Bruce Zoecklein

The Electronic Nose Knows

Handheld technology measures grape maturity

By Tim Patterson

In the field, a handheld electronic nose measures grape maturity. A bag surrounds a cluster and contains the volatiles.

Of all the issues wine producers have to worry about, determining grape maturity may be the one that gets the most concentrated attention and carries the highest stakes. Picking decisions at harvest time can make or break a vintage, reinforce or contradict a winery's established style, or force a lot of scrambling and improvisation in the cellar. As a result, there are dozens of competing approaches out there for defining maturity, from Brix readings to seed color, all of them useful to some degree but none a magic bullet. More and more, winemakers declare that they "pick on taste"—an attractive idea, but maddeningly hard to define.

Into this stew, some researchers are trying to introduce a whole new track: Have a machine give the answers. Electronic noses, technology that captures the presence of volatile aromatics from grapes on the vine, are getting put to work on the elusive problem of grape maturity, with promising results. Enoses have the potential to measure maturity in the vineyard, without any fruit destruction and without elaborate lab procedures, in a matter of seconds. Their use could reduce subjectivity in decision-making and even ultimately prove cheaper than having a small army of enologists running tests.

Electronic noses have been getting attention in many sectors of the food processing industry since the first equipment came on the market in 1999. Many of the applications have had to do with detection of food spoilage (for example, in dairy products and fish), hazardous substances and certain medical conditions that have odor signatures. These uses have spurred the development of more, better and cheaper equipment in a very short time span.

At the forefront of research on applying Enose technology to wine is professor Bruce Zoecklin and his lab at the Virginia Polytechnic Institute in Blacksburg, Va.

Highlights

- Electronic nose technology offers an interesting addition to the ongoing debate over how to measure grape maturity.
- Electronic noses can be trained to measure volatile aromatic compounds in grapes.
- Enoses do their work in the field in a matter of seconds, do not require sacrificing any fruit, and operate with consistent objectivity.
- Enose technology, already in use in other food processing industries, is not yet ready for direct commercial application, say researchers.

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The Enology-Grape Chemistry Group that Zoecklin heads has been working with several Enoses for more than three years, refining measurements, exploring the capabilities of the various machines, and constantly comparing their results with the standard numbers from familiar wine lab tests. Things are going well enough that, as Zoecklin notes, "The main question I get asked when I do presentations for growers is, 'Where can I buy one?'"

What the Enose knows

Several flavors of electronic noses, costing somewhere between $5,000 and $10,000, are available, and Zoecklin's group has worked with all of them. The basic differences among the Enoses have to do with how the sensors work, variously relying on quartz crystal oscillations, thin conducting polymers, metal oxide, and surface acoustic waves. All of the machines have to be trained (just like enologists) with a baseline "smell print" to recognize that a certain change in, say, electrical resistance indicates the presence of some functional group of aromatic compounds. Zoecklin and his graduate students put the Enoses to work looking for several kinds of grape-derived aromatic compounds—terpines, volatile phenols, isoprenoids and nor-isoprenoids, and so on. Some machinery simply gives an overall, summary rating for the presence of desirable, maturity-indicating aromatics, others generate more detailed results, compound by compound, with readouts similar to gas chromatography—but in 10 seconds, in the field.

The Enoses Virginia Tech has employed are hand-held, self-contained units; no other lab equipment is needed, except for comparisons with other maturity indicators. In the field, grape clusters are wrapped in plastic bags to contain the volatiles, and the Enose is inserted to get its readings. No fruit has to be picked, no berries have to be crushed, no juice separated from the solids.

Zoecklin's group has done extensive comparisons with nearly a dozen standard physical and chemical measures of maturity—Brix, berry weight, pH, titratable acidity, total phenols, total anthocyanins, absorbance units and groups of aroma/flavor precursors. The machines do as well as or better than the physical/chemical measures, individually or collectively, Zoecklin says.

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One advantage of measuring volatile aromatics is that these are the very characteristics winemakers are looking for in their grapes, a process quite similar to "picking on taste." Winemakers ultimately care about how a wine smells and tastes, not about its pH or the berry weight of the grapes. The standard physical/chemical measures are a step removed from the prime attributes; with a little practice, the Enoses go right to the heart of the matter.

Zoecklin says the sensitivity of the Enoses is quite good. They can distinguish among grapes at different weeks in the final maturation phase, and can tell the difference between clusters on alternate sides of a trellis system, even when the physical/chemical measures are identical. This suggests a great potential for helping detect and deal with uneven ripening. There are also clearly potential uses for sniffing wine as well as grapes, ranging from measuring the degree of typical

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Enose Achieves Same Deviation With Only One Sample

Figure 1: Canonical Plot of Physical/Chemical Analysis

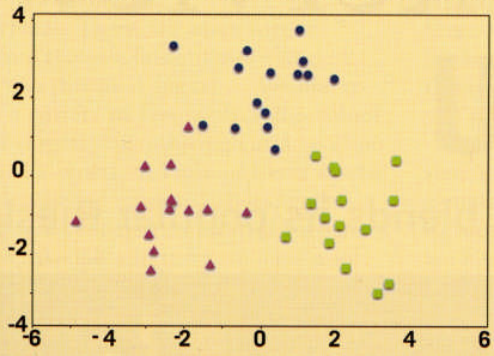

Figure 2: Canonical Plot of Enose Measurements

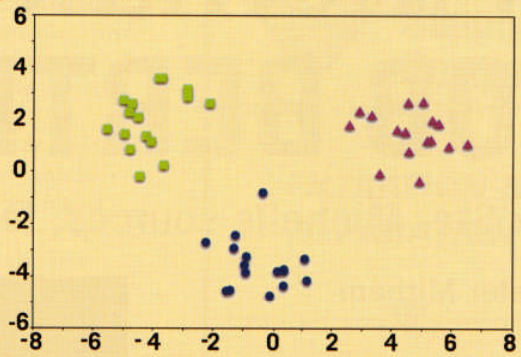

Figure 1 is a plot of all the chemical analysis data (10 maturity indices) for grapes sampled at 18, 19 and 20 weeks after bloom. The units on the axes don't measure anything about grapes, but are units of standard deviation, basically describing the statistical distance between observations. The samples cluster together according to sampling week; the different weeks are spread far apart.

Figure 2 is the same type of plot for the electronic nose measurements of headspace volatiles for the same samples. The Enose produced the same degree of separation with only one measurement per sample, unlike the 10 procedures needed for the standard measures. *Data from Athamneh and Zoecklein, 2007, Virginia Tech Enology - Grape Chemistry group, vtwines.info.*

regional character to alerting winemakers to spoilage issues in the making.

Zoecklin and his group see themselves as involved in applied research, with practical implications and applications clearly in mind. Their current work is focused on refining measures and methods, and sorting out the capabilities of the various machines that are available. As well, they put time and effort into popularizing the concept of using Enoses for measuring grape maturity, through grower presentations and conference talks, most recently the American Society for Enology and Viticulture meetings in Reno last June.

Virginia growers have so far been very receptive. In a competitive wine market in which raising quality and minimizing costly mistakes are critical, anything that can give a grower an edge is worth considering. Particularly for growers with large plantings or a diversity of grape varieties and vineyard sites, Enose technology could be cost-competitive as an alternative to multiple, laborious, time-consuming lab procedures.

Zoecklin isn't ready to certify the Enose as ready for prime time, but stay tuned. W&V