LOGGING INDUSTRY RESEARCH ASSOCIATION
NEW ZEALAND

ISSN 0111-4743

TECHNICAL RELEASE

Vol. 5 No. 2 1983

SPYDER STEEP-SLOPE FELLER-BUNCHER

Dallas C. Hemphill, Consultant Logging Engineer, Eugene, Oregon, U.S.A.

The Spyder X5 steep country feller-buncher

INTRODUCTION

The Spyder X5 is a small steep-slope feller-buncher adapted from an all-terrain "walking" excavator. The prototype feller-buncher version has recently been demonstrated in U.S.A. in both thinning and clearfelling operations. As with conventional feller-bunchers, this machine's potential lies in its ability to accumulate bunches of logs. Various other applications exist also, because of the unique method of locomotion.

This report is written as a first-cut evaluation of the concept's potential for New Zealand logging applications and covers the potential of the concept.

THE MACHINE

UNDERCARRIAGE

The machine "walks" on four hydraulically-powered "legs". These "legs" bear hydraulically driven wheels, the rear ones powering the machine along the highway at speeds up to 11 km/h.

For traversing rough terrain, the front wheels are removed, and each front leg is supported on a pad. The machine moves by using the front legs and the end of the boom alternately to "walk". A gear pump is used for the leg positioning function. The rear (powered) wheels do not contribute to movement, but they do help support the machine. A winch is used to tether the machine on steep slopes, for climbing assistance and as a safety precaution.

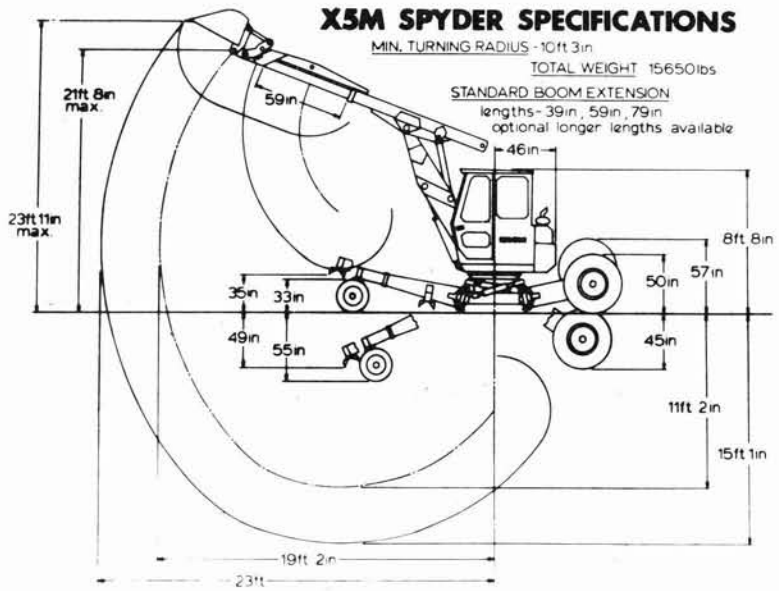
UPPERWORKS

The turntable permits 360° rotation. Power is by a 3-cylinder Deutz diesel of 40 kW. It powers the gear pump and the two piston pumps for the boom and drive functions. The cab is small, but comfortable and not crowded. The Spyder is complex to operate, and a three month learning curve may be expected for feller-buncher operators. Productivity would be very sensitive to operator skill. Most controls are conveniently located. Ergonomics will be improved by replacing the present toggle feller-buncher controls with stick controls.

The dipperstick-type hydraulic boom uses an operating pressure of up to 34 MPa. It has a Morbark 33 cm accumulating shear attached, which is modified only by the addition of a little extra guarding. The maximum tree weight that can practically be lifted by the shear at the full extension of 6.4 m is 900 kg.

DIMENSIONS

Weight	:	approximately 7,250 kg as a feller-buncher
Width	:	2.0 to 4.0 m
Length	:	Up to 5.5 m (over legs)
Height	:	2.6 to 4.0 m



COST

The cost of the Spyder X5 landed at Auckland is envisaged to be NZ$170,000.

APPLICATION

The Spyder has been tested as a feller-buncher in clearfell and thinning and it has other possible steep-slope logging applications, such as deadman installation and pre-bunching. It is widely used as an all-terrain excavator and rock drill, which are potential forest applications.

As a feller-buncher, the Spyder is limited to 33 cm diameter in softwoods; bigger trees must be hand-cut. A bigger shear would produce loads beyond the machine's capacity.

Given this diameter limitation, the potential application in most New Zealand operations will be only in thinning. Therefore, the following description of the Spyder's operation will principally address thinning.

OPERATION

The Spyder operates by cutting all the trees it can reach from one position, placing them in a single bunch. Bunch size is a linear function of the removed stocking.

The angler in the shear head, used to align the shear with the stem, was removed in an attempt to improve the payload. It was found that this substantially reduced the ability of the machine to conform to butt sweep or leaning stems, and reduced the machine's ability to manoeuvre cut stems between the crowns of standing trees. Tree form in the Douglas fir - western hemlock stand thinned in the demonstration was generally good; better than a young radiata stand but not as good as most Douglas fir plantations in New Zealand. Users said that heavy limbing down to the base of the tree was not a problem in positioning the shear; this might require further examination for the radiata case, however.

The machine needs to be levelled for efficient boom operation. This can be achieved in the present configuration on slopes up to 60% (31°). On greater slopes, productivity drops rapidly because boom operation speed is seriously impaired. Slope is apparently not an important factor affecting productivity on slopes under 60%, provided the soil is cohesive. The practical operating limit of slope is therefore 60% for the present Spyder. Small areas of steeper ground can be included, and it has worked on slopes as steep as 110% (48°).

Moving depends on having soil sufficiently cohesive that the shear head won't sink into it in pushing the machine uphill. The Spyder is unable to traverse non-cohesive pumice soils on slopes over 80% (39°), and productivity is poor on pumice slopes over 50% (26°). The installation of a winch on future models, using a 16 mm tether line, should give improved mobility on pumice soils.

At present, to traverse steep pumice slopes, the operator must frequently place the shear on a stump for support, and avoid travelling uphill perpendicular to the slope.

In thinning, it has been found that if all the trees are removed for a 3 m width, a corridor is created that is wide enough for the Spyder to travel. Typically, such a corridor will end up being four to five metres wide, and it later becomes a skyline corridor.

To date, thinning has been down to a crop stocking of about 300 stems/ha. Residual stem damage was evident, that was stated to be due primarily to operator inexperience. Stems were bunched at a 45° angle to the skyline corridor, all on one side of the corridor. This way, stems were not laid out into the next corridor, where the Spyder would have later broken the logs. Corridors were laid out only about 10 to 15 m apart in the trial area. Users feel that they will go for about a 20 m spacing in future, so that stems could be placed on both sides of the corridor. A cutter works alongside the machine, to fall trees over 33 cm with a powersaw and to act as lookout for the machine operator.

It is expected that ultimate productivity rates will be around 80 trees per productive hour in clearfell, and 50 trees per productive hour in thinning. (A "productive hour" is considered to include only minor delays). Move time becomes especially significant on slopes over 60% (31°) or with an inexperienced operator, and it may limit productivity improvements from system changes external to the locomotion system.

Following the prototype demonstration, it has been decided to make strengthening changes to various parts of the machine.

Calculations by University of Washington researchers indicate that the total stump-to-landing cost will be lower using the Spyder feller-buncher, than by using conventional manual cutting, assuming of course American labour and machine costs. The advantage is expected to be substantial for 15 cm dbh trees, decreasing to little or nothing at around 30 cm mean dbh. Given the usually greater machine: labour cost ratio in New Zealand, the break-even tree diameter would likely be less in New Zealand.

POTENTIAL FOR NEW ZEALAND

Firstly, with a 33 cm maximum shear capability, the machine has little future for clearfell in most New Zealand operations. A larger shear is not considered to be feasible, because of the limitations of the present undercarriage. As a thinning machine, the following features of the Spyder must be considered for its application in New Zealand :-

(1) The present model has a practical operating limit of only 50% (26°) on pumice soils. How much this will be improved in future is not yet certain.

(2) Given a reach limited to 6.4 m, the silvicultural desirability of thinning regimes with a close corridor spacing and/or unthinned strips midway between corridors should be assessed.

(3) Thinning productivity, expected to be only about 50 trees per productive hour, may be too low to be offset by gains in hauling productivity. The economics would require considerable investigation.

(4) Whether the form and limbing habit of radiata pine would impair productivity is not known.

(5) It needs to be considered whether sufficient work is concentrated, that could not be more economically felled and bunched by other technology already operationally available. It is likely that the Spyder would be a competitive feller-buncher only on slopes over 60% (31°). There may not be large contiguous areas like this that require thinning, in most forests. It might make more sense to use fallers than a specialised machine.

Other forest applications are worth considering. One future model is to be equipped with mainline and tailrope winches so that it can be used to pre-bunch manually cut timber. It could also be used for reaching sites inaccessible to a tractor, for deadman installation.

The Spyder is already used in many construction applications with forest road potential, such as drilling rock in areas that cannot be pioneered by tractor. A possibly significant application in the unstable areas of New Zealand is culvert and erosion control work in inaccessible work locations.

Looking further into the future, the "walking" concept of locomotion could have a wide application in New Zealand if a large enough machine were developed to fell mature trees.

CONCLUSIONS

(1) It has no potential for logging mature forest without complete re-design and re-sizing.

(2) The feasibility of operating future models on steep pumice slopes is not yet verified.

(3) Thinning productivity may be fundamentally limited by move time, with an average operator. The Spyder is unlikely to be competitive on slopes accessible to other feller-bunchers.

(4) On slopes inaccessible to other feller-bunchers, the economics and logistics of thinning with the Spyder require examination.

(5) Road construction applications are proven and possibly significant.

(6) The concept of walking locomotion is in its infancy. Systems based on it will probably take many years to mature, and are limited only by loggers' imaginations.

For Further Information Contact: N.Z. LOGGING INDUSTRY RESEARCH ASSOC. INC.
P.O.Box 147,
ROTORUA, NEW ZEALAND. Phone 87-168