Liro Forestry Solutions

LIRO PROJECT REPORT

PR 82

1998/99

The Application of Individual Log Identification (ILID)

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EXECUTIVE SUMMARY

The three main reasons why logs might be individually tagged or labelled (Individual log identification or ILID) are 1. inventory control 2. transfer of log attribute information and 3. chain of custody. Existing log tagging or marking systems such as paint or bar code, have a number of disadvantages in terms of either reliability, the quantity and type of information that can be conveyed, and the reading or scanning method. This report summarises some of the implications of ILID in four operational scenarios or "chains". Two tag or mark locations are examined, (i) the log end, or butt, and (ii) the log side or outer surface (RF tag only). An analysis is made of these implications, and recommendations made.

The main findings were:

- For Skid(logmaking) -to-Mill chains, application of RF tags to the side of logs offers the best opportunity for attribute information transfer.
- End marking by paint, barcode, or RF tag in log stacks is possible for inventory management purposes. All identified logs must be read from the end of the log. Random length logs in stacks, or on trucks, probably offer the biggest hindrance to reading.
- Reading of paint, barcode or RF tags can initially be carried out manually, or with hand-held readers. This is necessarily labour intensive, and will involve some changes to operational methods, but the alternative is investment in development of automated systems. Most automated systems currently available have been developed for factory or warehouse environments.
- Any application of barcode or RF tag identification must take into account tag removal to avoid contamination of pulp chips, or damage to sawmill machinery. This necessity probably favours side-of-log RF tag identification, and removal by debarker.
- For the TimberTech to Processor chain, essentially a stem identification issue, RF tagging offers the most potential for an automated solution since they are unaffected by problems with visibility (barcodes) and legibility (paint). A manual, numbered-label solution is a possible interim measure.
- The most practical solution for a (TimberTech to) Processor to Mill chain is also RF tag identification because these devices lend themselves more readily to mechanical application ie. insertion into the log's surface. They are also suited to automated reading, perhaps at the debarking phase.
- A truck-to-mill solution for log identification could be applied to export logs (currently barcoded). Logs would be end-tagged while in stacks - JAS SED would also be measured. This system has the potential to make log loading more efficient by reducing loading cycle time as well as providing real-time data for optimal stowage. An automated reading system offers the most advantage for this chain.

INTRODUCTION

Two current reasons for logs to be individually tagged or labelled (ILID) are inventory control, and transfer of log attribute information. Both have the potential to add value to a product with variable quality characteristics. A third reason, chain of custody identification, perhaps for "Green" certification or verification of origin, may become important in the near future.

The aim of inventory control is to provide information about stock levels down to the individual log. Value is added by streamlining the stock holdings and better managing the standing resource. This pre-supposes that orders can be accurate to the individual log level, rather than tonnes of log grade. Currently, only special orders, such as poles, are defined by number required.

The transferral of log or stem-related information would include information such as forest, skid, and crew; as well as log attributes, if these are available. Physical dimensions such as JAS SED or defects - including position, and internal qualities such as density or stiffness, could be included. The value of this information depends on the use to which it can be put. Currently, most mills are not in a position to exploit this information.

Current identification methods

There are three main methods or mediums in use (or with potential) for log identification: paint, barcode, and RF tag. Each offers advantages over the others in terms of cost, capability and complexity.

Costs

- Paint costs are approximately \$0.12 per m^3.
- Barcode (labels, equipment, labour) costs for export logs (read at weighbridge or CPY, and at loading the ship) are estimated at approximately \$1 per m^3.
- RF tags would almost certainly not be cheaper than bar code in this application. RF tag unit cost is unlikely to be less than \$1 per tag in the near term. Hardware and infrastructure costs for barcode and RF tagging are approximately equal.

Capability for information transfer

- Use of paint to mark log qualities creates difficulty in separation from other markings (forest owner, crew, grade, fell-date are normally applied). Other colours, and adverse weather conditions can affect subsequent readability. If yes/no information is desired (eg. high or low-density characteristics), paint may be an option (within an existing grade) or another grade may be allocated. If degrees of attribute, or several attributes are to be marked, in addition to existing markings, paint is unsuitable.
- Barcode labels, each carrying a unique number, are currently in use to identify export logs.
- RF tags can also have this feature (ie. unique numbers), but some tags can be programmed with additional information. Additionally, recent technology has enabled a group of tags to be read at once, rather than one at a time. RF tags have reliability advantages over barcoded labels. The tags can be obscured visually, and still be readable.

Complexity

- Paint is a simple, straightforward medium for identification.
- Bar code labels are easily manufactured. Readers or scanners are as complex as for RF tags. The scanners can also have the capability of RF communication to a remote computer. This is a feature of many warehouse barcode systems. Barcodes also have limited read ranges, and require favourable light conditions for a successful scan. An omni-directional scanner is needed if the label orientation is unknown or the scan attitude cannot be controlled.
- RF tags are complex, but the complexity is contained within the "chip". There are essentially four parts to the tag: a chip, antenna, tuned capacitor, and the casing. Some new developments do not have a separate capacitor, it is absent, or included in the antenna design. Tags come in two main types, high and low frequency. High frequency tags (eg. 13.56Mhz) have longer read ranges (up to 100cm), but cannot be read reliably through wood because of the moisture content. Low frequency tags (eg. 134.2Khz) are more suitable if through-wood reading is required. Once the tag number has been read, the information can be transmitted, or stored in a computer using the same systems as for barcode readers.

This Report

The objective of this report is to examine paint, barcode, and RF tag identification methods for logs or stems. Specifically, the following issues have been addressed:

(i) the identification requirements for a complete skid-to-mill identification system

(ii) the specific operational and technological problems that arise as a result

METHOD

Four example log identification "chains" are described. They represent either common processes, or processes that may soon become widely used. Comparison is made of the three log identification methods (paint, barcode, and RF tag), for two tag or label positions (end, and side).

Chain 1. Manual logmaking →Truck→Mill

Chain 2. TimberTech→Mechanised processor

Chain 3. Mechanised processor→Truck→Mill (continued from chain 2)

Chain 4. TimberTech→Truck (CPY or skid) →Mill

Each chain was subdivided into common processes or phases. For each phase it was decided whether application or reading is: required (but not currently possible), currently possible, or not required. For each identification method, the main limitations, and possible solutions to successful application and reading are summarised.

RESULTS

Chain #1. Manual logmaking → Truck → Mill; Tag position: End.

In this chain, all marks or tags are applied in the log stack. All tags or labels are removed manually before debarking, or automatically during the debarking process.

For manual logmaking, there is a limited amount of information to be transferred because there are no "currently" measurable log attributes. Regardless of identification method, information is limited to crew, grade, fell-date, and forest owner. It is probably sufficient to mark or tag logs in skid stacks. All application and reading involves manual effort or use of hand-held readers.

The main limitation that all three of the identification methods have is access to logs in the stack (random log lengths). For paint, another limitation is the legibility of markings. Legibility could be addressed by using pre-printed labels. With barcode, limitations are access, and visibility related. With RF tags, similar levels of access are required, but read conditions are easier. Both barcode and RF tag identification require tag or staple removal before processing. Effectiveness of RF methods depends on read range available.

Technological implications include development of robust labels and RF tag casings. Some modification of readers to make them weatherproof would also be involved. Barcode readers would need to be omni-directional.

Operational considerations include the use of labour to mark logs or apply tags or labels, and also to read labels or tags at different points in the supply chain. This would slow some operations, and require safe working practices to be developed for the necessary interaction with machinery (such as reading tags or labels while logs are held in a loader grapple).

	Paint	Barcode	RF tag
Operational Considerations	• random lengths in stack affecting access • heavy rain affecting legibility	• random lengths in stack affecting access • ladder for reading logs on truck • obscured or torn labels	• random lengths in stack affecting access • ladder for reading logs on truck
R and D Considerations	• letter or number size • number sequence for label	• label design • staple design • label size • scanner design • read range • label visibility • technology for removal of metal staples/label before mill processing	• tag casing/fixing method • technology for removal of tag before mill processing • handheld and fixed reader development • Use of multi-tag reading technology

Chain #2. TimberTech → Mechanised Processor; Tag position: End

In this two-phase chain, stems are initially marked or tagged on the skid or at the logmaking location, and then read either by the processor operator (paint) or automatically before processing. Tags would be removed when logs are in stacks. If slovens are set aside for chipping, then tags or labels/staples would be removed also.

Here information to be transferred is a unique ID number which is associated with a stem description to aid optimised processing.

The main limitation for this chain lies in the tag reading area. Paint and barcode require visibility, and good reading conditions. An RF tag solution will involve development of a machine-mounted reader.

An intermediate solution is a pre-printed label that ensures legibility. However, limiting the label digits to an easily read size introduces its own problems. Although each number in a series of labels would be unique, the size of the series (eg. 0001 - 9999) would mean that a repeat series would be necessary in a given period of time. This would introduce the possibility of confusion caused by two co-existent labels with the same number. Secondly, there is the issue of human error juxtaposing (or misreading) digits. This could also lead to multiple "current" identical labels. To some extent, this latter problem can be addressed by using a "check" digit, calculated from the values of the preceding digits. A computer would alert the operator to a "false" number being entered.

	Paint	**Barcode**	**RF tag**
Operational Considerations	• heavy rain affecting legibility • slovens hinder marking/reading • letter or number size	• slovens hinder scanning • label orientation • obscured or torn labels	• Tag casing/fixing method • methods for collecting tags for re-use
R and D Considerations	• letter or number size	• label design • staple design • label size • scanner design • read range • label visibility	• processor-based fixed reader development

Chain #3. Mechanised processing → Truck → Mill; Tag position: End

Application of a label or tag must be achieved by machine (a modification of the processor head). In this case, attribute information from the TimberTech stem description will be associated with the log identifier. Either barcode label, or RF tag identification (but not paint) is suited to this application.

Thereafter, reading of tags or labels depends on visibility and access, and indirectly, read-range.

All tags or labels are removed manually before/during debarking, or automatically during the debarking process.

Technological implications include development of tag or label application devices, which must be integrated with the processor head, or processor. Labels and tag casings would also require some development work. Some modification of readers to make them weatherproof would be involved. Barcode readers would need to be omni-directional.

Operational considerations include the use of labour to read labels or tags at different points in the supply chain. This would slow some operations, and require safe working practices to be developed for the necessary interaction with machinery (such as reading tags or labels while logs are held in a loader grapple).

	Barcode	RF tag
Operational Considerations	• random lengths in stack affecting access • close stacking • label orientation • obscured or torn labels	• random lengths in stack affecting access • close stacking • ladder for reading logs on truck
R and D Considerations	• label application device for processor • label design • staple design • label size • scanner design • read range • label visibility • technology for removal of tag before mill processing	• tag application device for processor • tag casing/fixing method • technology for removal of tag before mill processing • handheld and fixed reader development • use of multi-tag reading technology

Chain #4. TimberTech → Truck → Mill; Tag position: End

In this chain there is complete information transfer required. Logs are to be identified at source, after the stem has been marked for logmaking. The main limitation to this is the butting together of logs, following crosscutting or bucking, preventing access to the log ends. An important requirement is some identification of the stem itself by the TimberTech operator after marking. This is because of the time delay that might occur between the marking phase, and bucking. The parent stem identifier would be associated with each of the logs produced from it. Log position information (eg. 1,2,3,4) would have to be entered into the management system.

Thereafter, there are access and read range issues. All tags or labels are removed manually before/during debarking, or automatically during the debarking process. Paint marking is subject to legibility problems.

If logs are to identified at source, then they must be safely separated, or rolled apart. There are limited opportunities for this, and sufficient space/time must be available.

Technological implications include development of labels and tag casings. Some modification of readers to make them weatherproof would also be involved. Barcode readers would need to be omni-directional.

Operational considerations include the use of labour to mark logs or apply tags or labels, and also to read labels or tags at different points in the supply chain. This would slow some operations, and require safe working practices to be developed for the necessary interaction with machinery (such as reading tags or labels while logs are held in a loader grapple).

	Paint	Barcode	RF tag
Operational Considerations	• logs butted together • random lengths or close stacking affecting read access • heavy rain affecting legibility	• logs butted together • random lengths or close stacking affecting read access • label orientation • obscured or torn labels	• logs butted together • random lengths or close stacking affecting read access • ladder for reading logs on truck
R and D Considerations	• letter or number size	• label design • staple design • label size • scanner design • read range • label visibility • technology for removal of tag before mill processing	• Tag casing/fixing method • technology for removal of tag before mill processing • handheld and fixed reader development • Use of multi-tag reading technology

Chain #1. Manual logmaking → Truck → Mill; Tag position: Side

For manual logmaking (as with end-marking), there are currently no measured attributes for information transfer. This makes side marking of doubtful use for this purpose. RF tagging for inventory control reasons is a possibility.

In this chain, side-marking means that logs can be marked, tagged or labelled before being bucked from the stem. However, paint and barcode methods are limited by the fact that other logs in a stack will obscure the markings or the tag, making them unreadable. Log orientation at any other point in the chain will also deter reading. Thus, barcode and paint are not suitable log identification options for this supply chain. If an RF tag is applied to the side, close to the end of the log, it may be read from that end of the log. Thereafter, there are read range, access, and tag removal issues.

	RF tag
Operational Considerations	• random lengths or close stacking affecting read access • ladder for reading logs on truck
R and D Considerations	• Tag casing/fixing method • technology for removal of tag before mill processing • handheld and fixed reader development • Use of multi-tag reading technology

Chain #2. TimberTech → Mechanised Processor; Tag position: Side

The main limitations for paint and barcode identification methods are stem orientation at the read point, and visibility/legibility. RF tagging, which is not so dependent on orientation, has more potential for automated reading in this application. However, since the end of the stem is always accessible during logmaking, there is no reason for using the side as a mounting surface.

Chain #3. Mechanised processing → Truck → Mill; Tag position: Side

As with all other supply chains (side marking), the main limitations for paint and barcode identification methods are log orientation at the read point, and visibility/legibility. In this chain, the accent is on preservation of TimberTech derived information at the log-level. For this to take place, log identification must be applied by the processor during the bucking process. An RF tag, suitably encased, is robust enough to cope with mechanical insertion. Such a tag would be applied close to the end of a log, so that it could also be read from the log's end, when the log is in a stack.

Thereafter, there are read range, access, and tag removal issues. A side-mounted tag is suited to removal by debarker, especially if its position relative to the log's end is known.

	RF tag
Operational Considerations	• random lengths or close stacking affecting read access • ladder for reading logs on truck
R and D Considerations	• tag casing/fixing method • automated application technology for the processor • technology for removal of tag before mill processing • handheld and fixed reader development • Use of multi-tag reading technology

Chain #4. TimberTech → Truck → Mill; Tag position: Side

As in previous examples, paint and barcode identification are not suitable for side-of-log application sites.

In this chain (as with end-marking) there is a complete transfer of attribute information. As with end identification, stem identification is also required.

	RF tag
Operational Considerations	• random lengths or close stacking affecting read access • ladder for reading logs on truck
R and D Considerations	• Tag casing/fixing method • Automated application technology • technology for removal of tag before mill processing • handheld and fixed reader development • Use of multi-tag reading technology

DISCUSSION

The kinds of log identification methods that can conceivably be used depend on whether or not attribute information is to be transferred to another party or end-user. Attribute information includes knot or defect location, density, or log position in the stem. This information is of greater potential benefit to the end-user than non-attribute information. Non-attribute information includes grade, crew name, forest owner etc. This information is largely for superficial marketing purposes.

Any identification system (apart from paint-based) would associate a unique identifier/s with some other user-defined information. This would be transmitted or downloaded to a database to which access could be granted by the log-seller.

For transfer of attribute information, the log must be identified before, or at the point of separation from the parent stem. This requirement means that for manual (and probably most single-grip or Waratah-type) processing operations, only a tag that is located/inserted in the side of the log can be used. This is because of the practical difficulties of exposing the log end after bucking. Other processors, such as Hahn Harvesters, might offer less of a challenge, and enable barcode labelling.

In manual, skid-based operations, if the log could be rolled in some way, then end-tagging, with either high, or low frequency RF tags, or barcode, could be used. End tagging would enable a "single" RF tag reading system (as a opposed to reading many tags at once).

If a tag is applied or inserted into/onto the side of the log; only RF tagging (rather than barcode) is feasible because once in a stack, line-of-sight reading methods cannot apply.

In order for an RF tag to read through several centimetres of wood (such as a side-inserted tag, close to the end of the log) comparatively low frequency tags must be used. This is because higher frequencies are attenuated by the moisture in the wood. Also, because there is a likelihood of one or more tags being in the same reading range at the same time, the tags must have anti-collision features, or support reading of multiple tags.

Hence, the likely solution for attribute information transfer is: side-located (close to the log end), low frequency RF tags with anti-collision features. Because automated RF tag reading equipment is custom-made for specific applications, any system introduced into the forest environment in the near future would involve time-consuming work (applying, and reading) with hand-held readers. RF tagging is, however, the only technology which will suit the development of automated application/reading equipment for a demanding forest environment.

In a harvesting/marketing system where attribute transfer is not required, then either paint, or barcode labels are practical solutions. These could easily be applied to the ends of logs when they are in stacks, and just as easily read (and information entered), when necessary.

CONCLUSIONS

For Skid-to-Mill supply chains, application of tags to the side of logs offers the best opportunity for attribute information transfer from skid-to-mill, but only RF tags are suited to this application. End marking by paint, barcode, or RF tag in log stacks is possible for inventory management purposes. All identified logs must be read from the end of the log. Random length logs in stacks, or on trucks, probably offer the biggest hindrance to reading or scanning.

Reading of paint, barcode or RF tags can initially be carried out manually, or with hand-held readers. This is labour intensive, and will involve some changes to operational methods, but the alternative is investment in development of automated systems. Most automated systems currently available have been developed for factory or warehouse environments.

Any application of barcode or RF tag identification must take into account tag removal to avoid contamination of pulp chips, or damage to sawmill machinery. This necessity probably favours side-of-log RF tag identification, and removal by debarker.

For the TimberTech to Processor chain, where the issue is stem identification, RF tagging offers the most potential since tags are robust, and unaffected by problems with visibility (barcodes) and legibility (paint). They are also suited to automated reading. Because of currently high tag costs, a re-usable tagging system would be necessary. A manually-applied, operator-read, numbered-label solution is a possible interim measure.

The most practical solution for a (TimberTech to) Processor to Mill chain is also RF tag identification because these devices lend themselves more readily to mechanical application ie. insertion into the log's surface. They are also suited to automated reading, perhaps at the debarking phase.

A truck-to-mill RF tag solution for log identification could be applied to export logs. Logs would be end-tagged while in stacks - JAS SED would also be measured. This system has the potential to make log loading more efficient by reducing loading cycle time as well as providing real-time data for optimal stowage.