Shift Scheduling in Mechanised Harvesting Operations in South Africa

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Summary

Extending conventional working hours to compensate for the demands of harvesting processes by lengthening work cycles within shifts, or incorporating additional shifts, have become a universally common practice in forest operations. The motivation for this development is largely monetary of nature; i.e., ensuring adequate financial returns for employing large and expensive equipment, and increased production demands. There are however, many other factors that need to be understood within the shift work context, before decisions can be made as to which shift protocol to apply within specific circumstances. Shift work applications in forestry operations, as well as other industries, are complex as a result of various factors.

In the review of literature associated with shift work in both timber harvesting operations and other manufacturing sectors; careful consideration was given to human-related performance, the human/machine interface as well as equipment functioning within an environment of continuous production. In addition to the literature review an effort was made to gain reliable information from various experts both nationally and internationally. The responses were varied because either respondents were wary of disclosing so-called “best practice”, do not have a “best practice” or they did not know what to respond. What is clear is that there are as many shift work protocols in use as there are possibly operations running. An analysis of the literature also led to the conceptualisation of a shift work framework, although it became evident that there are still large gaps in knowledge related to this area, thereby warranting significant future research.
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Introduction

Undoubtedly, the main defining characteristic of the 21st century has been the onset of a contemporary technological revolution distinguished by an entire generation’s emphasis on continuous production. The current organisational environment however, is becoming increasingly unstable due to global economic concerns, while the technological development revolution has lead to ever increasing international competition. It has become evident that in this new paradigm, both the organisation and the employee will have to synchronise their goals to ensure sustainability in an uncertain future (Wheatley, 2006). From an organisational perspective, this implies providing employers with resources to not only retain workers but to ensure competitive levels of production. The paradox however, becomes progressively clear and relevant and gives rise to the question of how to simultaneously increase productivity while taking into account the limited capability of the human factor. In the current age of information, technology and creative problem-solving, human abilities will form an integral part of organisational strategies directed towards finding viable solutions for these concerns.

Although this dilemma is one which relates to all aspects of modern society, it is particularly significant to this report. In few industries has continuous and improved production been as deliberately stressed as in an area which requires shift-workers to operate in a 24 hour environment and, at the same time demand results, irrespective of the cost. This report will explore several hypothesised models of adaptation to shift work to ultimately form a basis of potential recommendations, before focusing on specific shift systems utilised in the timber harvesting industry, as well as provide a detailed account of the safety issue as related to shift work. Aspects related to South Africa will also be explored so as to offer an account of the problems facing industry in this diverse and unstable environment. In conclusion certain equipment considerations in the timber harvesting industry, as well as an attempt to establish a framework in which it will be possible to suggest viable recommendations unique to mechanised harvesting operations in South Africa will be explored.

Study Objectives

1. Conduct a Literature review of shift work in mechanized timber harvesting operations national and international and include results into the body of the text.

2. Complete electronic and telephonic surveys gain the following information.
   - What are the trends towards shift work from semi-mechanized to fully mechanized systems?
   - What shift scheduling strategies are being employed and how have these translated into improved productivity, reduced cost and labour relations?
   - What will be the effects of various shift systems on productivity, machine costing, operator ergonomics and fatigue as well as future training of machine operators?

3. Provide potential examples of recommended shift work strategies through case studies.

4. Provide a limited checklist for practitioners considering shift work with respect to the person potentially involved in shift work, the legal framework, the machine and the work place.
Study methodology

The study was undertaken through the review of literature and through e-mail and telephonic based surveys to international and local experts. The survey contained the following three questions (as listed under the study objectives).

1. What are the trends towards shift work?
2. What shift scheduling strategies are being employed?
3. What will be the effects of various shift systems?

The international and local experts contacted and interviewed:

- Prof Bo Dahlin  University of Helsinki. Finland.
- Prof John Garland   Oregon State University. USA.
- Dr Edgar Kastenholz  Germany.
- Prof Loren Kellogg  Oregon State University. USA.
- Dr Joachim Morat  KWV, Germany.
- Prof Esko Mikkonen  University of Helsinki. Finland.
- Prof Glen Murphy  Oregon State University. USA.
- Prof Reino Pulkki  Lakehead University. Canada.
- Dr Arto Rummukainen  Metla (Finnish Forestry Research Institute).
- Mr Simon Shackleton  John Deere. Australia.
- Prof Walter Warkotsch  Technical University Munich. Germany.

Telephonic interviews were conducted with the following local expertise:

- Mark Wells  PG Bison
- Ian Viviers   Merensky
- Matt Leov  Total Harvesting (Western Australia)
- Phillip Dohnt  LV Dohnt Harvesting (Western Australia)

A number of contractors where also interviewed, but due to the sensitive nature of the information supplied, requested that they not be named in this report. Information on shift schedules mentioned was gathered from many sources and accumulated to represent a general impression of operations in South Africa.

Responses were relatively poor with only John Garland, Glen Murphy, Arto Rummukainen and Esko Mikkonen responded to a greater or lesser extent from abroad. Of the respondents John Garland was the most helpful in providing additional literature not available in libraries in South Africa. As can be seen from literature list very little has been published, or for that matter researched, in the field of shift work in forestry operations. Most of the literature is from the mining related industry. Valuable information was however obtained from Prof John Garland and Dr Dana Mitchell on North American forestry practices and, although not always contextually relevant to South African conditions, did prove beneficial to develop an outline of focal points of this review.
Diagnosing the problem and considering the human factor

Shift work is defined as the condition in which one worker takes over from another in the same position within a 24 hour cycle. The result is an extended working day within the organisation in order to increase production in manufacturing industries (Sardiwalla, 2003). The main advantage for the shift-worker is increased earnings as a result of extended working hours beyond the normal eight to five day. The problems and challenges of extended shift work on the physical, psychological and familial well-being of the individual employee however; seem to far outweigh the potential advantages of implementing a shift work system.

Physical effects of shift work

A shift-schedule is described as the sequence of successive shifts and subsequent off-time allocated to a worker (Golsse, 1991). This implies that a method of rotation is required to allocate different shifts to employees according to a particular set schedule as determined by the organisation. If a change is made to the shift schedule so as to incorporate a double shift, workers are obliged to accommodate their sleep schedule appropriately (Costa, 1996). This inevitably leads to disparity between the workers internal biological clock and environmental time cues. These endogenous circadian rhythms are synchronised to function according to a 24 hour cycle as determined by various “time-keepers”, such as changes from light to dark to light, social interaction, work, and knowledge of clock time. The most obvious circadian body functions include sleep, work readiness, and most of the autonomic processes (Table 1), such as body temperature, metabolism and blood pressure (Grandjean, 1988).

Studies have revealed that these bodily functions are in optimal operation during the day in the so-called ergotropic phase, while the body recuperates and regenerates its energy reserves at night during the trophotropic phase (Grandjean, 1988).

Table 1. Circadian bodily functions that increase by day and decrease by night (Grandjean, 1988). Daily temperature.

- Heath rate.
- Blood pressure.
- Respiratory volume.
- Adrenaline production.
- Excretion of 17-keto-steroids.
- Mental abilities.
- Flicker-fusion frequency of eyes.
- Physical capacity.

The dilemma thus becomes apparent; shift work demands that individuals be active at a time of day when their circadian rhythms dictate they become inactive, and to sleep when their bodies are ‘waking up’. However, research has suggested that there are certain factors that can have a mediating effect on disrupting the cycle of waking and sleeping hours during shift work, and that these factors can potentially be important in establishing a context within which shift schedules can be developed, to
minimise their adverse impact on individuals. These factors include aspects of various shift systems (fixed or rotating), characteristics of the individual (age and personality) and the variation in jobs or tasks (workload) (Smith et.al., 1999). This will be elaborated upon in a subsequent section of this review focusing on existing models of adaptation to shift work.

Given that absolute adjustment to working at night does not occur rapidly, the shift worker’s bodily functions are only partially inclined to be working at night and resting during the day (Grandjean, 1988). Circadian cycle disruptions cause shift workers to become increasingly susceptible to certain nervous disorders and abdominal illnesses (stomach and intestines). The primary concerns are associated with unhealthy eating habits which occur when shift workers have to adapt to alternative mealtimes. The initial digestive complications resulting from the consumption of food at unfamiliar times can be very taxing and upsetting to the individual employee (Knutsson, 2003). A further, and perhaps even more harmful physical outcome of shift work, is the effect of chronic fatigue on the human body. Grandjean (1988) deems it justifiable to talk of “occupational sickness” among shift workers, particularly those symptoms that manifest as a result of chronic fatigue (Figure 1). These include exhaustion even after resting, petulance, bouts of depression and loss of vigour and strength resulting in a general reluctance to perform work-related tasks.

Figure 1. Diagram illustrating causes and symptoms of occupational ailments among shift workers who periodically work at night (Grandjean, 1988).
This already severe situation is aggravated by frequent headaches and colds (Grandjean, 1988). Additionally, harvesting machine operators conduct their work while in a continuous sitting position inside the cab of the machine. The lack of movement and exercise may further aggravate the situation by giving cause to a weakened immune system, sore neck muscles from bracing, and the ensuing risks connected with blood sugar levels (Mitchell et al., 2008).

Apart from the obvious and direct physical effects of shift work on individual health, another perhaps more critical issue becomes evident. Workers who experience chronic fatigue attempt to combat the symptoms by using sleeping tablets during the day and stimulants during night work (Grandjean, 1988), which, in certain instances, increases individual susceptibility to other drug and potential alcohol abuse. Substance abuse refers to the overindulgence in, and dependence on a drug or any other chemical, leading to effects that are detrimental to the individual’s physical and mental health, or the welfare of others (Mosby, 1998). The implication of substance abuse with regards to the context of work becomes increasingly cumbersome when viewed in light of the task of the shift worker which often involves mass-production, requiring low-level skills to engage in repetitive tasks, operating large and dangerous machinery, and often rotating on an eighteen hour shift-schedule (Oosthuizen, 2008) in some industries.

It thus becomes evident that the detrimental health effects of shift work on the individual employee are very prominent contemporary concerns, and the current methods that address these issues are in dire need of alteration. The degree of the problem is further increased when observing that approximately two thirds of all employees working shifts suffer, to some degree, of ill-health. About 15% of these eventually abandon shift work because of serious health issues (Grandjean, 1988). In an organisational where the wellbeing of the employee is carefully scrutinized, this issue must receive progressively more attention and should eventually emerge at the forefront of the corporate agenda.

**Psychological effects of shift work**

As is often the case, the severe effects of chronic fatigue, apart from physical exertion, may eventually lead to adverse psychological reactions, depending on the nature and extent of the exhaustion experienced by each individual. Venter (1974) argues that self-esteem, anxiety and conflict-pressure are factors that are indirectly influenced by shift work. If the worker perceives conflict resulting from the incompatible demands of all his expected roles and duties, it may result in lower self-esteem and escalated levels of anxiety. Personality traits also seem to function as a major determinant in the shift workers ability to adapt to night work. Furnham and Hughes (1999) established that nightshift television crew members experienced less job satisfaction than those working the dayshift. Interestingly, workers classified as introverts dealt better with these conditions than extroverts. This might be attributed to the importance that extroverts place on the maintenance of their social networks and consequently they may better cope in a team setup where interaction and mutual support from the group is possible. In addition, Tamagawa (2007) found certain personality traits to have a direct effect on the level of adaptation to shift work. In a study conducted amongst a group of police officers, it
was found that officers with a repressive emotional style are ill-suited for work during the night shift and that manifestation of physical ill-health and sleep problems are common amongst people with these personality characteristics.

**Family and social life**

Those with significant measures of wisdom and an even greater amount of first-hand life experience would claim that the key to a well-lead, prosperous life, is to maintain a balance between different pursuits throughout one's life. The dilemma with regards to shift work then, becomes apparent: How does one balance the demands of work that involves at least 12 hour shifts at arbitrary times of the day with mostly incompatible and overlapping requirements which family-life entails? According to research, one simply does not. The main concerns with shift work as relating to social aspects of work has to do with the disruption of family life, interference with a larger network of friends, and less occasion to participate in group activities (Grandjean, 1988).

According to Grandjean (1988), male shift workers perceive shift work as a threat to sound familial functioning with regards to their role as fathers, in that they often spend days at a time without being able to see their school-aged children during conventional 'family time', such as mealtimes. This usually results in the mother taking on the role of principal caregiver while the husband is forced to play a secondary role. Further domestic difficulties include the effort of diverting the spouse from her household tasks, the incapability of providing personal protection while on duty at night, and nurturing intimate relationships while having to reckon with incompatible working hours. Another dilemma that is of specific relevance to the South African context of shift work is that black workers in particular view their work as a priority, worth giving more attention to than their families (Ryan & Morgan, 1995). Higher earnings are the chief motivator behind such a viewpoint, and when taken to the extreme, it might potentially prove very disruptive for domestic harmony. This will however be elaborated upon in a subsequent section of this review which will specifically focus on shift work in the South African context.

Furthermore, Grandjean (1988) states that the ill-timed outcomes of shift work are not only felt in the intimate circle of one's closest family, but can give way to a ripple effect that can be experienced on a much wider communal level as well. Shift workers often feel that opportunities for them to partake in activities in a broader societal context, such as those pertaining to sports and politics, are severely restricted as a result of their shift schedules. Comparable to this limitation, is the problem of fostering friendships, particularly in areas where few other individuals reside with work of a similar nature. Accordingly, the shift worker is, as a victim of circumstance, forced to engage in solitary pursuits. After a certain amount of time, this may lead to feelings of social isolation.

**Performance**

Adding tasks to a shift worker's existing list of responsibilities may prove to be beneficial to the individual, as it can increase the range of competencies and diminish the repetitiveness and tedium of
mechanised forest harvesting operations (Gellerstedt et.al., 2005). Plant and factory surroundings merely allow for passive tasks such as monitoring changes (Persson et.al., 2001) and will ultimately result in lower levels of perceived job satisfaction for the worker. Allocated tasks which involve a certain amount of active participation of the shift worker with regards to planning and problem-solving, will lead to a greater sense of perceived control and consequently, a greater sense of job satisfaction. Furthermore, bodily functions, such as elevated body temperature and heightened adrenaline secretion, will add to the rejuvenating effect experienced by shift workers (Mitchell et al., 2008). The implementation of shift work operations can thus have an impact on workers pertaining to their physical and psychological health; the length and rotation of working shifts can physiologically alter individuals and contribute to the occurrence of lower job satisfaction, emotional wellbeing, and at-home conflicts. Comprehending shift scheduling and its associated influence on employees should thus be a chief objective among all harvesting company owners that are considering the implementation of multiple shifts.

Models of adaptation to shift work

From the above it has clearly been established that the impact of shift work on the individual can be visibly felt in three related, yet distinct areas: the physical, psychological, and social effects. These impacts cannot be ignored and have lead to the manifestation of some very notable and current concerns. Accordingly, several models describing the relationship between shift work and health have been proposed. The stated relationship are rationalised in terms of the current turbulent economic climate, stressing continuous production and employee health and wellbeing. These models of adaptation suggest a framework where the causal relationship between shift work and its potentially harmful negative effects on physical and psychological health and family life are traded off and viewed against possible coping strategies. Consequently four of the most prominent models will be elaborated upon below.

Rutenfranz’s model

One of the first models relating to shift work and the physical and mental condition of shift workers was introduced by Rutenfranz (1981). According to this model, stress caused by the erratic sleeping and waking hours as determined by shift schedules will be directly responsible for an onset of health problems and nervous tension. However, the model does acknowledge the presence of other variables which may serve as mediators between the relationship of the stress of ever shifting schedules and poor health. These mediator variables include environmental dynamics such as the family milieu and individual factors such as personality type. An example incorporating these variables is a night worker, who tends to be morning oriented, with an unsupportive spouse. Such an individual will have trouble coping with the ambiguous demands of opposing sides and will most probably not adjust well to working at night, thus making him more susceptible to sleeping disorders and other health disturbances.
Monk’s model
Monk (1988) offers a slightly more complicated hypothesis which presumes that the capacity to deal with the strenuous demands of shift work is governed by three interrelated yet distinct concepts known as the biological clock, sleep, and the social or domestic environment. The adjustment that is necessary to adapt to different times of sleeping and waking requires constant reorganisation of the body’s biological or circadian clock, resulting in sleep disturbances and interference with domestic obligations (Smith et al., 1999). These three spheres, apart from being interrelated, are interdependent as well. An example might suffice to explain the above; altering the hours of sleep (disrupting circadian rhythms) and looking after an ill child (familial responsibility) can both be responsible for the loss of quantity and quality of sleep. Monk (1988) thus proposes that in order to alleviate the adverse outcomes of shift work and consequently ensure successful adaptation, coping attempts should be concurrently targeted at all three domains.

Olsson’s model
The final model to be discussed is Olsson’s model of adaptation to shift work (Olsson, 1990). It differs from the previous prototypes in that the notion of evaluation and the ability to cope within a broad-spectrum, stressor-strain structures are integrated. Olsson’s model elaborates upon the Rutenfranz (1981) model by regarding shift work as only one of a number of possible job-related stressors believed to impair employee health (Smith et al., 1999). It hypothesises that work-related (e.g. shift work or time pressures) and non-occupational factors (e.g. disturbances in daily family life), along with certain personal elements (e.g. age or method of living) can all serve as significant predictors of employee ill-health. Furthermore, these relationships are predisposed to the aggregated effect of appraisals and individual coping mechanisms. This phenomenon is illustrated by shift workers’ propensity to evaluate perceived threats (stressors) in their immediate environment, and their ability to adapt to these threats. The type of response individuals engage in will determine the degree to which they will suitably adapt to shift work; a tendency for passive or cognitive retaliation related to unreasonable shifts, such as ignoring the problem, can possibly lead to some form of ill-health, whether mental or physical. In contrast, behavioural or active coping mechanisms like opting for the daytime shift will most likely result in positive adaptation to one’s work environment. According to this model, subjective perception is believed to be a major determinant in shift workers’ adjustment (Smith et al., 1999).

A process model of shift work and health
Thus far, the models that were under investigation - although specifying that a certain course of action is necessary to influence adaptation to shift work - have essentially served as heuristic frameworks, i.e. they were created from notions which exist amongst the shift work research community to direct and generate future study. This has lead to increasing demands for a process model of shift work that will aspire to combine individual and situational factors, which are anticipated to disrupt the daily course of life. Smith et al., (1999) propose just such a model where these disruptions necessitate the
utilisation of certain active and passive coping strategies available to the shift worker, in order to manage the situation and the ensuing stress it generates. If the chosen coping strategies are ineffective, the first symptoms will manifest as mild to moderate levels of fatigue, anxiety, emotional ill-health and job discontent.

Continuous, long-term ill-adaptation to shift work will ultimately result in more chronic problems as discussed previously. Interestingly, in samples investigated, Smith et al. (1999) discovered that when dealing with sleep, as well as family or social disturbances, the permanent night shift worker makes use of both avoidant (submitive) and active coping tactics. However, conversely to widely held beliefs regarding measures of coping, workers utilising both these tactics still experienced the potentially harmful effects of short-term trauma. In a sample drawn from a population of workers with rotating schedules, both passive and active coping strategies indicated significant correlation to the job satisfaction dimension. Increased use of a passive response style and diminished employment of active coping strategies were found to be tied to lower levels of job satisfaction. Additionally, the indirect consequences of workload on effective coping, sleep disturbances in the short-term, and chronic nervous tension, warrant further research on the variables of workload and sleep disturbances, as well as certain demographic factors, such as age. These outcomes may have important implications for the field, especially as it relates to future prevention and management strategies, and will be utilised in a subsequent section to formulate a framework for successful intervention with regards to employee safety and wellbeing, with specific emphasis on the forestry industry.

Shift systems in the timber harvesting industry

Shift rotation

Mitchell et al., (2008) defines shift rotation as the tempo with which a worker rotates between different shifts. During periods of rest between shifts, the majority of these workers will often revert back to traditional daytime circadian cycles. It may be regarded as a viable possibility for harvesting companies, offering permanent night schedules, to maintain circadian regulations if the social demands inherent to a well-balanced life do not claim otherwise. Additionally, research indicates that the effects of lethargy due to shift scheduling are experienced at its worst during the first day of recovery and not, as previously believed, on the final day of work (Akerstedt et al., 2000). In a study conducted by Mitchell et al., (2008), shift workers on 12-hour shifts, consecutively executed for two to three days, profess to be fully recovered on the first day off. However when combined with longer sequences, shifts that stretched up to 12 hours, had an adverse effect on the recovery time of workers, often extending it to up to three days. Another fact that arises when undertaking 12-hour shifts is that only 12 hours remain in which the worker has to sleep, commute to and from work, eat, and engage in other domestic activities. Individuals that work a more conventional eight hour shift have an additional four hours to complete these daily duties. Over the length of the rotation schedule, this accumulation of sleep deprivation will cause a worker to be become exhausted towards the end of the timetable. In light of this, one is able to deduce that longer rotations can be held accountable for
unnecessarily experienced strain and fatigue, as well as greater risk of injury and accidents near the end of the schedule. It may be advisable to inform shift workers of different sleep schedules so as to enable them to adjust theirs in relation to a specific rotation schedule.

Moreover Demerouti, et.al. (2004), highlight the often overlooked futility of rotating schedules through their research by illustrating that workers with rotating shifts (including weekends) will encounter higher levels of job discontent than those with set schedules. A fixed pattern of shift work will habitually bring about greater feelings of job satisfaction and professional efficiency, while decreasing cynicism and turnover rates. The drawback of this potential solution however, is that workers on a set schedule may be subjected to more family-work conflict as the permanent nature of these shifts hardly leaves room for anticipated social interaction and necessary familial obligations. Grandjean (1988) proposes a best practice method for shift rotation that entails little loss of sleep and the optimisation of family activities and other social contacts by utilising single, isolated night shifts, each followed immediately by a full 24 hours of rest (Figure 2).

Table 2. An example of a shift rotation for an individual worker in which the night shifts are widely scattered. where E = early shift; L = late shift; N = night shift (Grandjean, 1988).

<table>
<thead>
<tr>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
<th>Saturday</th>
<th>Sunday</th>
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<td>E</td>
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</tbody>
</table>

Shift hours
Research indicates that harvesting companies, who make the decision to move away from the traditional day-only, single-shift harvesting operations in order to incorporate multiple shifts into their operations, frequently give workers with greater seniority the option of the day shift, while new workers are assigned to the night shift (Penkala, 1994; Mitchell et al., 2008). It may be more beneficial to allocate the best person to work the night shift as they could be trusted to be responsible, make good decisions on their own, and ensure that production levels are satisfactory (Mitchell et al., 2008). In implementing work shifts in certain regions of the United States, it was found that special consideration had to be given to culture-specific societal norms and values. Church and related activities on Sundays are important rites for social acceptance in certain societies, and harvesting operators should critically evaluate the necessity to include Sunday shifts. In the South African context, this issue undoubtedly deserves attention when bearing in mind that practicing religion and active participation in community-driven activities, especially in the countryside where much of these operations are based, form an essential part of social recognition and approval.

An additional issue that arises when considering shift hours is that of isolation while on duty. Although a harvesting machine can typically work together in a compartment, the individual members of a
timber harvesting crew often work in seclusion (Mitchell et al., 2008). The feller-buncher machinist fells trees in advance of the skidder operator to the extent that there is little interface between the respective workers, although they are aware of one another’s position. Additionally enclosed equipment cabs further restricts interaction with fellow workers. As a result of this social seclusion and an absence of natural light, night workers tend to experience elevated feelings of segregation. It is proposed however, that workers who possess an internal locus of control would do markedly better on the night shift than those attributing events to an external source (Furnham & Hughes, 1999). Kirk (1998) nevertheless points towards the potential advantages of working the night shift; fewer people on site may reduce individual stress levels in that there are fewer man and machine interferences.

A final dilemma worthy of mention is the onset of worker fatigue during the night shift. Research indicates the potential risk of increased fatigue that is linked with longer episodes of mentally challenging and repetitive, but sedentary machine operation work (Cummins, 1998; Sullman & Kirk, 1998). Regular breaks are suggested to assist in the reduction of the cumulative effect of mental exhaustion and stimulation of the mind. Certain symptoms of ill-health associated with the lack of exercise and movement that is characteristic of sedentary work can be further diminished by leaving the machine, causing certain core muscle groups previously unused to be employed. Furthermore, Kirk (1998) advocates the importance of dividing the working day to allow for breaks every three to four hours to rest, eat, or conduct routine maintenance, and an additional five minutes break, for every hour operating equipment. Mitchell et al., (2008) reported in their study that a vast number of work schedules commence the day shift before 06:30 and that machine operators who rose early display their low circadian cycle with notably slower reaction times by mid-morning. This is generally regarded as an increasing safety concern for the reason that this particular time of day is consistent with accident statistics in a large number of studies and should be carefully considered when compiling a shift schedule.
Table 2. An overview of shift rotation and hours worked.

<table>
<thead>
<tr>
<th>Challenges</th>
<th>Advantages</th>
<th>Recommendation / consider</th>
</tr>
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<tbody>
<tr>
<td>Night work</td>
<td></td>
<td></td>
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<tr>
<td>• Lower production than day shift</td>
<td>• Continuous production</td>
<td>• Varying tasks</td>
</tr>
<tr>
<td>• Higher machine maintenance costs</td>
<td>• Increased output as compared to single shift</td>
<td>• Shorter night shift (e.g. 8 hour shifts)</td>
</tr>
<tr>
<td>• Increased worker fatigue</td>
<td>• Greater machine utilisation</td>
<td>• Regular breaks during shift</td>
</tr>
<tr>
<td>• Circadian incompatibility</td>
<td>• Less man/machine interference</td>
<td>• Schedule routine maintenance into shifts</td>
</tr>
<tr>
<td>• Increased safety concerns</td>
<td>• Reduced stress</td>
<td>• Later morning shifts starts</td>
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<tr>
<td>• Longer recovery periods</td>
<td></td>
<td></td>
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<tr>
<td>• Work/family conflict</td>
<td></td>
<td></td>
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<tr>
<td>• Worker isolation</td>
<td></td>
<td></td>
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<tr>
<td>• Absence of natural light</td>
<td></td>
<td></td>
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<tr>
<td>• Confined to the machine cab</td>
<td></td>
<td></td>
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<tr>
<td>• Social seclusion</td>
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<tr>
<td>Rotation schedules</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Long recovery periods</td>
<td>• Flexibility</td>
<td>• Fixed pattern of shift work scheduling</td>
</tr>
<tr>
<td>• Operator inefficiency</td>
<td>• Less work family conflict</td>
<td>• Sleep loss needs to be minimised</td>
</tr>
<tr>
<td>• Worker fatigue</td>
<td></td>
<td>• Improve social contact opportunities</td>
</tr>
<tr>
<td>• Job dissatisfaction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• High operator turnover</td>
<td></td>
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</table>

Production

Nicholls et al., (2004) determined that the overall production on the night shift was a mere 78% as compared to the output levels acquired during the day. One of the reasons for this apparent production deficiency can possibly be attributed to a lack of dedicated supervisors and managers on duty during the night shift, as well as an inadequate handover of information at shift change. Other explanations include poor visibility, glare, and circadian incompatibilities with the particular shift. In addition Murphy and Vanderberg (2007) established that, on average, the overall productivity on the night shift is approximately 12.5% lower than that recorded for the day shift. Shifts that are longer than nine hours can additionally impair the productivity of workers by a further 6% per additional hour.

Existing literature offers some assistance regarding the ensuing changes of the day and late shift production rates, but it still remains unclear what the costs associated with implementing multiple shifts would ultimately amount to (Mitchell et al., 2008). In a number of operation, and this is of specific relevance to the South African context, operators typically exhibit competence only on a small number of job-specific tasks; i.e., operators are trained to perform a single operation on one machine. Thus the idea of expanding the breadth of their duties, in order to combat boredom as a result of repetition, is becoming increasingly difficult. Mitchell et al., (2008) propose that by adding routine maintenance assignments in the middle of the shift, some of the monotony of the sedentary tasks, may be lessened. Gillberg et al., (2003) make an interesting argument in their research indicating that a
worker's level of output should increase during the course of the shift as individual reaction times gradually becomes quicker, and that scheduled breaks in every shift will result in a decrease in perceived lethargy for about 20 minutes following each break for plant workers. Finally, it was found that harvester processor machinists appear to recuperate from mental exhaustion while on duty, when two of more significant periods of rest were evenly divided throughout the course of the shift (Kirk, 1998).

From the above discussion on different shift systems utilised in the timber harvesting industry, several factors which give rise to noticeable concern were subsequently highlighted. Shift rotation systems are a main cause of circadian maladjustment leading to longer required periods of worker recovery. The effects of irregular work schedules will often manifest as conflict within the family domain. Feelings of social isolation due to increased absence from community activities and night work in isolated will amplify worker perceptions of monotony and the resultant onset of fatigue.

**Shift work and safety**

The 21st century has seen a revolution in the world of work and thus a shift in focus from an organisational perspective was warranted, and the lure of capitalistic gain is no longer the sole purpose of the large conglomerate, but rather a renewed interest in the wellbeing of its most valuable asset – the employee. This shift in attention to a more humanistic, holistic outlook where the latent potential of the individual employee is the organisation's greatest source of wealth requires a realignment of the organisation's core values and ideals (Wheatley, 2006). The implication this statement holds for the business world is immense and, of particular importance to this discussion, is its relevance with regards to employee safety. Although this issue has always demanded the necessary organisational awareness, the vigorous enforcement of the Occupational Health and Safety Act as of late, has seen it emerge at the forefront of the corporate agenda. Central to ensuring employee safety, and at the very core of it with regards to shift work, is the theme of unsafe work behaviour and the resulting accidents in the workplace.

Shift work operations in South Africa provide approximately half a million South Africans with jobs; this in turn, supports an additional five to seven million individuals. Furthermore, the resulting product is responsible for more than 32% of South African exports and 25% of foreign exchange income. Although these figures are chiefly tied to the mining industry, it is still of the utmost importance to make mention of them in this review as there are shared values and perceptions amongst the South African shift-working community with regards to workplace safety that nurture certain universal behaviours.

With this in mind, it is startling to note that South African mines have a casualty and injury rate that is three times higher than its counterparts in developed countries such as Canada and Australia. This is despite occupational health and safety legislation that is supposedly equivalent to those of other countries (Oosthuizen, 2008). Clearly, this is not the case. Even more disturbing, is the facts that up
to ninety percent of all mine-related accidents occur as a direct result of human behaviour (Copans, 2008). Thus it becomes evident that drastic measures need to be introduced to an industry bearing responsibility for such a vast proportion of the South African workforce. Oosthuizen (2008) argues that possible reasons for this apparent lack of safe behaviour may include the wide-spread belief that risk is inherently part of South African life and culture and the forestry industry is most certainly not precluded from this perception.

The vast majority of shift workers’ daily journey to work involves facing hazardous travel conditions. Unfortunately then, living in a society that rates among the world’s topmost countries relating to violent crimes, does not seem to foster law-abiding citizens. Furthermore, it is believed that the fluctuating Rand and erratic commodity prices over the last ten years have been responsible for the industry’s sole focus on production. Incentive programmes, further encouraging production among employees, have not assisted in the prevention of unsafe work behaviour either. Fundamentally then, the safety of workers is a key issue that needs to be addressed in South African trade and industry.

Models hypothesising about the possible causes of organisational accidents date as far back as the beginning of the 20th century. One of the most comprehensive models of accident causation is the domino theory proposed by Heinrich in 1931 (Seo, 2005). This theory states that an injury (5th domino) is brought about by an accident (4th domino) as a result of the unsafe actions of an individual and/ or unsafe conditions (3rd domino) caused by human error (2nd domino) and society (1st domino). Research indicates that the preferred method of reducing injury is the removal of the 3rd domino, namely the unsafe actions of the person or unsafe conditions.

Petersen (1988) elaborated on the above with his theory of multiple causation stating that there are numerous factors that, when combined in an arbitrary fashion, bear responsibility for the occurrence of accidents. In accordance, Heinrich suggests three fundamental sources of accidents, namely inadequate management strategies and procedures, as well as individual and environmental factors (Seo, 2005). Individual factors include employee motivation, intelligence, performance and being attentive to issues pertaining to safety, while environmental factors comprise of potentially harmful physical elements of the working environment. Extreme weather conditions, dust, slippery surfaces, dangerous articles and obstacles all form part of the possible risks associated with the business climate. Ultimately though, the personal and environmental factors relevant to the concept of unsafe work behaviour as discussed above can be largely influenced by management actions, poor management procedures and top level decisions (Seo, 2005).

The carefully concealed, yet markedly obvious suggestion of organisational responsibility with regards to unsafe work behaviour implies a distinct division between hierarchical entities. Bearing this in mind, one could argue that the reasons behind unsafe acts and employee accidents would differ for every organisation and thus be unique in its application across different situations. Logic dictates that the very essence that encapsulates organisational identity, culture, climate, beliefs and norms cannot be
accurately reproduced in any other setting. In light of this it becomes clear that careful attention needs to be given to the subtle, yet significant, variances found across different organisations in order to adequately grasp unsafe behaviour as a consequence of physical or psychological exhaustion within the context of shift work. As illustrated by this discussion, unsafe behaviour at work is not simply a concept that can be viewed in isolation, but rather it involves a dynamic interplay between various other factors greatly impacting the way a business is managed. Some of these factors will be discussed below in order to stress the importance of ensuring employee safety in the current global setting of modern day industry which often requires continuous production managed with a multi-shift schedule. This demanding macro-environment more often than not completely disregards the human factor. The reason that the safety element is included in this review is to establish it as a permanent focal point in an industry riddled with paradoxes – promoting health and safety while simultaneously demanding optimum production.

Causal factors of unsafe work behaviour

The safety of workers is a complex phenomenon. At the forefront of this issue, the shift-working forestry industry will always remain uncertain and dangerous because of its outdoor operations, complicated on-site plant and equipment operation, coupled with workers attitudes and behaviours towards safety. The nature of the industry’s rapidly changing conditions and associated work hazards further aggravate the situation (Choundry & Fang, 2007). However, unsafe organisational exploits and conditions are often thought to be at the root of industrial accidents. Seo (2005) argues that it is actually only the symptom indicating failure. In order to grasp the essence of the problem, one has to enquire into the primary antecedents responsible for the manifestation of these symptoms. It has been proposed that personal and environmental factors, as well as managerial policies and procedures, are significant indicators of the prevalence of unsafe work behaviour within organisations. It is argued that accidents occur not only as a result of technical or human error, but are also noticeably affected by fundamental organisational elements such as the existing culture. Two distinct concepts that arise when evaluating the incidence of unsafe work behaviour. The first implies collective beliefs, standards, attitudes, and actions regarding safety (HSC, 1993), while the latter serves as a pointer of the essential “state of safety” specific to a workgroup, plant or organisation (Flin et al., 2000). Additionally, Seo (2005) substantiates the earlier argument of the importance of effective leadership by emphasising its function in the establishment of an infallible safety culture and climate. Thus far it has become evident that unsafe behaviours within the organisational context seem to result from a combination of many factors, including the human and situational or environmental aspects, an organisation’s managerial function, as well as its subjective culture and climate. Subsequently, certain determinants of unsafe work behaviour will be explored. These determinants will be based on an explicative model of unsafe work behaviour designed by Seo (2005) and elaborated upon by utilising valuable insights from other key role players in the field. Additionally, specific mediator and intervening variables will be identified.
Perceived safety climate

At the forefront of factors significantly contributing towards unsafe work behaviour is perceived safety climate as illustrated by Seo (2005). The causal relationship that exists between this so-called safety climate and that of unsafe actions at work, consist of five dimensions. Firstly, and most crucial in the establishment of a satisfactory safety level, is managerial commitment to employee wellbeing. This notion is emphasised by Choundry and Fang’s (2007) research on employee safety relating to construction and mining sites. They signify strong employee views regarding the responsibility of managers to plan, organise and introduce safety policies and working procedures in the organisational context. Supervisor safety support also rates as a significant moderator variable in the relationship between unsafe work behaviour and perceived safety climate (Seo, 2005). Choundry and Fang (2007) refer to this phenomenon as the “psychological feature” because of the value employees place on well-defined and satisfying relationships with their supervisors. Additional prevailing variables influencing perceived safety climate include support from colleagues, employee involvement, and competence level of the workforce (Seo, 2005).

With specific reference to the forestry industry, several policies can be introduced to offer protection to workers when they exit the machine cab after dark, such as ensuring that other moving equipment are stationary while an operator is outside the cab. LeFort et al. (2003) argue that the occurrence of increased mechanisation has, of late, been responsible for a definite decrease in accidents in the industry. Furthermore, the industry has seen an increase in fall-related injuries, which can be attributed to mounting or descending from the equipment. For this reason, appropriate and safe methods for mounting and dismounting from the cab should be integrated into routine safety practices and vigilantly be enforced by all supervisors with an acceptable degree of consistency.

Perceived danger level

Throughout history, researchers have contemplated the apparent advantages of a hygienic, comfortable and disciplined working environment. These aspects of the working environment are said to lead to improved quality production, as well as resulting in a definite reduction in the occurrence of injury (Seo, 2005). Rundmo (1992) supports this view with his research regarding basic ergonomics in the workplace such as temperature, noise and humidity, and its influence on the incidence of accidents and near-accidents. A further distinction is also made with regards to groups of jobs categorised as more dangerous than others. Of particular relevance to this research, the perceived level of danger associated with unsafe work behaviour can be traced to industries demanding shift work. These operations frequently demand vast amounts of time spent in less than desirable conditions. Consequently, logic would dictate that by improving labour conditions of the workforce and thus minimising potential hazards in the environment, accidents will decrease.

In a study by Mitchell et al. (2008) relating to the human factors of shift work in the forestry industry, it was established that the provision of adequate lighting and similar supplementary measures on the night shift was essential to the successful completion of tasks. These supplementary measures
include machine lights, hardhats fitted with headlamps, high visibility vests, plant lighting packages, as well as power generators. Further elements of the working environment that are perceived to influence the relationship between the apparent hazard level and unsafe work behaviour includes suitable security of the job site, guarding of machinery and operators, and prohibiting access to harvesting work sites (Choundry & Fang, 2007).

**Perceived work pressure**

Perceived work pressure refers to an excessive workload, the anticipated tempo of the work that needs to be done and time constraints. Seo (2005) indicates that the above can be a reason for both accidents and unsafe work behaviour. Further research has also investigated the likelihood of perceived work pressure serving as a mediator variable in itself between the relationship of perceived safety climate and unsafe work behaviour (Brown et al., 2000). Essentially then, when work pressures are perceived as too high, it can lead to unsafe work behaviours with dire consequences. Choundry and Fang (2007) yet again emphasise the role of top management in communicating the value of safety above performance pressure down the organisational hierarchy.

**Perceived risk**

According to the Health Belief Model (HBM) individuals will act deliberately to avoid situations with potentially harmful consequences. These protective behaviours are driven by the instinct to prevent the event from taking place (Seo, 2005). The interplaying variables with regards to perceived risk then, are the product of an anticipated prospect of sustaining an injury and the apparent gravity of this injury (Rundmo, 1992). A dilemma arises when employees underestimate the amount of risk involved in their work, and if these workers are not knowledgeable or their experience is limited the risk factor will be increased even further.

An additional factor influencing the perception of risk in the workplace is the issue of ground-level employees perceiving themselves to be more susceptible to harm than senior management (Choundry & Fang, 2007). An adequate prevention plan should therefore aim to increase an individual’s knowledge of anticipated hazards, and the apparent risk entailed in certain actions in order to avoid it. An effective strategy to convey the potential risk involved in certain unsafe acts in the work environment is one of incentives and compensation packages. It is said that these means of increasing employee awareness can greatly contribute to the way that safety is perceived among the workforce (Lilley et al., 2008). Workers that are paid according to the piece rate are decidedly more likely to take less or no breaks due to production targets. Consequently, the dilemma occurs when these workers become fatigued, and accordingly, more inclined to overlook basic safety procedures.

Furthermore, logic dictates that a satisfied worker is more likely to be industrious and meet the set production goals than a fatigued one. Thus close knowledge of best practice shift-scheduling, and active implementation of regular breaks is of the utmost importance to ensure the optimal functioning of all employees and should not be disregarded when measured against objectives.
**Table 3.** An overview of causal factors of unsafe work behaviour.

<table>
<thead>
<tr>
<th>Factors</th>
<th>Elements of safe work behaviour</th>
</tr>
</thead>
</table>
| **Perceived safety climate** | • Managerial commitment  
                             | • Supervisor support  
                             | • Co-worker support  
                             | • Competent workforce  
                             | • Employee involvement |
| **Perceived danger level** | • Ergonomic improvements (improve labour conditions, minimise potential hazards)  
                             | • Selective access  
                             | • Securing site  
                             | • Guarding machinery |
| **Perceived work pressure** | • Limit time constraints  
                             | • Decrease workload |
| **Perceived risk** | • Understand inherent risk of work |

**Shift work – A South African perspective**

**Labour law implications**

Before engaging in an elaborate investigation into the conditions that depicts the South African shift work milieu, individuals will have to be made aware of the labour law implications regarding multi-shifting. A brief overview of the most important aspects pertaining to shift work will be discussed. A brief summary with regards to overtime (Department of Labour, website accessed October 29, 2009) follows for reference:
Conditions of Employment

- An employer may not require or permit an employee—
  (a) to work overtime except by an agreement;
  (b) to work more than ten hours’ overtime a week.

- An agreement may not require or permit an employee to work more than 12 hours on any day.

- A collective agreement may increase overtime to fifteen hours per week for up to two months in any period of 12 months.

- Overtime must be paid at 1.5 times the employee’s normal wage or an employee may agree to receive paid time off.

With regards to a compressed work week:

- An employee may agree in writing to work up to 12 hours in a day without receiving overtime pay.

- This agreement may not require or permit an employee to work—
  (a) more than 45 ordinary hours in any week;
  (b) more than ten hours’ overtime in any week; or
  (c) more than five days in any week.

With regards to meal intervals:

- An employee must have a meal interval of 60 minutes after five hours work.

- A written agreement may—
  a) reduce the meal interval to 30 minutes;
  b) dispense with the meal interval for employees who work fewer than six hours on a day.

With regards to daily and weekly rest periods:

- An employee must have a daily rest period of 12 consecutive hours and a weekly rest period of 36 consecutive hours, which, unless otherwise agreed, must include Sunday.

With regards to work on Sundays:

- An employee who occasionally works on a Sunday must receive double pay.

- An employee who ordinarily works on a Sunday must be paid at 1.5 times the normal wage.

- Paid time off in return for working on a Sunday may be agreed upon.

With regards to night work

- Employees who work at night between 18h00 and 06h00 must be compensated by payment of an allowance or by a reduction of working hours and transport must be available.

- Employees who work regularly after 23:00 and before 06:00 the next day must be informed—
  (a) of any health and safety hazards; and
  (b) the right to undergo a medical examination.

Production implications

In a country where HIV/ Aids, crime, unemployment, and an ailing education and health system where the scars of past inadequacies are still clearly visible in everyday life, one could argue that a standardised solution spanning from various first world countries would prove entirely futile and that a
unique solution for this varied environment is essential to enable true competition that can be recognised at a global level.

It is important to note the reasons why it has become so important to incorporate multiple shifts as part of the country’s economic agenda. Improved employment of existing capital equipment could potentially diminish increasing demands for new production equipment and, consequently, ease the pressure on the balance of payments of mounting imports of plant equipment. Additionally, the act of employing multiple shifts in the current economic climate will significantly contribute to strengthen the faltering South African workforce, while ensuring that the cost of these newly created jobs remains minimal (Ryan & Morgan, 1995). Although some predict a looming economic misfortune with regards to South Africa’s probability for long-term profitability, their cynical notions fail to consider free growth potential as afforded by a more wide-ranging utilisation of the multi-shift option. The problem, however, lies in the feat of determining the extent to which multiple shifts are currently used in South African trade and industry.

The reasons for this problem range from statistical inadequacy to the inability to decide upon the type of shift operation to be used. The latter can be either of two basic alternatives; the first includes shift operations in which staff is rotated between spells of night and day shifts, while the other option entails the employment of a permanent contingent of night workers (Ryan & Morgan, 1995). The implication that this dilemma holds for South African organisations can be immense as it may serve to influence critical decisions regarding the selection of a pool of potential candidates, wage factors, and board and lodging considerations for permanent workers. An additional issue that arises is that of productivity. Ryan and Morgan (1995) point out that many operations are not even fully utilising their one-shift facility. South African industries are renowned for this particular inability and consequently, the emphasis should be on the exploration of intervention strategies to obtain optimum levels of production from a single shift before giving consideration to the multi-shift option. However South Africa become part of a global economy, furiously competing for market share at international level, and the use of multiple shifts suddenly seems all too appealing, despite these evident inadequacies. Unfortunately, the choice of incorporating multiple shifts is not solely a result of overly optimistic expectations regarding productivity improvement and financial gain, despite it having immense implications for both capital and labour productivity. Market need serves as a driving force behind any decision to expand the breadth of existing shifts.

The above mentioned amendments to enable a smooth transition to multi-shifting will, however, not prove entirely effortless and some notable concerns, specifically as it relates to the South African context, arise. Ryan and Morgan (1995) clearly contend the importance of managerial supervision during all shifts in order to maintain productivity levels. The dilemma surfaces when it is concurrently stipulated that the vast majority of South African managers are unmistakably reluctant to work throughout the night, or even just being called upon after hours. Secondly, as is often the case when scrutinising the African milieu, is the matter of safety. The majority of South African shift workers
arriving and departing from work at odd hours are residing in extremely hazardous township locations. Exactly for this reason then, many companies that must make use of continuous processes, provide their workers with hostel accommodation or, alternatively, provide safe transport to and from work for all nightshift workers.

An additional problem facing the South African industry with regards to multi-shifting is that of trade union resistance. This severe stance is rooted in the notion of legitimate demand, and the idea that if said demand is genuine, capacity will be increased regardless, and union members will get their jobs on the more desirable and much preferred day shift. Resistance is further ameliorated because of the threat it poses to employee overtime and the higher remuneration it affords. One final issue worth mention is the stark realisation of many South African organisations regarding the desperately low productivity levels of the night shift. This has made several large conglomerates rightfully weary and active efforts need to be investigated and pursued in order to adequately address this problem.

Forestry operations in the South African milieu

With specific reference, and of particular relevance, to the harvesting sector is its increasing partiality for fully mechanised harvesting operations. While timber harvesting industries in some Scandinavian and European countries are currently almost entirely mechanised (Akerstedt et al., 2000), South Africa has only recently joined the ranks of those advocating the apparent advantages of fully mechanised harvesting almost tirelessly.

South Africa’s status as a third world country, along with its geographic location does limit its ability to directly benefit from developments in the northern hemisphere. When viewed in this light it becomes evident that South Africa is still far from being regarded as a global equivalent. This is particularly emphasised when considering the high costs involved in purchasing and operating these machines to the extent necessary to produce a certain volume of output. Furthermore, even with continuous production as an inevitable possibility, one still encounters the frequently recurring theme of industry relying on mass-production, and requiring employees with low-level skills engaging in repetitive tasks, operating large and dangerous machinery, and often rotating on an eighteen hour shift-schedule, six to seven days a week. Although these seemingly extreme schedules are not necessarily common practice in South African harvesting operations, it is has been duly observed in certain locations. In the past, this has often lead to an increase in Repetitive Stress Injuries (RSI’s) among machine operators, as well as a reduced ability to concentrate, chronic fatigue and ultimately, poor judgement and decision making.

Long-term exposure to such ergonomically inadequate conditions can potentially be very harmful to the welfare of the shift worker and may manifest itself in a multitude of ways, ranging from the cause of slight discomfort to serving as a trigger for devastating consequences pertaining to ill-health and social wellbeing. Markedly, this issue warrants further investigation; firstly as means to establish and maintain a healthy, well-adapted workforce and secondly, to ensure long-term organisational
sustainability. The section to follow will subsequently address the most noteworthy of these issues, but not before closer exploration of some additional concerns regarding multi-shifting, unique to the South African climate.

**Equipment considerations for extended working hours**

The latest international information regarding the costs involved in harvesting, although not particularly relevant to South African conditions but nonetheless worthy of inclusion in this discussion when read in context, point to an upward spiral of rates increasing by as much as 40% from 1995 to 2005. At the same time, the estimated price that was paid for timber harvesting services diminished by 10% (Mitchell, 2008). The resulting dilemma then is that timber harvesting operators needs to find the means and the methods to diminish the cost of their processes, or alternatively, investigate ways of increasing the value of products offered in order to remain sustainable in an immediate future. In this situation, the decision to incorporate multiple shifts into one’s corporate agenda might assist to lessen the effect of escalating costs. Mitchell (2008) contends that the foremost cost considerations for timber harvesting ventures are executive operating expenditure, outsourcing relevant tasks, coverage fees, labour costs, consumables (fuels etc.), as well as timber harvesting machinery and other equipment integral to the tasks at hand. Although a seemingly trivial sum of the total expenditure on a company’s balance sheet, this equipment is one of the relatively few aspects subject to organisational decisions in an industry riddled with uncertainties and latent threats (Stuart et.al., 2005).

Furthermore small to mid-sized business ventures are not expanding the range of their equipment costs. In South Africa, this issue may give rise to mounting concern as many of the commercial timber harvesting endeavours are outsourced from large conglomerates to privately owned, small businesses which are, consequently, lacking in the necessary numbers to be regarded as sizeable. Safety and other ergonomically-related issues such as additional lighting might be necessary as a result of difficulty in raising the necessary capital when considering multiple shifts. As such they should be carefully scrutinised as a potential departure point for possible recommendations and covert risks. For this reason, salvage values and the effect of depreciation and taxes on machinery and related timber harvesting equipment will be elaborated upon below to adequately conclude the financial implications of extended working hours before establishing a framework for possible recommendations and solutions pertaining to shift work in the South African context.

**Salvage values**

A noteworthy mention warranted from a South African perspective, *although possibly not exactly replicable or applicable to its conditions or experience*, are salvage values of forestry equipment. Salvage values are significant financial determinants of any timber harvesting operation, as they can have a marked effect on maintenance and repair, substitution schedules, as well as the rates and rapidity of depreciation. The incorporation of multiple shifts and extended working hours is a relatively novel phenomenon, therefore rendering it difficult to establish its influence on the salvage values of timber harvesting equipment as of yet (Mitchell, 2008). It may, however, rightly be assumed that its
impact will not go by unfelt or unnoticed. Consequently, this issue warrants further investigation to determine whether it will be economically viable for timber harvesting operators to make the decision to switch to multiple shifts, especially in the South African context of small ventures and volatile conditions.

A further concern that arises when examining salvage values of aged equipment is when a piece of machinery has higher operating hours than others of similar age. In a study that was aimed at investigating the resale values of timber harvesting equipment, it was found that age was the single most noteworthy predictor of resale worth for equipment up to five years old (Cubbage et al., 1991) as opposed to actual hours worked. The condition of existing equipment did not significantly influence the resale value of those dated more recently, but the effect was reversed for older machinery (Mitchell et al., 2008).

Depreciation and taxes
Another implication of the over-utilisation of timber harvesting equipment, by including multiple shifts as a business component, is that of taxes and depreciation. Replacing existing equipment will have a noticeable effect on taxes, depreciation based on book values, as well as prospective financial profits or losses resulting from sales which can be added to the machinery’s basis for tax purposes (Mitchell et al., 2008). Timber harvesting operators should carefully deliberate the necessity for multiple shifts, especially in light of their anticipated replacement schedules and obligatory financial demands. The replacement of machinery on the basis of operating hours will occur much more frequently on a schedule of multiple shifts than on one comprising of traditional working hours (Mitchell et al., 2008).

Due to the high cost involved in keeping these machines running, it is essential that the levels of production are adequate to compensate for the accompanying monetary expenses. As previously mentioned, extending work hours will result in an increase of machine employment which may additionally lead to a possible reduction in the cost of producing a single tonne of wood. However, for this supposition to hold true, one must be able to rightly assume that production levels have increased since the incorporation of multi-shift scheduling and form information provided in previous chapters this is not always the case. Existing literature offers some assistance regarding the ensuing changes of the day and late shift production rates, but it still remains unclear what the costs associated with implementing multiple shifts would ultimately amount to (Mitchell et al., 2008). South African operators however are faced with extremely high cost of machine purchase due to inherent high interest rates, unfavorable exchange rates and inflation. With financial institutions demanding rapid payback of loans they are forced to multi-shift to cover fixed costs of machine. This issue therefore demands continued research.

Recommendations for shift scheduling in the South African forestry industry
As an introduction to this section it must be clearly stated and to prevent false expectations of this report, that there is currently no evidence nationally or internationally of a single, universal shift-
scheduling process, applicable across the spectrum of mechanised harvesting operations or systems. Different needs warrant different responses, especially as experienced in the South African milieu, known for its difficult outdoor operations and conditions, complicated on-site plants and equipment operation, unskilled workers, lack of staff, cultural diversity and incompatibility, labour law constraints, as well as safety concerns pertaining to the community and greater societal context. However, certain globally-applicable guidelines can be utilised to enable the establishment of a framework appropriate for this ill-defined context. Firstly though, a single case study related to shift scheduling processes will be examined in order to grasp the importance of viewing this problem holistically to find the best possible means of formulating viable recommendations.

Throughout this review, the various benefits and potential drawbacks of opting to change from a traditional business cycle to one incorporating extended working hours have been critically analyzed. Thus far, the evidence seems altogether contradictory with the one extreme indicating impending catastrophe relating to health concerns for the individual shift worker and the other maintaining the importance of raising production levels by keeping machines in constant operation. The following section will examine an effort which attempts to combine these two extremes; a so-called best of both practice.

**A case study**

After a decision to switch half his harvesting operation to a mechanised CTL harvesting system, Ontario based harvesting contractor Fred Brown became aware that the widely-used two, 12 hour shifts (Figure 2) were not sufficient to cover the production costs of an all-day operation. Forced to think outside the traditionally imposed constraints of industry-specific directives, he came up with an alternative system of split-shift scheduling. A single shift (Figure 3) would comprise of eleven hours with four spent harvesting, an hour of leisurely occupation, two hours sharpening chains and making hoses, one hour of team-based routine maintenance, and concluding the shift with an additional three hours of harvesting. Employees would get paid for a ten hour shift. Brown maintains that within days of implementing the new system, productivity levels soared to all-time heights; production increased from the processing of 46 trees/hour on the old schedule, to 66 trees/hour. After an additional two weeks on this particular system, the crew were averaging between 86 and 92 trees/hour. Consequently, more output was being generated by operating the machines for fourteen hours daily as opposed to the previously utilised, full day. In addition, the fewer running hours and added maintenance inspections have resulted in an increased uptime. A fourteen hour day also leaves considerably more room to meet targets by working overtime when the occasion demands it. Further benefits of this split-shift system include a reduced strain on harvesting equipment, as well as the valuable machine operator, and thus ultimately, a longer economic lifespan for both. Finally, by operating on a split-shift schedule, the effort of training new operators become markedly more simplistic due to the fact that the shifts of operators overlap, ensuring the presence and availability of an experienced operator at all times, with the added advantage of half the new operators commencing their shift in the morning during daylight.
**Figure 2:** Conventional 12 hour shift.

<table>
<thead>
<tr>
<th>6 a.m.</th>
<th>6 p.m.</th>
<th>6 a.m.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harvest 12 hr (operator 1)</td>
<td>Harvest 12 hr (operator 2)</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 3:** Adapted split shifting.


**The way forward**

Gellerstedt (1997) maintains that with a continuous job-rotation schedule, the most expensive machines will be employed more efficiently. The health benefits are also substantial as this shift schedule reduces the risk of machine operators being plagued by occupational overuse syndrome. It is further suggested that all members of a particular harvesting team’s opinions regarding preferred working hours are taken into consideration when compiling a new schedule. A well formulated shift schedule will reduce high levels of turnover and sick leave but, in order to be effective, it has to rely entirely on the co-operation of the entire workforce. The most appropriate means to go about determining a feasible shift schedule in order to establish higher levels of performance and production will be discussed below according to the views and recommendations of Gellerstedt (1997).

**Objective**

It is of crucial importance for any timber harvesting operator to ascertain the main objectives for the business in terms of production, wages and output. Necessary for this process is the involvement of the entire workforce and patience should be exercised so as to determine the main features of an optimal schedule. During the course of implementation, employees will expand the breadth of their existing skills since high performance schedules demand work engagement, multi-tasking, and greater responsibility for the successful completion of assigned duties.
Machine utilisation and maintenance

When incorporating a multiple shift schedule in timber harvesting operations, it is essential to have access to accurate production for the equipment per annum, as well as levels of output per hour. Once this has been established, it needs to be determined if it is necessary, and whether the means and resources are, in fact, available to boost the levels of productivity, while avoiding having to increase the hours of scheduled work per day. It may prove valuable to exchange experiences with other timber harvesting crews regarding the most appropriate schedules in order to inspire and develop unique business ideas.

As discussed in a previous section of this review, machine maintenance is an important part of daily work activities and great care should be taken to ensure that it is performed adequately. These machines are expensive and a lot of unnecessary expense and safety concerns could be avoided by incorporating maintenance into the daily schedule as a core responsibility. It is advised that maintenance be done in teams of workers at the middle of the day. Furthermore, it is noteworthy to establish machine-specific responsibility, especially when several workers are using the same piece of equipment, as well as including assistance and spare parts for the equipment at nights and during weekends.

Job rotation and labour division

The role of the principle employer is central in the development of workers’ motivation, training and education which is aimed at broadening their range of competencies to enable adequate job rotation. Each worker’s capability needs to be assessed to identify potential areas for improvement and development, allowing for more sustainable production. A further recommendation is to initiate rotation between manual and machine work such as log-making, felling, and audit. This task can be made considerably easier with regards to implementation if all the machines that are being utilised in the timber harvesting operations are owned by the same contractor or company.

The allocation of responsibility also deserves the necessary attention to ensure an effortless progression of work during the course of a particular shift. A lot of time can potentially be saved if certain administrative tasks are completed on site, and if the crew are provided with basic support and information to successfully complete required duties.

Leave considerations, travelling concerns and solitary work

Incorporating planned leave into the work schedule is essential, in addition to making the necessary arrangements for unforeseen sick leave – an operator should alternate off days by being on standby. Rest breaks should also be assigned to designated work groups as a whole and solitary work should be avoided. As previously mentioned, the South African context unfortunately does not guarantee a secure journey to and from work and appropriate alternatives needs to be considered, such as travelling in a group whenever possible.
Weekend and night work; the importance of a fair and effective compensation system

Working the early or late shift is decidedly more exhausting than that of a traditional dayshift, and as a result requires more periods of rest and relaxation to remain healthy. The adverse impact of these shifts on maintaining a beneficial work and family balance has also been elaborated upon in a previous section and should be considered when reviewing shift schedules. The distance travelling to and from work, weather conditions, and leisurely pursuits should be considered in order to develop a system to benefit the whole crew, on top of addressing the needs of individuals. When reviewing a multi-shift system, it is important to give sufficient attention to appropriate compensation systems in order to keep workers motivated and productive. The payment of maintenance costs, as well as the inherent costs involved in providing employees with training opportunities to encourage job enrichment, should also be a main theme on the corporate agenda.

Economic, safety and health audit and the role of the employer

It is essential to any business to have viable means of establishing the levels of output and overall productivity. This implies that, if production rates are not reaching the anticipated targets, some form of intervention is required. Crew meetings are important to monitor the satisfaction levels of the entire workforce, provide feedback on current activities, and offer support and guidance in areas warranting special attention such as explicitly monitoring production and work load.

Finally, when tendering out forestry work, the forest owner, as the principle employer, decides upon the benchmark for the work environment and should incorporate this into the proposition by setting clear production and contextual goals. The key to generating a contented and rewarding crew dynamic is to emphasise a policy of open and respectful two-way communication. In South Africa especially, careful attention to this subtle issue is warranted. The level of education of operators does not always seem to encourage a mutually respectful relationship, but in order to become economically sustainable and globally competitive, old prejudices will have to be disregarded against a novel framework of continued reinvention and advancement.

Current shift schedules in South Africa

This section of the report looks into a number of different shift schedules being applied around in South Africa and Australia. Data regarding shift work was gained through personal interviews with contractors and company representatives who apply shift work in their daily operations. The report does not allow for exhaustive documentation and the author has taken the liberty to select what has been classed as a representative sample of shift types being generally applied in South Africa, from the many examples encountered during the survey. In addition to the South African examples, interviews with foresters in Western Australian allowed additions to the report, of their experiences.

The format of presentation will deal with particular and specific shifting schedules; followed by their inherent advantages and disadvantages related to both legal and psychological/physiological (the
human factor) parameters from discussions with interviewees. In closing some recommendations for current and future mechanised shift schedules are suggested.

Single 12-hour day shift
The main objective of the single 12 hour day shift is to make the most use of available daylight hours. The shift usually starts early morning and ends late afternoon or early evening (Figure 1).

<table>
<thead>
<tr>
<th>Start</th>
<th>Lunch/Breaks</th>
<th>End</th>
</tr>
</thead>
<tbody>
<tr>
<td>06:00</td>
<td></td>
<td>18:00</td>
</tr>
</tbody>
</table>

Figure 3: One 12 hour single shift.

The shift is a continuous 12 hours, with allocated times for equipment service and operator breaks (Figure 3). In this shift schedule design, operations usually run seven days/week, with operators mostly working in cycles of five days before being replaced by another operator.

With regard to making provision for machine service times, there are two options; in-shift or out-of-shift service time. The reason for in-shift service time is that overtime work by operators and support staff involved in machine maintenance is kept to a minimum. With in-service servicing the operator partakes in the service and therefore takes ownership of the machine. The operator also has a break from operations if the service period is located somewhere in the middle of the shift (Figure 3). On the other hand service time out-of-shift limits disturbance and interference on productive work time.

Advantages
- Daylight hours are utilised and no night work.
- Better control of the operation, management and support staff is available during most of the scheduled working hours.
- Improved operations (work quality) because operators prefer working during daylight.
- Operators have time off for personal and familial obligations due to operator rotation.
- Operator rotation assures that working hours remain aligned with the Basic Conditions of Employment Act (BCEA).
- If additional volume production is required, a night shift can be added.

Disadvantages
- Substantial operator fatigue due to long working hours.
- Depending on operator rotation (days working and days off) it could mean that at some stage operators do not have weekends off to spend time with family and friends or attend to their religious requirements.
• If working hours between the operations and maintenance crews (mechanical workshop) are not synchronised there will be times when a breakdown will occur and no service personnel will be available.

• Seeing that management (supervisory staff) need to be available during the shift; they also need to work 12 hours/day seven day-weeks - resulting in fatigue and associated problems as with the operator.

• Servicing time in-shift reduces potential scheduled machine hours.

• Greater operator fatigue due to longer work periods.

**Two 12-hour shifts**

Managers who apply this shift schedule are trying to maximise production, and the number machine hours worked in order to pay the machine off as soon as possible. This shift design usually follows the same schedule as a single 12 hour day shift, by adding a night shift of the same length (Figure 4).

<table>
<thead>
<tr>
<th>Start</th>
<th>Lunch/Break</th>
<th>End</th>
</tr>
</thead>
<tbody>
<tr>
<td>06:00</td>
<td></td>
<td>18:00</td>
</tr>
</tbody>
</table>

**Figure 4:** Two 12 hour shifts

Shifts change in the early morning and late evening. Refuelling and maintenance is done in-shift at specified times. For a double shift, refuelling and maintenance needs to be done at least once during the day and once at night. Support staff need to be on duty and available should breakdowns and other problems arise during any of the shift periods. Shift rotation is usually done week by week where one team would work day shift one week and night shift the next. Operators are however given time off during the month so that total hours worked do not exceed maximum allowed by government legislations.

**Advantages**

• According to some managers, production can be higher at night due to fewer distractions to the operator.

• Potentially a greater number of hours worked than with any other shift schedule.

• Well designed operator rotation can allow operators some time off for personal obligations.

• Operator rotation, and time off, assures that working hours remain aligned with the BCEA.

• One operator per machine per shift so it is easy to identify misuse of equipment.

• Potential high machine utilisation.
Disadvantages

- A full compliment of support and management staff need to present and on duty for both shifts.
- Service and support staff need to attend to breakdowns with same urgency during the night as with day shift, this puts a lot of pressure on these individuals.
- Breakdowns can affect the next shift if support staff is not able to react fast enough.
- Fatigue during ‘graveyard’ shift may cause “nuisance” breakdowns while in daylight operations these would be less prevalent.
- Difficult to synchronise workshop personnel and operations time; i.e. to have maintenance staff available at all times.
- Night shift operators do not get enough rest during the day and this fatigue accumulates as time goes on.
- Operators take time to adapt between night and day shift during operator rotation which can cause serious mental and physical health problems.
- The shift schedule includes working on Sundays affecting operator familial and religious relations.
- Night shift work can cause serious familial problems in that the operator very seldom sees his family awake or has time to commune with them.
- Servicing times affect the scheduled number of machine hours available for work.
- In most cases night shifts are characterised with lower production and productivity.

Two 10-hour shifts

<table>
<thead>
<tr>
<th>Time</th>
<th>07:00</th>
<th>17:00</th>
<th>17:00-19:00</th>
<th>19:00</th>
<th>05:00</th>
<th>05:00-07:00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start</td>
<td>Meal break</td>
<td>End</td>
<td>Service time</td>
<td>Start</td>
<td>Meal break</td>
<td>End</td>
</tr>
</tbody>
</table>

![Figure 5: Two 10-hour shifts](image)

A two, ten-hour shift schedule (Figure 5) usually comprise of a full day and night shift with allowances for two periods of two-hours for fuelling and machine maintenance at the end of each shift. Operators usually alternate weekly between day and night shift. Time off is given during the month to keep hours worked in line with BCEA.

Advantages

- Potentially high machine utilisation.
- Operational hours per shift are less than the two preceding scenarios which will reduce operator fatigue to an extent, and allow the operator to concentrate more effectively on the task.
- One operator is allocated per machine per shift so it is easy to identify misuse of equipment.
- Fixed time for servicing and refuelling machines.
Disadvantages

• A full compliment of support and management staff need to present and on duty for both shifts.
• Service and support staff need to attend to breakdowns with same urgency during the night as with day shift, this puts a lot of pressure on these individuals.
• Breakdowns can affect the next shift if support staff is not able to react fast enough.
• Fatigue during ‘graveyard’ shift may cause “nuisance” breakdowns while in daylight operations these would be less prevalent.
• Difficult to synchronise workshop personnel and operations time; i.e. to have maintenance staff available at all times.
• Night shift operators do not get enough rest during the day and this fatigue accumulates as time goes on.
• Operators take time to adapt between night and day shift during operator rotation which can cause serious psychological and physical health problems.
• The shift schedule includes working on Sundays affecting operator familial and religious relations.
• Night shift work can cause serious familial problems in that eh very seldom sees his family awake or has time to commune with them.
• Servicing times affect the scheduled number of machine hours available for work.
• In most cases night shifts are characterised with lower production and productivity.
• Greater operator fatigue due to longer work periods.
• The shift schedule includes working on Sundays affecting operator familial and religious relations.

Two 9-hour shifts

Shifts coupled with late night shift changes pose many problems, not only for management and support staff but also the alertness and shift readiness of the operators. By scheduling two 9-hour shifts, contract managers still manage to achieve relatively high number of machine hours, schedule breaks and service time but eliminate shift changes at arbitrary times (late and night or very early in the morning).

<table>
<thead>
<tr>
<th>04:00</th>
<th>13:00</th>
<th>13:00-14:00</th>
<th>14:00</th>
<th>23:00</th>
<th>23:00-00:00</th>
<th>00:00-04:00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start</td>
<td>End</td>
<td>Service</td>
<td>Start</td>
<td>End</td>
<td>Service</td>
<td>Machine idle</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Time</td>
<td></td>
<td></td>
<td>Time</td>
<td>time</td>
</tr>
</tbody>
</table>

Figure 6: Two 9-hour shifts

The shifts are usually scheduled so that each operator has a period of daylight work time (Figure 6). The first shift usually start in the early morning and ends at midday after equipment checks and servicing, the second shift starts and usually ends late in the evening, the final service and equipment check is done to prepare the machine for the next shift which start early in the morning after a period
of machine idle time. Operators are usually rotated on a weekly basis between day shift and night shift allowing time-off to stay in line with BCEA.

**Advantages**

- Allocated/fixed machine services and refuelling times, so time for necessary preventative maintenance is provided or available.
- The daylight part of the shift helps maintain focus and prevent potential unnecessary breakdowns.
- More control over operation with both shifts having the majority of work time within normal working hours.
- Productivity and operator alertness is much higher during the day shift.

**Disadvantages**

- Relatively long periods of machine idle time at the end of each day.
- Lower productivity during night hours (up to 10% less).
- Increased machine down time at night, due to fatigue and lack clear visibility.
- Operator fatigued at end of long continuous shifts.
- A full compliment of support and management staff need to present and on duty for both shifts.
- Service and support staff need to attend to breakdowns with same urgency during the night as with day shift, this puts a lot of pressure on these individuals.
- Breakdowns can affect the next shift if support staff is not able to react fast enough.
- Fatigue during ‘graveyard’ shift may cause “nuisance” breakdowns while in daylight operations these would be less prevalent.
- Difficult to synchronise workshop personnel and operations time; i.e. to have maintenance staff available at all times.
- Night shift operators do not get enough rest during the day and this fatigue accumulates over time.
- Operators take time to adapt between night and day shift during operator rotation which can cause serious psychological and physical health problems.
- The shift schedule includes working on Sundays affecting operator familial and religious relations.
- Night shift work can cause serious familial problems in that operators seldom see their families awake or has time to commune with them.
- Servicing times affect the scheduled number of machine hours available for work.
- Greater operator fatigue due to longer work periods.
A 12-hour split shift

Split shift scheduling has been shown to maintain constant machine hours and keep operators focussed and productive for the times that they are working. The main principal of split shifting is that operators remain focussed on their task (productive) for three to four hour stretches.

<table>
<thead>
<tr>
<th>Time</th>
<th>05:30</th>
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<th>09:00</th>
<th>09:00-12:00</th>
<th>12:00</th>
<th>12:00-15:00</th>
<th>15:00</th>
<th>18:00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infield</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operator 1</td>
<td>start</td>
<td></td>
<td></td>
<td>Lunch,</td>
<td>start</td>
<td>end for</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operator 1</td>
<td></td>
<td>end</td>
<td></td>
<td>planning</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operator 2</td>
<td>start</td>
<td></td>
<td></td>
<td>Lunch,</td>
<td>start</td>
<td>end for</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operator 2</td>
<td></td>
<td></td>
<td></td>
<td>planning</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 7: 12-hour split shift

Figure 7 illustrates a split shift operation where two operators arrive at the worksite at different times during the day; they are able to rotate duties on machines so that machines are continually working while the other operators take breaks. Depending on management objectives, this shift schedule is used to replace multiple shifts. The constant machine hours worked during the day allows for the operation to be run during more manageable hours. This places less strain on management and support functions.

Advantages

- Less operator fatigue and greater focus on the task at hand.
- Productivity can be kept constant with relatively little reduced production at the end of shift.
- Easier control, management can be available throughout the shift.
- Depending on how the shift is scheduled there are minimal working hours in darkness.
- Shift can be scheduled during a normal working week, machine hours and production should be high enough to justify this.
- Less overtime for operators and support staff.
- Fewer operator induced breakdowns due to an even spread of time off machines during the shift.
- Working hours for operator will always remain in line with the BCEA.

Disadvantages

- Servicing and refuelling needs to be done outside shifts (after hours and/or weekends), these functions can however also be scheduled to start work at different times to the rest of the operators.
• Fewer hours to produce volumes required (but can be mitigated due to higher more constant productivity).
• Transport of operators to the site and back needs to be done multiple times a day.
• Response time for support staff needs to be effective and fast, infield workshops need to be available and operators need to report faults accurately.
• Operators need to trust each other not to damage machines and cause unnecessary breakdowns. Operator starting the day needs to thoroughly check the machine for faults and problems.

Practical implementation of this shift schedule has found that not only are the productivity outputs comparable to double shifts; being only slightly less but so are breakdowns and other operational downtime.

Three-8 hour shifts
Of the managers interviewed none where using a three shift system. Some mentioned that they had tried to implement the system but there was general dissatisfaction with the administration, by the operator, and machinery issues were experienced. Problems were specifically related to late night or early morning hour periods. Operator fatigue and shift change over were always issues regarding the logistics of getting operators to work not to delay operations. In this shift system it was found that the machine operators do not get enough rest during the day to allow optimal operations at night. Another problem was the availability of support staff to support the operations.

Once again the phenomenon of increased prevalence of machine breakdowns and stoppages related to general fatigue of operation was a factor. This severely affects the economics of the operations. It was also found that other shift schedules were a lot easier to manage even though machine hours were less in some of the other systems.

Australian shift scheduling experiences
Australian management of shift scheduling is similar to those in South Africa. Our Australian counterparts provided some recommendations and pointers form their experiences.
• Harvesting operations only work during the day. It was found that not only were night shifts not productive enough to justify replicating all the support staff for a night shift, but operators are also not prepared to work at night.
• Operator fatigue greatly influences production. Even though nine or ten working hours were scheduled, actually only at most eight productive were achieved purely due to fatigue, isolation and monotony of the task.
• Because operators were paid on wood produced with added incentives for additional production; day only shifts were sufficient to produce the desired production.
As with South African operations the main factors influencing their harvesting systems and the viability of shift works depends largely on operators’ attitudes, their willingness to work in the forest and the availability of operational and technically competent harvesting equipment. This combined with the availability of support staff to deal with problems and breaks downs when they occur should ensure sound and productive operations without resorting to night work.

Current shift scheduling issues and recommendations

Mandatory breaks and remuneration

Operational managers interviewed all had different ways of remunerating operators. These remuneration strategies were mostly coupled with incentives of increased remuneration for production over and above planned targets.

Breaks are however an important part of these highly specialised mechanical operations. Machine operators need to take breaks to regain focus and in extreme cases prevent circulation and RSS problems developing. Although most managers interviewed did say breaks were mandatory, this is not always the case because of production targets and incentive schemes. This situation then negates the benefits that can be derived and the viability of the systems is once again impaired by increased stoppages and breakdowns, lowered productivity and the increased prevalence of accidents and injuries, and physiological damage to operators.

A balance needs to be found between operator production, remuneration and allocation for mandatory breaks. Threshold productivity targets more than likely need to be linked with a certain maximum number of machine hour worked in order to prevent over-use of the operator. This can hopefully assist in striking a balance between maximum machine hours and high daily production.

Productivity

An increase in shift hours is not necessarily related to productivity increases. Double shifts usually have reduced productivity in the second (night) shift, although in some cases the absence of distractions such as radios and other machines operating in the same area, can lead to the operator being more focussed and thus increase production slightly over the day shift. The increase of machine hours versus possible machine breakages, operator fatigue and related production slumps needs to be carefully weighed up with the best shift schedule for particular systems and contract/order volumes. This may mean that machine operational hours may need to be reduced in order to prevent crippling machine breakages. Examples of these shifts have been discussed above.

Operator transport

The survey revealed that the modes of operator transport to and from work sites varied from own transport to company transport. It remains vitally important that whatever means of transport used, the operator has the assurance that he will be able to get to work and return home safely, particularly
during late night shifts. It is also important that this transport happens promptly so that the operator is able to get home and do household tasks and rest sufficiently to be ready for the next day’s work. Single or double shifts are easier to manage than split or shifts which have staggered starting times. The use of independent operator transport (including own transport) is a possible option and can potentially reduce problems in mismatched logistics.

**Relief operators and operator rotation**

Fully mechanised operations and equipment are highly specialised, and operator absence due to illness and other reasons can be highly disruptive. It is very important to have relief operators available to prevent equipment standing, with the resultant loss of production. There is always the danger, and it does happen, that when an operator falls ill, and no replacement is available, that an operator at rest is called on to work. This places the supposedly resting operator and operation at risk. The best option is to have at least one more operator than what the system requires and alternate these operators through a series of shifts. This can potentially relieve the operators of the rigours of mundane and especially night work. Another scenario that has been used is to have a trained, but not fully operational operator on standby to take over in cases of operators not arriving at work.

**Social**

Mechanised machine operators are generally paid more, and thus have higher levels of disposable income than the majority of their peers. With this greater amount of disposable income available, some operators tend to be at risk of drug and alcohol abuse, and potential sexual promiscuity. This can lead to higher risk of HIV infection which is not only life threatening but also affects the individuals’ ability and willingness to work. However many of these highly paid operators do support extended families, more money in the family system does benefit and uplift the community in contrast to the previous points discussed.

**Religious considerations**

A factor frequently overlooked is that operators/workers need to associate and participate in their religious beliefs. Operators or workers exposed to shift work are by far more marginalised in this respect. However insignificant it may seem, employees may need to go to church on Sundays. It is part of their spiritual association and to prevent this will be an additional negative factor when considering the institution of shift work in a company.
Forestry shift work – decision checklist

Shift work:

- Have you considered workers ability to cope with shift work both mentally and physically?
- Have you done individual psychological tests to assess to worker inherent adaptability and ability to partake in shift work without due stress developing with the operators or operators and their families?
- Have you done individual medical checkups on operators?
- Are your operators happy to do shift work?
- Are your operators dependent on habit forming drugs or medication/
- Have safety assessments been performed on the area were shift work is to be performed – particularly relevant to night-work?
- Have you consulted with your operators with regard to the potential of doing shift work?
- Are the machines safe and ergonomically suitable for continuous and extended shift work?
- Have you considered the requirements of work, rest and remuneration as stipulated by the Department of Labour?
- Are shift workers able to make relevant decision independently of the manager/supervisor; i.e., are they suitably trained?
- Are the necessary support mechanisms available at the work site for the worker; i.e., adequate supervision, tools, spares and fuels, safe and secure transport to and from work, first-aid/medical kit.
- Are there adequate means of communication (devices) between operators and between operator and supervisor and between operators and maintenance and repair personnel?
- Consider the needs and opinions of the entire harvesting crew.
- Consider the individuals workers psychological adaptability.
- Consider the individuals workers social requirements and roles in the family.

Shift hours

- Consider the advantages of shorter shifts e.g. eight hours as opposed to 12 and longer hours.
- Consider the potential advantages of split shifting as opposed to 12 or more hour shifts.
- Consider regular scheduled breaks within the shift to allow for change in focus.
- Consider routine maintenance to break the monotony or change in focus.
- Consider job rotation to alleviate repetitive work and expand worker’s breadth of skills.
- Consider to rather reduce working hours than extended and long shift periods.

Night shift:

- Consider that lower production is synonymous with night shifts.
- Consider increased maintenance costs due to higher machine damage related to night shifts.
- Consider the provision of safe and secure transport for night workers.
- Consider a safe and secure work place for night work.
Consider the isolation of the worker working at night.
Has adequate lighting been provided either on the machines or work area if needed?
Is communication available between operators and between operator and supervisor and between operators and maintenance and repair personnel?
Are the necessary support mechanisms available at they work site for the worker; i.e., tools, spares and fuels, adequate supervision, transport to and from work, first-aid facilities?

Conclusion

The goal of this review was to present an introduction to the shift work milieu and provide a framework for its application in mechanised forestry operations in South Africa. This was attempted, firstly, by diagnosing the problems associated with shift work and, accordingly, exploring certain models describing adaptation to extended hours of work. This was followed by a scrutiny of various shift systems routinely used in universal timber harvesting practices before embarking on an investigation of global safety concerns attached to the shift work paradigm through the identification of certain causal factors of unsafe work behaviour. This was followed with an effort to contextualise both the climates of shift work and forestry operations to gain a greater understanding of the factors contributing to the characteristically unique conditions that depicts the organisational environment in South Africa. Equipment considerations for extended working hours were subsequently reviewed before concluding this study with the establishment of a collective structure that may prove essential in the generation of viable recommendations for the forestry industry in South Africa.

Evidently, the shift work dilemma warrants further and continued attention to ascertain so-called best practices in industry. This will assist in answering the more ambiguous questions relating to the actual necessity of incorporating multiple shifts, as well as consideration for the limited capability of the human factor, in order to lay the foundations for the way forward. This apparent paradox epitomises the essence of contemporary business, and accord needs to be reached between the efforts of preserving the wellbeing of the employee, while furiously demanding optimum production. Industry will consequently have to realise that transition to new corporate strategies are unavoidable and indispensable, and accordingly, align their business approach to ensure the ongoing sustainability in a turbulent, but promising economic climate.
References


