A Report on Conceptual Advances in Roll On/Off Technology in Forestry

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October 2007

Introduction

Over the last two decades, increasingly severe fire seasons have led policymakers to recognize the need for thinning overgrown stands of trees.

However, thinning presents a financial challenge. The problem is that hazardous fuel reduction projects —especially projects in the Wildland/Urban Interface— contain mostly smaller trees, which have traditionally lacked market value. Since these projects can't pay for themselves, managers have been looking for ways to reduce the net costs of fuel reduction projects.

Currently the U.S. Forest Service implements thinning projects by paying contractors to cut and pile trees and brush, then either burning the slash itself or paying contractors to burn also. A more cost-efficient alternative might be to market the smallwood rather than burn it; a complementary alternative would be to increase the efficiency of smallwood removal.

Heading an alliance of industry executives, forest contractors and government agencies, MCDC coordinated the publication of a 2004 white paper entitled *A Study of How to Decrease the Costs of Collecting, Processing and Transporting Slash*. www.smallwoodnews.com/Docs/TechMachinery/SlashStudy.doc

The study found that in certain situations, slash removal could be made economically viable through the use of trucks equipped with hooklifts and roll on/off containers, because these trucks can reach slash piles that are too remote for large chip vans.

Since the study's publication, significant conceptual advances in forest-related roll on/off container technology have been made. This report will summarize those advances. It will also outline several new studies that are now underway to test the economic and environmental viability of these new technologies.

2004 to 2006: Roll On/Off Container Technology Hits the Ground.

One of the prime movers of the 2004 slash study was Bob Rummer, an official in the Southern Research Station of the Forest Service's Forest Operations Research Unit. Rummer not only provided a grant but also led data collection for the study. Then, using data from the study, he developed the Forest Residue Trucking Simulator (http://www.srs.fs.usda.gov/foresto ps/biomass.htm), a computer model to help others calculate the costs of handling slash with roll on/off containers.

Craig Thomas, a Montana-based professional forester and logging contractor, was also a slash study participant. He witnessed first-hand the potential efficiencies of roll on/off equipment, and after using Rummer's computer model, he decided to add roll on/off capability to his forest contracting operation, Cky-Ber Enterprises, Inc.

Thomas bought a 1989 Peterbilt Class 8 truck and mounted a Stellar Model 52,000 lb.-capacity hooklift system. He then engineered special roll on/off containers that could nestle inside each other, to allow two to four containers to be hauled with a single truck.

Thomas proceeded to manufacture four of these nestling roll on/off containers. After just a few field trials, he saw the need for even more containers. The opportunity to acquire them came in the form of a grant. Assisted by Dave Atkins of the Forest Service, Thomas and MCDC's Craig Rawlings applied for a $238,000 Wood Biomass Collection System grant, which was awarded in the spring of 2006.

Working as the grant administrator, MCDC supplied the funds for eight roll off/on log bunks and five more containers and then leased the new equipment to Cky-Ber. In the summer and fall of 2006, Cky-Ber deployed its new roll on/off equipment to several timber sales in nearby forests.

2006 to Present: Roll On/Off Container Technology Goes Deeper into the Woods.

Developing the Concept

As has been noted, from 2004 to 2006 the "slash study" group in Montana was exploring and implementing the use of roll on/off attachments on logging trucks, in order to allow access to remote landings, which are not available to highway container trucks.

However, at about the same time, project leaders from the Forest Service San Dimas Technology and Development Center (SDTDC) had been thinking about roll on/off attachments on log *forwarders*. Ed Messerlie, an engineer/forester, and Andy Horcher, a forester, reasoned that a hooklift-enabled forwarder could accelerate the movement of logs from the cutting site to the landing.

To illustrate this concept, Messerlie created a video animation showing a sequence in which:

-a hooklift-equipped truck delivers bunks. (See photo below)
-a hooklift-equipped forwarder picks up the bunks and then fills them with logs.
-the forwarder carries the loaded bunk back to the roadside and leaves it for the truck to pick up.
-a truck picks up the loaded bunks and transports them offsite, presumably to a mill or transfer site.

Note: the Messerlie video animation is viewable at
www.smallwoodnews.com/Projects/Rollon/index.php

Hooklift-equipped truck delivers bunks

Forwarder sets a loaded bunk at roadside


Truck picks up the loaded bunk

In 2006, Bob Rummer put Craig Rawlings in touch with Messerlie. Ed made his forwarder animation available to MCDC and its partners in Montana, all of whom immediately recognized that this was the "missing link"— the next step forward in roll on/off technology in the forest.

As Rawlings and Messerlie talked, they realized that their respective resources meshed well. The SDTDC Forest Management Program had secured enough funding to support the purchase of a hooklift, but not enough for a forwarder or bunks or containers. On the other hand, the Montana group had the forwarder and attachments, but no hooklift.

Ed Messerlie left the Forest Service temporarily for the private sector. However, Andy Horcher teamed up David Haston (another San Dimas colleague), and arranged for a $35,000 Challenge Cost Share grant for the Montana project. The money was used to buy a hooklift, which Craig Thomas installed on a Cky-Ber 820C Timbco forwarder.

Estimating the Time Savings

The slash study participants estimate that a roll on/off forwarder will eliminate one to two hours of work from the typical woods-to-roadside cycle. For example, using a forwarder and a harvester (or in some cases, a combination forwarder/harvester), an operator would typically perform the following tasks:

1. Drive from roadside to the cutting site
2. Cut, delimb, and process trees to log length
3. Use a grapple to place the logs in the bunk
4. Drive to the landing
5. Use the grapple to unload the logs onto a deck (approximately one half hour)
6. Later, a truck driver would use a grapple to reload the deck into the bunk of the truck, or a dedicated loader operator would load the truck (approximately one half hour)

However, with the hooklift-enabled forwarder, steps “e” and “f” should take about five minutes. Thus, the crucial final steps could be shortened by 50 minutes. (Note that this is a conservative scenario, which presumes that larger logs are being moved. The fact is that the smaller the logs, the greater the time savings; if a typical load of thinned logs or slash is involved, the time saving in final unload/load cycle could be as much as two hours.)

The hooklift-enabled forwarder should add not only speed, but also versatility. That’s because it opens up more options:

-The operator can set the log-filled bunk at roadside for the truck to pick up.

-The operator could carry slash in a container out to the roadside, then continue down the road to a landing, where a grinder could process the material into chip vans.

-The operator could simply dump the load at roadside.

Together, the forwarder, harvester, truck, container, and bunk form the prototypical roll on/off system, which should allow more slash to be recovered, and more smallwood to be moved more quickly.

Facilitating the Time Savings: RFID Technology

As just described, roll on/off systems consist of five core components. But as more units of each component are deployed, the logistical complexity of a job increases. For instance, Cky-Ber Enterprises already has a truck, a forwarder, nine containers and eight bunks.

To address this issue, Bob Rummer of the Forest Operations Research Unit has been working with Cambium Forstbetriebe, a German company that specializes in RFID applications for forestry. Rummer collaborated with Cambium's owner, Gerhard Friemel, and with Rick Myatt, a private consultant; together they have solved a series of technical problems in order to adapt the Cambium system to the requirements of forestry in the Western U.S.

In the modified Cambium system, RFID tags are placed on every container and bunk; each tag has a unique code that is read by a scanner in the cab of the truck. The scanner feeds data into a web-enabled laptop computer, which in turn is connected to Google Maps. Using GPS and time coordinates, the system allows managers to track the locations of the truck and every container and bunk, plus the type and amount of material being transported.

Testing

Recognizing the Need for Tests

The hooklift-enabled forwarder/truck system is more efficient on paper, and Craig Thomas has started to use the equipment to good effect. However MCDC and its partners recognized that Forest Service managers, private contractors, timber industry managers and others need objective, third party data on costs and soil impacts.

Accordingly, Dave Atkins searched for thinning projects that could serve as test sites. His main criteria were:

-A site area of 100 to 200 acres
-NEPA-approved status
-Uniformity of soil, topography, and flora within each site. Uniformity is important, because as presently envisioned, each study area will be divided into two sections, each roughly equal in size. One section will be thinned traditionally by hand cutting, piling and burning; the other section will be thinned using a hooklift-enabled truck and forwarder together with roll on/off containers for slash and roll on/off bunks for logs. In the roll on/off section, slash will be harvested, not burned.

By mid-2007, Atkins had arranged contracts for studies at two upcoming thinning projects on National Forest System (NFS) land:

A.100 acres in the Gallatin National Forest by Hebgen Lake
B.150-200 acres in the Kootenai National Forest near Eureka, in the Eureka District

Cost Testing

Cost Test Administration

Dave Atkins conducted a successful search for third-party professionals who were qualified to set up and properly monitor the two sales and then analyze the resulting data.

Data collection will be led by Dr. Beth Dodson, an assistant professor of forest management at the University of Montana/Missoula. Beth will lead efforts to study the production and costs of the roll on/off containers under different production scenarios — and to compare them with traditional slash treatment systems that do not utilize biomass. Bob Rummer will also lend his skills and resources to the collection and analysis of data.

Cost Test Objectives

The primary objective of cost testing is to determine whether roll on/off technology lowers the net cost of thinning. That cost has two components:

- **The thinning process.** On hazardous fuel reduction projects, the Forest Service is currently paying contractors around $500 per acre for cutting and piling, and spending $100 to $150 per acre for burning. We know that for the roll on/off alternative, those burning costs will be eliminated, but we want to know if cutting and piling costs can be lowered.
- **The value of recovered product.** Slash and smallwood will be sold to a number of markets, including Fuels for Schools programs, post and pole companies, compost manufacturers, and lumber companies looking for smaller saw logs. The net profit from these sales will be deducted from the cost per acre of the alternative treatments.

If possible, two other variables will also be measured.

- **Reduced pollution.** If the slash at each test site can be accurately measured, the study should be able to quantify the amount of carbon and particulate matter withheld from the atmosphere at the roll on/off area. (This reduction would be the result of burning slash in a controlled boiler system as opposed to open burning in the woods.)
- **Fossil fuel consumption offset.** The study should be able to measure the net fossil fuel consumption of the traditional slash treatment system and compare that to the roll on/off container system. (The study will take into account the fact that since slash will be used for renewable energy production, a certain amount of BTUs can be deducted from the roll on/off area.) Again, this depends on whether accurate measurements can be made — in this case, measurement of the total fuel consumption by machinery in both sections of each site.

Soil Testing

Soil Test Administration

To study the effect of slash removal on soil, Dave Atkins chose Deborah Paige-Domroese, a research soil scientist at the Forest Service's Rocky Mountain Research Station lab in Moscow, Idaho. Domroese will collect soil data before and after treatment in both halves of each test site.

Soil Test Objectives

Domroese will measure the nutrients in the soil of each "forwarder" area, and compare that to material that's been either removed or burned in the piles of the control areas. She will also compare the two areas in terms of the amount of soil disturbance and soil compaction produced by equipment.

In addition, Domroese will compare the roll on/off sites to sites that have been burned by wildfire. The variables for this part of the study will be nutrient composition and soil disturbance. The ultimate objective is to discover whether thinning with roll on/off technology removes more or fewer nutrients than wildfire.

Pre-treatment soil samples have already been collected at both the Hebgen and Kootenai sites.

Design of the Hebgen Test Project

The design of any thinning project is affected by many variables, including proximity to processing facilities. As it happens, slash from the Hebgen Lake project will be processed by a compost company just five miles from the site. As a result, we have opted not to process any slash at the thinning site. Instead, the project will conform to the following design:

-In the woods, the forwarder will load slash into containers.
-The forwarder will carry the containers to roadside.
-The truck will take the containers to the compost company yard and dump the slash at the composting plant in West Yellowstone, MT.
-A grinder will process the slash.
-50% of the slash will be used on site by the compost company.
-The remaining slash will be carried in containers and/or larger chip vans to other markets, possibly including:

--The wood-fired boiler at the University of Montana's Western campus in Dillon, Montana.
--The multi-fuel boiler at the Basic American Foods (BAF) potato processing plant in Rexburg, Idaho.

RFID Technology and the Hebgen Test Project.

The roll on/off equipment at the Hebgen Lake test site will be RFID-enabled. Our expectation is that RFID technology will not only add efficiencies to the roll on/off system, but that it will also make it easier to test those added efficiencies, since Beth Dodson will be able to access a website in order to track the day-by-day movement of slash and smallwood from forest to processing center to final markets.

Publication of Test Results

MCDC will publish test results online, at smallwoodnews.com and timberbuysell.com, and in a printed white paper report. The test results will consist of Beth Dodson's cost studies and Debby Domroese's soil studies.

Summary

In 2004, hooklift-enabled trucks with roll on/off containers were found to make slash collection more efficient under certain conditions at remote landings.

Since then, several conceptual advances in roll on/off technology have been made, including the use of hooklift-enabled forwarders with roll on/off containers for slash, and roll on/off bunks for logs. A multi-use grinder/processor boom attachment also promises to make hooklift-enabled forwarders even more efficient at slash and log collection in the woods.

These conceptual advances will be objectively tested by forest science professionals on at least two upcoming test sites in Montana.

Appendices

Appendix A. The Versatility of Extra Hooklift Attachments

As previously noted, the basic system configuration would consist of:

-Hooklift-enabled truck
-Hooklift-enabled forwarder and harvester
-Roll on/off container for slash
-Roll on/off bunk for logs

This system allows efficiencies to extend deeper into the woods. However, there are many other kinds of hooklift-related attachments, all of which fit onto the same frame on a truck or forwarder. These attachments allow efficiencies to be extended not only more deeply, but also *more widely*, in the sense that they shorten the work cycle not only in traditional logging operations, but also in other applications such as firefighting.

For instance, the following roll on/off attachments have recently been engineered:

Flatbed attachment for hauling construction or firefighting cargo
Water reservoir with 10,000-gallon tank and firefighting pump
Seeding apparatus
Mulch blower

To give just one example of improved efficiency: As part of its firefighting support business, Cky-Ber had traditionally used a water reservoir that took a day to bolt on or off a forwarder. However, now that the company has adapted its reservoir to the roll on/off frame, it can be attached or removed in five minutes.

Forwarder with roll on/off water reservoir

Roll on/off technology also extends the usefulness of equipment into additional seasons. In the Intermountain West, work areas can become either too wet, or too deep in snow, or too hot and dry. During these down times, contractors often have to move to other regions for work. However, if a slash-hauling truck can be quickly adapted to other purposes, it can remain useful without having to be moved long distances.

This versatility has provided even more justification for continuing to explore roll on/off technology.

Appendix B. Multi-Use Boom Attachment on Forwarder

Integrating the Multi-Use Boom into the Roll On/Off System

A hooklift with roll on/off attachments can allow a forwarder to gather slash and logs more efficiently. But to make the forwarder more efficient still, MCDC and its partners have begun to explore ways to improve the other end of the forwarder, namely the boom.

This exploration led MCDC's Craig Rawlings to Reg Isley and his company, Risley Equipment, of Grand Prairie, Alberta, Canada. Rawlings had learned that Risley was developing an attachment that is both a processor and a grinder.

The Risley attachment would allow the forwarder to become, in effect, an in-woods processing plant, delimbing and cutting logs to length, then grinding non-saw logs — and in the process, eliminating several trips from the woods to the landing.

In one possible scenario, the operator would perform the following tasks:

-Cut trees with the processor head
-Delimb the trees
-Set the logs in decks in the woods
-Select material that doesn't meet log specifications and grind it into the roll on/off container
-Forward the grindings to the landing
-Pick up an empty container
-Fill the container with logs
-Forward the log-filled container to the landing

This in-woods grinding should allow the forwarder to stay productive longer in the woods before returning to the landing. It should also allow some smallwood to avoid the slash pile and instead be turned into marketable products such as posts and poles, pulp logs, and small saw logs. These assumptions will be tested in the field trials.

The Multi-Use Boom Attachment and the Site Study: Improving the Process

Our study sites contain trees that can be used as both saw logs and roundwood. This presents the forwarder operator with two options after the logs have been cut to length and delimbed:

a. Grind the tops of the roundwood into the container, take the container to the landing, then come back with a log bunk and pick up the saw logs.
b. Reverse the order — that is, pick up the saw logs, take them to the landing, then come back with the container and grind the roundwood tops into it.

Beth Dodson's study will determine which option is the most efficient, and in which kinds of conditions.

The Multi-Use Boom Attachment and the Site Study: Improving the Nutrient Mix

Deborah Paige-Domroese's soil study will determine the amount of nutrients taken from the soil using the roll on/off process. The study will also help determine the quantity of nutrients that need to be left, if it turns out too much is being removed.

Risley's multi-use boom attachment will allow Domroese's recommendations to be implemented accurately, because a computer will be able to tell the operator exactly how many trees need to be chipped and blown onto the ground instead of into the container — for example, every 10^{th} tree.

Appendix C. Efficient Slash Removal and Cellulosic Ethanol

The most recent addition to the "slash study" partnership is Brad Blackwelder, a scientist at the Department of Energy's Idaho National Laboratory. Blackwelder's lab is exploring biomass processing and the production and transportation of bioenergy, including cellulosic ethanol. His team's focus had been agricultural residues but now includes woody biomass feedstocks. Blackwelder and his team are interested in working with MCDC to find ways to more efficiently develop slash as a feedstock for biofuels.