Bordeaux 2016 Abstract Submission

Title
A low-cost, easy to implement sensor system to underpin modern winery sustainability schemes and third-party financing.

I want to submit an abstract for:
Conference Presentation

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Keywords
sustainability; winery; sensors; certification; environmental monitoring

Research Question
Can a low-cost sensor network be designed to increase both the uptake of sustainability initiatives in the wine industry and the power of certification schemes

Methods
Sensor networks are rolled out across two wineries, measuring heat flux from tanks, water flow through hoses, ferment temperature, cap dryness and energy use of pumps etc

Results
The sensor network provides a powerful interface for the integration of lean manufacturing into the winery environment, and decreases the effort to implement sustainability measures across two wineries

Abstract
The global wine industry is making a concerted push towards the three pillars of sustainability – economic, environmental and social. The consensus method to achieve this is a top-down approach centred on certification schemes which are generally based around variations on ISO14001 or similar. Wineries and vineyards which sign up to these schemes seek compliance through audit cycles that follow a sequence of action – audit – reaction, repeat. However, without detailed numerical benchmarks the process is inherently inefficient and relies on relatively non-specific aspirational goals. For example, calculating thermal losses from winery refrigeration is
normally done through rule-of-thumb models which do not take into account ΔT despite this driving heat flux through the tank or conduit surface. Likewise, calculating facility-wide water use is simple, however calculating it for individual process is, again, generally achieved through rule-of-thumb algorithms. This heuristic approach may be adequate for predicting annual water requirements but provides little means for a producer to (1) monitor the effects of efficiency measures within a particular procedure, or (2) provide the data necessary to reduce the measurement uncertainty in the certification process. Once all the components of the winemaking process are accounted for as part of an environmental management scheme, the combined error from the accumulated rules-of-thumb we have a situation where there is insufficient resolution to quantify even significant changes in important inputs. Some schemes seek to increase the resolution of the monitoring methods, for example the “California Code of Sustainable Winemaking” describes the potential use of flow meters to monitor water use. However, two facets reduce the effectiveness. Firstly, users are required to seek further information from a separate document, albeit one of impressive breadth, the Wine Institute’s “Comprehensive Guide to Sustainable Management of Winery Water and Associated Energy”, increasing the institutional inertia. Secondly, the suggestion is embedded within a standard that concentrates on total facility water use and estimates of process-specific water use, therefore lacking the resolution required.

We describe a low-cost, easy-to-implement system for monitoring the largest winery inputs; labour, water and energy. A series of sensors are rolled-out across 2 wineries:

- Non-invasive current sensors are placed on all electrical equipment used within the process cycle, including pumps, crusher/destemmer, and presses. The “California Code of Sustainable Winemaking” describes implementing such measures as Variable Speed Drives replacing single-speed pumps. While this is a good idea, this alone does fulfil all the requirements of certification. It must also be coupled to usage data for it to truly be effective. These sensors cost US$10 each, the wineries used in this experiment required 3 for full coverage of the processing.

- Flow-meters are placed on individual hoses. This is critical as it allows highly detailed usage patterns to be ascertained simply. Without this, and relying on total water only, requires extrapolation to estimate process-specific usage. These sensors cost US$9, the wineries used in this experiment required 4 for full coverage of the processing.

- Heat flux sensors are the most expensive component of the sensor bank (US$310) however it is, nonetheless crucial for the holism of the system. These pad sensors can be simply deployed and allow precise monitoring of the energy flow through a material. This is the gold standard for measurement of the effectiveness of insulation works as it simultaneously takes into account the R value of the material as well as the difference between the internal and external temperature (ΔT). The wineries used in this experiment required 2 for full coverage of the processing.

- Temperature and moisture level sensors to monitor the progress of fermentations. Particularly the moisture level sensors are used to measure the dryness of red wine fermentations, which allows wineries to minimise the labour required for cap management operations, through punch-downs or pump-overs. These are both expensive and hazardous activities which are still done following traditional schedules which are not specific to the dynamics of individual fermentations. These sensors cost US$30, the wineries used in this experiment required 4 for full coverage of the processing.

These sensors are logged centrally with the data carried to the cloud-based repository through wi-fi, Bluetooth or RFID-based telemetry units based on the Zigbee system. Each telemetry unit costs US$100, the wineries used in this experiment required 9 for full coverage of the processing.

The overall cost of the system, not including the cloud-based API (used for visualisation of the data), came to US$1720.

It is demonstrated that this data not only reduces the institutional inertia inherent in efficiency programs it also provides the data necessary for certification. Interestingly, the resolution of this data critically provides the data of a quality necessary for underpinning structured financing of equipment upgrades focussing on increased efficiencies. For example, by accurately logging the heat flux through an uninsulated tank, this data can be used to calculate the savings from third-party funded insulation, funded through a power purchase agreement.

Overall, the project provides a new concept for certification, where technology is embedded within the schemes DNA, and provides the data necessary for sound and strategic efficiency decisions.