VEHICLE SCHEDULING PROJECT SUCCESS AT SOUTH AFRICAN AND SWAZILAND SUGAR MILLS

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Abstract

Typified by the South African sugar industry, current sugarcane transport and indeed also loading and supply systems have been identified as very inefficient and costly components of the sugar logistics chain. These systems have become significantly overcapitalised, fragmented and relatively poorly managed and coordinated, which has resulted in significant under utilisation of equipment for growers, transporters and the miller. This has contributed to role-player antagonism, distrust and unnecessarily high costs for all three role-players.

It was proposed that at a mill a single control centre should schedule all the vehicles and also coordinate supply and loading operations to improve efficiency and reduce inbound supply chain costs. As a component of the SLIP programme, FREDD, a vehicle dispatching/ scheduling programme developed in New South Wales, Australia, has been introduced into four Mills in SA and Swaziland, which has resulted in significant improvements in efficiency.

This paper will discuss the above mentioned projects' objectives to (1) customise FREDD for South African mills, (2) reduce vehicle delays by as much as 67%, thereby reducing the number of vehicles in the fleet and maximising vehicle utilisation, (3) reduce the occurrence and duration of mill no-cane stops by as much as 50% and (4) demonstrate how the central measurement and management strategy exposes areas of weakness and opportunity. It will discuss the success of the project and also highlight further opportunities for technology use within the sugarcane supply chain and a number of spin-offs in terms of improving the general supply chain management.

Keywords: FREDD, SLIP, supply chain improvement, vehicle scheduling, sugarcane transport

Introduction

Background

Rőnnqvist (2003) explains that the timeline (operational, tactical or strategic) is an important aspect for supply chain management. Typically in the strategic and tactical environment, computer simulation models have been specifically designed and are capable of testing different transport scenarios. Models can identify bottlenecks within the systems and are used to either optimise or evaluate scenarios of interest. Pinkney and Everitt (1997), considered the use of a scheduling simulation program named ACTSS to simulate an integrated approach to harvesting and rail transport control in the Australian Sugar Industry. Diaz and Perez (2000) used transport and harvest simulation modelling to identify bottlenecks and provide information pertaining to resource allocation and risk management. Arjona *et al.* (2001) developed a discrete event simulation model of harvest and transport systems for the Mexican sugar industry to assess the problem of machinery overcapitalisation and underutilisation. The model demonstrated how less machinery operated more efficiently could maintain production levels and that the inefficiencies resulted mainly from an inability to manage the complex system. Gaucher, *et al* (2003) developed a computer model to simulate the planning and operation of mill sugarcane supply throughout the season, with the objective of assessing, amongst other aims, the impact on the transport capacity. Higgins *et al.* (2004) and Higgins and Davies (2005) developed an integrated model of sugarcane harvest and rail transport processes in the Australian sugar industry.

In contrast and in the operational environment, scheduling tools have been used to improve efficiency to great effect. As early as 1971 the use of a manual type real-time vehicle scheduling system was designed and this successfully operated at Tongaat Sugar (Dent, 1973). Since the mid-1960s scheduling has been used in the Australia sugar industry in rail (Murry, 1968). More recently Dines *et al*. (1999) designed and introduced an operational vehicle scheduling system named FREDD into the New South Wales sugar road industry in Australia. Although not used in a sugarcane application, a computerised scheduling system named ASICAM was developed for the Chilean timber industry in 1990. Through the use of ASICAM, the fleet was reduced by approximately 30% at the four mills where it was introduced (Cossens, 1992). The ASICAM operational tool was also used in a strategic modelling role where it was used to simulate possible improvements within the sugar transport efficiencies and thereby reduce costs. The study showed that the current transport fleet could be effectively halved, realising savings of R17 million. Further reductions were achievable where factors such as loading time, payload or vehicle power were improved (Giles *et al.*, 2008).

Problem definition

Typified by the South African sugar industry, current sugarcane transport and indeed also loading and supply systems have been identified as very inefficient and costly components of the sugar logistics chain. These systems have become significantly overcapitalised, fragmented and relatively poorly managed and coordinated, which has resulted in significant under utilisation of equipment for growers, transporters and the miller. This has contributed to role-player antagonism, distrust and unnecessarily high costs for all three role-players and, according to Milan *et al.* (2005), sugarcane transport costs are the largest unit costs in raw sugar production. In the Australian and South African sugar industries transport costs amount to 25% and 20% of total production costs, respectively (Higgins and Muchow, 2003; *Giles et al.*, 2005).

Proposal

It was proposed that at a mill a single control centre should schedule all the vehicles, and also coordinate supply and loading operations to improve efficiency and reduce inbound supply chain costs. As a component of the Sugar Logistics Improvement Programme (SLIP)(Perry and Wynne, 2004), a vehicle dispatching/scheduling programme (FREDD) developed in New South Wales, Australia, was introduced to four mills in SA and Swaziland, and has resulted in significant improvements in efficiency.

This paper will discuss the projects' objectives to (1) customise FREDD for South African mills, (2) reduce vehicle delays, thereby reducing the number of vehicles in the fleet and maximising vehicle utilisation, (3) reduce the occurrence and duration of mill no-cane stops and (4) demonstrate how the central measurement and management exposes areas of weakness and opportunity. It will discuss the success of the project and also highlight further opportunities for technology use within the sugarcane supply chain and a number of spin-offs in terms of improving the general supply chain management.

FREDD's Introduction into Southern Africa

FREDD development began in NSW, Australia in the 1990s. Initially the FREDD software was designed to take pressure off the weighbridge clerk when a second weighbridge was built at Harwood Sugar mill in order to accommodate the newly built refinery. The software aimed to mimic the decision making processes of the best of the sugar mills' manual schedulers, i.e. a heuristic type solution. In this application FREDD proved very effective and the management realised the system's potential to increase the mill crushing rate. This would accommodate mill area expansion without introducing extra trucks into the system, and thereby significantly minimise additional transport costs. In time the solution grew to include real-time monitoring of vehicle performance, harvest telemetry and factory prediction modules (almost completely autonomously). This increased the supply chain management's confidence in the transporters' ability to deliver sugarcane reliably in a 'just in time' (JIT) fashion to the mill. In one instance the FREDD software actually signals the factory process control system to adjust the crush rate according to the actual real-time supply pattern.

Currently the FREDD software is operational at four mills in Australia, three for Sunshine Sugar in NSW and one for Bundaberg Sugar in the Tableland region near Cairns (see Figure 1 that shows various photographs of FREDD operations in Australia). In the best case, the efficiency of the trucks measured in tons per vehicle per day is nearly double that of the best Southern African truck at a similar lead distance, even though the Southern African trucks have a 40% higher payload.

Figure 1. Various aspects of the Australian transport operation controlled by the FREDD software, loading, the control centre and offloading.

From 2002 to 2005 and as part of SLIP, Southern African mills participating in the programme were measuring various efficiency aspects of the supply chain. One of these parameters was the mill turn-around time and delivery patterns, which clearly showed the particularly poor and deteriorating status of the transport element of the supply chain.

The frustration led to a series of SLIP workshops held with various supply chain role-players, including South African Cane Growers' Association, South African Sugarcane Research Institute (SASRI), prominent growers in the regions, hauliers and millers as well as the Australian designers of FREDD, which culminated in a three month pilot project at Darnall Sugar Mill on the North Coast.

Although the pilot only lasted three months which included the typically chaotic tail end of the crushing season, much was learnt from this pilot, including the fact that the principle was indeed sound. It was realised that some customisation would be necessary to accommodate the complex nature of the Southern African Supply Chain and that in the South African environment significant savings would be realised if implemented commercially (Giles *et al*., 2005).

Based on the success of the pilot the following year (2006), Malelane Sugar Mill in Mpumalanga (TSB Sugar) implemented the FREDD system in its first commercial application in Southern Africa. Darnall (Tongaat Hulett) soon followed and implemented FREDD commercially towards the end of the 2006 season. This was followed by Maidstone (Tongaat Hulett) and Simunye in Swaziland (RSSC Sugar) in 2007 and 2008, respectively, and this completed the fourth implementation.

To date considerably more software customisation than was ever envisaged has been completed, and a total of 143 software versions that have taken more than 15 000 man-hours have been completed. This highlights that even an industry specific software tool needs significant customisation to suit the specific environment and, although marketed as such, no generic product exists in reality. In addition, in order to be successful, it is important to note that, three distinct and necessary roles are needed on such a project, namely, the software developers, the client and the client interface who interprets the client's needs for the developers.

The FREDD System

At the outset it is important to note that a successful scheduling project is not purely a function of software and is rather a result of a dependant four part set consisting of the following:

- Scheduling Software suite (including software development team).
- Enabling and supporting hardware (including support and maintenance).
- Project personnel (including both operational staff , support and maintenance staff).
- Supply Chain Improvement Process (including analysis tools and consulting staff).

Software
As discussed briefly previously, the software aims to mimic a competent manual scheduler with the advantages of a high speed computer algorithm, with consistency and the inability to be externally influenced. The system used the real-time method of scheduling where when the vehicle leaves the sugar mill, the driver is given a single instruction of where to pickup the next load of sugarcane. This allows the system to accommodate the many operational changes that take place during the day as various logistical constraints occur.

The current FREDD suite is generic in nature and, depending on the local supply chain requirements and project maturity, may include some or all of the components shown in Table 1 and screen captures which are shown in Figure 2.

Table 1. FREDD Software Suite Modules and purposes.

Module	Purpose
FREDD Traffic Scheduler	Scheduling application that sends and receives vehicles, manages cutting groups, software setup and acts as a data hub for all other modules
FREDD Database	Describes the mill area environment and holds certain operational data
Kiln Sheet	Daily input of transport task including quantities, zones etc
FBI	Communicate in real-time to the factory the ACTUAL inbound supply rate
SHAZAM	Real-time management of the zones/fields and communication of this information to the Traffic Scheduler
ETA calculator	Interprets truck GPS coordinates into accurate arrival times at the mill
FREDD Lights Server	Coordination of the holding yard with the objective of maintaining relative haulier equity and encouraging correct fleeting and performance
FREDD Reports/LIP	Standard reporting on the supply chain performance as well as interactive analysis of performance

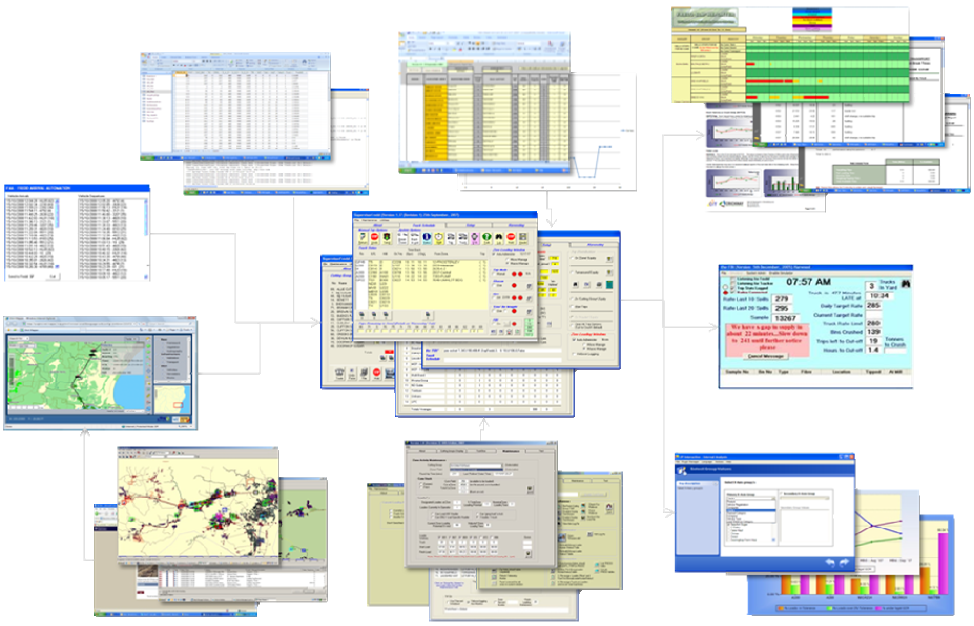

Figure 2. Screen captures of the complete FREDD Suite of modules.

A large degree of the development in the Southern African environment was centred around reporting (including reporting on individual scheduler performance), accommodating the complexity and business rules of the supply chain.

Hardware

The FREDD software suite does not require any particularly sophisticated computing power and will run very satisfactorily on a set of standard Personal Computers that are networked and linked to the internet. In the Southern African context, instructions are given to drivers via a till slip which is printed at the weighbridge.

In order to monitor the progress of vehicles while travelling or loading, truck on-board computers with a GPS and GSM modem are installed on all vehicles.

The FREDD system is significantly enhanced if directly interfaced with local information systems, such as LIMS or the local factory control system. This allows for a significant increase in data accuracy, as well as enabling various automation procedures for schedulers to spend more time on supply chain problem identification and problem resolution, such as cane availability.

To ensure sufficient FREDD system uptime, a formal business continuity plan has been implemented at every site. All the hardware is maintained and supported by internally nominated or contract personnel. In almost all cases replacement hardware with the applicable software installations are held onsite so that hardware changes may be completed easily and downtime minimised. To protect against data loss, the FREDD software has been configured to backup to an off-site server in near real-time. This allows scheduling to continue as before with all the most recent data from prior to the hardware failure.

Project personnel

The supply chain management function that the FREDD project fulfils is indeed a very important one for all the role-players, miller, haulier and grower. Therefore in all cases the most competent personnel are sought. Without any doubt, these individuals determine the ultimate success or failure of the project. Knowledge of the agricultural supply chain environment is important as well as a significant passion for logistics improvement.

The four discrete role categories are:

- Supply Chain Manager
- FREDD Schedulers
- Project change agents
- Support and maintenance.

Change process

On implementation, the operational use and operation of FREDD software quickly provides an improvement in the performance and efficiency of the entire supply chain (growers, hauliers and miller) by coordinating and managing the entire logistics effort as a single unit rather than the individual elements managed independently of each other.

One cannot expect 100% success immediately, but, rather that the FREDD software enables one to manage the resources optimally within the given constraints. The ongoing challenge is, therefore, to gradually remove these constraints and allow the software to coordinate the supply chain more and more efficiently. Indeed one of the most valuable functions of the software is to identify, record and expose areas of weakness and opportunity in the supply chain so that they might be addressed.

Examples of supply chain constraints are: complexity imposed on the system by vehicles that can only haul from certain growers, unbalanced loading windows, suboptimal shift change strategies, and loader availability.

Many of these areas of opportunity and weakness were either unknown to role-players or were misunderstood resulting in incorrect or ineffective management.
A formal process of supply chain improvement should be followed, this allows for low risk, high return, reliable improvement to occur. The process is as follows:

- Define the specific business objective
- Gather data
- Provide information and benchmark
- Build understanding
- Prioritise and prepare for change
- Make the change
- Consolidate and track progress.

This process is facilitated by using the Logistics Information Platform (LIP), which is a software tool designed and supplied by Crickmay and Associates as a component of the project. LIP provides the FREDD project with all of its reporting capability as well as providing for an interactive component for the Supply Chain Manager and Change Agents to interrogate the information and better understand the problems that need to be addressed.

Results

Results from the FREDD Project are presented in two broad categories, namely; quantitative (those relating to efficiency improvement and the cost saving resulting from the efficiency improvement) and the qualitative improvement resulting from the project.

The improvement in supply chain efficiency is well assessed by measuring two parameters: the mill vehicle turn-around time and the mill no-cane-stops. A decrease in mill turn-around indicates a reduction in truck cycle time, thereby increasing vehicle productivity and utilisation. A decrease in mill no-cane-stops directly increases the overall efficiency of the mill.

As discussed previously, efficiency improvement occurs over a period of time and is a function of both the introduction of FREDD as a management tool and the elimination of supply chain constraints. Figure 3 shows the improvement in mill vehicle turn-around time at Darnall mill from 2003 through to 2008. The graph demonstrates the effect that the FREDD project has had on the turn-around with the implementation completed in late 2006 when the vehicle turn-around was at its worst (2.1 hours). Effective FREDD operation commenced at the start of the 2007 season. Since 2006, the turn-around has reduced to 0.7 hours per delivery equating to a 67% reduction or 1.4 hours in just 2 years. This turn-around time is shown relative to the SLIP Industry average (all Southern African Mill's participating in SLIP) and Darnall was the benchmark mill in 2008 in terms of turn-around time in the Southern African sugar industry. The cost saving for growers and hauliers from the FREDD Project in 2008 emanating from the reduced mill turn-around time alone is estimated conservatively at over R12.7 million.

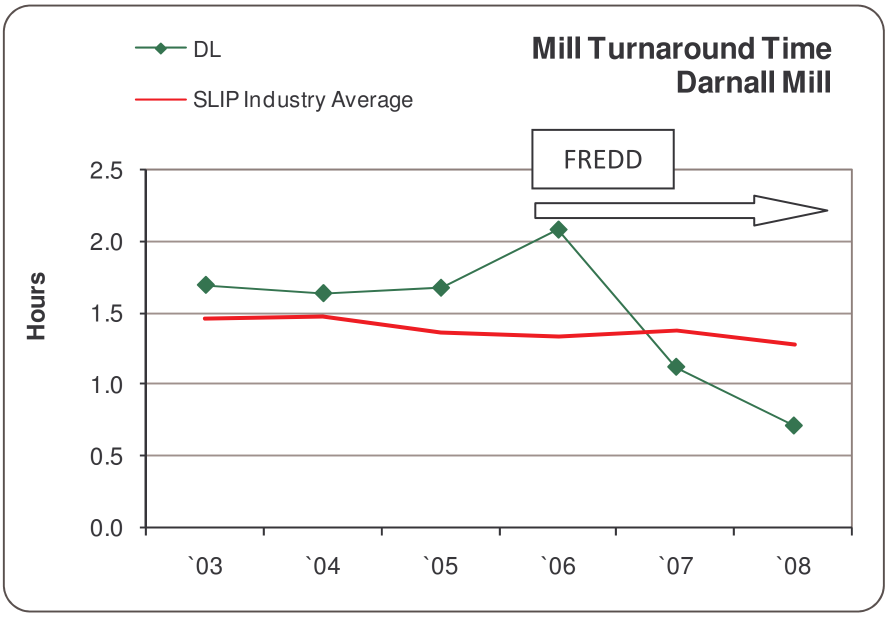

Figure 3. The vehicle mill turn-around time at Darnall Mill with the effective FREDD operation commencing in 2007 shown relative to the SLIP industry average mill turn-around time.

The mill no-cane-stops at Maidstone are shown in Figure 4 from 2005 through to 2008. This graph demonstrates the effect that the FREDD project has had with a 54% reduction in mill no-cane-stops in 2008, from 1369 hours to 636 hours in the first year of FREDD operation.

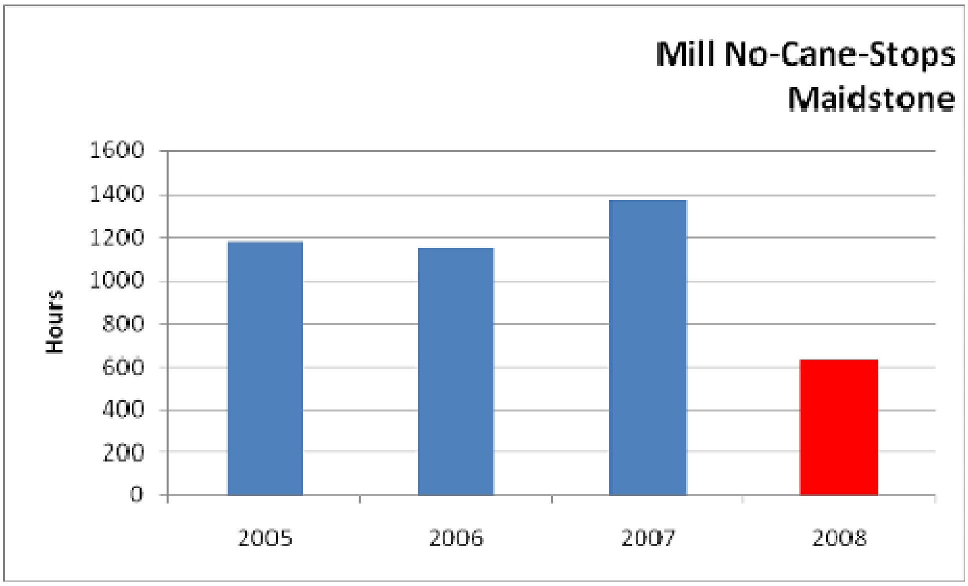

Figure 4. Mill no-cane-stops at Maidstone Mill after effective FREDD implementation in 2008.

Although difficult to calculate exactly, the savings associated with the reduction in mill stops and accruing to the miller are estimated to be in excess of R14.7 million.

Qualitative remarks from role players at the mills include:

- Supply Chain Manager Darnall – "We used to operate with as many as 23 trucks in the holding yard and seven in the mill (shown in Figure 5). I never thought I would be comfortable with only three trucks in the yard."

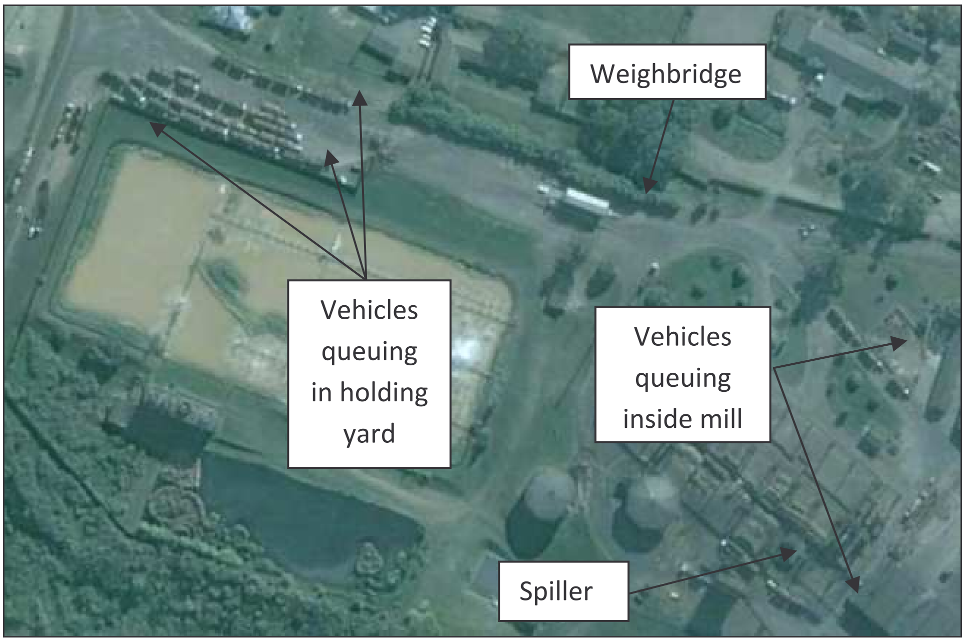

Figure 5. An aerial photograph of the Darnall Mill reception area prior to FREDD implementation showing the 30 trucks queuing to offload (top left and bottom right corner of the photo).

- Third Generation Darnall Grower – "The mill performance in the last two years has been the best for as long as we have grown cane in the area (1920s)."
- Two biggest private growers in the Darnall area – "We haven't left a stick of cane behind since FREDD has been introduced."
- Darnall grower and private/commercial haulier – Has increased total tonnage hauled from 36 000t (own cane) by 31 000t (new commercial contracts) to more than 67 000 (with the same two vehicles).
- Supply Chain Manager Darnall – "In 2008 we had our worst mechanical efficiency (83%) at the mill for a ten year period. Every grower in the area that does not know the figures says it has been the best year since 1987 (1.5 million tons); this is because the FREDD controllers smooth the movements of trucks and good communication allows all to know if there is a delay, why and how it will influence their daily delivery."
- Inbound Logistics Manager Malelane – "We used to think we knew where our problems were; but now we know. I never knew how bad it (the supply chain) was."
- Darnall/Gledhow grower/haulier – "What I do with two trucks into Darnall I need three for transport into Gledhow without scheduling. In addition the drivers needed to be swopped between mills as the load based incentive scheme was only working at Darnall and drivers were very unhappy."
- Major haulier into Darnall – "Two drivers left the company and numerous others have complained because they do not have to wait outside the gate to come into the mill - so they feel they do not have enough resting time to have lunch and supper as they previously had; the turn-around time is too quick."
- Darnall Miller – "Traditionally and prior to FREDD, if there were less than seven vehicles at the mill, the mill operators would start preparing for boil-off and a no-cane stop. Currently we have got a maximum of five and minimum of three vehicles at the mill at any given time. Mill operations and best practices had to be changed to accommodate this and the mindset change of all employees had to take place as they

constantly wanted to boil-off or 'bank' the boilers due to the perceived shortage of trucks."

- Darnall Supply Chain Manager - 40 000 tons of Direct Bundle growers have gone onto spiller last year as they believe the cane is crushed quicker (thus better test results) by moving it with spiller instead of bundles, the thinking of "at least the cane is in the mill and I only have to work six days per week which is more than the spiller can say" has turned into "my cane is moving at the same rate yet with higher RV's!"
- Darnall Supply Chain Manager – "We have not only reduced our mill turn around by over 50% but at the same time have been able to increase our average crush rate."
- Darnall grower/haulier – "This year I have transported over 53 000 t with one vehicle. This just would not have been possible without FREDD at our mill."
- Darnall Efficiency Committee Member – "Management of cane yard has never been easier."
- Maidstone Efficiency Committee Member – "The Transport Joint Venture project would have been impossible without FREDD": Darnall grower – "Having advanced notice of cane flowing to the yard enabled them to take effective action."
- Malelane Efficiency Committee Member - "We have been able to move 200 000 t more with no extra vehicles in the fleet."
- Malelane commercial haulier – "We have been able to sell six of our older (and all different) vehicles and buy four new identical ones to do the same job."

Discussion and Conclusions

The FREDD project has been a resounding success

It is clear that scheduling works effectively in the Southern African environment and can improve the supply chain for all role-players; miller, hauliers and growers. The FREDD project does indeed return significant savings for a mill area which far exceed the project investment costs, with a conservative project Return on Investment >10.

It is important to note that not all improvements can be attributed specifically to the FREDD Software alone. Rather it is the larger logistics effort initiated and then led by FREDD that consists of a number of sub-projects (facilitated in some cases by external consultants and change agents) or management focus areas such as the Transport Joint Venture Projects, the Stock Project and Zone Management Project, and the Driver Quality and Driver Incentive Projects.

Momentum

The implementation of a system such as FREDD creates much momentum to address other inefficiencies and effect change as gains are made. As with all changes, although initially they might require much work to get them started, once they are operational they create a certain amount of their own momentum, inertia and confidence to tackle other supply challenges.

'Level playing field'

Before FREDD it was common practice for supply chains to experience all manner of underhand practices in an attempt to gain some advantage at the expense of others who were operating legitimately. In the FREDD environment this is now impossible as the FREDD software has a whole host of equity based algorithms which continuously monitor and manage all role-players in real-time relative to each other, e.g. fair management of all the vehicles waiting to offload and only calling the correct truck to offload when it is correct to do so, and also sending trucks to collect cane in a equitable manner.

Visibility/information of the supply chain as a decision support
FREDD allows the miller, cane supply manager and other role-players to 'see' what is happening at any point in time. This kind of visibility enables them to make better decisions as they now ***know*** what is happening.

Good leadership and management
The FREDD Supply Chain Manager position is the most important person in the FREDD project, both in the short and long term. The success of the FREDD project is determined by the manager's ability, authority and capacity to perform his function well.

The FREDD Schedulers are key to the success of the project and therefore the highest calibre person possible should be sought.

Supply chain must function as a single unit
A mill area needs to work as one team and not as a group of individuals.

For the FREDD system to work and for the sugar supply chain to be effective, the supply chain must work as a single logistics unit. A fragmented supply chain, where the one party does not know what the other party is doing and are not coordinated as a single entity will result in much inefficiency.

When and when not to change FREDD
From an implementation and change agent perspective, the single largest challenge is to decide whether to change FREDD to accommodate an inefficient business practise or whether to change the business practice to suit FREDD and force it to be more efficient.

Software and hardware are not a silver bullet
Although FREDD is largely made up of software and hardware, the FREDD System entails so much more. For the FREDD System to operate effectively requires four highly interdependent parts, namely the software, the hardware, the personnel and the improvement process. These four parts provide a reliable and effective mechanism to manage and improve the supply chain efficiency at a mill. The quality of each of these parts directly impacts on the degree of improvement and in all cases the best possible quality should be sought.

It is important to note that, although the FREDD software suite is a 'live scheduling' system, and has also proven to be an extremely effective tool for improving and sustaining supply efficiency, it is not a 'silver bullet' to improving efficiency and reducing costs, but rather a tool which exposes opportunities to do so.

Improvements do not happen overnight and substantial long-term improvements will only be seen after months or even years. The FREDD system focuses one's attention on the supply chain, and in so doing highlights other problems which subsequently need to be addressed. This in turn improves the whole supply chain.

Value of a proven industry specific solution
A total of 143 versions consisting of over 15 000 man-hours have been built to make FREDD suitable for Southern African conditions even though FREDD was already a sugar specific

solution. "The Devil and the risk are in the details." Many different scheduling software providers claim that their products are generic and can be customised, but the reality is that this statement is simply not true.

One can manage what one can measure

The saying, 'If you cannot measure it, you cannot improve it' has been proved once again. Without accurate measurement the supply chain operates relatively unchecked and members of the supply chain need to be made aware and be accountable to one another. FREDD plays a two-part role: firstly to schedule trucks efficiently to arrive JIT to offload, and secondly to provide management data that can be used to explore areas of opportunity and weakness. When parameters are measured they can be effectively managed.

Logistics flexibility

In a system where there are many complex sub-systems, and vehicles are constrained to pick up only from one or a few locations, the supply chain operates sub-optimally. To counteract this, as many trucks as possible should be able to go to as many destinations as possible.

This deliberate move towards a single haulier strategy with a single generic type of truck and configuration that can perform satisfactorily well in all circumstances is critical to the initial success of the project. This is in contrast to the well established strategy where vehicles were designed for specific applications and should be noted by those in logistics design roles.

Pereto principle

The Pereto principle holds true on this project, where significant efficiency improvements are seen early when implementing only a partial solution suite with relatively low effort, but there is a need to implement the entire suite of software to realise the remaining efficiency and cost savings.

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