HARVESTING TECHNICAL NOTE

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LOGGING PRODUCTIVITY MONITORING

Summary

To improve harvesting productivity, planners must have monitoring tools that accurately measure performance. This paper reviews some currently existing tools, and introduces some ideas about how they might be applied or modified to provide more useful data.

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Introduction

To improve an operation, its performance first needs to be measured and monitored. The methodologies historically used in the forestry industry suffer from being either too expensive or too inaccurate. If the New Zealand forest industry wants to make any progress in improving productivity, it first needs to improve dramatically the way information about the performance of its logging systems is collected. In most other manufacturing industries, including agriculture, detailed productivity information is collected in real-time during manufacturing or harvesting.

One of the FFR Harvesting Theme's main goals is to improve logging productivity dramatically through researching and developing new methods and systems. Before this can be achieved, a set of productivity monitoring tools must be developed. The aim of FFR research task 20001 is to develop such a set of cost-effective tools for real-time productivity monitoring for logging equipment.

What Needs To Be Measured

What exactly is needed from a productivity monitoring system depends largely on why productivity is being measured in the first place. At a coarse level, harvesting supervisors and harvesting crew managers require accurate information on machine utilisation, capital productivity, etc. This information can be gained by recording the hours of work, the operating hours of the machine and the volume harvested per day. At the more detailed level, methods improvement studies and production equation development require more detailed information on each production cycle during a day. Information is often needed for each element in the cycle, which means that information must be collected in real time.

Existing Tools

Most production studies in the past have been carried out by either getting operators to note down daily productivity information, or having an observer timing the different phases of the operation with a stopwatch. The problem with these methods is that the data collected are either too coarse in resolution or too expensive to collect.
Automated methods using service recorders and data recorders have been used in the past. However, their inability to collect information such as payload and yarding distance has limited their use, particularly in research.

The MultiDAT, developed by FERIC (Forest Engineering Research Institute of Canada), is a data logger designed specifically for monitoring forestry equipment. It is used widely in the Canadian forestry industry. The MultiDAT data logger utilises an internal motion sensor to measure vibration; by setting a minimum recording threshold on the vibration, an accurate assessment of productivity (machine utilisation) can be measured. The MultiDAT also has the ability to monitor at least five other sources of data, one of which is location data from an external GPS antenna.

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Potential Tools

GPS

GPS (Global Positioning Systems) have previously been used in productivity studies, but their potential is yet to be fully realised. Significant breakthroughs in GPS have been made in the last couple of years, dramatically improving the ability to track satellites from under the forest canopy. These developments should improve the applicability of GPS in productivity monitoring, particularly in aiding the measuring of yarding distance.

Accelerometer

An **accelerometer** is a device for measuring the total specific external force on a sensor. Accelerometers are used to measure vibration on cars, machines, buildings and process control systems. They can also be used to measure tilt in three dimensions. Their cost has decreased significantly over the last couple of years.

Accelerometers seem ideally suited to being used to monitor logging equipment. Purfürst and Erler (2006) used them to monitor the movement of a harvester. Research is under way as part of the current FFR Harvesting Research Program to determine the potential of accelerometers for measuring payload.

CAN-Bus

The **CAN-Bus** is a serial bus system developed for automotive applications. It is now widely used in forestry equipment to control and adjust engine and driveline performance automatically. In harvester and forwarder applications it is widely used to control hydraulic systems that control booms, harvesting heads and grapples (Suvinen and Saarilahti 2006). In many ways the CAN-Bus is like the brain and nervous system of a machine. It tells the hydraulics systems to work when the operator pushes a button or moves a joystick.

Suvinen and Saarilahti (2006) used CAN-Bus information to determine a range of different forces that a forwarder is subject to, such as rolling resistance, slope resistance and total resistance. They suggested that the methodology they developed could be used to solve off-road routing problems to facilitate better logging planning.

Tension Monitoring Systems

Tension monitors can be attached to the skyline of cable yarders to monitor the safe working loads on the skyline cable. Monitoring the changes in tension would not only give an indication of the overall productivity, but also potentially allow the collection of productivity information on the different time elements. It is also possible to use the skyline tension plus other variables (percent deflection, carriage weight, skyline weight, skyline cord length, carriage position and cord slope) to give the approximate payload of a drag.

Video

Recording an operation on **video** and carrying out the time study at a later date has been used in a number of cases in the literature. This method has some significant advantages over the traditional time study methods. The accuracy of the timing of the different work elements is significantly improved. The ability to go back to the video footage to understand why a particular cycle took so long has some real advantages in analysing systems. Over the past two years, Richard Parker (COHFE) has been carrying out numerous productivity studies on individual workers such as fellers using helmet-mounted cameras on mini digital video recorders. In the foreseeable future most time study carried out as part of the FFR harvesting research programme will be carried out using video equipment.

The Next Steps

FFR Harvesting Theme Research Task F20001 is about developing a set of tools for the monitoring of productivity of logging equipment for both research projects and day-to-day managerial monitoring of logging crews.

Any system developed to monitor real-time productivity will probably use a combination of the above technologies. There seems to be a range of different approaches that could be used to extract time information on individual work elements. Some equipment, such as a harvester, has onboard computers that could be configured correctly to provide information on the productivity of both that individual machine and the crew in total. On other equipment, a range of data from different sources such as accelerometers and the CAN-bus may be available to analyse and determine time spent on different work elements.

GPS is the clear key to measuring yarding distance. On ground-based systems there are few problems to installing GPS to measure yarding/skidding distance. On a cable yarding system, a GPS would need to be installed on the carriage. This will probably work on large carriages, but on systems such as North Bend which have a small carriage on the skyline, the ability to install a GPS unit for yarding distance and productivity will be limited.

Accelerometers seem to hold some potential for collecting information on number of movements on a number of different machines. Accelerometers are relatively cheap, meaning several can be installed on a machine to measure the movements of the different parts such as the boom, harvesting head, wheels, etc., independently.

Payload of individual cycles and volume harvested are key variables in determining productivity, and are going to be difficult to measure automatically. It may not be possible to measure payload directly. On cable systems, the use of the tension monitoring systems to determine payload seems to hold promise, but these are not installed on all haulers, and when they are installed they are often not used. Accelerometers are being investigated for their potential for measuring payload on grapple skidders. The accelerometers will be used to measure the degree of openness of the grapple; this openness would then be related to payload.

The FFR Harvesting Theme will not be focused on redeveloping something like MultiDAT, rather the focus will be on evaluating the raft of sensor technologies that could be used to monitor the variables needed to measure logging productivity. Task F200.01 is about the integration of a range of different existing technologies, and not about the invention of new ones. The Task will be undertaken over an 18-month period starting 1st January 2008.

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