By John Nelson, PhD, RPF

Road Network Projection Models: Planning Roads for the Long Term

Anyone travelling by air will be amazed at the extent of harvesting and forest roads across the BC landscape. Google™ Earth also gives a broad picture of how the landscape has been altered by harvesting and forest roads (Figure 1).

Figure 1. Google™Earth image north of Vanderhoof, BC showing harvest units and forest roads on an area of approximately 540 sq. km. Source: Google™Earth, accessed April 25, 2011.

It's hard to find out how many kilometers of forest roads we have in the province. However, if I take the annual harvest as 180,000ha and note that 3.5% of the harvest area is in permanent access structures (BC Ministry of Forests, Lands and Mines, 2010) and then consider that an average road right-of-way of 20m, and I get 3,150 km of roads built per year – very close to the distance from Vancouver to Toronto by air. At rate of 3,150 km/year, our forest roads circumnavigate the globe every 12.7 years. That's a lot of road and we have been doing this for decades.

So how are these road networks planned and designed? While there have been strategic decisions to develop certain areas with high-class, forest service roads, such as the Morice River Road, and mainline access to new drainages and operating areas, much of the existing road network was been developed using a short-term planning horizon of about five to 10 years. Hence, many of the secondary and branch roads have been located and constructed based on a limited view of the entire life cycle of these roads.

Until recently, there have been good reasons for why this short-term planning has been the case. First, it is an enormous task to manually project an entire road network. Even projecting a road network for single drainage is time consuming as it requires multiple trials based on yarding distance, landing locations, grades, alignment and soils—just to name a few. Creating alternative networks based on different assumptions (e.g. yarding distance, maximum grade, alignment, etc.) is not a timely/cost effective option if the process is done manually.

Second, we rarely have a long-term view of the life cycle of each road segment within the network. We typically don't have reasonable estimates of how much volume will be hauled over the road and when during the next rotation and beyond. Without this information, it is difficult to make the best decisions regarding deactivation/reactivation strategies and the standard of road to construct.

Finally, we don't have the means to answer strategic questions such as how yarding distance and road design parameters affect the total length and cost of the network, area of productive land lost to roads and the amount of sensitive habitat within a specified distance of a road.

At this point it is important to distinguish between the strategic planning of a road network and the final, field location of a specific road. At the strategic level, we want to answer the 'what if' questions, not the operational 'when and where' questions. The dynamic nature of economic, social and environmental goals in forest management means that many changes can occur between the time of planning and the actual construction of the road. Further, thorough field work by professionals is required before any forest road is approved for construction.

Recent advances in decision support systems for road network planning have removed many of these barriers. First, road network projection models have been developed that automate the manual process of projecting roads (Anderson and Nelson, 2004; Stuckelberger et al., 2007) and are capable of creating complete road networks within a matter of hours, depending on the size of the forest estate. Multiple networks based on different inputs and assumptions can easily be generated to evaluate alternatives and answer strategic questions. There are a number of forest planning consultants in the province that offer these services and the new timber supply model being developed by the Forest Service includes a road network projection module.

Second, models that determine the optimal road construction class and deactivation/reactivation strategy for each road segment in the network have been developed (Anderson et al., 2006). By linking the projected road network to a forest estate model it is possible to determine the amount and timing of volume transported over each road segment throughout the strategic planning horizon. Different assumptions about construction, maintenance and deactivation/reactivation costs can be quickly assessed with this type of model, as can the assumptions about silviculture systems and harvest timing in the forest estate model. The optimal road class models have been used on research projects, but to my knowledge, they haven't been used by industry and consultants in road network planning applications.

Like all planning, road network planning is a continuous process where we plan, implement, monitor/assess and re-plan on a regular basis so that changes in management goals, technology, markets, etc. are incorporated in future projections. Given that roads represent an enormous financial investment and bring both desirable and undesirable consequences, it makes sense that that we plan them carefully, evaluate our underlying assumptions and assess alternatives.

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