quantifiable.

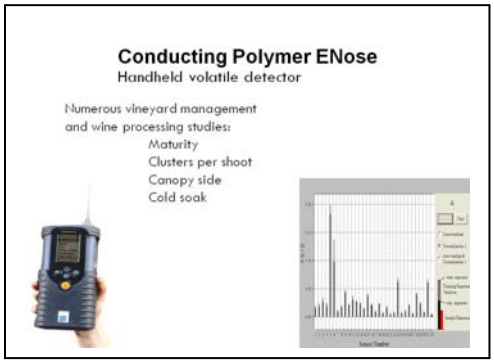

Figure 5. Electronic nose and sample "smell print."

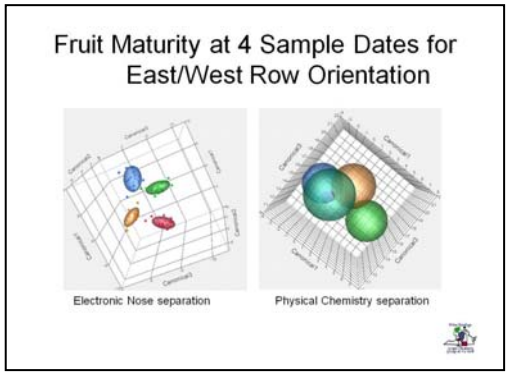

Figure 6. Canonical distributions of electronic nose and physico-chemical analyses.

We have used electronic nose (Enose) technology (Figures 5 and 6) as a tool to evaluate the impact of several grape growing and winemaking practices on aroma, including fruit maturity, clusters per shoot, grapevine canopy side, and cold soak. Figure 5 illustrates a hand held conducting polymer electronic nose and the 'smell-print' pattern it creates. Figure 6 (adapted from Devarajan et al 2010) demonstrates a comparison of 11 maturity indexes with the electronic nose evaluation of grape volatiles. These are canonical plots that represent the multivariate means of data as circles whose size indicates the 95% confidence limit of the mean. Non-interesting circles indicate signification differences. As can be seen, the electronic nose does a better job of discriminating and in vastly less time.

The use of such a tool allows us to monitor the impact of some viticultural and winemaking practices on volatile compounds (for additional information go to www.vtwine.info; see either on-line publications or *Enology Notes*).

What is on the horizon? We are working on a conducting polymer-based electronic nose system that has but a few (less than 30) conducting polymers specific to certain groups of wine cultivars.

d. YAN. We now understand the fundamental link between yeast assimilable nitrogen concentration (YAN) and wine aroma. Aroma is qualitatively impacted by juice nitrogen, both by too much and too little. For three seasons, the Enology–Grape Chemistry Group's Enology Service Laboratory has evaluated the N content of juice for the industry in real time, allowing for adjustments when needed (Figure 7). Such evaluations and focused adjustments have lowered the incidence of SLO (sulfur-like off odors) and increased the production of desirable aroma

volatiles. (For additional information go to www.vtwines.info. See either *Enology Notes* or on-line publications.)

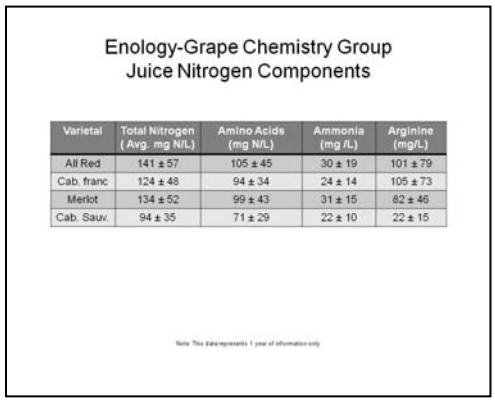

Figure 7. Juice nitrogen content.

What is on the horizon? It is postulated that YAN measurements could be a good barometer of the nitrogen status of the plant. Currently, our lab and others are evaluating those relationships.

2. Industry Challenges. As suggested by Grahm (2010) in order for the industry to move forward, not laterally, from one vintage to the next, we need to keep Ray Koch's famous remark in mind: "You cannot manage if you cannot measure." I would modify those comments, however, to suggest: You cannot understand if you cannot measure. *How much management* can be a philosophical debate. There is no debate that increasing our knowledge base has the potential to improve our wines. Our challenges in crafting fine wines include the resolution to these questions, adapted, in part, from Dokoozlian (2010):

- Vineyard management and fruit chemistry.
- What are the relationships between fruit chemistry and wine chemistry?
- What are the relationships between wine chemistry and sensory properties?
- What are the relationships between sensory properties and consumer perception?

The key driver is to link chemistry with sensory perception. To some, this mechanistic approach may seem *contra natura*, against their philosophical nature, too technocratic and against artistic winemaking.

However, this goes to the core belief that luck is the residue of design. Fine winecrafters should espouse to the general mantra: keep things as simple as possible, but not simpler. The answer to these questions allows such a practice.

How do we, as an industry, improve?

We must understand our goal(s).

In the environment of New World wines, we have two distinctively different products, as suggested by Soter (2009) and Grahm (2010):

- Beverage/industrial/*vins de efforts*
- Agricultural/*terroir/vins de terroir*

Beverage wines are products that are consistently made by a standardized process, and are designed to please most people. Such wines are referred to by some as industrial wines, or *vins de efforts* (Grahm 2010). The proliferation of wine additives and adjuncts allow for a certain homogeneity of such wines.

Agricultural wines, also known as terroir wines, on the other hand, can be characterized as having some uniqueness, subtlety, and avoidance of mediocrity.

There are those who believe that high quality wine can only be achieved by water deficit, suggesting that there is no terroir effect without water deficit. However, to Soter (2009), the way of differentiating is to simply ask the question: Could this wine exist in nature? The heart of this question is: What processes are acceptable to you? In order to understand the full potential of a variety, we need to be able to evaluate the full intrinsic potential of the grape.

We must also understand the difference between empirical or observational data, and science-based knowledge. We must understand the limits and merits of each.

As indicated, enology does not have all the scientific knowledge to promote excellence. On the other hand, secondhand empirical knowledge (also known as hearsay) is sometimes faulty, because what applies to one circumstance may not to another.

The question is one of relativism. What information is universal, and what information is specific to time, place, and circumstance?

As an industry, this distinction is sometimes blurred. An additional problem with relying too heavily simply upon empirical observations is that, if two outcomes are similar, we have a tendency to assume they must have a similar cause. This may or may not be correct.

This problem goes back to Francis Bacon and beyond, who reminded us, *"Genius is like fleet of foot, method is the right path. Fleetness of foot on the wrong path never leads to knowledge."*

We need to know what we know, and know what we don't know. That is a good definition of knowledge. And besides – it is what you learn after you know it all that really counts. BZ

Lucie Morton is a viticulture consultant based in Virginia with an international reputation. She said Virginia Bordeaux reds have grown from veggie juice to friendly wines to serious Meritage quality wines. No single viticulture practice or site condition will lead to good or great wines but some common characteristics of fine wine vineyards include exceptional air and water drainage, close to north-south oriented rows, low vigor rootstocks – in so far as rootstocks influence vine performance they are part of a field blending strategy, avoiding vines with wet feet (see drainage), using healthy plant materials, mixed clones when available and practical, 39" to 48" spacing between vines, spur-less bi-lateral cane pruning on a vertical shoot positioned (VSP) trellis system. Canes are less prone to overwintering diseases and this method of pruning can be an important part of an integrated pest management program. Uniformity in the vine and vineyard is a key to quality. Canes should be kept short to promote even bud break and uniform shoot length along the entire cane, ideally every shoot is the same length and diameter. Renewal spurs are not needed, especially on Merlot, which can be renewed from basal canes. *General Viticulture*, the old and classic standard viticulture textbook in California recommended 1.5 spurs (~3 shoots/ft) which is less than the current standard recommendation of 4-5 shoots/foot of trellis.

In humid-wet growing conditions, great canopy management is essential in Eastern vineyards. Keys to successful canopy management include: lateral removal in the fruit zone, reducing vegetal (methoxypyrazines) flavors/aromas, light leaf removal on the east side of the vine – but care must be taken not to expose clusters too much and risk sun burn and loss of aromatic compounds, and hedging as necessary. Crop parameters include average yields of 2.5-4.5 t/a, or 1-1.5 lb fruit/foot of trellis. A well-trained harvest crew is essential because sorting for wine quality begins in the vineyard, followed by trained helpers on a sorting table prior to the destemmer. This is an important method used by successful garagiste producers in Bordeaux to raise the quality of fruit from secondary vineyards to a much higher level. Just looking at the bin can reveal a lot about the quality of grapes in them, with or without an IR reader or electronic nose device. Finally, high quality wine barrels are necessary.

Lucie and I debate the relative merits-dilemmas of vine vigor, too much, too little but rarely, it seems just enough. Lucie doesn't want growers to fear the "vigor monster." She explained that vine vigor is really a state of mind. Eastern growers have "vigor phobia" which has evolved in our viticultural culture. There is a device to tame the monster called a hedger that removes calories from the fat vine. Virginia can do high density vineyards as they do in Bordeaux where it also rains. Rain and humidity are part of our viticulture reality and together they promote vigor but growers should not get stuck on it and get down to managing it. Some of management tools include rootstocks, cover crops, and hedging. Vigor will lessen over time so manage it until the vines come into balance. While a healthy vine is not necessarily a vigorous vine, adequate vigor needs to be maintained to be resistant to diseases and cold, and assure longevity. When new vineyards are planted, the first two years are very important to controlling vine vigor. At a vineyard she works with the CS 341 on Riparia Gloire (RG) is less vigorous than Merlot 181 on RG. CS seems to be more sensitive to rootstock influence. 5BB and SO4 are more vigorous than RG and should be used with care. She gave the example of vigorous Merlot vines that grew during a rainy period but when the sun came out growth slowed, leaf removal opened the fruit zone and the wines were excellent. Don't panic at the site of vigor but develop a strategy to get the vines under control. Cabernet franc is particularly susceptible to uneven ripening within the cluster and between clusters but it can catch up if vines are healthy and allowed sufficient

ripening time on the vine. The fruit is part of the canopy, manage it, too. Do not let clusters touch – this helps to lower disease and shading problems. Merlot has a lot of secondary clusters that should not get into the wine. Rootstock selection is important to vine performance. 101-14 vs. 1103P will have dramatically different characteristics.

An example of early vine training for Bordeaux red varieties includes 7' x 4' (1900 vines/ac), in the second year train to four shoots per vine (on 101-14) and keep fruit to balance the vine. Planting vines closer together encourages deeper rooting, whereas wide spacing will keep roots shallow. Competition between vines is mainly for light, not for roots. Prune 4-12 shoots/vine. At one vineyard 3 t/a was harvested on 2 year old vines and the wine won awards. The vines were in balance. By the fourth year the vines should be in balance and the vineyard should be in maintenance mode.

Clones are very important to wine quality. Early plantings of Cabernet franc clone 2 on SO4 were infected with leafroll virus which affected the wine quality. LRaV 2 doesn't affect ripening as much as LRaV 3. She cautions that if CS 337 does not develop red leaves, it may not be the correct clone (possibly clone 15). New clones often have smaller berries and other favorable wine quality characteristics. In general, wine quality favors small berries and clusters, low soil fertility.

- Cabernet franc clones include 214, 312, 326, 327 and 623. Lucie would recommend planting 50% 214.
- Cabernet Sauvignon clones include 169, 191, 337, and 341.
- Merlot 3 is reliable and holds up. 300 is also very good. 15 and 181 are the same and very high quality. Other clones are 182, 343, 347 and 348.
- Petit Verdot is likely FPS 2 or clone 400 but new and better clones are coming.
- Malbec 598 has big berries and is more suited to hot climate.

Jim Law is the proprietor at Linden Vineyards in northern Virginia. Linden is a cool site at 1300' elevation. Cabernet Sauvignon is has favorite grape and the foundation of his wine program at Linden. Over the years he has learned where Cabernet Sauvignon performs best on his site, he is strong believer in matching variety to terroir. He noted that CS can be either very good or very bad but when it is good, it is often hard to tell the difference between a right bank Merlot-based wine from a left bank CS-based wine – ideal ripeness tends to pull the sensory characteristics of the varieties closer together. One stunning example of the influence of soil vs. variety is a trial of three varieties on three soils at Chateau Cheval Blanc. Among the nine wines, varietal differences were far less noticeable than striking differences between wines grown on sand, gravel or clay.

Jim believes that steep slopes with rows up-down (not across, unless safety is an issue) are an important contributor to wine quality. Vines have fewer problems when growing on slopes and performance is enhanced across varieties. Shedding water is the key to this qualitative gain. He has found that Merlot performs well in clay (see Petrus) but CS definitely prefers a rockier soil. The PV tends to get placed anywhere that Merlot or CS cannot grow. His highest quality grapes come from fully ripe grapes that have just achieved the ripening threshold. October 20 is his magic date at Linden, if the grapes have to wait until after this date to be picked, they probably

will not be ripe enough to make a great wine. Jim doesn't like it too warm either - fruit harvested in September tends to lack color and finesse and is marked by rough tannins. He is always striving for a balanced vine and, for the Bordeaux reds, the less vigor the better. He tries to fill up the canopy and not have open windows but also minimize hedging – one light hedging and some modest regrowth is ideal. Most importantly, the shoots must stop growing at veraison. This is the big challenge in September if rains arrive. Jim tried dealing with vigorous vines by using the Lyre system, then removing every other vine and still the vines were too big.

Cover crop has been an excellent tool to adjust vine vigor but it is a challenge to fine tune cover crop use because seasons and vines vary so much and the misuse of a cover crop can do as much harm as good. The intention of the cover crop is to help balance the vine. Canopy management includes strict shoot thinning on Bordeaux reds to 2 shoots/foot of trellis. Jim stated that his shoot thinning practice is more important than pruning. Shoot positioning is an absolute necessity in a wet climate. Leaf removal is done at bloom with a quick pull of the east or north side but then no more. In September, depending on how the vintage is developing, he will strip the leaves around the fruit zone to get heat to the clusters, which helps to balance the acid and reduce green flavors. CS and PV are always pushing the limits of ripeness at Linden. He is comfortable with 1 lb/ft for red Bordeaux varieties but especially with CS. Vine density is 1500-2500 vines/acre. He strives for a healthy vine on the highest density possible.

In his wine making he is seeking a more extracted style of wine. He has learned over time not to be afraid of the wine. Ripeness in a California wine is of a very different nature than wines from Bordeaux or Virginia. For example, in Bordeaux green seeds are okay, but never in Napa. He sorts grapes manically, four times from vine to fermenter. Grapes from vines with red leaves are not picked or unripe clusters/berries or clusters with bunch stem necrosis. He has found out that botrytis cannot be tolerated in fine Bordeaux red wine making. An experienced crew starts the sorting on the vine and grapes are sorted again before the destemmer. With CF pink berries are especially unwanted. The third sort is done after the destemmer by a vibrating table where shot berries, stem jacks and stink bugs are kicked out.

Extraction is the attempt to get the most goodness from the berries that survive the sorting process. A five-day cold soak at 8C is normal, followed by a 7-10 day fermentation period and a 10-day post fermentation maceration period. The five-day soak is an average based on sensory characteristics of the must. Color (as BZ stated) is an indicator of quality and after 3-4 days a shift in color intensity occurs as it changes from pink to a deeper red and flavors evolve from tooty-fruity to darker fruit. During extraction they look for tannin and weight in the juice. Yeast is added after the cold soak. Jim doesn't place the emphasis on yeast that many other do and has used native and commercial yeasts. Wine is tasted for extraction and flavors every day. Samples are kept so comparative tastings can be done to measure progress, or lack of it. Jim is using more oak in his Bordeaux reds, up to 50% new oak for his Hardscrabble. He says that Bordeaux reds love oak but commented that the '09 we tasted was over-oaked, but young red wines should be over-oaked and reduced, the reduction guards red wines, helps to keep it fresh and will always blow off later. Wines are racked 1-2 times and returned to new barrels. In the second year they rest in puncheons through a few cycles of warm and cool that help to eliminate the "ya-yas" from the wine.

Declassification was a critical quality advance for Bordeaux wines in the 1970s. Being able to not put average wine in the best wine blend was a huge step in making better wines. Prior to this practice, even the top wines were sometimes green and light. In this final sorting step, the lesser wines are removed through a constant process of analytical tasting and culling out what doesn't fit the style.

The Octagon meritage blend from Barboursville Vineyards is undoubtedly one of the best Bordeaux red wines (or any type of wine) made in the East. At 165 acres located north of Charlottesville, BV is among the largest estate vineyards in the East. Luca Paschina is the wine maker and Fernando Franco is the grape grower, and together they are one of the most talented wine growing teams I have ever met. The new blocks at BV are planted on 8' x 3' spacing, bilateral cordons, and yields are 2-4 lb/vine. Yields have become lower in the last 10 years but still vary according to variety. In the past vines were too vigorous and site selection and variety assignment was poor. Now only the correct varieties are planted on a particular site, i.e. CS must go on a CS quality site. His advice is to ignore the market and plant what is most appropriate to the site. Merlot is easier to find a soil than CS and because of the availability of high quality Merlot, Octagon is a Merlot-based wine. CS is a vigorous vine that requires lots of hedging, but will never make as good a wine as a naturally balanced vine. In 2004 (a very wet year) the vines were hedged eight times. On new sites CS produced very good wines in the early years but then quality dropped because of excessive vigor, now it is under control but still not producing the best wines. Planning ahead will help to avoid the need for viticultural band-aids later on but correct rootstock and clone can help to control vine vigor. Leaf removal is an important practice – the east side heats up and it is important not to remove too many leaves. Timing is important and the sooner the better, usually after fruit set using an Avidor. Removing leaves early helps to reduce sunburn problems.

Fruit thinning is done to adjust and optimize yield and according to vintage conditions, such as quality of fruit set or uniformity of color at veraison. Slow clusters will never catch up and should be removed. Two passes are made, the first to adjust crop level and the second to remove fruit that is lagging behind in ripeness. Weak shoots, which are often secondary shoots, are removed from the vines. His preference is for cane pruning which yields more uniform shoots but acknowledges that cordon spur is easier to prune and manage. BV is divided into 42 separate blocks and each is managed uniquely, such as nutrition needs. The biggest pest challenges in the vineyard are wildlife and viruses.

In 2000 the Nebbiolo seeds were bright green but today the wine is beautiful. Merlot is often picked between 20-27 of September. CF comes off early-mid October and CS is always after mid-October. As Jim stated, after mid-October, it is unlikely that fruit will ripen. Luca does not like warm seasons, like 2001, that hasten ripening too quickly – the wines lack elegance, display more bitter tannins and lose aromatic quality. Merlot at BV almost always ripens fully.

Chris Hill consults for some of the best names in the Virginia wine industry including Keswick, King Family, Veritas, Pollack and others. Many of the sites grow large vines on divided training systems but a balanced vine always has a shot at making very good wine. Chris grew the grapes for a Michael Shapps meritage. Blending shows the wine maker's style and goal through the aromatic and structural qualities of the wine. In Virginia, CF is an important variety but so is

PV, which he says is underrated and a very consistent performer in the vineyard and cellar. Merlot has soft tannins when fully mature with no green flavors, offer structure and mid-palate depth and shines in a meritage-type wine. The ’07 is 50% CF, 30% Merlot and 20% PV, 2 years in French oak (50% new) and is made from fruit from Pollack, King, and Carter Mountain. Michael wants vineyards with well-drained soils, good sun exposure and vines that are in balance without green flavors.

Chris adds that having a south slope helps to promote fruit ripening and having the vines in the sun all day long (no trees or hills blocking the sun). He believes in getting vines into balance with good canopy management, fruit gets filtered sunlight and not over-cropping vines. Many of his vineyards are on vigorous sites but they get excellent sun exposure and the vines, while big, are in balance on a ballerina system with yields ranging from 3.5 to 5 t/ac, 10’ x 7’, cordon/spur with 20-24 nodes and yield adjustment. They try to get good basal bud exposure. Vine spacing and trellis aren’t as important if the quality of viticulture management is outstanding. Whatever the system you choose, manage it properly and keep the crop load down.

The wines presented were uniformly very competent, if not on the verge of exciting in this category, and they certainly demonstrate great progress in quality. In my experience at the Virginia Governor’s Cup tastings, red wines were often light in color and body, green, lacking complexity and, while technically correct, not exciting. These wines are a vast improvement. For depth and complexity I prefer the Linden Hardscrabble. For elegance the wine of Michael Shapps was smooth as silk. For overall balance and delicious fruit it is hard to beat any of the wines made by Luca Paschina at Barboursville. The Sweeley Estate showed well but needed more stuffing that will come as the vines and methods mature. Comparing and contrasting the viticulture and vineyard sites is the intriguing exercise behind the wines. They range from moderately high density, VSP, hillside to deep, fertile soils trained to a divided ballerina system - you couldn’t ask for a more stark contrast. Yet the growers and wine makers were able to make wines of distinction under highly variable conditions and management practices.

1. 2009 Linden Hardscrabble
2. 2006 Linden Hardscrabble
3. 2008 Barboursville Merlot
4. 2007 Michael Shapps Meritage
5. 2006 Sweely Estate Meritage

It takes vision and investment to do what Virginia is doing. The land grant, governor, legislature, departments of agriculture and tourism, restaurants and retailers and, perhaps most importantly, the local wine consumers, must see the possibilities in a thriving wine industry. Most of all, it takes hard work and leadership in the wine industry to guide itself forward into a successful future. Virginia has not arrived yet, but it is certainly going in the right direction.

Tony's take home points:

- 17 years from '93 to '10 have seen a lot of progress in the production of Bordeaux variety red wines in Virginia
- Rootstocks are more important and Riparia Gloire and 101-14 are more widely used
- Excellent soil drainage is critical to Bordeaux red wine production
- Slope and aspect are also significant contributors to quality
- Clone selection can impact quality
- Vine density has increased and resulted in improvements in vineyards yields and wine quality
- More growers are using head trained-cane pruning
- Uniformity of fruit exposure is necessary
- Vine health is a factor. In '93 crown gall was the big problem, now it is vine decline and leafroll virus.

Reference resources – Tony and Bruce have outstanding web sites and e-newsletters that I consider essential reading for all serious Eastern wine growers. They also offer workshops that are well worth the effort to attend. A tour of selected wineries and vineyards in Virginia can yield a tremendous amount of practical information and ideas in grape growing, wine making, wine business and marketing.

Dr. Tony Wolf, viticulturist, Virginia Tech: http://www.arec.vaes.vt.edu/alson-h-smith/grapes/viticulture/index.html

Dr. Bruce Zoecklein, enologist, Virginia Tech Enology Group: http://www.vtwines.info/

Virginia Vineyards Association: http://www.virginiavineyardsassociation.com/

Virginia wines (VDACS): http://www.virginiawine.org/

Dr. Markus Keller is the Chateau Ste Michelle distinguished professor of viticulturist at the Washington State University Irrigated Agricultural Research Experiment Station in Prosser Washington. He has just written a comprehensive guide to grapevine anatomy and physiology called *The Science of Grapevines.* Dr. Keller began with a slide that displayed these popular wine principles:

- Lower yields > Better quality
- More stress > Better quality

These relationships cannot be explained quite so easily. Yields have been correlated to Sotheby's vintage ratings and if the relationship is extended to its logical conclusion, then the best wine is made from a vine with no fruit on it. Yield and quality data do not correlate exactly but the variations used to be much greater and, in fact, with improvements in viticulture both yields and quality have increased.

Here is what we want as grape growers:

- Balanced vines
- Ideal microclimate (vine canopy)
- Open and productive canopy
- High yield and high quality
- Low disease pressure
- Vineyard access and mechanization

To achieve these goals we have these tools in our viticultural toolbox:

- Site-variety-clone selection
- Trellis design and training system
- Pruning strategy
- Nutrient and vineyard floor management
- Water management
- Canopy management

Influencing berry function, too much or too little heat can slow the ripening process. Temperature is a vital contributor to ripening and trumps crop load – nature has more influence than nurture on some grape growing goals. Water enters the berry and returns back to leaves via the xylem and phloem, and is lost through transpiration. The phloem brings nutrients to the berries. At 9-10 brix color change is initiated in berries (veraison). Berries can accumulate soluble solids to a physiological maximum of 25 brix, any additional sugar is a result of evaporation (for each 10% of reduction in berry weight results in a 2 brix increase). At veraison the phloem flow increases and xylem is reversed. Before the seeds are ripe (pre-veraison) the acid (sourness) in the berries deters birds. During ripening mostly malic and tartaric acids are produced. The conversion of malic to CO_2 is very sensitive to temperature and will degrade faster with higher temperatures.

Arginine (not proline) is the most important form of nitrogen for yeasts. After veraison, the flow into the berry changes from the xylem to the phloem so nitrogen cannot enter the berry which can lead to lower levels of yeast available nitrogen necessary for a clean fermentation.

Phenolic compounds in the berry include anthocyanins responsible for berry color and tannins, those scratchy compounds that are another early defense against bird attraction. After veraison phenolics polymerize into longer chains and there is no additional phenoloic production. Flavanols are a kind of phenolic compound that provides a sunscreen to the berry skin to help prevent sunburn by ultraviolet light. Phenolic synthesis is sensitive to nitrogen status, temperature and light so it makes sense to manage these inputs. There are hundreds of volatile compounds in wine which are responsible for the complexity that give wine writers something to write about, including monoterpenes in Riesling and Muscat varieties, methoxypyrazines, and norisoprenoids. They do not volatilize until the fermentation process is started and you can't smell monoterpenes in juice. The wine maker who is wandering through the vineyard tasting berries and claims to taste or smell the essence of the variety has a vivid imagination. Most flavors are locked up in the berry, waiting for release in the wine making process. Taste is mostly limited to sweet and sour flavors. A low nitrogen diet with regulated sun exposure will help to enhance color and phenolic development in the berry. The best way to degrade color in Pinot noir is to apply a lot of nitrogen in the early season and then remove excess vegetation. Adding too much nitrogen will exacerbate vine vigor and create more disease problems, especially with powdery and downy mildews. Nitrogen drives yields, light drives quality. Keep them in balance.

Physiological maturity is when the seed is ready for germination, not when it is crunchy or brown and telling the wine maker to "pick me." Physiological seed ripeness is at veraison. Malic acid and methoxypyrazines degrade soon after veraison along a shallower curve. Terpene compounds accumulate later but also volatile phenols that can result in brettanomyces at higher pH.

Temperature has a big effect on ripening. Optimum range is quite wide at 68F to 86F. What matters most to berry physiology is the tissue temperature, not ambient air temperature in and around the canopy. Skin temperature can be up to 25F warmer than ambient and sunburn or color/aroma degradation can occur if the berries get to hot. The sun side of the vine evaporates water and the late afternoon or evening side can cook the berries in hot regions. Leaf removal should be practiced according to the temperature profile of the vineyard, influenced by row direction, canopy dimensions, trellis system, fruiting wire height, etc. In general, leaves should be removed on the east or north sides of vines for morning sun and shade provided on the warmer sides. Berries need to acclimate to light so leaf removal should occur shortly before or after fruit set. If white varieties get too hot it may cause bitter flavors to develop. Chardonnay tends to be a more forgiving variety, do not overexpose white grapes.

Terroir is all about the availability of water over time and space. Soil moisture determines vine vigor and hence canopy density and yields. All chemical compounds are affected by water and the berry itself is 70 to 80 percent water at harvest. Do not let the berries dry out. The xylem connection between berry and rachis is closed at veraison. If this happens does rainfall or irrigation affect berry size and weight and water content after veraison? Experiments using irrigation demonstrated distinct swell-shrink cycles before veraison and no change after veraison.

Irrigation nominally prevents berries from shrinking after veraison and a grower cannot "pump up" a berry after veraison using water absorbed from the roots. An experiment with vine roots in a closed pressure chamber was able to force water up into the vine. At pressures as high as 10 bar water did not enter the berry even though it exuded out of the leaves! The threshold for uptake into the berry is 15-16 brix, after that there is no berry response to soil moisture. Instead, berry size can be affected by rain, humidity, or sprinkler irrigation which allows for direct movement of water across the berry skin and will leach sugar from the berry. In this trial, Concord took up water more readily than Merlot. The take home message for a region with harvest rains is to protect cluster from rain by keeping leaves over the clusters.

Crop load will affect quality and fruit color, generally as yields decrease color will intensify. Syrah color is especially influenced by yield, Pinot noir much less. The best response to yield is at the low end of the spectrum. It takes one leaf to feed 5-10 berries. Too much leaf area creates shade which can delay ripening. Growing shoot tips after veraison compete with berries. Stop shoot tips with moderate water stress prior to veraison. When adjusting yield wait as long as possible to thin red varieties, early thinning will promote shoot and lateral development. Cutting the bottom third of flower cluster at bloom will help to elongate the cluster and reduce rot problems.

Here are Markus' ideal vine qualities:

- Shoots/canopy length — five per foot
- Shoot length — 3-4 feet (~15 nodes)
- Lateral shoots — 5-8 buds per shoot
- Pruning weight — 0.2 to 0.4 lbs/foot
- Cane weight — 20 to 40 grams
- Leaf area/fruit weight — 10-15 cm^2/g
- Canopy gaps — ~30%
- Fruit exposure — >50%

All of these physiology and anatomy facts and principles are in Dr. Keller's new book: *The Science of Grapevines: Anatomy and Physiology*. 2009. Elsevier/Academic Press. You can order a copy at www.amazon.com/

In his second presentation, Dr. Keller talked about why things sometimes go wrong in crop development. We are familiar with many of the environmental, physical and physiological culprits, from poor bloom-set that leads to a short crop (see almost any variety in 2009), cold/frost injury and predation by everything with two wings or two or four legs. Water and nutrient stress can affect fruit set adversely. Growers need to be careful about managing stress contributors like cover crops and vine nutrition. Bunch stem necrosis (BSN) has been a problem in red varieties for many years and the cause is still not clearly understood. A recent problem that is widely experienced in Europe, California and has appeared in Eastern vineyards is berry shrivel (BS). The two can be easily confused. With berry shrivel, the grape stop producing sugar and begin to wither on the vine. It can sometimes be confused with sunburn. But these grapes cannot make good wine. You can learn more about berry shrivel at http://matthews.ucdavis.edu/BS.html and http://wine.wsu.edu/vinevoice/2009-09-24.html.

Fruit set was a big problem in Eastern vineyards in 2009 with Cabernet franc particularly affected. Dr. Keller offered these elements of yield that growers should be aware of:

- Pruning level – number of fruitful shoots
- Bud fruitfulness - number of clusters
    - Optimum: high light (>1/3 full sun), warm temperature (68-86F), adequate water and nutrients and open canopy
- Bud break – number of flowers
    - Optimum: high reserve status, cool air, warm and moist soil
- Bloom/fruit set – number of berries
    - Optimum: large leaf area and above
- Cell division/expansion – berry weight
    - Optimum: seed(s), optimum temperature (77-86F) and above

Granted that many of these conditions are beyond the control of the grower but knowing these physiological parameters can aid in site selection and canopy management to improve yields and quality.

You can read more about Dr. Keller's research and find a list of publications on his web site: http://winegrapes.wsu.edu/markus.html

I would like to thank Dr. Tony Wolf and Ms. Kay Thompson for their invitation to attend the VVA conference and for their hospitality during my visit.

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