56. SIMULATION OF SKYLINE SYSTEMS IN NORWEGIAN CONDITIONS

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Introduction

Large volumes of spruce-dominated forests established on steep terrain are maturing in western Norway (>70 mill.m^3). Their harvesting calls for investments in cable yarding, processing and transport systems and knowledge on the appropriate technology for the Norwegian conditions. Cable yarding and truck transport have strong interactions due to limited buffer storage between them. Discrete-event simulation has been applied successfully in the analysis of a wide variety of wood harvesting and transport systems, where the productivities of different parts in the supply chain are interlinked (Asikainen 1995, 1998, 2001, 2010; Talbot et al. 2003, Myers and Richards 2003, Väätäinen et al. 2005).

Material and methods

In this study a discrete-event simulation model was programmed to find optimal setups for the timber yarding-processing-truck transport system in the Norwegian conditions. The simulation model is based on dynamic operation using typical performance levels and breakdown patterns of a yarding system. The model estimated the performance and costs of the yarding-processing unit and truck transport system. The work of a yarding-processing unit was divided into two main phases: actual operation and randomly occurring machine delays. As the yarding system was operating, its output was set to 10 m^3/effective hour. The variables describing the time between machine failures or any other delay were drawn from a random number distribution that had a mean value of 5 hours. Delay time was also a negative exponential distribution having 1 hour as mean value.

The timber truck with a trailer was modelled for the road transport of timber. Its average driving speed was set to 50 km/h and load volume to 30 m^3. In the simulation experiments the average transportation distances are 20-180 km, with a SD of 10 km. Additionally, the number of trucks varies from 1 to 3. The yarder places the processed timber on the truck road next to the yarder. If there is no truck at the landing, the yarder has to wait. The trucks enter the model on the road leading to the landing. As the truck arrived at the landing, it first loads the wood in the buffer storage and then waits (if necessary) that yarder processes the rest of the wood to fill the truck load. When the truck is fully loaded, it leaves the landing and drives to the mill and unloads. If there is more than one truck in the system, queuing can take place at the roadside landing and at the receiving terminal. The trucks have randomly occurring machine failures according to negative exponential distributions, where average time between delays is 5 h and average delay 0.5 h.

Results

Cable yarder blocked time increases rapidly as the transport distance exceeds 60 km and only one truck is used for transportation of timber. When more trucks are used, blocked time is modest up to 140 km (fig. 1A). Queuing time of trucks decreases as the transport distance becomes longer (fig. 1B). Sufficient buffer storage between the skyline system and truck transport was found to be 40 m^3 (fig. 1C). It smooths the impacts of random arrivals of trucks or delays of the yarding system. Finally the costs of yarding and truck transport were summarized to find out the optimal number of trucks at different transport distances (fig.1D).

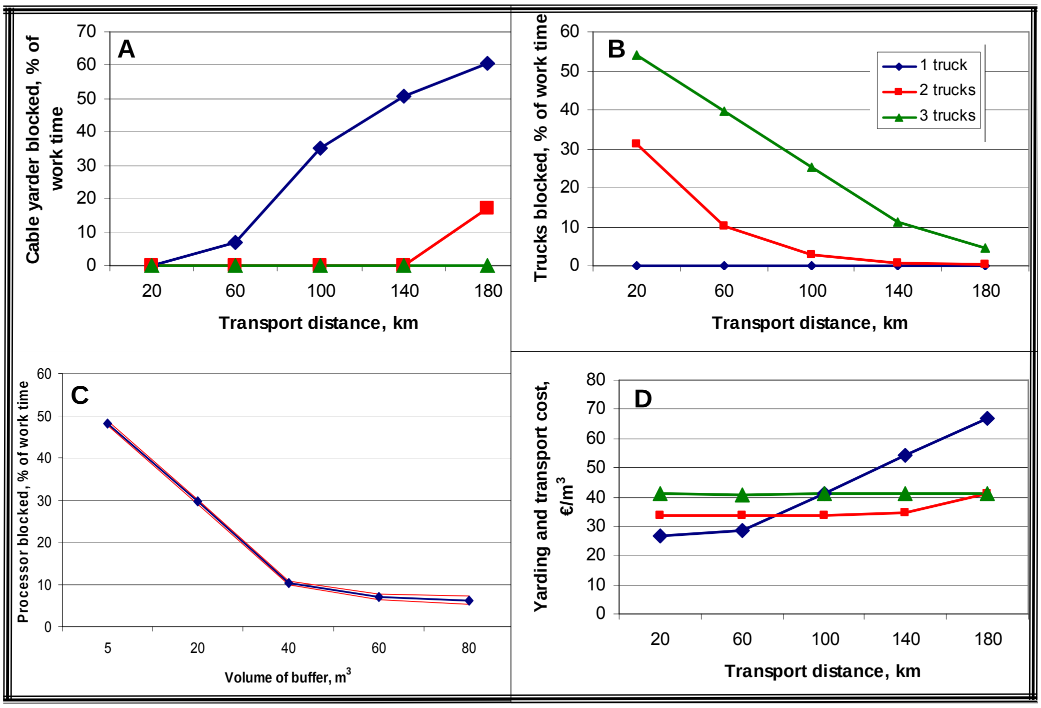

Figure 1 (A) Cable yarders' blocked time and (B), trucks' blocked time, (C) Impact of buffer storage's volume on the processor's blocked time, (D) Total costs of yarding and truck transport

Up to 80 km transport distance one truck is sufficient. At distances 80-180 a system based on two trucks is the most cost efficient and above 180 km distances three trucks are needed.

Next steps

In the next phase the model uses real logging site data from western Norway. The activity times for logging, yarding of trees and processing them into assortments will be calculated with available functions (Stampfer et al. 2003, 2006). Finally the alternate skyline system solutions are compared and the optimal technology for different stand categories is recommended.

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