WINERY DESIGN PART THREE

Integrating Form and Function

"If you want to understand the point, observe the circumference"—Johann Goethe

Story by Dr. Bruce Zoecklein

According to humorist Dave Barry, the most important part of any winery is the pretentious phrase room. It is here that the most critical part of winemaking is performed, namely thinking of descriptors to make fermented grape juice sound more complex than nuclear physics.

The complexities of winery layout and design, including the pretentious phrase room, can seem overwhelming. In developing the calculus, Newton understood the difficulties of tackling complex problems. He made use of the principles of Descartes: when a problem seems too big or complicated, break it down into smaller, less complicated features. This is the principle of calculus. With that in mind, the complexity of winery layout and design—including equipment integration and energy and water use calculations—can be divided into small component parts to enhance the planning process. The following is a review of some development considerations adapted from Winery Planning and Design, Zoecklein, 2007 (information available at www.vtwines.info).

BRUCE ZOECKLEIN *is head of the Enology—Grape Chemistry Group at Virginia Tech University. For information regarding programs and activities, including receiving their free electronic technical brief, Enology Notes, go to www.vtwines.info.*

THE BIG PICTURE FOR WINERY DESIGN

Winery layout can be broken down into the following general-use areas. While many wineries do not have these areas as distinctly separate spaces, it may be easier to review them as such for design and planning purposes. Each should be considered with an understanding of size, equipment, energy, water, waste, and overall integration.

- Raw Product Handling
- Fermentation
- Storage
- Laboratory
- Bottling
- Warehousing
- Tourism/Administration

Flexibility in design and layout should be

At a Glance

- Winery layout can be broken down into a few major general-use areas.
- Flexibility in design and layout should be incorporated to facilitate future growth.
- Process flow, or line models, that include all equipment and how they relate is an essential planning tool.
- Creating energy-use models provides insight into overall energy required and where possible losses could occur.
- Refrigeration is the most important energy consideration in the winery.
- Determine which of the winery areas will be fully enclosed.
- Caves can provide a natural, constantly cool and humid environment, while expending little energy.
- Caves can impress people and, as such, they are not simply a natural thermal system, but a marketing tool to enhance visitation and image.

incorporated to facilitate future growth in production volume and changes in processing techniques. As outlined in a previous edition, production philosophy and practices have changed as a result of advances in knowledge and technology. This trend will continue, suggesting the need for designs that allow for flexibility. Incorporating design flexibility and an understanding of how winery areas relate helps to assure processing and energy efficiencies. Such an understanding is best accomplished by creating process flow models.

PROCESS FLOW

Process flow, or line models, that include all equipment and how they relate is an essential planning tool. This aids the planning process by creating an understanding of optimum or available capacity and changes over time. Conditions such as temperature flow rates and residence times at all pieces of equipment can be calculated. Such reviews can be created for specific wine styles. For example, hyper-reductive winemaking techniques, cryo-extraction, vin santo-style, etc., each impact flow rates and space requirements differently.

Process flow models should include the integration of appropriate equipment. Winery equipment categories include the following:

- Harvest containers
- Weight scale
- Fruit dumping system
- Grape inspection table, pre-destemming sorter, post-destemming sorter
- Grape elevator
- Destemmer/crusher
- Fermentation vessels: bins/tanks/bags/barrels, concrete
- Presses
- Must pumps
- Must lines
- Tank mixers, irrigators, washers
- Barrel washers
- Transfer pumps
- Transfer lines
- Storage vessels/tanks/barrels
- Forklifts
- Filters: plate and frame/pressure leaf/membrane, and possibly cross-flow
- Laboratory equipment
- Bottling equipment

ENERGY USE AND FLOW MODELS

Creating energy-use models provides insight into overall energy required and where possible losses could occur. This is of great importance to the wine industry as we desire to save money and follow sustainable practices. Using an equipment spreadsheet, based on flow models described above, helps to identify overall energy demand per unit (gallons/hL, tons of fruit, cases of wine, etc.), space requirements, and process bottlenecks. It also interrelates energy demand and equipment. It may suggest the need for additional insulated tanks and aid in dictating winery layout.

For example, all pipes from product

lines, refrigerant, and water should be designed for minimum pressure drop and with pumps properly sized for flow volume and expected pressure drop. Simple design considerations, such as minimum pipe radius and avoiding sharp bends, lower frictional drag, as does a reduction in the number of bends and length of pipes. Such reviews can result in selection of smaller and presumably cheaper pumps. Energy-use models can assist in placement of specific equipment within the winery design.

As discussed in a previous edition outlining energy conservation, refrigeration is the most important energy consideration in the winery. Optimizing refrigeration load management requires integration across the entire winery and is an important planning consideration. Knowing various load demands needed, when, and for how long, helps to optimize performance and reduce cost. This knowledge allows for planned alternatives and contingencies for possible outages and for managing peak energy demand.

Energy-use calculations must integrate overall building energy considerations from insulation to methods of heating and cooling. Radiant heating and cooling systems have been the tradition in our industry. Such systems are based on thermal storage and radiant heat-exchange and include both active and passive (cave) systems.

Embedding plastic pipes in the slab and walls and installing chilled beams or panels under the ceiling can be used to create radiant cooling. Such systems can be energy efficient because higher cooling water temperatures require less power input than most air conditioning systems. Thermal storage effects achieved by engaging the building fabric can maintain fairly stable temperatures. Thermal energy storage can prove very useful in optimizing the energy efficiency of the winery, both in terms of production and storage of wine. As a result of temperature control through cold surfaces, the relative humidity is naturally maintained at high levels with minimal need for artificial control.

One important question to resolve early in the planning process is to determine which of the winery areas will be fully enclosed. Outside tanks that are not insulated can be subject to considerable heat gain from solar radiation, which must be removed by the winery refrigeration system. Naturally, prediction of the solar heat load has implications for winery design.

The justification for enclosing all or most of the winery is founded on the desire to manage temperature fluxes and save energy costs. Enclosed wineries have less surface area exposed to ambient conditions. The specific advantages or disadvantages, including energy savings, are naturally dependent upon such factors as the climatic environment and the build-

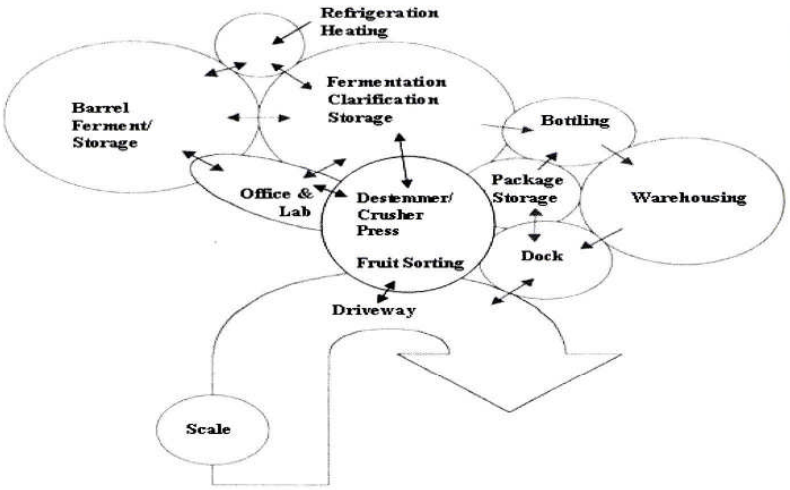
ing insulation. Some considerations include:

- impact on the work environment
- exhausting CO_2
- cleaning the air in the building
- control of humidity and radiant heat transfer between vessels
- potential loss of control in maintaining tanks at different temperatures
- sanitation

WINE CAVES

Caves are passive thermal systems used traditionally in the wine industry. There are several different types, including tunneling and/or excavation caves, air form, and cover caves. Caves can provide a natural, constantly cool and humid environment, while expending little energy. Unfortunately, the energy savings can be somewhat dwarfed by the establishment costs. As outlined by Fuchs (2006) for standard cut caves, the nature of the geology is the largest cost variable.

Geological information determines the required support, the difficulty of cutting into rock and, therefore, the general economics. Certainly, not all sites are viable from a geological perspective. One of the main disadvantages with cut



Production Area Topology

caves is that the true geology can only be best determined after excavation has begun. Therefore, unlike buildings, a limited percentage of the necessary information is known before construction of a cut cave. As such, evaluations are usually done concurrently with excavation, rather than entirely before construction.

Cave design considerations often include a review of the following:

- site preparation and construction costs
- energy savings
- overall layout
- general aesthetics
- architectural style
- intersections
- overall dimensions
- entertainment areas
- portal configuration and locations
- doors
- lighting
- wash stations
- plumbing
- cave finish
- floors, including slopes
- drainage, leakage and mold control methods
- barrel storage and barrel cleaning methods
- ventilation

Certainly, caves can impress people and, as such, they are not simply a natural thermal system, but a marketing tool to enhance visitation and image. Caves are widely used as entertainment centers for a host of winery functions. Because of their multi-functional nature, it is essential to determine in the initial planning stage how much emphasis will be on wine processing/storage, versus entertainment and general tourism.

In order to optimize winery layout and design, the smallest details must be carefully reviewed and understood. The lack of complete understanding is somewhat reminiscent of the Monte Carlo Fallacy, which some gamblers are surprised to learn is a fallacy, and treat as a strategy. If a roulette wheel comes up red for six consecutive spins, some assume that the next bet should be black. Their limited understanding of the laws of probability suggests black is due. Of course, the wheel has an equal probability of landing on red or back no matter the previous spins. Winery planning without a full understanding of the complexities of winery design and energy utilization is an equally unjustified gamble.

REFERENCES

Fuchs, W. 2006. Carving out a niche. Avoid pitfalls when planning a wine cave. Wines and Vines, November 2007.

Zoecklein, B. 2007. Winery Planning and Design. CD format, available from www.vtwines.info.

Questions or Comments?

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