American Society of
Agricultural and Biological Engineers

An ASABE Meeting Presentation

Paper Number: 075011

Physiological and Psychological Impacts of Extended Work Hours in Logging Operations

Dana Mitchell, Research Engineer

USDA Forest Service, Southern Research Station, 520 Devall Drive, Auburn, AL 36849 USA

Tom Gallagher, Assistant Professor

School of Forestry and Wildlife Sciences, Auburn University, Auburn, AL 36849 USA

Written for presentation at the
2007 ASABE Annual International Meeting
Sponsored by ASABE
Minneapolis Convention Center
Minneapolis, Minnesota
17 - 20 June 2007

Abstract. *A study was initiated in 2006 to develop an understanding of the considerations of using extended work hours in the logging industry in the southeastern United States. Through semi-structured interviews, it was obvious that loggers were individually creating ways of successfully implementing extended working hours without understanding the impacts that extended working hours can have on employees. Some use rotating shifts, while others use permanent shifts. Some work 24 hours/day while most did not. Many cited that they had problems with employee retention while trying to initially implement extended working hours with their existing logging crews. This paper provides a brief synthesis of existing literature on the physiological and psychological impacts of extended working hours on employees. Because little documentation is available about extended working hours in the logging industry, these logging interview data are compared and contrasted with published shift work impacts from other industries.*

Keywords. human factors, shift work, extended working hours, logging

Introduction

Implementation of extended working hours is a fairly new development in the logging industry in the southeastern United States. Logging company owners are interested in using extended work shifts to increase their production. Most logging businesses include several pieces of expensive heavy equipment, such as feller-bunchers, loaders and skidders. If production is increased, fixed equipment costs can be spread over additional production, resulting in a decreased cost for every ton of wood produced. While the focus of the business owner's efforts is economics, the impact on their employees has largely been ignored.

From a logging company owner's perspective, equipment expenses account for approximately 14% (Stuart et al, 2005) of logging business costs. Equipment expenses are one of the few costs that can be controlled through business decisions. Logging equipment has a fixed cost. The business owner has to pay financed equipment payments whether the machines are working or not. The manufacturers suggested retail price of a new 215 hp (160 kW) rubber-tired grapple skidder ranges from $185,000 to over $200,000 (USD) depending on the options included. Most logging businesses include several additional pieces of expensive heavy equipment, such as feller-bunchers and loaders. If logging costs are based on the unit cost of producing each ton of wood, then additional production lowers the per unit fixed costs of this equipment, thus reducing the cost of producing each ton of wood and, hopefully, making businesses more profitable. Expanding the number of hours that the machine is scheduled to do work is one method currently being explored in the southeastern United States. This is being accomplished through the implementation of extended working hours, or shift work.

The decision to implement shift work is often based on economics. However, the impacts of shift work on employees are largely ignored. This paper addresses this issue by providing a basic understanding of the types of physiological and psychological impacts that shift work can place on workers, describes the shift work (extended working hours) implementation schedules used in the southeastern United States, and relates the published impacts from other industries to the logging industry.

Methodology

Semi-structured interviews were performed to gather information about how logging business owners were implementing shift work in the southeastern United States. The interview process began in the spring of 2006. Twenty-two interviews across seven southeastern states were completed with loggers who have made efforts to implement shift work. Data collected during the interviews included shift hours, shift scheduling, employee turnover and operational characteristics of each shift.

Generally, shift work hours are defined as those hours outside the normal daylight hours, 7 am to 6 pm (Rosa and Colligan, 1997). Some people in the logging industry use the term "double-shifting", but it does not provide any meaning as to hours of work for the two shifts, or whether the two shifts encompass a 24-hour period or less. "Extended hours" may mean that longer days are worked, but no additional shifts are implied. For this paper, "extended working hours" will include hours outside of typical daylight hours (7 am to 6 pm) and signify that one or more shifts are used in a scheduling period.

Results and Discussion

Shift Schedules

Of the twenty-two loggers interviewed, twelve are still implementing extended working hours. Ten returned to more traditional working hours. Because only 3 of those that quit using extended working hours cited employee retention as one of the reasons for quitting, all work schedules are included in the sample data (Table 1) and discussion.

Table 1. Sample of Shift Schedules Used in Logging Operations in the Southeastern United States[1] (n=22)

Schedule A: 12-hour work days with weekly rotation (n=1) Shift 1 DDDDDDD●●●●●●● Shift 2 ●●●●●●●DDDDDDD	**Schedule D: Permanent shifts with weekends off (n=2)** Shift 1 DDDDD●● DDDDD●● Shift 2 NNNN●●● NNNN●●●
Schedule B: Permanent shifts with weekends off (n=16) Shift 1 DDDDD●●DDDDD●● Shift 2 NNNNN●●NNNNN●●	**Schedule E: Rotating weeks with weekends off (n=1)** Shift 1 DDDDD●● NNNNN●● Shift 2 NNNNN●● DDDDD●●
Schedule C: Bi-weekly rotation with weekends off (n=1) Shift 1 DDDDD●● DDDDD●● NNNN●●● NNNN●●● Shift 2 NNNN●●● NNNN●●● DDDDD●● DDDDD●●	**Schedule F: Rotating daily for extra second shift (n=1)** Shift 1 DDDDDD● DDDDDD● Shift 2 NNNNN●● NNNNN●●

[1] D=Day Shift, N = Night Shift, ● = Day Off

Six separate shift schedules were documented during the interview process. The loggers interviewed indicated that the schedules shown in Table 1 were their final schedules implemented and that they arrived at these through a trial-and-error approach. Two loggers used schedules that required operations that worked 2 shifts of 12 hours/day. The remaining loggers operated fewer hours/day with most ending their night shift by 0100 and beginning their day shift no earlier than 0600. Most (91%) of the crews had weekends off. Just 18% of the reported schedules employed a rotating shift.

Physiological Impacts

Typically, humans are in a state of wakefulness during the daytime hours and resting or sleeping during the night hours. This behavior is regulated by the body's circadian rhythms (Costa, 1996). A circadian rhythm is the natural body rhythm that provides an oscillating pattern of bodily functions that occur over a period of 24-25 hours. Some of the body functions regulated by circadian rhythms are body temperature, blood pressure, and hormone excretions. As such, circadian rhythms control when workers are sleepy or alert. Further, there are physical and societal time cues that aid in resetting the daily circadian rhythm to a 24-hour schedule. Some examples are mealtime, external thermal conditions and sunlight. Working nights can disrupt these circadian cues.

The typical circadian low point occurs between 0300 and 0500 when oral temperatures are at their lowest. When scheduling work during the very early morning hours, factors to be considered may include job workload, safety criticality, environment and staffing levels (Popkin

et al, 2006). In practice, only four of the loggers scheduled work between 0300 and 0500. Therefore, most avoided scheduling work during the circadian low hours. Loggers employing a schedule of working during the circadian low hours may want to reconsider the workload placed on workers during the early morning hours.

Some workers tolerate adjustments to their sleep cycles better than others. For example, people commonly referred to as "night-owls" normally go to bed later than others, so they delay their sleep. Adjustment to night work may not be as difficult for these people as for others (Burgess et al, 2002). Long-term effects of phase shifts are difficult to assess from a research standpoint because those workers who do not tolerate shift work typically quit their jobs, leaving only those individuals who are able to adapt in the available research study groups. In keeping with these research findings, most loggers indicated that their employee turnover rate was highest when first implementing extended working hours. Some workers quit because they were not able to or did not want to adapt to the shift schedules while others requested the night shifts. Replacement workers were hired with the expectation that they would be required to work some night hours, which reduced the turnover rate.

Psychological Impacts

Studies typically find that working rotating shift schedules and permanent night shifts often result in negative influences on job satisfaction, psychological well-being, self-esteem and job stress. Tamagawa et al (2006) was able to distinguish traits that made some New Zealand police officers less tolerable of night shifts and others intolerant to rotating shifts. This study reported that police officers who possess a repressive emotional style and negative mood showed intolerance to night shift work that was exhibited in physical health and sleep problems. Tolerance to rotating shifts was impacted more by mood states rather than personality traits (emotional style). Loggers in this study had been implementing extended working hours for periods of 8 to 22 months. Given the short timeframe of implementation, the high initial employee turnover, and the use of self-selection for night shifts, it is difficult to distinguish the identified traits of the logging crew workers. Additionally, few loggers used rotating schedules.

In a self-assessment, forest workers that were manually felling trees in a thinning operation reported feeling more tired after the first four hours of a shift as compared to the beginning of the shift (Fibiger and Henderson, 1984). The workers felt increasingly more tired as the shift progressed, despite taking work breaks. As they became more tired, they slowed their work tempo and productivity. The high physical demands of the job created a long-lasting constant workload. If workload could be decreased or task variability could be introduced, there could be an opportunity to increase productivity.

All loggers interviewed limited night operations to machine operators, where the operators worked inside a protective cab. The long-lasting constant workload of the day and night shift workers could also make them feel more fatigued during the latter portion of their shifts. One way this was avoided during the night shift was to offer a shorter shift length at night as compared to the day shift. The reason this shorter shift was implemented was often due to limited mill delivery hours and as an incentive for people to work nights. However, human factors impacts may have been reduced from this arrangement.

Conclusion

There is no single perfect work schedule for shift operations, and in logging, shift scheduling is often through a trial-and-error approach. A myriad of work shifts are in use in the southeastern United States. Loggers are successfully implementing extended working hours in shifts that operate two shifts for up to 24 hours/day. Others operate single daily shifts, but employ a longer

shift length. Much of the existing literature on the physiological and psychological impacts of shift work may be applicable to logging, but because of the short experience time with implementing extended working hours and variability of schedules, it is difficult to assess.

References

Burgess, H. J., K. M. Sharkey, and C. I. Eastman. 2002. Bright light, dark and melatonin can promote circadian adaptation in night shift workers. Sleep Medicine Reviews 6(5): 407-420.

Costa, G. 1996. The impact of shift and night work on health. Applied Ergonomics 27(1): 9-16.

Fibiger, W., and M. E. Henderson. 1984. Physical Work Load in Thinning Pine Plantations. Australian Forest Research (4): 135-146.

Popkin, S. M., H. D. Howarth, and D. I. Tepas. 2006. Chapter 28: Ergonomics of Work Systems. In Handbook of Human Factors and Ergonomics, 761-800. G. Salvendy, ed. Hoboken, N.J.: John Wiley and Sons, Inc.

Rosa, R. R., and M. J. Colligan. 1997. Plain Language About Shiftwork. DHHS (NIOSH) Pub. No. 97-145. Cincinnati, Ohio: National Institute for Occupational Safety and Health.

Tamagawa, R., B. Lobb, and R. Booth. 2006. Tolerance of shift work. Applied Ergonomics (2006) in press, doi:10.1016/j.aperfo.2006.05.0003

Stuart, W.B., Grace, L.A., Altizar, C.B. 2005. Preliminary 2004 Logging Cost Indices. November 2005. 15p.