Applying innovative decision support technologies to achieve harmony and adaptability in an Australian wine supply network

SMART 2005 Conference, 1–2 June 2005

Simon Dunstall* and Russell Johnstone**

* CSIRO Mathematical and Information Sciences, Private Bag 10, South Clayton, Victoria 3169; Simon.Dunstall@csiro.au. ** Orlando Wyndham Group, PO Box 943, Rowland Flat, South Australia, 5352; Russell.Johnstone@orlando-wyndham.com.

Abstract

Since 2003 Orlando Wyndham Group and CSIRO have worked in partnership to scope, develop and deploy innovative decision support technologies in Orlando Wyndham's grape and wine supply network. The shared supply network goal is to maximise the value that is realised from material and intellectual assets in the supply network. A prime example of the partnership's results is a system for simultaneously planning the harvesting of grapes and the intake of these grapes into wineries. Harvesting and grape intake require that the operations of grape growers, harvester operators, grape transporters and wineries are tightly coordinated, resilient to disruptions and can adapt to unplanned events. Assistance from computerised decision support is necessary if coordination and adaptability is to be achieved repeatedly and reliably throughout the grape harvesting season, and this decision support must account for the diverse set of goals and constraints that apply to each of the many supply network participants. We begin with an overview of the motivations, principles and project work being undertaken in the research and development partnership. We then look in detail at the harvest and intake planning system and its adoption during 2004/2005. Through this case study we highlight the benefits attainable by way of supply network technology innovations, explain how the technologies have helped progress towards shared supply network goals, discuss the various cultural and technical challenges we have had to overcome, and critically assess the impact of the harvest and intake planning system in the period since its inception.

Acknowledgements

The authors wish to acknowledge the significant contributions made by each of the many people involved in the Adaptive Supply Networks initiative in Orlando Wyndham, and in particular: (Orlando Wyndham Group) Ric Hayman; Steve Cutbush; Tiffany Greig: Tiffany Jellicoe; Bill Rowe, Sarah Bache, Richard Bastin; Ben Gibson; Joy Dick; Nick Bruer; Tony Hooper; Neil Woolford; (CSIRO) Mohan Krishnamoorthy; Andreas Ernst; Bowie Owens; Guy Eitzen; Gaurav Singh; Richard Jarrett; Geoff Robinson; Xun Guo Lin; Mark Horn; René Weiskircher.

Introduction

From a decision-making perspective, an adaptive supply network is a network of decision-makers, each with different goals, who collaborate and share rich information in order to arrive at decisions that mutually affect them. “Adaptive” relates to a capacity to respond creatively to situations in fast and flexible ways.

This paper discusses the research and development efforts that have set in motion a transformation towards adaptability in the supply network for grapes, juice and wine that surrounds Orlando Wyndham Group (OWG). The work is being carried out as a joint Adaptive Supply Networks (ASN) venture between OWG and the CSIRO Division of Mathematical and Information Sciences. The focus of this paper is on describing the deliverables of the research and development effort, with reference to observations of the use of the deliverables, “in the real world”, during the first half of 2005. A more detailed description of the motivation and principles behind the work can be found in Dunstall et al (2004).

From OWG’s perspective, an adaptive supply network promises the following outcomes:

- Increased value extraction from the capital assets and perishable assets supply network;

- The maintenance of competitive advantage, by continuing to lead the industry in supplier relations and wine quality;
- Retaining corporate memory, by encoding knowledge within decision support systems.
- Profitable future growth by transforming the supply network into an entity that is maximally efficient, effective and robust to scale.

In mid-2003 OWG formed a partnership with CSIRO. The scoping study had the specific aims of:

- mapping and analysing OWG's supply network;
- identifying and understanding the key value drivers (where value is created) and the value eroders (where opportunity to gain value can be lost) in this supply network; and
- developing a case for changing and improving the way in which decisions (particularly collaborative decisions) are made and the way information is exchanged in the supply network.

The scoping phase translated the general notion of an adaptive supply network into a concept with specific meaning in the OWG context. The scoping study report documented the outcomes that research and development would target. These outcomes were motivated by key value-drivers for the business. The path towards an adaptive supply network was described by way of a series of project plans that proposed innovative and transformational technology, yet remained practical and actionable.

The Supply Network

OWG's raw materials supply network for fresh grapes is characterised by complexity. The inter-dependencies between wineries, carriers (i.e., grape transport companies), harvesters and growers are extremely strong. On a financial basis this inter-dependency is attributable to contractual arrangements and also simply because of a joint reliance on the health of the Australian wine industry.

From the perspectives of decision-making and activity-coordination, the inter-dependency is attributable to multiple factors. Figure 1 provides a schematic illustration of the flows in the supply network, and below we list three of the major factors that contribute to the decision-making and activity-coordination inter-dependencies.

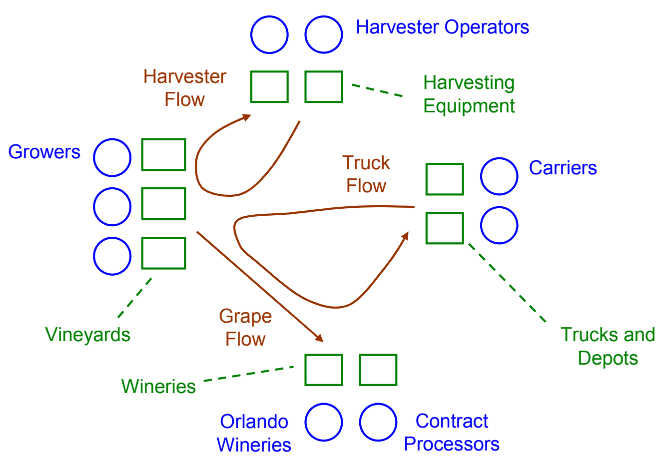


Figure 1: A schematic illustration of the physical flows in the supply network

First, a collaborative approach is taken to monitoring grape maturation and determining readiness for harvest. Information and samples from vineyards are exchanged between OWG's regional offices and grape growers. Furthermore, when a harvest is about to occur, all of the parties have a joint responsibility to ensure that harvest conditions (such as ambient temperature, or the presence of disease in the vineyard) are acceptable, and to play a role in reacting to adverse conditions.

Second, ripened grapes must be harvested as close as possible to an ideal date for the vineyard concerned (the choice of date is affected by the grape maturity level and the wine product the grapes are intended for). The resource limitations of the stakeholders constrain the supply network's ability to meet the demands from all blocks, leading to schedules being a product of many compromises, each compromise ideally resulting from explicit and exhaustive consideration of the available options.

Third, the consequences of resource limitations are amplified due to the fact that harvested grapes must be transported to a winery before significant berry deterioration occurs. As a rule of thumb, the acceptable time-lag between a berry being picked, and acceptance of the berry into the processing system, is around six hours for red grapes and two hours for white grapes. Berry deterioration leads to irreversible losses of value, as do the imperfect in-winery decisions that can follow delays and other unexpected logistical disruptions.

In total, communicating accurate and timely information, and managing and coordinating activities in a wine supply network, presents a range of very complex problems. The scale of the issue is highlighted through noting the following figures relating to OWG's raw materials supply in 2005: 156,000 tonnes of grape; 35 grape varieties; 33 distinct areas; 520 growers; 104 unique wines; and 3123 harvest units (or "blocks" — predetermined areas of a vineyard that are harvested as a unit). Furthermore, in 2005 there were 186 harvester operators and 91 transport entities involved in OWG's supply network, many of these firms also being engaged by other wine producers. The actions of the growers, harvesters and carriers eventuate in the supply of grapes to six OWG-managed wineries and a further nine contract processors.

It is important to reflect on the fact that grape harvest is seasonal (approximately January to May) and that each vintage (i.e., season) is different. Figure 2 illustrates the differences that can be exhibited between vintages.

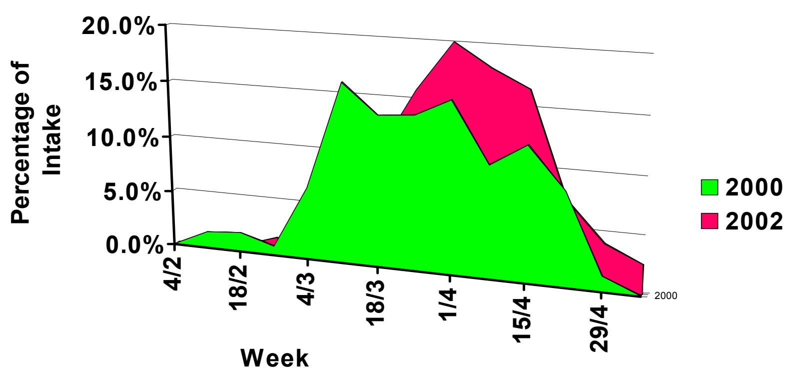


Figure 2: A comparison of winery intake for the 2000 and 2002 vintages

Decision-making in the supply network is, in general, characterised by cooperation and a mutual intent to achieve good outcomes for the participants that are directly involved, and for the industry as a whole. Nevertheless, the practice of decision-making is typified by communications that are chaotic, frequent and asymmetric. OWG operators have the best view, but generally, there is poor visibility of activities and constraints, both up and down the value chain. It is also significant that, from year-to-year, there can be an appreciable turnover of people involved in the management of a vintage. Even for those who have a more stable presence, the people, equipment and systems are "rolled out" annually for only around three months. The results of this are: (i) "patchy" knowledge management and knowledge retention; and (ii) a slow "natural" growth rate in the effectiveness of management processes and systems.

In the future, with or without supply network management initiatives, it is expected that the supply network will span more players, different products, and be larger and more widespread. As basic requirements for this future:

- communications need to be automated and become transparent to all participants;
- temporary participants must be supported by rules and knowledge that is captured in information systems;
- the natural costs of increased of complexity need to be outweighed by the more efficient use of capital and resources.

The research and development described in this paper is concerned with addressing and extending well beyond these basic requirements.

Intake Planning

Figure 3 illustrates the planning and monitoring phases for winery intake, in terms of the hypothetical trajectory of a grape block through the successive yet parallel phases (left to right) over time. Time is represented vertically, the darker bars in Figure 3 relate to weekends, and thus the diagram spans about six weeks of vintage. In most of the phases, the corresponding planning or monitoring process does not occur continuously, but rather, is undertaken at regular pre-determined intervals. Periods of planning are indicated by shading/non-shading in the diagram.

Intake planning is the main process of interest and it occurs once each week, over a total duration of around 48 hours. The output of intake planning is an intake plan that consists of: (i) a plan for the tonnes brought into a winery, by area, variety and quality, at each winery for each day in a week; and (ii) an intake schedule which nominates an area, variety and quality for each half-hour timeslot at each winery.

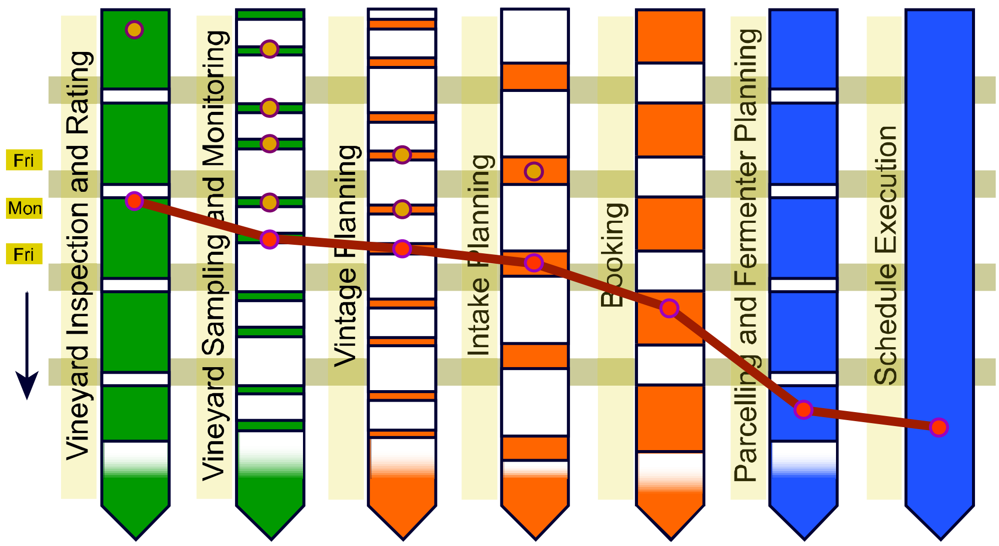


Figure 3: The planning and monitoring phases for winery intake

Intake planning is preceded by phases related to sampling, monitoring and inspection, and is directly followed by a period over which "bookings" are made. A booking is a confirmed commitment by the grower, harvester, carrier and winery that a harvest and subsequent "crush" at a winery should occur. Ideally, the booking represents a small piece of a network-wide joint plan that is feasible and mutually-acceptable to all participants.

The principal actors in the intake planning process are Grower Liaison Officers (GLOs) and the Grape Logistics Coordinator. The role of a GLO is centred on the management, on an operational basis, of the relationships and activities between OWG and its suppliers in a certain geographical region (e.g. the Riverland). A GLO is based in a regional office (e.g. Barmera), and usually is supported by several administrative and technical staff. The intake-planning activities of a GLO result in a "bid": a partial intake plan that considers the vineyards in their region of operation, and which claims a proportion of the available capacity at the wineries. The Grape Logistics Coordinator's role, in intake planning, is to reconcile the bids and form an intake plan.

Ideally, a bid is the product of extensive information exchange and close collaboration between the GLO and many relevant parties. According to this ideal, the Grape Logistics Coordinators' main task is to iron out small-scale conflicts between the bids (for the major wineries located in the Barossa Valley, this will span three GLOs) and formulate an overall intake plan. However, the practice prior to 2005 was often quite far from this ideal. In the worst case, the sum of tonnes across bids would exceed the available winery capacity by so much that the Grape Logistics Coordinator would discard almost all of the "local" knowledge implicitly provided by a GLO in a bid (the gathering of this information is the main function of the bid process) and draft the entire intake plan almost from scratch.

Time lags in the planning phases, as they currently stand, can be considerable. One of our main goals is to reduce these time lags, but for Vintage 2005 we concentrated on the delivery of decision-support and chose not to appreciably alter the timing or overall structure of the planning process. Given the current planning frequencies, if the schedule is to be executed for the week starting Monday March 21, the intake planning phase starts at or before Friday March 11, and bookings start to be made on Monday March 14.

In the "as-is" state, which applied fully to 2004 and to a diminishing extent thereafter, the overall winery-intake management process could be said to be characterised by intermittent and quasi-sequential planning. Further, re-scheduling and disruption management was undertaken very frequently, yet in a rather improvised manner. There could be long time-delays between planning and schedule execution. Critically, a restricted information flow (and/or information utilisation) between planning phases was viewed as responsible for winemakers having a tendency to react to the intake stream, rather than be driving it.

On the whole, the prevailing success of OWG in achieving economical operation and quality wines could be attributed to a great deal of creativity and tenacity being shown by employees and partners who: (i) worked outside of "supported" processes for a considerable proportion of the time; and (ii) worked with incomplete information, a localised perspective, and data that was often in need of re-keying and/or re-compilation.

The goal in the ASN research and development work, targeting harvest and intake scheduling, is that by Vintage 2007, OWG will have the tools, processes and culture to carry out continuous or "on-demand" harvest and intake scheduling. In this adaptive mode of operation, planning can be undertaken whenever new information becomes available, using the full range of complete and accurate data, and with decision-support tools that can ensure that all activities and resources are fully coordinated.

By moving to a continuous/on-demand model, "blind-spots" (in time) and "discontinuities" between phases should be eliminated. There are many other expected benefits, and in summary we can state the expected outcomes of this transformation in decision-making as: a stream of grapes ideally managed at any point in time; "decision harmony" for participants; supply network adaptability; growth without sacrificing wine quality and winemaking principles.

Development Work

The development of a new system for intake planning has drawn on techniques and technologies in software engineering, applied statistics, mathematical modelling, data management, optimised scheduling, and studies of collaboration in decision-making. The high level of data quality and detail in the OWG corporate database has laid a strong foundation for the deployment of new decision-support tools. The early adoption by OWG of RFID technologies at its wineries, and on its grape bins, has certainly helped in this respect.

The aims for Vintage 2005 intake planning were as follows.

- Automate major parts of the process: to achieve data integrity, reduce the time burden on the main actors in the process, and emphasise intellectual rather than routine activities.
- Achieve controlled and collaborative bidding: to reduce "overbidding" (i.e., asking for many more tonnes that are conceivably feasible), set and meet informed targets, and make astute operational compromises.
- Address complexity using decision support: through the "smarter" use of information and the integration of automated (and optimised) scheduling functionality into the process.

We were successful in these aims, although we achieved only superficial integration of the scheduling functionality, and so are looking to next vintage for major success on that front. Figure 4 shows the revised intake planning process for Vintage 2005. This process was not deployed and operational in its entirety until two-thirds of the way through Vintage 2005, but some of the tools were in use for the full duration (that is, since late January 2005).

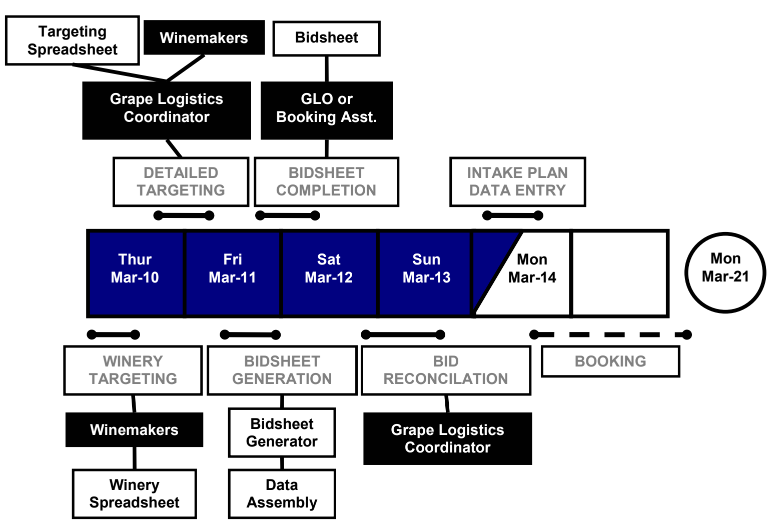


Figure 4: Intake planning in Vintage 2005, using an example of intake for the week starting March 21.

The two targeting steps ("winery targeting" and "detailed targeting") are entirely new, and are associated with the aims of increasing collaboration and achieving controlled bidding. The generation of the bidsheet is new, in that the bidsheet construction is now automated, with the data being sourced from OWG's viticulture database. Bidsheets are generated at around midday on Friday to facilitate bidding by a GLO or colleague ("Booking Assistant") on late Friday afternoon or Saturday morning. This year, the reconciliation of bids remained a manual process, as did the entry of the intake plan into the central database: these two activities occur on Sunday and Monday.

Winery	RB

Dates	
Today	26-Apr-05
First Week Starts	18-Apr-05
Second Week Starts	25-Apr-05
Third Week Starts	02-May-05

Export Target and Tank Data

Target Daily Intake Tonnes			
Day	W/s Apr 18	W/s Apr 25	W/s May 02
Monday	450	100	0
Tuesday	400	100	0
Wednesday	400	100	0
Thursday	400	100	0
Friday	400	100	0
Saturday	200	20	0
Sunday	0	0	0

Target Weekly Intake Tonnes			
Day	W/s Apr 18	W/s Apr 25	W/s May 02
Minimum	3500	0	0
Target	2250	520	0
Maximum	8000	4000	2500

Total Tank Capacity			
	Ferment and Store	Storage Only	Total
tonnes	10138	121348	131486
kL	7627	91036	98663

litres/tonne	750

Available Fermentation Capacity			
	W/s Apr 18	W/s Apr 25	W/s May 02
tonnes	2834	708	0
kL	2133	533	0

Tank Information						Permissible Quality (Fermenting)		Equipment Count			Maximum Number of Fermenters Available		
Tank Type	Capacity (tonnes)	Capacity (kL)	Maximum Ullage (%)	Average Turnaround (days)	Grape Types	Greatest Rating	Least Rating	Ferment and Store	Storage Only	Total	W/s Apr 18	W/s Apr 25	W/s May 02
60 t Vinimatics	**60**	45	90%	8	R	2	4	6		6	3	2	0
88 t Vinimatics	**88**	66	90%	8	R	2	4	4		4	2	2	0
66 t Vinimatics	**66**	49.5	90%	8	R	2	4	10		10	5	2	0
Bins	**2**	1.5	75%	15	R	1	3	25		25	0	0	0
Open fermenters	**6.5**	5	75%	12	R	1	3	4		4	2	0	0
45 t Potters	**45**	34	75%	12	R	1	3	16		16	6	2	0
25 t Potters	**25**	19	75%	12	R	1	3	8		8	3	2	0
45 t Statics	**45**	34	75%	12	R	1	3	32		32	12	2	0
25 t Statics	**25**	19	75%	12	R	1	3	24		24	8	2	0
75 t Jets	**75**	56.5	75%	10	R	2	4	14		14	0	0	0
150 t Jets	**160**	120	75%	8	R	3	5	27		27	6	0	0
88 t Jets	**90**	67.5	75%	10	R	3	4	4		4	1	0	0
680 kL Storage	908	**681**	0%		R	3	5		76	76			
272 kL Storage	362.5	**272**	0%		R	3	5		1	1			
228 kL Storage	304	**228**	0%		R	3	5		98	98			
168 kL Storage	224	**168**	0%		R	3	5		11	11			
142 kL Storage	189	**142**	0%		R	3	4		13	13			
112 kL Storage	149	**112**	0%		R	3	4		46	46			
93 kL Storage	124	**93**	0%		R	3	4		25	25			
57 kL Storage	76	**57**	0%		R	2	4		47	47			
46 kL Storage	61	**46**	0%		R	2	4		8	8			
38 kL Storage	50.5	**38**	0%		R	2	4		2	2			
27 kL Storage	36	**27**	0%		R	2	4		60	60			
15 kL Storage	20	**15**	0%		R	1	3		30	30			
10 kL Storage	13	**10**	0%		R	1	3		22	22			
5 kL Storage	6.5	**5**	0%		R	1	3		16	16			

Figure 5: An example of a winery spreadsheet.

Figure 5 is an example of a winery spreadsheet, and it relates to a major winery in the last fortnight of vintage this year. Week-to-week, the changing data are the tonnes to be brought into the winery, and the number of fermenters (tanks for fermenting wine) to be made available. This data is highlighted by the cells marked with a yellow background. The data in the winery spreadsheet are used for setting targets. A target, in the context of intake planning, is a number of tonnes of grape to be harvested and processed over a certain time interval. The relevant time intervals are days-of-the-week or the full week.

A winemaker uses the spreadsheet of Figure 5 to express daily and weekly targets for all grape-tonnes into the winery. The number chosen for a target is a function of the "vintage plan" (that is, structured knowledge of what remains to be processed during vintage), the capacity of winery-intake equipment (such as grape crushers), and the numbers and types of fermenters that are likely to be available. The targets apply at the winery level; that is, all tonnes of grape into the winery.

During detailed targeting the winery-level targets are split into targets for each GLO. The interface for detailed-targeting is also a spreadsheet. The data of both spreadsheets is translated into XML for the purpose of automated bidsheet generation. Thus the targeting information flows directly through to the bidding process. Furthermore, targeting provides value in a wider sense, because it formalises and quantifies decision-making relating to the overall management of intake. That is, it fulfils a "reality check" function that draws winemakers and other "target setters" into a process where they first consult information from various sources outside of their immediate ("local") domain, e.g. a winery, and then synthesize this information into a local context. In practice, we noted that this "information-based collaboration" not only occurred to a greater extent in Vintage 2005 (as a result of the developments), but that supplemental person-to-person collaboration reinforced the recognition of inter-dependencies between the participants in the intake and wine-production processes. The intended result of this is the fostering of "supply network thinking" which includes acquiring a motivation to gain for themselves, and permit for others, a "visibility" up-and-down the value chain.

After the two-stage targeting process is complete, the automated generation of bidsheets is initiated. The software for doing this consists of three distinct parts. The first part uses a scripting approach, in Python as well as the query language of the OWG central database, to develop XML documents that contain all of the necessary information — this includes data about vineyard blocks, wineries, employees, geographical locations, subcontractors and intake targets. The second part of the system is a "black box" that takes the full XML document and performs a series of grape-maturation and schedule-related computations. The result of this is completed bidsheets in a raw form. Whereas the first two parts are run on a unix server, the final part is a windows program that instantiates Microsoft Excel and "drives it" (via "office automation") to produce multi-worksheet bidsheets that have intricate formatting details (including comments, colours, borders and plots).

Figure 6 shows an example of a bid sheet in the form utilised by a GLO. The names of grape-growers have been concealed for privacy reasons. During development, much effort was expended on displaying the necessary data as insightfully and efficiently as possible. The eventual bidsheet format was a product of several iterations of developers consulting with users. Nevertheless, the bidsheet is an extensive document, and Figure 6 shows only its leftmost side.

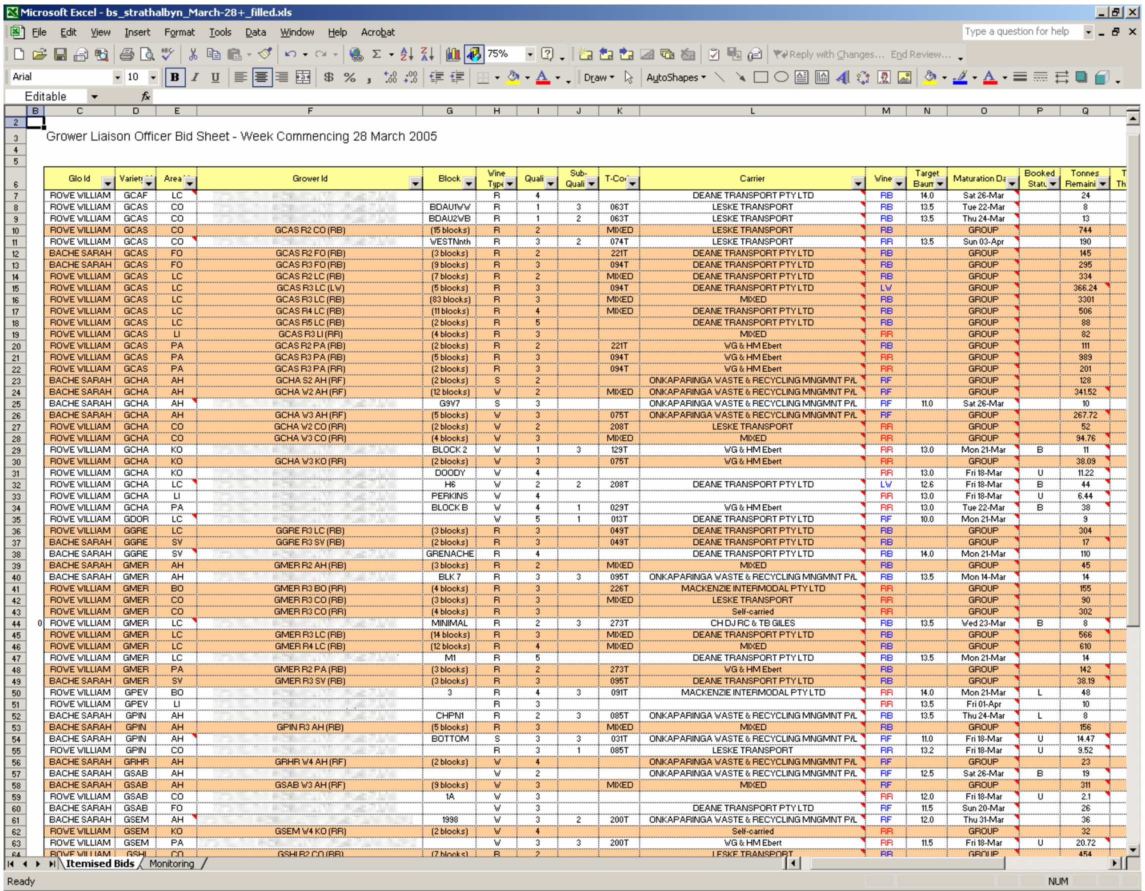


Figure 6: The leftmost side of a bidsheet from Vintage 2005.

Each row in a bidsheet corresponds to a block of grapes (white rows), or in some cases a group of blocks (orange rows). The logic of group-formation, and many other data and functions associated with intake planning in particular and the supply network in general, is stated within the "rule system" (see below). Much of the data on leftmost side of the bidsheet is "static" data about the block: the grower's name, grape variety, product assignment ("T-code") and so on.

Column "O" holds maturity information for the block, and much of this is computed during bidsheet generation using mathematical relationships combined with the rule system. For an individual block, the "Maturation Date" cell holds Baumé (grape sugar level) sample information and predictions of future Baumé (i.e., for the week being planned). The information is held in a "comment" as shown in Figure 7.

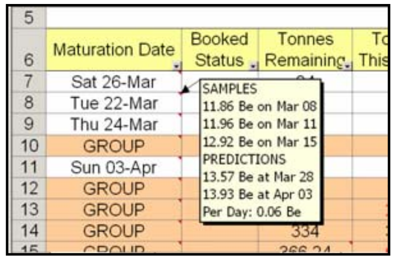
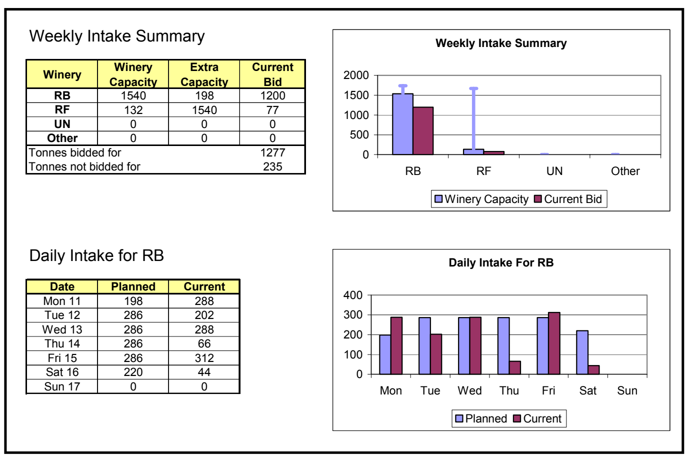


Figure 7: An example of a comment embedded in a bidsheet

Comments are used extensively throughout the bidsheet, for various purposes. They are useful not only because they permit the bidsheet to cover a minimum number of spreadsheet columns, but because they act as an "on-demand" and "interactive" source of information for the user. They are also relatively easy to present in a context-specific way: in that, for example, the "Maturation Date" column shows samples and predictions for a single block, but the sum-of-mature-tonnes and the number-of-mature-blocks on a day-by-day basis for a group.

The rightmost side of a bidsheet has columns that a GLO uses to tentatively schedule the harvest and processing of blocks (or groups). These numbers are summed conditionally, to provide a tonnage-per-day and tonnage-per-week into each winery. This derived information is presented — relative to the targeting information arrived at during prior intake-planning steps — on a separate worksheet. Figure 8 shows how this information is presented to the user.



Weekly Intake Summary

Winery	Winery Capacity	Extra Capacity	Current Bid
RB	1540	198	1200
RF	132	1540	77
UN	0	0	0
Other	0	0	0
Tonnes bidded for			1277
Tonnes not bidded for			235

Daily Intake for RB

Date	Planned	Current
Mon 11	198	288
Tue 12	286	202
Wed 13	286	288
Thu 14	286	66
Fri 15	286	312
Sat 16	220	44
Sun 17	0	0

Figure 8: A section of the targeting worksheet of a bidsheet.

In Figure 8, "RF" and "RB" are the major OWG wineries in the Barossa, and in the topmost table the "Winery Capacity" is the target weekly tonnes for that winery, arrived at after the detailed targeting step that apportions the overall winery target into amounts for each GLO. "Extra capacity" represents an allowable margin for "overbidding", and "Current Bid" is the sum of tonnes that the GLO (user) has bid-for so far. The data is presented graphically by automatically-instantiated plots (show to the right in Figure 8), and daily data for each winery is also shown. The idea behind the provision of the plots is to highlight "overbids" (where current bid-for tonnes exceeds the target) and other discrepancies between targeted tonnes and bid-for tonnes.

The intake-planning decision-support tools described so far (with interfaces illustrated in Figures 5 to 8) have all been primarily concerned with data automation, data integrity, and communication/collaboration between people and the information they possess. While these are all highly necessary (and very useful) components of decision-support in adaptive supply networks, they do not directly address the complexity-management and optimisation requirements of being fast, flexible and adaptive.

There are two major aspects of this "higher technology" requirement we have progressed significantly towards since embarking on the Adaptive Supply Networks initiative. The first is integral with our Vintage 2005 decision-support, while the second is yet to make sizeable in-practice impact.

The *rule system* is an XML-based rule language and engine that permits the evaluation of expressions (rules) that have an "*if (condition) then (action)*" structure. When the condition is true, the action(s) are executed. An action can be “almost anything that makes sense in the context of the application”, and for intake planning the actions range from setting a quantitative attribute in a data object, to attaching specialised maturation-modelling or optimised-scheduling functionality to a series of data objects (where the data objects represent, for example, vineyard blocks, bidsheets, wineries or sub-contractors). The rule system is a flexible, effective and reliable way to manage the construction of large volumes of data, when this data is computed in a potentially different way for each member of a large and diverse population of data objects. In essence, a rule system presents the only practical way for us to maintain the multiplicity of parameters and “decision-tool specific” data that is invariably required for supply network optimisation.

For intake-planning there is a collection of approximately 250 rules that relate to grapes, processing equipment and winemaking. These rules allow us to manage the computation of “new” attributes and assign specialised functionality to the (more than 3000) vineyard blocks. For blocks, specialisation is achieved via the rule “condition”, and the correct rules are distinguished based on the differences between blocks (grape variety, location, wine-product and so on). Thus the computed values and assigned functionally depend on the properties of a block, and the rules capture the logic of this dependency. If we were to use conventional methods to manage the computed data, we would need to “manually” compute and maintain well in excess of 50,000 data elements.

The most powerful rules tell us the result of mixing one lot of grapes with another (“batching rules”). Such rules are used by prototype “parcel planning” software. Sample output from the parcel-planner is illustrated in Figure 9 (where grape-grower names are concealed for privacy). The parcel-planning software takes the same input as the bidsheet generator, but produces weekly plans for the batching of fruit.

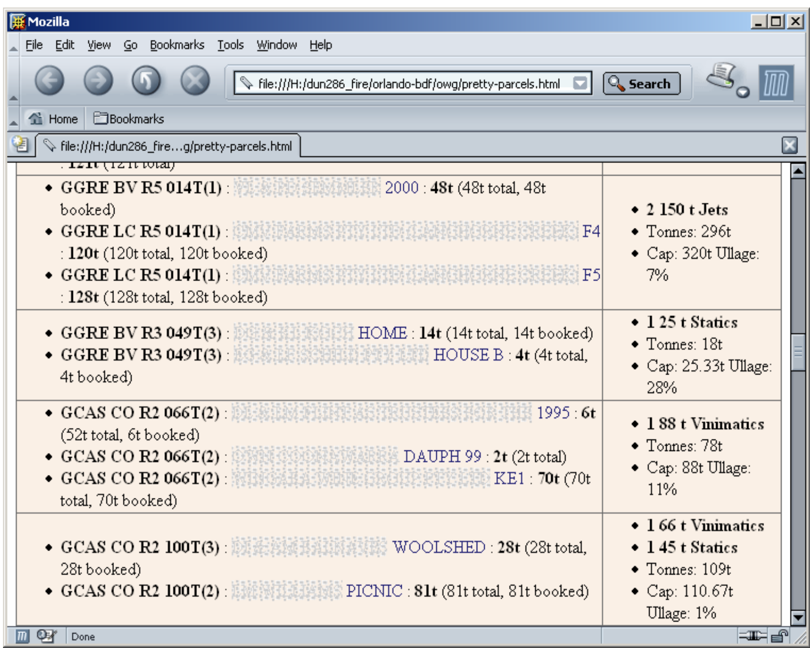


Figure 9: HTML-formatted output from parcel-planning software.

The batching rules are used as part of an optimisation procedure that forms quantities of grape that will be processed as a unit (i.e., as a “parcel” of fruit). The parcels must satisfy winemakers’ policies, and must be assigned to one or more fermenters which have been signalled as available (e.g. via the winery targeting spreadsheet). Minimising unused fermenter capacity (“ullage”) is important for conserving winery capacity and producing quality wine.

Optimising the quality of mixes of grapes from different sources is vital, from winemaking-practice and value-chain perspectives. Decision-making for an adaptive wine supply network must drive the network towards a winery intake stream that avoids mixing dissimilar fruit as much as possible, and maximises the quality of those mixes that are unavoidable. The technology in the parcel-planner is a key plank of this. The parcel planning software is part of a scheduling system that will be used extensively in Vintage 2006, along with other parts of the system that will look after logistics (carriers and harvesters) and winery intake equipment.

Conclusions and Observations

In this paper we have described the motivations, and some of the intermediate deliverables and outcomes, of an initiative focussed on creating an adaptive supply network for grape intake at wineries. The work has been the result of a close partnership between CSIRO Mathematical and Information Sciences and Orlando Wyndham Group.

In terms of collaboration between the supply-network participants, in near-horizon operations planning, we have observed that the decision-support deliverables have reduced the barriers between planning phases. "Targeting" winery intake has been a key device. This is because in order to target effectively, people must cross-reference plans across the different timescales, and also refer to perspectives across different local domains within the network. Due to improved information management and collaboration between planners and in-field operatives, we have also observed that vineyard inspections are driven more by the planned intake stream, in comparison to previous vintages. Vineyard inspections must precede the intake planning for a vineyard block, and so this leads to an increased probability that grapes are ready to enter the intake-planning phase at right time.

Overall, logistics coordinators, grower liaison officers, winemakers and viticulturists are talking about new topics and are interacting in new ways, as a result of both the technology deliverables and the adaptive supply network concepts the deliverables embody. We have observed a faster adaptation and response to seasonal differences, and a high level of commitment amongst the operational planners, both to adaptive supply network principles and the adoption of the new processes and tools.

The decision-support tools used in Vintage 2005 source their data almost exclusively from a central data store. As a consequence, this data-store's role as a "single version of the truth", and a key corporate asset, has been much emphasised. We estimate that the re-keying and re-formatting of data, for planning purposes, has been reduced by at least 80%. Existing data errors have been highlighted and quickly repaired (e.g. errors in block-to-harvester and block-to-winery assignments). We have an increased confidence that every vineyard block is accounted for fully and correctly throughout vintage.

Valuable new information was introduced into the planning process during Vintage 2005, mainly in the form of intake targets, and maturity information and other critical data about vineyards was seamlessly integrated into the planning interfaces, leading to more informed decisions. We have been disappointed with our progress so far, in relation to specifying and evaluating suitable performance metrics for the supply network. Although we have been well aware that this was an issue, performance can be very difficult to measure both meaningfully and quantitatively. In no small part, this is because every vintage is different (as shown in Figure 2). A quantitative comparison of Vintage 2004 and Vintage 2005 is planned, however, once Vintage 2005 is completely finished.

In our view, the internal supply network of OWG is starting to collaborate better, is adopting a new culture, and is doing a better job of managing and coordinating intake. There is increased harmony being reached between conflicting objectives, concerns, and constraints: that is, we have made progress towards harmonised "local" and "global" perspectives. The prime example of this is that in Vintage 2005 we saw the bidding process become collaborative rather than competitive. As far as the external supply network is concerned — OWG's raw materials and services suppliers (growers, harvesters and carriers) — we have placed an importance on developing an awareness and interest in the initiatives. The benefits so far for these parties have been appreciable, although indirect. Improved OWG planning performance has led to better supply-network coordination, more certainty, and less "flip-flopping" on operational decisions that affect them.

The tools delivered during Vintage 2005 have established a basis for "higher technology" decision-support, the development of which has been well underway since the beginning of the adaptive supply networks initiative. The tools seed supply-network collaboration and they help to secure a foundation of information-rich data. They also keep people abreast of developments and deliver quick wins within key business processes. It is the "higher technology" decision-support tools which will ultimately transform the supply network into an adaptive entity in future vintages, but the benefits of the current clutch of deliverables are clear and demonstrated. Moreover, their role in the development path, from both technical and cultural perspectives, should not be underestimated.

References

Dunstall, S., Ernst, A.T., Johnstone, R.S. and Krishnamoorthy, M., *Collaborative planning for grape logistics and batching*, in: Proc 12th Australian Wine Industry Technical Conference, 2004.