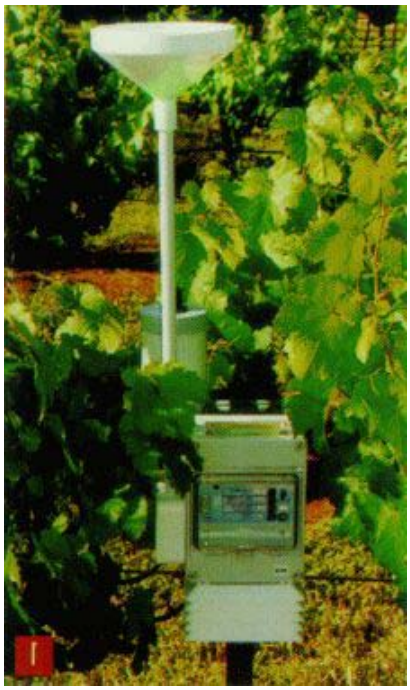
Reliable, cheap weather stations as predictors for improved disease and pest control



FINAL REPORT to GWRDC

GRAPE AND WINE RESEARCH & DEVELOPMENT CORPORATION

Project Number: DAS 92/2

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Research Organisation:
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EXECUTIVE SUMMARY

In a past research project (DAS 9), DMODEL, a simulator of downy mildew, was developed to provide advice of when rain events favour and do not favour disease. After 20 years of developmental research with collaborators interstate and overseas, the scene was set for Australian grapegrowers to know when a spray was needed to control downy mildew and importantly, in our dry climate, when not to spray. This effort reached a culmination in the expansion of the DMODEL simulator into Ausvit™ - a decision support system for grape growers. However, AusVit™ relies on access to accurate vineyard weather data to make predictions of disease events and to provide management advice. When the present project began, automatic weather stations (AWS) were commercially available but at high cost ($4-6,000 or more). Many growers considered this prohibitive. Consequently, there was a danger that useful decision-support information from AusVit™ would not be used by the average grapegrower.

The objective of this project was to develop a simple to use, low cost, reliable weather station for grapegrowers. If possible, it was also intended to incorporate some level of 'intelligence' to allow in-field prediction of downy mildew events (and other diseases and pests). Such a device could be widely used either in conjunction with AusVit™, or separately, to improve the control of downy mildew and reduce chemical use in Australian viticulture.

To construct a low-cost, robust and easily used AWS, we modelled development on the *Model T* Ford. In the early 1900's, the 'horseless carriage' enabled vast improvements in productivity and mobility but at a cost above the capacity of most Americans. In response, Henry Ford designed and manufactured the very successful *Model T*, a lightweight car. Robust and reliable, it was easy to drive and af*Ford*able(!) for 'every American.' It was our plan to emulate this in weather station technology.

Inquiries to existing manufacturers of AWS both in Australia and overseas proved of little value. A low-cost device was considered impractical and/or uneconomic. To complete our objectives, the services of a local Australian electronics designer was therefore sought and contracted in a collaborative project.

The first step in developing **the *Model T* weather station** was to specify the criteria for its construction. For this purpose, a workshop was held at the University of Adelaide's Waite Institute during 1993. Over 20 delegates from Australia and overseas attended including manufacturers of weather stations and dataloggers, plant pathologists and industry representatives. The keynote speaker was Dr Bob Seem from Cornell Univ., NY, USA who had had extensive experience in disease prediction and weather station technology.

An AWS disease predictor consists basically of three parts – sensors, a datalogger and software. In order to be of sufficiently low-cost for widespread acceptance (near $1000), the predictor would need to be purpose-built for use by grape (and other) growers. It would be of modular construction with the base model providing only the components needed for common use by growers. The following sensors were considered essential: temperature, relative humidity, leaf wetness, rainfall and an indicator of day and night light intensity. (Other parameters such as wind speed and direction, soil moisture and solar radiation were not needed to manage disease and pest events and would significantly increase cost.) For each sensor, the frequency of sampling, accuracy, range and sensor type was established. Sufficient in-built computer capacity would be needed for the AWS to store micro-climatic weather data from the vine canopy for at least 28 days and to enable prediction of downy mildew primary (and secondary) infection events.

Construction of purpose-built low cost sensors was considered. For instance, a small electronic microphone could perhaps be calibrated in such a way as to sense the impact of raindrops to measure rainfall intensity. Most conventional humidity sensors perform poorly at the very high humidity necessary for downy mildew events. An alternative proposed was the concept of a humidity sensor based on the electrical conductivity of salts that detect a specific humidity threshold, rather than a range of humidities. These proved unacceptable with present technology. Self-cleaning ceramic wicks were chosen as a more robust means for measuring relative humidity in vineyards.

The components of a datalogger (the electronic brain) for the disease predictor was another aspect needing innovative design. If the low-cost objectives were to be met, a low-power requirement for the AWS was essential to avoid the use of expensive batteries and solar cells. An easy means of presenting logger outputs was

also needed. It was decided to use simple low-powered lights operated by push buttons to provide disease risk statements. The possibility of radio transmission of data back to a central computer was also considered but proved too expensive with existing technology.

Concerned was also expressed about the availability and accuracy of computer models for prediction of disease. In recent years, complex simulation models such as DMODEL, have become available. DMODEL requires 2 million bytes of computer memory and was considered by some delegates, to be too large for the planned AWS. Models published in the scientific literature are not subject to copyright considerations. It was resolved to use a modified (smaller) version of DMODEL.

Since the workshop in 1993, there has been remarkable progress in the development of low-cost disease predictors. Several of these delegates have now produced lower cost AWS/predictors. For example, Pessl in Austria, produced first the MiniMetos™, a smaller version of their standard weather station disease predictor, and later, the µMetos™, a powerful low-cost version of the MiniMetos™. Measurement Engineering Australia, produced a grower version of their standard weather station at a reduced price. These AWS sell for $1500 or more.

In attempt to consolidate construction of a 'true' *Model T* AWS*,* Western Electronic Design, Loxton, SA., designed an AWS that met the project specifications. Known as the *Model T MetStation*™, this weather station has in field tests in three states of Australia, proven reliable, robust and easy to use. Importantly, innovative design has led to the unit being powered by six AA batteries available at low-cost to function for 12 months. The *Model T MetStation*™ operates as a stand-alone weather station or as a predictor of downy mildew primary infection events. Push-button operated lights indicate whether a disease event is underway or if an infection event has occurred and if oilspots are to be found in the vineyard. Data may be easily transferred to the grower's office computer by hard-wire connection, laptop download via RS232 connection, or by taking the *MetStation*™ to the computer. Simple, user-friendly software allows easy display of the data as detailed on coloured graphs to be scanned by eye. Alternatively, the data are output in form compatible with AusVit™ for more detailed disease decisions.

The *Model T MetStation* is:

- easily used
- low cost ($1,000 including software)
- low powered (x6 AA batteries / season)
- compact and rugged construction
- simple installation and operation
- simple and inexpensive maintenance
- modular design for adaptation/up-grade as developments occur.

Specifications of the standard sensor set:

- Temperature -10^0C to $+53^0$C (+/- 0.5^0C)
- Relative humidity - ceramic wick
- Rainfall – tipping bucket (+/- 0.1 mm)
- Leafwetness - resistive grid
- Daylight/darkness - set for downy mildew
- Capacity for additional sensors.

Data:

- Scan interval - 1 minute
- Storage interval - 10 minutes
- Storage capacity - 28 days.

Field Tests: Of 24 primary infection events predicted in an unsprayed vineyard at Loxton, SA, by AusVit™, the *Model T* successfully predicted 20 within +/- 6 hr and 3 within +/-12 hr. One event predicted by AusVit™ was missed by the *Model T* (Type 1 error) and 12 events from the *Model T* were not predicted by AusVit™ (Type 2 error). The lack of sufficient field data on disease events prevented discrimination of which system is correct. These results indicate that the *Model T MetStation*™ provided predictions at least as

accurately as AusVit™. If in error, it is more likely to over-predict disease, *ie.* signal a disease event that does not occur in the vineyard.

The success of the present project can be assessed by the fact that, although the concept of a low-cost AWS was considered radical at the time, this means of collecting on-site weather data is now well accepted. Additionally, there is good prospect of linking use of such AWS to improved weather forecasts through the application of site-specific weather and disease prediction systems. Services such as CropWatch™ have and will play an important role in this mission. In the future, the challenge is to make more detailed recommendations accessible to growers and not just weather data. The current AusVit™ system is complicated, requires a computer and some computer literacy. We envisage a low cost and simple to use *Model-T* AusVit™ to link grower accepted AWS to AusVit™ software. The *Model-T* AusVit™ could use Internet and mobile phone technology. This would allow growers to access powerful, low-cost AWS from their tractor seats enabling more effective and efficient decision making, assisting spray timing and thus improving disease and pest control.

The *Model T MetStation*™ is now commercially available and allows AusVit™ to be used by an increased number of users in Australian viticulture. It and similar technology provides a good step in the direction of highly efficient and effective disease and pest control.