April 1998

Field Note No.: Processing-98
Previous Reference Sheet No.: None

DEVELOPMENT OF AN INNOVATIVE PROTOTYPE SOLUTION FOR FELLING AND CHIPPING UNDEBARKED FULL-TREES

Geoff Hart, B.Sc.F., Specialized Technologies, Eastern Division

INTRODUCTION

FERIC has a proud tradition of innovative mechanical design, dating back to the Institute's founding in 1975. In the wake of the successful design and commercialisation of FERIC's feller-forwarder, informerly known as "the Green Machine", the Institute's advisory committee on forest engineering research (ACFER) asked FERIC to investigate how to reduce the costs of producing undebarked full-tree chips. ACFER identified this research as a priority because of the prohibitive costs of the combination of a Nordic single-grip harvester and a high-productivity delimber-debarker-chipper.

After proposing and discarding several prototypes, FERIC settled on a single machine design that combined the felling and chipping functions. Although hybrid machinery is generally more costly than individual machinery, the opportunity to reduce the number of machines and workers on the cutover may actually make a single hybrid machine more economical in the long run.

REQUIREMENTS OF THE PROTOTYPE

In consultation with ACFER, FERIC identified the following requirements for the prototype device:

- The machine should be based on a low-profile, tracked carrier such as an excavator, to maximize the ability to negotiate difficult terrain and minimize soil disturbance on more fragile sites.
- The machine's loaded weight should not exceed 30 tonnes.
- The cab should provide full 180-degree rotation, with minimal rear overhang.
- The harvester head should integrate a delimbing function.
- The device should produce an acceptable range of chip sizes.

Based on these specifications, FERIC designed a machine known as the M60 that could be built at a cost of about $1 million (1997 dollars) from off-the-shelf parts purchased at retail prices. Although this represents a large initial capital outlay for a single machine, it compares favorably with the combined cost of an advanced Nordic single-grip harvester capable of harvesting a wide range of tree sizes (ca. $600 000) and a high-productivity whole-tree chipper ($600 000). One significant advantage of FERIC's proposed feller-chipper is that productivity in stems per PMH would be entirely unaffected by tree size, although volume productivity would increase in direct proportion to tree size. Preliminary analyses based on FERIC's proprietary mechanical design software suggest that there would be no practical diameter limit to the size of the trees the M60 could harvest.

The prototype M60 is based on a 300-kW tracked carrier powered by a standard diesel engine, and has a loaded weight of 30 tonnes, operated by a two-man crew; one man would operate the felling and delimbing devices, while a second man navigated the machine through the cutover. Optionally, a foreman can ride along safely inside the M60, or ride on the superstructure, with head exposed, where low visibility is a factor. The latter configuration is not recommended, as it places the foreman outside the protection of the prototype's forestry-grade ROPS and FOPS. The felling head and integrated delimber represent the two most innovative aspects of the M60, as both are based on expendable kinetic-energy devices rather than conventional knives or saws; by expending small, relatively inexpensive felling and delimbing implements on each tree, replacement costs increase but maintenance costs and down-time for parts replacement drop to zero; moreover, there is no safety hazard resulting from metal fatigue on worn parts. Potential secondary uses of the delimber might be cone collection and pruning trees at the edge of a stand to reduce windthrow. An artist's impression of the M60 is shown in Figure 1.

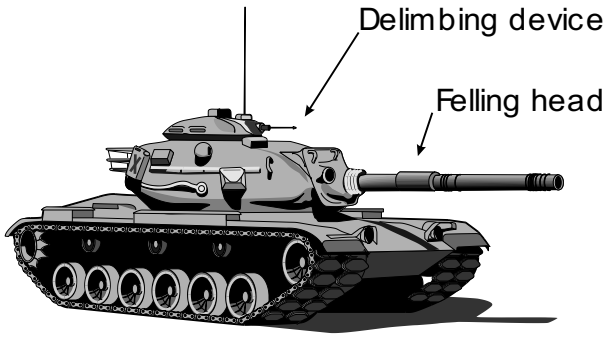

Figure 1. FERIC's M60 feller-chipper prototype.

PRODUCTIVITY STUDY

Because FERIC has not yet secured funding for the development of a working prototype, all cost and productivity calculations were performed using FERIC's Interface software. Based on the assumption of a materials consumption cost of more than $50 per tree for felling, delimbing, and chipping, the prototype would be substantially more expensive than the harvester–DDC combination. However, this cost analysis relies on retail pricing for limited-availability, proprietary consumables. Given the standard cost of $500 U.S. for a government-issue, MILSPEC-grade kinetic fastener-embedding tool (Figure 2), which would be available for less than $10 from public providers such as Canadian Tire (a 50-fold difference), substantial cost reductions are forseeable once the M60 enters commercial production and a range of manufacturers begin competing for sales.

Figure 2. MILSPEC-grade kinetic fastener-embedding tool.

DISCUSSION

In addition to the consumables cost, the cost of the M60 itself could be expected to fall dramatically once it entered full-scale production. As noted previously, the use of non-MILSPEC parts could also be expected to dramatically lower the production and operating costs. FERIC believes that the resulting price reductions would render the M60 cost-competitive with the aforementioned harvester–DDC combination.

The viability of FERIC's device depends in large part on the availability of markets for undebarked whole-tree chips. Given the remarkably rapid incorporation of Simco-Ramic's optical chip-sorting technology into pulp mills since the publication of FERIC's report on their product (Franklin 1996), this market can only be expected to expand. However, various intractable problems remain to be solved before the M60 can enter commercial operations. FERIC is confident of being able to solve the following problems:

- The chips are produced in a wide range of sizes, which may require some fine-tuning of the integrated chipping–felling device.
- The delimbing device has an effective range of nearly 1000 m, which poses obvious operational safety problems for other forestry workers in adjacent stands. Appropriate coordination of work schedules should easily resolve this problem.
- Chip recovery can be problematic. With larger trees, the mass of the tree tends to confine the chips to a relatively small space; however, computer simulations suggest that chips from smaller trees would be spread over a considerable area; simple modifications to the power of the chipping device should resolve this problem.

REFERENCES

Franklin, G.S. 1996. Upgrading in-woods chips with the Simco/Ramic optical-pneumatic chip sorter. For. Eng. Res. Inst. Can. (FERIC), Pointe-Claire, Que. Special Report SR-113. 11 p.

DISCLAIMER: This report is published solely to distribute information to FERIC's members. It should not be taken as an endorsement or approval of a product to the exclusion of others that might be suitable.